University of Sheffield

School of Health and Related Research

An Investigation of the Factors which Influence Children with Asthma having an Unscheduled Medical Contact around the Start of the New School Year

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Author:
Rebecca M. Simpson

Supervisors:
Prof. Steven A. Julious
Prof. Wendy O. Baird

June, 2018

Acknowledgements

First and foremost, I would like to thank my two supervisors, Prof. Steven Julious and Prof. Wendy Baird, without all their advice, guidance and expertise I would not have been able to complete the work. Both Steven and Wendy have been incredibly kind and supportive throughout the whole Ph.D.

I would like to thank the schools and children who participated in the qualitative study, without them this work would not have been possible. I am extremely grateful to those who helped recruiting the schools. I also need to thank the PLEASANT PPI group who helped me develop the topic guide and my colleagues and their children for helping me practice my communication skills.

There are numerous members of ScHARR staff that have helped me along the way. I would like the thank the medical statistics group, they have all been supportive with attending presentations and providing invaluable advice and encouragement over the past three years. In particular, I would like to thank Mike Campbell for the help and advice he gave me on time series analyses. I would also like to thank Stephen Walters and Susan Baxter for their expert views and suggestions for the work following the confirmation review.

I owe a huge thank you to my friends and family who have been with me throughout the Ph.D. journey. There are many, but I would especially like to thank Rachel W, Aure, Erika, Milad, Hannah, Sophie, Abisola, Jane, Laura, Rachel K, Jake, Amy, Sarita, Fabrizio and Jo. Those who I shared office 1.03 with, the smiles and the cake made the days much more enjoyable. I also need to thank those friends who were not ScHARR Ph.D. students, they have been there through all the ups and downs. I owe a special thank you to both Dr. Ane Errasti and Dr. Laura Winter for using their clinical knowledge and kindly proof reading the clinical content of the asthma background chapter. Also to my flatmate, Birsu, thank you for being there through the worst and the best times. I want to say a massive thank you to my family, especially my Mum and Dad, they were always there and gave me encouragement and confidence when needed. Without them, I would not be where I am now, so thank you.

Last but not least, this project would not have been possible without the the studentship I received from both ScHARR and the Faculty of Medicine, Dentistry and Health. Their funding not only made this project possible, but also helped me develop as a researcher and gain invaluable skills and experience. Thank you.

Abstract

It has been proposed that the reported increase in the number of unscheduled medical contacts in September among school-aged children with asthma is caused by a viral challenge at the start of the school year. It has also been hypothesised that this challenge is compounded by children not taking their asthma medication over the summer holiday.

The aim of this research was to identify which factors influence children with asthma having an unscheduled medical contact following the return to school in September.

A mixed methods approach was used to investigate this aim using quantitative data from the PLEASANT (Preventing and Lessening Exacerbations of Asthma in School-age children Associated with a New Term) cluster-randomised intervention study combined with a qualitative study. The PLEASANT data analysis informed the development of a two stage qualitative study, before and after the school summer holidays. The qualitative results then informed further in depth analyses of the PLEASANT data to validate the qualitative results.

Two large datasets were used for the analyses. Quantitative data included daily contacts for two years for approximately 12,000 school-aged children with asthma. Qualitative data came from semi-structured interviews conducted by the researcher from 38 school-aged children. The interviews were analysed thematically. Various methods were used to analyse the PLEASANT data such as mixed effects models and interrupted time series.

From the results of the analyses, it is thought that exercise could play a key role in the September increase as some children with asthma may not exercise over the summer break. This sub-population of children could be at a higher risk. It was also found that females, primary school children and those who are in the transition from primary to secondary school year are potentially at higher risk of unscheduled medical contacts.

The findings led to the suggestion that the children who do little exercise during the summer may benefit from an exercise based intervention over the summer holidays. Further work would be required to determine what intervention would be beneficial for females. The findings also suggested that primary school children, males and those who transitioned from primary to secondary school could benefit from continuing to receive the original PLEASANT intervention.

Conferences

Oral Presentations

Simpson R, Julious S, Baird W: Identifying subgroups of children with asthma who are at higher risk of having an unscheduled medical contact in September: A mixed methods study. *The 39th Annual Meeting of the Society for Clinical Trials.* May 2018, Portland, Oregon, USA.

Simpson R, Julious S, Baird W: Exploring the reasons why children with asthma may have unscheduled medical contacts after their return to school in September - Qualitative Study. *The 47th Annual Scientific Meeting of the Society for Academic Primary Care.* July 2017, University of Warwick, UK.

Simpson R, Julious S, Baird W: An Investigation of the Factors which Influence Children with Asthma Having Asthma Exacerbation around the Start of the New School Year. *The 38th Research Students' Conference in Probability and Statistics.* August 2015, University of Leeds, UK.

Poster Presentations

Simpson R, Julious S, Baird W: An investigation of the factors which influence children with asthma having unscheduled medical contacts around the start of the new school year in England and Wales - a mixed methods study. *The 38th Annual Meeting of the Society for Clinical Trials.* May 2017, Liverpool, UK.

Simpson R, Julious S, Baird W: An investigation of the factors which influence children with asthma having unscheduled medical contacts around the start of the new school year in England and Wales. *The 37th Annual Meeting of the Society for Clinical Trials.* May 2016, Montreal, Canada.

Papers

Steven A Julious, Michelle J Horspool, Sarah Davis, Matthew Franklin, W Henry Smithson, Paul Norman, Rebecca M Simpson*, Heather Elphick, Oscar Bortolami, Cindy Cooper: Open-label, cluster randomised controlled trial and economic evaluation of a brief letter from a GP on unscheduled medical contacts associated with the start of the school year: the PLEASANT trial *BMJ Open*, Feb 2018.

Contents

List of Figures

List of Tables

1. Introduction

Asthma is a chronic disease (McConnell and Holgate, 2000; Byrne and Thomson, 2001; Naspitz et al., 2001) that affects about 1 in 12 adults and 1 in 11 children in the UK (NHS, 2014a). Symptoms of asthma include coughing, breathlessness, wheezing and having a tight chest (Woolcock et al., 2001; Holgate, 2006; Rees, 2010; Levy et al., 2014). There is no full understanding as to why people develop asthma and there is no cure but it is possible to use medication to manage the symptoms (Warner et al., 2001; Rees, 2010).

Some patients that adhere to their prescribed medication can live their lives symptom free, as they control their asthma which prevents asthma exacerbations (Warner et al., 2001; Rees, 2010). However, this is not true for everyone as patients symptoms will vary, some people will find it much harder to control their asthma (Warner et al., 2001). The importance of adherence to their medication plan is highlighted in a report from asthma UK which states that 2 out of 3 asthma deaths are preventable in the UK (Asthma UK, 2015b).

Asthma is a seasonal condition, meaning that the hospitalisations and deaths follow a similar pattern every year (Fleming et al., 2000; Silverman et al., 2003). Studies have found that this seasonal trend decreases as age increases, so childhood asthma is more affected by the seasonality (Silverman et al., 2003). One of the key features of this seasonality is the clear peak in hospitalisations for children in Autumn (Storr and Lenney, 1989; Silverman et al., 2003), particularly in September, following the return to school (Julious et al., 2007, 2011). It is thought that children may not adhere to their medication plan during the summer holidays when there are fewer triggers for asthma (Julious et al., 2011). If children do not take their medication in the summer then they may no longer have adequate protection against any challenges they may face when returning to school.

An intervention study called 'PLEASANT' was conducted to remind children of the importance of taking their medication. PLEASANT stands for 'Preventing and Lessening Exacerbations of Asthma in School-aged children Associated with a New-term' (Horspool et al., 2013). PLEASANT was a cluster randomised trial with a control and an intervention. The intervention was in the form of a simple letter sent out by the GPs of school-aged children in the summer which emphasised the importance of continuing to take asthma medication during the summer holidays (Horspool et al., 2013). The data from this study formed the basis for this Ph.D. project.

1.1 Project aim

The overall aim of this project was to investigate the factors that influence children with asthma having unscheduled medical contacts in the weeks after returning to school in September.

This research aim was split further into three research questions:

- What are the factors that influence children with asthma having unscheduled medical contacts around the start of the new school year?
- Is it possible to predict which children are more likely to have unscheduled medical contacts at the start of the new school year?
- If knowing which children are more likely to have an unscheduled medical contact at the start of the school year, will the PLEASANT intervention work better in this sub population? Or is there a new intervention that could be proposed?

1.2 Project Methods

A mixed methods approach was used to address these research questions. This means both quantitative and qualitative analyses were used (O'Cathain and Thomas, 2006; Teddlie and Tashakkori, 2009). The quantitative data came from the PLEASANT study and the qualitative data came from an interview study with children with asthma. The study was conducted in four stages with each stage being informed by the previous stage; initial quantitative analyses, qualitative study and analyses, and further quantitative analyses.

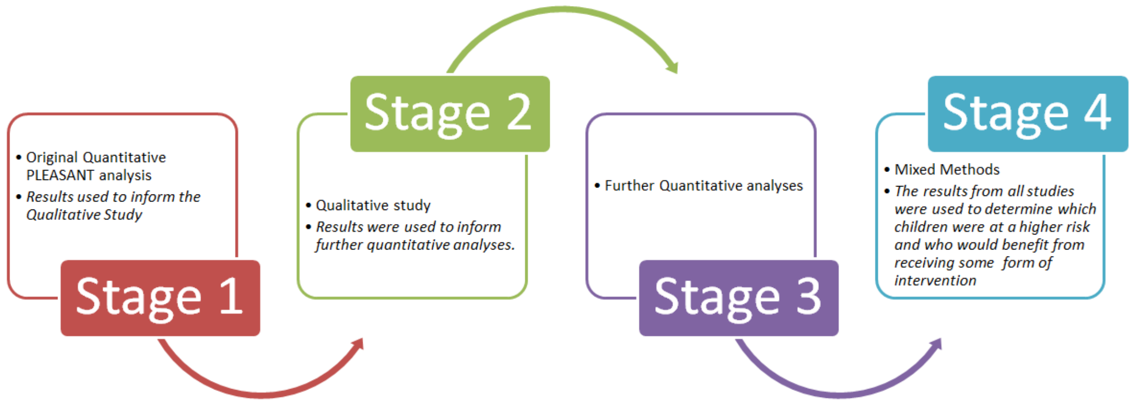


Figure 1.1: Flow diagram of the stages of the project

The initial quantitative stage was a re-analysis of PLEASANT which was then used, alongside previous literature, to help develop the interview topic guide. The qualitative interview study was used to determine whether children take their medication during the summer and also to obtain the childrens' views on why there is peak in September. The results of the qualitative study were then used to guide further analyses of the quantitative data, such as various at risk subgroups. All these analyses were then used to determine whether the PLEASANT intervention would work better in a different subgroup of children, or whether a new intervention could be proposed.

A key part of mixed methods is the combining of the different methods. If the different methods are done but then not combined, then the study does not comply with this core principle; instead they would be two stand alone studies. One of the updated definitions of a mixed methods study is:

> *"Integrating quantitative and qualitative data collection and analysis in a single study or a program of inquiry"* (O'Cathain and Thomas (2006),p 102).

The key word in that sentence being *'Integrating'*, suggesting without integration the research would not be classed as a mixed methods (O'Cathain et al., 2010).

There are different stages where integration can take place, the main two being at the analysis stage or at the interpreting stage. Each stage has a different method of integration that can be applied. Also, the design of the mixed methods study itself can be a method of integration (Creswell, 2013). Other methods that can be used for integration are using a mixed methods matrix, triangulation and 'Following a thread'. A mixed methods matrix was not suitable as this requires both analyses to contain the same cases (O'Cathain et al., 2010).

Triangulation is usually described as a *"Process of studying a problem using different methods to gain a more complete picture"* (O'Cathain et al., 2010). This process is usually conducted at the interpreting stage and involves creating a convergence coding matrix which is a way of displaying the findings from each data collection into one table. This then makes it possible to determine whether the two methods agree, partially agree, silence or disagree on any of the themes that arose (Farmer et al., 2006; O'Cathain et al., 2010). It was not possible to use triangulation to its full potential as the datasets did not contain the same themes/variables.

The other possible method which could be used for integrating the data is 'Following a thread'. Following a thread is used at the analysis stage of the study. After finding initial themes and questions in the data, the theme/question will be taken from one data set and followed through to the other data sets (Moran-Ellis et al., 2006; O'Cathain et al., 2010; Goodman et al., 2012). This was relevant due to the sequential nature of the study.

Various methods of integration were used within this study. The first being incorporated within the design of the study, having the qualitative study built upon the quantitative analysis and further quantitative analysis built upon the qualitative study. The second method being triangulation which was done after the quantitative and qualitative analyses had been conducted. Triangulation was used to compare, when possible, the results from both data sets to see whether they agree or disagree with each other. The similarity and differences in results were discussed. Following a thread is a much more iterative approach, which was also used in this study as a method of integration. Themes that were found in one stage were followed through to other sequential stages of the study, if the data allowed.

1.3 Report Structure

Chapter 2 - Background

This chapter reports background information on asthma and the PLEASANT study. The first half focuses on asthma, providing details of what asthma is, asthma symptoms, and the risk factors and triggers for asthma. The second half provides further detail into the PLEASANT study, including the reasoning behind the study.

Chapter 3 - Literature Review

This chapter examines previous literature on seasonality of asthma (UK and Worldwide) and looks at both quantitative and qualitative studies. The start of the chapter shows the research gap this Ph.D. aims to address.

Chapter 4 - Analysis of PLEASANT

This chapter repeats the analysis of PLEASANT but on the complete data only. This analysis was conducted to provide confidence in the methods and analyses as it was possible to compare the results to the original study. The analysis also helped develop the initial themes for the qualitative study, Chapter 5, alongside the literature in Chapters 2 and 3. The original study methods and endpoints were used in this analysis. Limitations of the original study are provided at the end of this chapter.

Chapter 5 - Qualitative Study

This chapter details the full qualitative study from methods to results. The chapter first provides a description of the different qualitative methodologies with justifications for the methods chosen. The chapter also includes the methods used for the interview study, the results and discussion. The chapter ends with a list of potential 'at risk' subgroups that informed the quantitative analysis in Chapter 6.

Chapter 6 - Subgroup Analysis

This chapter presents the results of the subgroup analyses conducted on the control arm to see whether children and their characteristics within the subgroups were more likely to have an unscheduled medical contact in September. The results from the subgroup analyses were carried forward into the intervention analysis conducted in Chapter 7.

Chapter 7 - Intervention Analysis

This chapter tests the original PLEASANT intervention on the 'at risk' subgroups to see whether the intervention could have had more of an affect. This chapter also uses interrupted time series as a method of analysis, which was not used in the original PLEASANT analyses.

Chapter 8 - Discussion

This final chapter brings together and discusses the main findings of this Ph.D. project outlining implications and limitations of the research. The chapter also includes details of potential further work arising from this project.

2. Background

2.1 Introduction

The previous chapter provided a brief outline of the project, including the research aims and methods. This chapter provides further background information about asthma and the PLEASANT study. The first section of the chapter provides information on what asthma is, the symptoms of asthma and the triggers and risk factors associated with asthma. Following that, this chapter provides a detailed description of the PLEASANT study including the rationale for the study.

2.2 Chapter Aims

The aims of this chapter are:

- To provide information about what asthma is and the associated asthma symptoms and treatments.
- To discuss the epidemiology of asthma including the risk factors and triggers.
- To provide details of the PLEASANT study.

2.3 Asthma

Asthma is a chronic disease (McConnell and Holgate, 2000; Byrne and Thomson, 2001; Naspitz et al., 2001) that affects about 1 in 12 adults and 1 in 11 children in the UK (NHS, 2014a). Symptoms of asthma include coughing, breathlessness, wheezing and having a tight chest (Woolcock et al., 2001; Holgate, 2006; Rees, 2010; Levy et al., 2014). Asthma is caused by inflammation of the bronchi (Sears, 1998; Holgate, 2006). Bronchi are small tubes through which the air travels when a person breathes (American Thoracic Society, 2015). Asthma is difficult to diagnose as there is no simple definition of what asthma is (Burney, 2000). However, the Global Initiative for Asthma (GINA) have provided a definition:

> “Asthma is a heterogeneous disease, usually characterised by chronic airways inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that varies over time and in intensity, together with variable expiratory airflow limitations.”(Global Initiative for Asthma, 2015a)

A person’s lungs can be irritated if they come into contact with certain triggers (Rees, 2010). When this happens the bronchi get narrower because the muscles around them contract which can also lead to an increase in phlegm (a sticky mucus) being produced (Holgate, 2006). Sometimes, asthma symptoms can get worse, this can happen gradually or suddenly. This is known as an asthma exacerbation or an 'asthma attack' (Holgate, 2006). These attacks, if severe, can cause hospitalisation or worse, death (Holgate, 2006).

There is a lack of understanding as to why people develop asthma but it can happen at any age. Asthma is more common in adult women than men (Sears, 1998; Holgate, 2006; Rees, 2010) and it is more common in children (Clark, 1998; Naspitz et al., 2001; Holgate, 2006). However, in children asthma is more common in boys than girls, although girls’ asthma tends to continue into adulthood and boys tend to ‘grow out’ of it (Sears, 2001; Rees, 2010). There is no cure for asthma but it is possible to use medication to manage the symptoms (Warner et al., 2001; Rees, 2010). Avoiding triggers that are known to affect individual patients, such as allergens, exercise and weather conditions, can also decrease symptoms (Clark, 1998; Thomson, 2001; Levy et al., 2014).

2.3.1 Asthma Symptoms

Patients with asthma can experience a range of symptoms which are dependent on the severity of the patient’s asthma and whether their asthma is controlled by their medication (SIGN-153, 2016). The severity of asthma is different for each patient, some patients experience very few symptoms whereas other patients experience most symptoms the majority of the time (NHS, 2014b).

The clinical symptoms of asthma are, having a cough, wheeze and tachycardia (unusual increased heart rate) (Holgate, 2006; SIGN-153, 2016). A patient who has asthma can find that the cough can be constant or recurring. They can often find that it will disrupt their sleep as the cough can be worse during the night and early morning. Diagnosis of dyspnoea is made when:

- Patients use the accessory muscles not normally needed for quiet breathing (Campbell, 1969).
- Patients find that they wheeze when they exhale.

- Patients struggle to speak without having to take a breath.
- A symptom that is more common in children is that their nostrils will flare up when they inhale (Holgate, 2006).

If the symptoms described above get worse, this can result in an asthma exacerbation, which can be potentially life threatening (Holgate, 2006). The change in symptoms can happen gradually or suddenly (Holgate, 2006; SIGN-153, 2016), though it is more common for the symptoms to develop slowly. Patients with asthma will usually have an inhaler that can be used to try to prevent the worsening symptoms becoming an asthma exacerbation. As the attacks have the potential to be prevented, early detection is important so the correct medication and actions can be taken (SIGN-153, 2016).

Symptoms of an asthma exacerbation can include any of the following: the previous symptoms getting worse and becoming more constant; breathing faster and finding it difficult to eat, sleep and speak; the patient is feeling dizzy, tired or drowsy and their lips and fingers turning blue; the patient can also find that their reliever inhaler is not relieving the symptoms (NHS, 2014b; SIGN-153, 2016).

It is common for other conditions to be associated with asthma patients. Many patients with asthma will suffer with hay-fever, rhinitis, sinusitis and eczema (Holgate, 2006; Rees, 2010). As these conditions, including asthma, are all allergen conditions, the clinician may ask the patient if they have suffered from these before. This could provide the clinician with more information which can be used for the diagnosis of asthma.

2.3.2 Diagnosis of Asthma

As there is no fixed definition of what asthma is, it is difficult to diagnose (Clark, 1998). If a patient has the usual symptoms associated with asthma and presents themselves to their clinician, then the clinician will consider asthma. After the clinician has asked the patient about the symptoms and family history, there are a few tests that can be used to help diagnose asthma. The majority of these tests will only work on adults as it is harder to diagnose asthma in children as some of the tests are not appropriate for children (NHS, 2014b). Examples of the tests that can be used are the peak flow test and spirometry (SIGN-153, 2016).

2.3.3 Epidemiology of Asthma

The definition of epidemiology given by the World Health Organisation (WHO) is:

> "Epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems." (WHO, 2014)

In this section the epidemiology of asthma will be outlined. This will include the prevalence and incidence of asthma, the risk factors and the causes of asthma. The discussion of the causes and risk factors will be linked to controlling asthma, as avoiding these if possible could prevent the patients asthma worsening.

Due to the difficulty of defining or diagnosing asthma, it is hard to estimate the prevalence and describe the epidemiology of asthma (Burney, 2000). In this next section, books and articles will be used to explore the differences in opinions and values for the epidemiology of asthma.

2.3.3.1 Prevalence of Asthma

The prevalence of a disease is the number of people in the current population of interest who have that disease (Rothman, 2012).

Worldwide

It is estimated that there are about 300 million people in the world who have asthma and a mortality rate of about 346,000 every year (Masoli et al., 2004; Global Initiative for Asthma, 2015b). The Global Initiative for Asthma (2015a) 'Global Strategy for Asthma Management and Prevention' report provides estimates of prevalence for different countries around the world, ranging from 1-16%. Some of the highest prevalence countries are: Australia, UK, New Zealand, Ireland, and USA, whereas some of the lowest prevalence countries are: Italy, Taiwan, India, Indonesia, and China. The values of the prevalences of these countries can be seen in Figure 2.1.

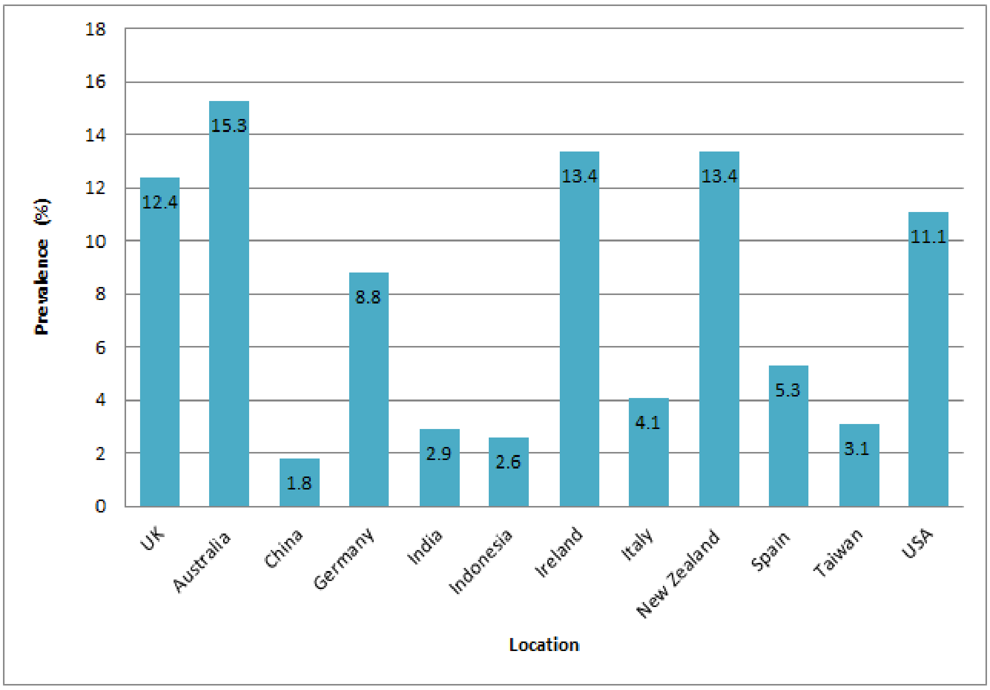


Figure 2.1: A barchart of the different prevalence estimates for 13-14 year olds for a selection of countries (Taken from Global Initiative for Asthma (2015b))

The prevalence values in Figure 2.1 are taken from Global Initiative for Asthma (2015b) 'Global Strategy for Asthma Management and Prevention Appendices'; These values were based on the values given by Lai et al. (2009) 'Global variation in the prevalence and severity of asthma symptoms: Phase three of the International Study of Asthma and Allergies in Childhood (ISAAC)' study. This selection of countries was chosen to include some of the highest prevalence values, some of the lowest and a couple of the middle values. The graph shows that the UK has one of the highest prevalences of asthma in the World.

UK

In the UK it is estimated that 5.4 million people have asthma (Levy et al., 2014), 4.3 million adults and 1.1 million children (Asthma UK, 2015a). This value can be broken down into England, Scotland, Wales and Northern Ireland. Where Scotland has the lowest prevalence (1 in 14) and Wales and Ireland have the highest (both 1 in 10) (Asthma UK, 2015a). Asthma UK has estimated these values of prevalence from the number of people currently receiving medication for asthma.

For the PLEASANT study, a person was considered for inclusion in the trial if they have been prescribed asthma medication in the past 12 months, in line with Asthma UK's definition.

2.3.3.2 Risk Factors for Asthma

There are certain risk factors that are known to increase the likelihood of someone developing asthma (Woolcock et al., 2001). Risk factors can be split into three categories; The first; environmental factors, second; genetic factors, and third; environmental triggers that can cause asthma symptoms to worsen (Woolcock et al., 2001; Holgate, 2006). Environmental factors are factors that an individual has been exposed to that increases their risk of developing a disease (Holgate, 2006). Genetic factors are factors that a person is born with that makes them more susceptible to developing a disease. Environmental triggers are triggers that can cause symptoms to worsen in a person who has already developed asthma (Holgate, 2006). More details of the triggers are given in the next Section 2.3.3.3.

2.3.3.3 Triggers of Asthma

Triggers are stimulants, substances or conditions that can cause the symptoms of asthma to start (Asthma UK, 2014b). There are many triggers that can be associated with worsening the symptoms of a patient with asthma, e.g. exercise, smoking, and pets. Being aware of the possible triggers can prevent avoidable asthma exacerbations (Clark, 1998; Samet et al., 2001; Woolcock et al., 2001; Holgate, 2006). When the patient is aware of a particular trigger that can affect their asthma control, it is recommended that the patient avoids these triggers as much as they can (Clark, 1998; Woolcock et al., 2001; Holgate, 2006).

Exercise

Exercise is a well known trigger that can affect patients with asthma (Anderson and Brannan, 2001; Carlsen, 2001; Holgate, 2006; Rees, 2010; SIGN-153, 2016). As this trigger is known, it can be used to try to diagnose asthma. When a patient with asthma undertakes some form of exercise, the airways in their lungs become narrow, which can make their asthma symptoms worse (Clark, 1998; Anderson and Brannan, 2001; Carlsen, 2001; Holgate, 2006; SIGN-153, 2016). One theory about Exercise Induced Asthma (EIA) is that when undergoing exercise, the air that is breathed in is cooler. When a person is at rest, they are breathing more slowly, so the body will heat up the air as it enters the lungs. When doing exercise, the person will be breathing more quickly, so the air is not heated as much as it enters the lungs. The cool air can cause the airways to become more dry, which, for a person with asthma, can cause the airways to narrow (Clark, 1998; Anderson and Brannan, 2001; Carlsen, 2001; Holgate, 2006). It was found that EIA can be simulated if a patient breathes in cool dry air, which would be similar to the air breathed when exercising, but without the physical activity (Clark, 1998; Rees, 2010). In support of this theory, it has been noticed that patients with asthma can go swimming without it affecting their asthma symptoms. It has been suggested that this is due to the air being humid and warm at a swimming pool (Clark, 1998; Carlsen, 2001; Holgate, 2006).

As exercise is a known trigger for asthma, this can discourage people with asthma from taking part in sport. However, as exercise is good for keeping fit and healthy, it is important that their asthma does not stop them from exercising (Clark, 1998; Rees, 2010). This can be a challenge for school-aged children as they will have to participate in physical education as part of their school's curriculum (Clark, 1998). However, there are methods of overcoming this challenge. Children and adults with asthma can take reliever medication, 15 minutes before they do any exercise (Clark, 1998; Anderson and Brannan, 2001; Carlsen, 2001; Holgate, 2006; Rees, 2010). Patients who have their symptoms under control may be able to exercise with just the protection from their preventer inhaler (Anderson and Brannan, 2001; Holgate, 2006; Rees, 2010). However, regular exercise can mean that the medication is taken more often and this can lead to the patient becoming tolerant to the treatment (Anderson and Brannan, 2001; Carlsen, 2001).

It has also been found that warming up slowly before exercise can be beneficial for patients with asthma. This can prevent EIA due to a phenomenon called 'refractoriness' (Anderson and Brannan, 2001; Carlsen, 2001; Holgate, 2006; Rees, 2010). This means that people with asthma can experience EIA but then they can be protected from having more EIA if they continue exercising after they have got the EIA under control. So warming up before exercise can cause this phenomenon to occur (Holgate, 2006; Rees, 2010).

Exercise was found to be a key trigger in the qualitative interview study, therefore exercise is discussed in further detailed in Chapter 5.

Pollution

There is a strong belief that pollution is a trigger for asthma patients, but this may not be the case (Burney, 2000; SIGN-153, 2016). The effect of the gas ozone can reduce lung function but this can affect everyone, not just people with asthma (Anderson and Brannan, 2001). Some patients can be more susceptible to ozone, meaning that it can be a trigger for them, and in this case, the pollution caused by ozone can cause their symptoms to get worse (Anderson and Brannan, 2001).

Previous studies that have looked at the different air pollutants and levels of pollution compared with the number of asthma cases have not found any significant results (Burney, 2000). However, there may be an association with high levels of traffic and the pollutants produced with the number of asthma cases and asthma exacerbations (Burney, 2000; Anderson and Brannan, 2001).

Animals

Pets and animals can be a trigger for some people's asthma (SIGN-153, 2016). The main cause for this trigger is from the animals dander and hair, but it can also be caused from the urine and saliva from the animal (Clark, 1998; Anderson and Brannan, 2001; Rees, 2010). The animals that are associated with worsening asthma symptoms are cats, dogs, horses, birds or rodents, though cats are thought to be the worst (Clark, 1998; Anderson and Brannan, 2001; Holgate, 2006; Rees, 2010).

It is advised, that if the patient or a family member of the patient has asthma, then they should not get any new pets. If they have a family pet, then this pet should maybe be removed, but this is easier said than done. Removing the pet can cause emotional upset which can worsen asthma symptoms (Clark, 1998; Rees, 2010). Normally a trial separation of the pet and the asthma patient is advised. The easiest method is for the patient with asthma to stay somewhere else for a couple of weeks and see it this helps their asthma symptoms (Clark, 1998; Rees, 2010). If this does help, then removing the pet from the home should be seriously considered. If this is not an option, then keeping the pet away from bedrooms and keeping the pet clean by washing them once a week should help (Holgate, 2006; SIGN-153, 2016). The SIGN-153 (2016) guidelines recommend that healthcare professionals do not offer advice on pet ownership as a prevention strategy for childhood asthma.

Infection

Viral respiratory infections are one of the most common triggers that can worsen someone's asthma symptoms. These infections include a cold, influenza, and the rhinovirus (Clark, 1998; Burney, 2000; Anderson and Brannan, 2001). As these are all viral infections, they cannot be treated with antibiotics. This means that if a patient with asthma has one of these infections, they cannot be treated for the infection (Clark, 1998). The effects of catching a viral infection in a patient with asthma can last for about 6 weeks afterwards, meaning that their asthma symptoms continue to be worse after they have recovered from the infection (Clark, 1998; Anderson and Brannan, 2001).

It is thought that people who have had a history of respiratory infections may develop late-onset asthma as an adult, and this can happen in up to 50% of cases (Clark, 1998; Anderson and Brannan, 2001).

The PLEASANT study (more details in Section 2.4) suggested that the viral challenge the children face when they return to school could be contributing to the peak in medical contacts in September. This was also found in the qualitative study, Chapter 5.

Smoking

Smoking is another known trigger that will affect people's asthma. Smoking can cause the airways in a person's lungs to narrow, which makes the asthmatic symptoms worse (Clark, 1998; Anderson and Brannan, 2001; Le Souëf, 2001). Although this is well known, 20% of patients with asthma still choose to smoke (Clark, 1998).

There are two ways in which smoking can affect people with asthma, personal smoking or passive smoking (Anderson and Brannan, 2001). It is advised that people with asthma should not smoke (Clark, 1998), not only is it particularly bad for their lungs, it also has other health repercussions, as smoking also causes heart disease, cancer, stroke, etc. (Health and Human Services, 2004). Passive smoking is also a trigger, people who smoke should be aware of smoking around people with asthma, as the smoke can worsen the symptoms of the person with asthma (Clark, 1998; Holgate, 2006).

There have also been studies that have found a link between people with asthma smoking as a young adult causing their symptoms to be more constant at a later age (Anderson and Brannan, 2001; Le Souëf, 2001). A birth cohort study which was conducted in 1958 based in the UK found that among the people who had asthma relapses aged 33 most of them were smokers (Strachan et al., 1996). Another study that was conducted in Aberdeen, which followed children for 25 years, found that those who smoked as young adults had worse asthma symptoms later in life (Godden et al., 1994).

Diet

Asthma excerbations caused by food intolerances are rare but can happen, if they do happen, it is more likely to occur in young children (Bousquet et al., 2001; Holgate, 2006). Food intolerances are more likely to causes eczema and stomach problems rather than asthma symptoms (Rees, 2010).

As well as food intolerances, the diet the patient follows can also be a trigger for making the asthma symptoms worse. Diets that are low in vitamins C and E can be associated with making asthma worse. Also diets that are low in nuts, fish and meats can affect it (Rees, 2010). In the early 20$^{\text{th}}$ century, a restricted diet was part of the asthma treatment plan, as it was thought that some foods made the asthma worse. They then realised in the late 1940's that this probably did more harm than good (Burney, 2000).

Emotional factors

Psychological and emotional factors can be triggers that play a significant part in a patients asthma (Clark, 1998; Bender, 2001; Rees, 2010) particularly in children (SIGN-153, 2016). Although emotional factors can be a trigger for making asthma symptoms worse, there is no evidence to suggest that emotional factors are the root cause of asthma (Clark, 1998; Godfrey, 2000). As stress and emotions can be a trigger for asthma, it is important to include this in the management of a person's asthma (Rees, 2010). In Chapter 40 of 'Manual of Asthma Management', it states that after looking at different studies and cases that there is an association between people that have severe asthma and having psychological factors (Ruffin et al., 2001).

Alongside stress and emotional factors being a trigger for asthma, it can also affect the way in which a person adheres to their medication plan (Bender, 2001). When a person is stressed or upset, they can become distracted and forget to take their medication. The person can become distressed and lose their daily routine which would normally include their asthma medication plan (Bender, 2001). Sometimes if this is the case, the patient will need to recover or stabilise their emotional factors before they can begin managing their asthma again (Bender, 2001).

Emotional stress can play a big part in the lives of children with asthma if they do not have a stable family background. If the family is not well organised or supportive then the child may not adhere to the treatment plan they have set (Bender, 2001). A child is likely to need parents or guardians who understand what help they need and create a routine to remind them to take their medication. The child will also benefit from parents or guardians who are able to communicate with the child's GP regarding the symptoms and exacerbations the child may have had as the child may not be able to express these details (Bender, 2001). It is often found that children who have uncontrolled asthma have dysfunctional families. This is because the emotional stress is not directly related to the individual as it would be in an adult, in a child it is related to how the whole family functions (Bender, 2001).

Emotion factors, such as stress and upset, were found to be key triggers in the qualitative chapter. These will be discussed in more detail in Chapter 5.

Pollen

Pollen can be a trigger to many patients with asthma and is known to cause seasonal asthma (Rees, 2010). Hay-fever is caused by pollen and patients with asthma often suffer with hay-fever (Clark, 1998; Rees, 2010). One method of avoiding the pollen would be to avoid going outside and keeping doors and windows shut but this is not practical(Clark, 1998; Paton, 2001; Rees, 2010). However, many patients with asthma who have pollen as a trigger, can control their asthma during the pollen season with their current medication plan (Rees, 2010).

Medication

Although medication is used to help control a patient's asthma, there are some medications that can make asthma worse. The two main drugs which are known to do this are Non-Steroid Anti-Inflammatory Drugs (NSAID) and β-blockers (Clark, 1998; Chung, 2001; Rees, 2010).

NSAIDs, such as aspirin, can cause the airways in the lungs of a patient with asthma to narrow (Rees, 2010). If a patient is intolerant to NSAIDs and they take this type of medication, then the reaction can happen any time from half an hour to two hours later (Dahlén et al., 2001). Symptoms can include, nasal congestion, heat rash, tightening of the chest and fatigue. In extreme cases, the reaction can cause the patient to become unconscious or have a respiratory arrest (Dahlén et al., 2001). If a patient experiences a reaction to a NSAID then they should avoid all NSAID and aspirin (Rees, 2010).

β-blockers are another medication that patients with asthma should avoid (Clark, 1998; Rees, 2010). β-Blockers can cause bronchoconstriction in the lungs which can be fatal (Clark, 1998). Patients with asthma should avoid all β-Blockers, it has been known for even β-Blockers in the form of eye-drops to cause an adverse reaction in patients with asthma (Clark, 1998; Rees, 2010). If a patient with asthma does take β-Blockers, the reaction can usually be reversed by taking β-stimulants. However, large doses will be needed to reverse this reaction (Clark, 1998; Rees, 2010).

2.3.4 Asthma Treatments

The severity of asthma will determine the medication plan for the patient. There are two types of inhalers that people with asthma will mostly use routinely, a reliever inhaler and a preventer inhaler.

The reliever inhaler is used when the asthma symptoms need to be relieved quickly (Holgate, 2006). All people with asthma should have a reliever inhaler. This inhaler works by relaxing the muscles around the bronchi, making the airways wider which will reduce the asthmatic symptoms (Holgate, 2006). An example of this type of medication is short-acting β_2-agonists. This type of inhaler should not be used for long periods as they do not reduce the inflammation in the lungs. In well controlled asthma this type of inhaler should not be used very often, if at all. If the patient is finding that they have to use this inhaler a couple times a week then they should go back to their GP and discuss their asthma plan as it may need updating (Asthma UK, 2014a).

The preventer inhaler is used to prevent asthmatic symptoms occurring (Holgate, 2006). An example of this is inhaled corticosteroids. This type of inhaler works by reducing the inflammation of the bronchi in the lungs. As these inhalers take a while to work they need to be taken daily to keep the symptoms at bay (Holgate, 2006).

2.3.4.1 Reliever Medication

As stated above, reliever inhalers are used when the patient's asthma symptoms get worse and need to be relieved quickly (Holgate, 2006). Each such patient will have a reliever inhaler. Details of a few of the different types of reliever medication are described below:

Short-acting β_2-agonists

Short-acting β_2-agonists are an inhaled medication (SIGN-153, 2016). An example of this medication is salbutamol (Holgate, 2006; Rees, 2010). This type of medication is used to control bronchoconstrictions, which is when the airways in the lungs start to tighten (Bass, 2014). Bronchoconstriction is normally associated with acute exacerbations and exercise (Holgate, 2006). This medication is fast acting, salbutamol will take 15 minutes to start working and will last for about 4-6 hours (Rees, 2010). This medication should only be used when the symptoms of asthma have worsened and need relieving, it should not be for regular use (Holgate, 2006; Rees, 2010).

Anticholinergic

Anticholinergics are also inhaled medication (Holgate, 2006; Rees, 2010). Examples of this are ipratropium bromide and oxitropium bromide (Holgate, 2006). These are less effective than short-acting β_2-agonists (Holgate, 2006; Rees, 2010), they are also slower at acting, taking half an hour to an hour to react (Holgate, 2006). However, they can be used as an add on along with β_2-agonists if they are failing to work efficiently on their own (Rees, 2010).

Oral Corticosteroids

Oral Corticosteroids are a type of steroid that may be taken for a short amount of time if the patient is experiencing acute asthma exacerbations (Holgate, 2006; Rees, 2010). They take a similar amount of time as the anticholinergics to react but are useful to take when the patient is experiencing an asthma attack (Holgate, 2006). Courses of oral corticosteroids should be short, for a maximum of 14 days as the side effects will start to outweigh the benefits (Rees, 2010).

2.3.4.2 Preventer Medication

Again, as stated above, preventer inhalers are a type of asthma medication that should be taken daily. The purpose of this medication is to control the patient's asthma (Holgate, 2006). There are many different types of preventer medication that can be used, a few of these are described below:

Inhaled Corticosteroids

Inhaled corticosteroids are inhaled steroids that are used as preventer medication which are used to control the patient's asthma. Inhaled corticosteroids are the most effective method for controlling asthma (Mash et al., 2001; Holgate, 2006; Rees, 2010; SIGN-153, 2016). Examples of this medication are beclometasone dipropionate, budesonide and fluticasone (Holgate, 2006; Rees, 2010). These medications work by reducing the inflammation in the patient's airways which then cause the asthmatic symptoms to improve (Holgate, 2006). This medication should be taken daily, sometimes twice daily if necessary to control the symptoms (Rees, 2010).

Long-acting β_2-agonists

Long-acting β_2-agonists are used to relax the muscles in the airways. Examples of this type of medication are formoterol and salmeterol and they last for about 12 hours (Cates et al., 2012). This kind of medication is most effective when taken with other inhaled steroids. Patients will often start taking this type of medication alongside their usual medication if their inhaled steroids are not controlling the asthmatic symptoms (Holgate, 2006; Rees, 2010).

Combined Medications

As long-acting β_2-agonists need to be taken with an inhaled corticosteroid, combination medication tends to be used for patients where inhaled corticosteroids is not enough to control the asthma symptoms (Holgate, 2006; Walters et al., 2007; Rees, 2010; SIGN-153, 2016). Clinical trials have shown that the combination of the two medications works better for uncontrolled asthma than upping the dosage of the inhaled corticosteroids (Holgate, 2006; Walters et al., 2007). Inhalers that contain both of these medications are available for the patients who need both (Holgate, 2006).

2.3.4.3 Stepwise Medication Plan

For patients with asthma there is a stepwise method to getting the right treatment plan for each individual (Clark, 1998; Holgate, 2006; Rees, 2010; SIGN-153, 2016).

Adults

The method is made up of 5 steps for adults. When a patient is diagnosed with asthma they will start on step one and will go up steps until they have their asthma under control. Patients can also be stepped down a level if they find that their asthma has been under control for several months (Clark, 1998; Rees, 2010; SIGN-153, 2016).

At step one the patient will be given a reliever inhaler which will be used to relieve symptoms of asthma when they feel them coming on. If the patient finds that they are having to use the reliever inhaler several times a week they will be moved on to step 2 (Clark, 1998; Rees, 2010; SIGN-153, 2016).

At step 2 the patient will be given a preventer inhaler as well as the reliever inhaler that they had in step 1. The preventer inhaler should be taken daily as the effects of this treatment take a while to work. The patient should take this every day even if they are feeling well. This inhaler is to prevent asthmatic symptoms occurring (Clark, 1998; Rees, 2010; SIGN-153, 2016).

The patient will be moved to step 3 if they find that even though they are taking the medication given in step 2 correctly, they are still experiencing asthmatic symptoms. At this step, the clinician will first try giving an 'add on' treatment which would be a long acting reliever inhaler. This works the same as the original reliever inhaler except that it suppresses symptoms for a longer time. These can be taken 2 times a day and must be taken with a preventer inhaler. If the patient's asthmatic symptoms are still occurring but the new long acting reliever is working then the clinician will consider upping the prescription of the preventer inhaler. If the long acting inhaler is not working then the clinician will take the patient off this medication and up the prescription of the preventer inhaler. If the patient is still experiencing asthmatic symptoms there are a range of other 'add ons' that the clinician will try. The clinician will trial the patient on each 'add on' one at a time until they find one that works. If they find one that works then the patient will be kept on this even if they go on to step 4 or 5. The 'add ons' that could be used are Preventer Tablets, Theophylline, Steroid Tablets and Combination Inhalers (Clark, 1998; Rees, 2010; SIGN-153, 2016).

At step 4, the clinician will increase the prescription of the preventer inhaler one more time if the patient's asthma condition still is not under control (Clark, 1998; Rees, 2010; SIGN-153, 2016).

The last step is step 5, the patient will be moved up to this step if they still haven't got their asthma under control. At this step the patient will be put on steroid tablets as well as all the medication they were already taking. As well as this, the clinician will refer the patient to an asthma specialist who will take over their asthma care (Clark, 1998; Rees, 2010; SIGN-153, 2016).

Children

Children between the ages of 5-12 will follow the same stepwise method as the adults. The only difference occurs in step 3 and step 4. In the child stepwise method there is a limit to how much the medication can be increased by. In step 3, the preventer inhaler can be increased up to 400mcgs per day and in step 4 the preventer can be increased up to 800mcgs per day (Clark, 1998; Kanabar, 2010; SIGN-153, 2016). Children older than 12 follow the same stepwise method as the adults.

For children under 5 there are 4 steps rather than 5 (Kanabar, 2010). Step 1 is the same for ages 5-12. Step 2 is similar; however, if the child is unable to use the preventer inhaler the clinician may prescribe preventer tablets instead. These are to be taken once a day and can come in form of a chewable tablet or granules so that they can be taken with food (Kanabar, 2010; SIGN-153, 2016).

At step 3, if the symptoms are still persistent, then the clinician will first check that they are taking their inhaler correctly; if they are then the clinician will consider prescribing preventer tablets as well. If the child was taking preventer tablets in step 2 then the clinician will consider prescribing a preventer inhaler as well (Kanabar, 2010; SIGN-153, 2016).

If the child still does not have the asthma symptoms under control then the clinician will refer them to a respiratory paediatrician after checking that the child is taking the treatments described in steps 1-3 correctly (Kanabar, 2010; SIGN-153, 2016).

2.4 Background to PLEASANT

PLEASANT stands for ‘Preventing and Lessening Exacerbations of Asthma in School-aged children Associated with a New-Term’ (Horspool et al., 2013).

PLEASANT was a cluster randomised trial which had a control and an intervention (Horspool et al., 2013). The intervention was in the form of a simple letter sent out by the General Practitioner (GP) at the start of the school summer holidays (end of July 2013) which emphasised the importance of continuing to take asthma medication during the summer holidays (Intervention letter can be found in Appendix A). The control was the ‘usual care’ the GPs would normally provide. The continuation of the asthma medication can prevent asthma exacerbations which, in turn, could lead to reduced hospitalisations after the return to school. The trial was designed to have 140 GPs involved in the trial, 70 on the control and 70 on the intervention. The sample size of 140 was calculated to detect an effect size of 5% with a power of

90% and a type 1 error of 5%. This calculation also took into account an intra-class correlation (ICC) of 0.03 (Horspool et al., 2013).

The background behind the development of this study was based upon the increase in unscheduled medical contacts at the start of the new school year in September. It is believed that during the summer holidays children stop taking their asthma medication as they are feeling well and they are not interacting with other children so they are less likely to catch infections (Horspool et al., 2013). If they stop taking their medication, then when the children return to school, the children with asthma may no longer be protected by their medication against the challenges that returning to school can present. When they return to school they are mixing with other children again so there is a high chance they will catch a virus such as a cold. As well as this, there is a change in climate as the seasons change from summer to autumn, meaning a decrease in temperature (Horspool et al., 2013).

A previous study had been conducted which involved a random sample of children with diagnosed asthma aged 5-16, which used General Practice Research Database (GPRD). The study was a gender and age (within 2 years) matched study of controls (children without asthma) and cases (children with asthma) (Julious et al., 2011). This study found that there were more unscheduled medical contacts throughout the year for cases compared to controls; the effect was approximately double between the two. Also, it was found that there was a greater than predicted increase in unscheduled medical contacts at the start of the school year for the cases compared to the controls. Furthermore, the study found that there was a decrease in the number of prescriptions for asthma medication in August compared to the months either side of August, which followed on to show that patients who did not get a prescription had 0.14 more unscheduled medical contacts (Julious et al., 2011).

The outcome data for the PLEASANT study was collected through the Clinical Practice Research Datalink (CPRD) (Horspool et al., 2013). CPRD is funded by both the (NIHR), National Institute for Health Research and the (MHRA), Medicine and Healthcare products Regulatory Agency and it is an interventional research and observational data service (CPRD, 2015). The GPs were invited to join the study by a letter via the CPRD. The letter was sent to all the active GP CPRD sites in England and Wales. See section 2.4.1 for more details on CPRD data.

PLEASANT recruited 142 GP practices into the study, however one practice withdrew from CPRD, leaving 141 practices. There were 70 practices on the control arm and 71 on the intervention arm. There were approximately 12,000 children included in the study. The data was collected for 2 years and the intervention was sent out during the summer after the first year at the end of July 2013. The study was randomised by stratification based on the size of the GP practice. The primary endpoint was the number of school-aged children with asthma between the ages 5-16 who have at least one unscheduled medical contact at the start of the new school year in September. An unscheduled medical contact was defined as ‘An unscheduled contact will be any contact not part of the patient’s care plan that is either patient initiated or as a result of illness’ and a scheduled medical contact was defined as ‘A scheduled contact is defined as any contact that is part of the planned care for the patient, for example an asthma review; a medical review; repeat prescription or immunisation’. As well as the primary outcome, there were a number of secondary endpoints that were measured, including the number of patients who had an unscheduled medical contact in the months September - December. There were 12 secondary endpoints in total (Horspool et al., 2013), a list of all these secondary endpoints is provided in Appendix A. For each endpoint, there were two results, one for under 5’s and one for 5-16’s. This is because it is difficult to diagnose asthma in children under 5 (discussed previously in section 2.3.2). For this Ph.D. study only over 5’s were looked at as the study was interested in unscheduled medical contacts following the return to school.

2.4.1 CPRD data

As mentioned briefly in the previous section, the data for the PLEASANT study was from CPRD routine collected data. The CPRD database is an ongoing collection of anonymous general practice medical records. The database includes GP practices in the UK covering over 11.3 million patients (PLEASANT included practices in England and Wales). Of these patients, 4.4 million are active and meet the quality criteria, therefore approximately 6.9% of the population are included in the database. However, the sample is representative of the population in terms of age, gender and ethnicity (Herrett et al., 2015). The database is rich and includes information on symptoms, tests and diagnoses as well as demographics (Herrett et al., 2015).

Alongside the data being anonymous and representative, there are other advantages of using CPRD data. The data is relatively cheap, collecting primary data is costly as well as a timely process, so using readily available CPRD data reduces both time and costs for the study (Kane et al., 2000). As the data is anonymous and collected by the GP practices, individual ethics for each patient is not needed. The practice opts in to the CPRD data collection process and individual patients can opt out if they wish. The database is large and includes follow up data, therefore it is possible to conduct studies investigating long-term outcomes and epidemiological associations with higher precision (Herrett et al., 2015). Some aspects of the data quality are improved due to the Quality and Outcomes Framework. This is an incentivised programme which aims to encourage GP’s to record key items such as smoking status (Herrett et al., 2015). However, the quality of the data is variable, which leads to the disadvantages of using CPRD data.

There are a number of disadvantages to using CPRD data, there first being the accuracy of the data (Kane et al., 2000). The data is entered during the GP consultation and is not for the purpose of research. This can affect the quality of the data as the GP has a long list of diagnosis codes to choose one from, different practices have different routines on how they code the consultation, and patients may present with a number of issues and only one may be coded meaning others may be missed. The CPRD have two methods which can be used to assess data quality. Theses methods do not ensure quality data, however it is advised these steps are conducted first before trialling other methods (Herrett et al., 2015). There can also be missing data, certain outcomes may be more readily recorded depending on the condition. Other aspects of health may not be recorded such as medication adherence, prescription fill and over-count medication. Alongside missing data, whole populations of people can be missing such as private patients, homeless people and those in residential homes (Herrett et al., 2015).

The disadvantages described above may impact on the quality of the data used in the PLEASANT study. As PLEASANT aimed to reduce the number of unscheduled medical contacts in September, the consultations needed to be categorised as unscheduled or scheduled contacts. The coding was completed by the data management team alongside and advisory team which included three GP's. The GP adjudication panel were there to try to help limit any inaccuracies in the data when coding scheduled and unscheduled contacts. The decision was finally made to first code the contacts by 'clinical consultant type' and then remaining contacts by 'consultant consultant type' (Julious et al., 2016).

2.5 Adherence Frameworks

This sections provides background information on two adherence frameworks. The first is the 'Intentional and Unintentional Non-adherence Framework' and the second is the 'Necessity-Concerns Framework'. Both these frameworks are not unrelated (Clifford et al., 2008) and can be used to explain and understand adherence and non-adherence. Both these frameworks are used later in the research on the interview data from the children.

2.5.1 Intentional and Unintentional Non-Adherence

Section (2.3.4) described the different types of asthma medication that people with asthma can be given. However, good control over asthma can only be taken if patients adhere to their asthma medication. It is known that adherence to asthma medication is low in children (Desai and Oppenheimer, 2011) which is key to the

PLEASANT study (Section 2.4). There are many reasons why children may not adhere to their medication. However, all these reasons can be split into two categories, intentional and unintentional non-adherence (NICE, 2009).

Unintentional non-adherence includes situations when a patient would like to follow their medication plan but something, beyond their control, is preventing them from doing so (Gordon et al., 2007; Lehane and McCarthy, 2007; Ho et al., 2009). Examples of this are, forgetting, unable to afford the costs, unable to use the treatment or difficulty in following the medication instructions (NICE, 2009).

Intentional non-adherence includes situations where the patient has deliberately chosen to not adhere to their medication plan (Lowry et al., 2005; Lehane and McCarthy, 2007). Examples of this are, not liking their medication due to side effects or taste, or the patient may believe that they do not need their medication (NICE, 2009).

These categories of non-adherence have been applied throughout the project. In particular, the interview study with the children covered adherence and barriers to adherence (Chapter 5).

2.5.2 Necessity-Concerns Framework

Another framework used to explain non-adherence is the Necessity-Concerns Framework. This framework, developed by Horne and Weinman (2002), describes the balance between the patients beliefs of the potential benefits and the 'Necessity' of adhering to the medication and the patients beliefs of the disadvantages or 'Concerns' they have about the medication (Horne et al., 2013). For example, if a patient believes that taking their medication will increase their quality of life and enables them to live symptom free, then they may see this as a necessity and adhere to their medication. However, if a patient believes that the cons, such as side effects, outweigh the pros, then they may see this as a concern and not adhere to their medication (Chapman et al., 2015; De Simoni et al., 2017). It is thought that for the Necessity scale, asthma patients would rate lower than diabetes patients but higher than patients with a psychiatric condition. However, on the Concerns scale, asthma patients are thought to score higher than diabetes patients due to the nature of the medicine taken for asthma (Horne et al., 1999).

A paper by Van Steenis et al. (2014) studying people with asthma found that the Necessity-Concerns framework was correlated with self-reported adherence and not refill adherence. As the children in this Ph.D. project were interviewed, this framework was applied to the interview data. Again, this framework has been applied throughout the project to determine whether adherence was due to necessity and non-adherence was due to concern.

2.6 Conclusion

This chapter provided background on asthma and the PLEASANT study. The background information on asthma provided evidence that asthma is a worldwide problem which has a high prevalence in the UK. There were also a number of asthma triggers that were discussed such as, exercise, illness and emotional factors. Triggers of asthma will be discussed further in the qualitative study (Chapter 5). This chapter also provided a detailed description of the PLEASANT study. The data from the PLEASANT study was used in the quantitative analysis in Chapters 4, 6 and 7.

The next chapter explores background information on asthma further by providing a narrative review of the literature focused on the seasonality of asthma and adherence to asthma medication.

3. Review of the Literature

3.1 Introduction

The previous chapter provided background on asthma and the PLEASANT study. This chapter provides a narrative review of the literature around the seasonality of asthma and adherence to asthma medication. These two topics were the focus of the review as they provided an overall background and a rationale for the PLEASANT study.

3.2 Chapter Aims

The aims of this chapter are:

- To provide details of the systematic search to show the research gap.
- To discuss the seasonality of asthma based on previous studies with a focus on the return to school in September.
- To discuss adherence to asthma medication based on previous studies.

3.3 Methods

A systematic approach was not undertaken as the Ph.D. project followed on from the NIHR funded PLEASANT study that had conducted a review prior to starting the study (Julious et al., 2016). The aim of this review was to 'set the scene' for this Ph.D. The literature was initially sought by looking at the bibliography of the PLEASANT protocol and for the publications following that (Section 3.5). However, a systematic approach was used to show that there was still a research gap in the literature which is described in the next section (Section 3.4).

Quality appraisal techniques were not used for the review as the papers were used to provide a picture of what has already been done on the topic, not how well they were conducted.

3.4 Research Gap

A literature search using two different databases: Medline and Scopus; were used to determine what research around the question of the Ph.D. project had been previously done. The search was based on the first two research questions:

- What are the factors that influence children with asthma having unscheduled medical contacts around the start of the new school year.
- Is it possible to predict which children are more likely to have an unscheduled medical contact at the start of the school year.

The aim of this systematic search was to confirm that there was a research gap for the study. With this in mind, narrow inclusion and exclusion criteria have been applied to clearly define the gap.

The two questions above were narrowed into: the population of children with asthma; the outcome of unscheduled medical contacts and being in England and/or Wales (or Britain). Finally, the last search criterion was whether the paper was looking at factors or predictors. The search limited the location to England and Wales as that was the focus of the PLEASANT study. PLEASANT was focused on England and Wales, rather than the UK, as Scotland has different school term dates. Scotland's earlier start date after the summer break results in an earlier peak in unscheduled medical contacts (Julious et al., 2007), which could be influenced by different factors causing the peak.

The full search terms used can be found in Appendix B for both databases. The final search was conducted on the 8/11/2015 retrieving 98 hits from the Medline database and 94 hits from the Scopus database. The following inclusion and exclusion criteria were applied.

Inclusion

- Children
- Children diagnosed with asthma
- Studies in England and/or Wales
- Discussion about September peak

Exclusion

- Adults
- Young Children, i.e. under 5

- Articles not focused on children
- Not diagnosed with asthma
- Not written in English
- Based outside England and/or Wales

After removing duplicates and reading the titles and abstracts to remove any that did not lie within the search criteria there were 17 articles left. From these 17, a further 12 were removed for various reasons such as: there was no full text; there was no discussion about the September peak and they had been previously missed in the original exclusion. This meant there were 5 papers left to be read in further detail. From the 5 papers left, 2 were papers written by Steven Julious (Supervisor) which lead to the development of PLEASANT. The remaining three articles, although they followed the inclusion criteria, they were not directly relevant to the research questions. The papers briefly mention the September peak, but not as the main focus of the study.

There were no papers identified that looked at the factors which influence and predict which children are more likely to have an unscheduled medical contact at the start of the new school year in England and Wales. This lack of research indicates that there is a research gap in this area.

3.4.1 Update 2017

The previous search terms were re-run on the same databases, Medline and Scopus, on 14/08/17 to see whether there was still a gap in the literature. Medline had 14 new papers and Scopus had 30. All papers from both databases were excluded using the previous inclusion and exclusion criteria and examining the titles and abstracts.

3.4.2 Conclusion

This section of the review has shown, systematically, that there is a gap in the literature where this research project fits. The next section aims to 'set the scene' for the Ph.D. by using worldwide literature on seasonality of asthma and adherence.

3.5 Seasonality of Asthma

Asthma is a seasonal condition, meaning that the hospitalisations and deaths follow a similar pattern every year (Fleming et al., 2000; Silverman et al., 2003). Many articles have been written about the seasonality of asthma, looking at the different trends it can follow and exploring the reasons behind these trends. The first part of this section looks at the general asthma trends throughout the year and then the second part focuses on the peak after the return to school in September, as this is the focus of the Ph.D.

3.5.1 General Trends

Most studies looking at the seasonality of asthma have found there is usually a peak in the Autumn/Winter months and a nadir in the Summer months. However, not all studies have found these results.

3.5.1.1 Age Effect

A study in the USA by Weiss (1990), looking at hospitalisations and mortality for people aged less than 5, 6-34, 35-64, and 65+, found that in general, asthma followed the usual seasonal trend. Nevertheless, the study found that the different age groups followed slightly different patterns. People aged between 5 and 34 had a peak for hospitalisations in September-November and a trough in June-August. However, the age groups 35-64 and 65+ followed a different pattern, they both peaked in the months January-March and troughed in July-September. Seasonal trends were not looked at for the under 5s (Weiss, 1990).

Mortality for ages 5-34 followed a seasonal pattern of a peak in May-September and a trough from January-April. The pattern for the 35-64 and 65+ again both had a different pattern, with a peak in the colder months, December-April and a trough in June-September. The 5-34 age group almost has an opposite pattern to the 35-64 and 65+ age group. Again, mortality trends were not looked at for under 5s (Weiss, 1990). Demographics such as race, gender and location were included in the data. There was no difference in the seasonal trends for the different demographics (Weiss, 1990).

A more recent study, also conducted in the US, by Silverman et al. (2003), looked into how age can affect the seasonal patterns of asthma. The age range for this study was 0-80, which was split into 2 ages groups, children (13 and younger) and adults (14 and older), and then split again in to 6 age groups (0-1, 2-4, 5-13, 14-29, 30-59, and 60-80) (Silverman et al., 2003). The results from this study found that, the two age groups, children and adults, followed similar seasonal patterns, a peak in September-December and a trough from May-August. After splitting the age groups further, the data showed that as age increased, the seasonality decreased, with the the group with the most variable seasonality being the 5-13 year olds. The eldest age group was almost constant throughout the entire year (Silverman et al., 2003).

Other studies have also looked at how age affects the seasonal pattern, such as an article by Kimbell-Dunn et al. (2000) which was done in New Zealand. The age groups in this study were 5-14, 15-44, and 45+. This study found that the younger age group, 5-14, had a much higher rate of monthly hospitalisations compared to the other two groups, about double. The hospitalisation seasonal pattern included a peak in April-June, which would be Autumn in New Zealand, and a dip in January (Summer) for 5-14 and 15-44 year olds. For the oldest age group, they had a slightly later peak which was in August (Winter) and a dip in January to February (Summer) (Kimbell-Dunn et al., 2000). By comparison, monthly mortality rates were highest in the oldest age group compared to the other two, being up to 14 times higher compared to the youngest group. The seasonality of mortality varied much more in the youngest age group with three peaks, February, May, and September, it was noticed that these peaks coincided with the school holidays (Kimbell-Dunn et al., 2000). The pattern for 15-44 year olds was less varied with a peak in December to March and a dip between July and September. The mortality pattern for the 45+ year olds followed a similar pattern as for the hospitalisations pattern for the 45+ group (Kimbell-Dunn et al., 2000).

Age was found to be a factor that influenced unscheduled contacts in school-aged children in both the qualitative and quantitative studies in this Ph.D. therefore this will be discussed further in Chapter 6 and 7.

3.5.1.2 Environmental Factors

As there is a lack of knowledge as to what causes the seasonal trends in asthma hospitalisations and deaths, many articles have looked into different possible causes. Some of the causes that have been studied are: pollution, pollen, climate, smoking, indoor risks, and infection.

Two studies have been conducted in Taiwan which have looked at how, and if, pollution affects the seasonal pattern of asthma. The first study, by Yeh et al. (2011), looks at hospitalisation data for children with asthma and data on the different levels of pollution for two years. The different pollutants that the data included were: Nitrogen Oxide (NO_2), Ozone (O_3), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), and aerodynamic particles smaller than $10\mu m$ (PM_{10}). In this study, air was considered poor quality if it has a Pollutants Standard Index (PSI) of more than 100 (Yeh et al., 2011). The study found that there was no significant relationship between the number of days with poor air quality and asthma hospitalisations. However, there was some significant relationships with pollutant concentration and hospitalisations, PM_{10}, O_3, and SO_2. In relation to age differences, this study also concluded that different age groups were affected more by the pollutants, it had more of an effect on younger children (Yeh et al., 2011).

The second study, by Xirasagar et al. (2006) looked at both climate and environmental factors and how they may affect seasonality of asthma in children. This study had similar results to the previous one, finding that PM_{10} and O_3, as well as CO, could be used to predict hospital admissions in preschool children. They found that different pollutants affected the different age groups of children. This study looked at climate as well at pollutants and concluded that rainfall, temperature and pressure were predictors for hospital admissions (Xirasagar et al., 2006). This study looked at the seasonal patterns of the different age groups and concluded that, for children aged 0-2, they had a peak in November (Winter) and a trough in January-February (Winter/Spring) and June-July (Summer). For children aged 2-5, again, they had a peak in November and a trough in June-July. The older children, 6-15, had peaks in March and September with a dip in June-August (Xirasagar et al., 2006).

Not every study has come to the same conclusion. A study by Gergen et al. (2002) in the USA, looked at whether atopy, passive smoking, and pollution had an affect on the seasonality of childhood asthma. The study followed children with asthma, aged 4-12, for about four years. The children had the usual seasonality trend of a peak in September (Autumn) and a dip in June-August (Summer) (Gergen et al., 2002). The study found that exposure to Environmental Tobacco Smoke (ETS) has no affect on the seasonality trend. The study found that whether the children were atopic or not also had no affect on the seasonality trend. In contradiction to the previous two studies in Taiwan, there was only one pollutant that had a similar pattern to the asthma pattern, and that was SO_2, though no statistical tests were done on this (Gergen et al., 2002).

As well as outdoor environmental factors, there are also indoor ones that could affect the seasonality of asthma morbidity, such as house dust, cockroaches, and water damage. A further two studies in Taiwan have looked at the indoor exposures. The first study by Han et al. (2009), took participants from the (ISAAC) study which was discussed previously in Section 2.3.3.1 aged 6-15. The results found a seasonal pattern of a peak in the winter and trough in the summer. They split the children into four groups, winter, spring, summer/fall and perennial (experienced asthma at least one month every season) (Han et al., 2009). The results concluded that water damage had an affect on all the asthma groups, cockroaches affected the summer/fall group, mould affected the winter and spring group and passive smoking affected the spring and summer/fall group (Han et al., 2009).

The second study, by Kao et al. (2001), looked at the time trends and seasonality of asthma hospitalisation in children aged 2-14. The seasonal trend for this study included a peak between October and December. Though no statistical analyses were done on this study, the author has suggested that the seasonality could be associated with house dust mites (Kao et al., 2001).

A study in Finland by Harju et al. (1997) looked at the seasonal variation in hospital admissions for children with asthma. The children were under the age of 15 and data was collected for 20 years. The seasonal pattern found in this study was slightly different to the usual trend. There was a peak in May, Autumn and early Winter and a trough in late Winter and Summer (Harju et al., 1997). This study also found that age had an affect on the variability of the seasonality, aged 0-4 being less variable and 5-9 being the most (Harju et al., 1997). The authors were unsure what caused the seasonality in this study, they speculated many different options, pollen, house dust mites and infections but no definite conclusions (Harju et al., 1997).

3.5.2 September and the Return to School

As the primary endpoint for PLEASANT was focused on September the studies discussed in this section were ones that focused on the September peak in the seasonality of asthma. Most of the articles have suggested that the peak in September was due to the children returning to school and/or the passing of viral infections. It is also thought that another possible reason for this increase in hospitalisations in September is because children may not take their medication over the summer holidays. There have been studies which have looked at the monthly prescription rate of asthma medication which have found that there is a decrease in August (Butz et al., 2008; Johnston and Sears, 2006; Julious et al., 2011; Johnston et al., 2005). The PLEASANT study was designed to evaluate this hypothesis.

The majority of the articles that have been discussed in this section are based in the UK but there are others that are based elsewhere such as, Canada, Malta, and Israel. As a starting place, the articles that are based elsewhere in the world are discussed followed by the articles in the UK. The first article by Sears and Johnston (2007) which was undertaken in Canada, looked at hospilisation data for school-aged children from 1990 to 2004. The data showed that over this period, there was consistently a peak in September, which tended to be week 38, but had been week 37 and week 39 in a selection of years. This study suggested that the cause for the peak in September is due to children returning to school and the spread of infections (Sears and Johnston, 2007). They have discussed previous studies that have looked into the September increase in different countries and found that the peak happens 2-3 weeks after the return to school. This was noticed as different countries start school at different dates and the peaks correspond to those dates. A study by Julious et al. (2007), that looked at admissions between Scotland and England, found similar results. Sears and Johnston (2007) noticed that a peak in September is greater than a peak in August (Earlier school start date), they suggested that this could be because the conditions in September are more favourable for spreading infections.

Other studies in Malta and Israel also found similar results, an increase in September following the return to school. Both these studies have suggested in their conclusions that children should restart their medication before going back to school (Grech et al., 2004; Cohen et al., 2014).

Studies that have been done in the UK have also found similar results to the studies done around the rest of the world. The asthma hospitalisations seasonal patterns are affected by age. Different age groups have different levels of susceptibility to the seasonality causing more defined season patterns. Grech et al. (2004) looked at the admission rates in Brighton aged 0-16 over 11 years. The age groups were split into three, 0-3, 4-10 and 11-16. Age 11-16 had the least variable seasonal trend and 4-10 had the most (Grech et al., 2004). All three age groups had a peak in September, after the long school holiday. The study concluded that this was most likely due to viral infections spread when children return to school (Grech et al., 2004). Similar results relating to age and seasonal trend were found by Fleming et al. (2000) and Khot et al. (1983).

3.6 Adherence

Following on from the previous Section 3.5, a number of studies suggested in their conclusions that children should start taking their preventer medication again before the start of the new school year so that they are adequately protected against the challenges the return to school can bring (Grech et al., 2004; Julious et al., 2011; Cohen et al., 2014).

Adherence can be looked at in two ways, qualitatively and quantitatively. Quantitative methods can be used to determine the prescription trends and levels, in which months children receive their medication and how much they have taken. If there is a month where there are fewer prescriptions, then this could suggest that children are not taking their medication that month. However, this is not a reliable way of measuring adherence. Qualitative methods can be used to inform the results that quantitative studies find. They can be used to find out from the patients if they are taking their medication and if not, why not.

Quantitative studies have been used to look at the trends and patterns of asthma medication prescriptions. As stated in Section 3.5.2, there have been studies which have recorded a decrease in prescriptions in August (Johnston et al., 2005; Johnston and Sears, 2006; Butz et al., 2008; Julious et al., 2011), which is followed by an increase in prescriptions in September to December (Johnston et al., 2005; Butz et al., 2008). There are also studies which have looked into the demographics of an individual that could affect the prescription trends of asthma medication. A study in the USA by Kit et al. (2012) looked at the different trends of children's (aged 1-19) preventative asthma medication (PAM) over a period of 20 years. The study compared different age groups (1-5, 6-11, and 12-19), gender, different racial groups (Non-Hispanic white, Non-Hispanic black, Mexican American, and Other) and whether they had health insurance or not. The results concluded that non-Hispanic black and Mexican American children had lower use of the PAMs compared to non-Hispanic white children. Older children aged 12-19 used PAMs less than younger children aged 1-5 and children who did not have health insurance used less PAMs compared to those who did (Kit et al., 2012).

A drawback of quantitative studies is that it is difficult to accurately measure medication adherence. There are many different ways of measuring adherence such as, physician assessment, electronic measurements, and pharmacy record (Desai and Oppenheimer, 2011). Each method has its advantages and disadvantages, though electronic measurements are considered to be the best (Burgess et al., 2011; Desai and Oppenheimer, 2011; Morton et al., 2014). It was not possible to measure adherence in the PLEASANT study.

The quantitative studies can be used to describe the different trends and patterns in adherence to the medication and which sub-population are less likely to adhere, but they cannot explain why this is, other than speculate reasons. Qualitative studies can be used to find out why certain sub-populations adhere less and why individuals might not get their prescription in August. The term ‘barriers’ is used when talking about reasons that prevent individuals adhering to their medication plan. Interviews, focus groups, and surveys are all different methods which can be used to explore the different barriers that individuals face when it comes to their asthma medication.

Previous studies have used interviews and focus groups to discover, from the individuals themselves, what they perceive as barriers. Key barriers that occur are lack of motivation, inconvenience, and forgetfulness, though different articles discuss many more. A focus group based study by Penza-Clyve et al. (2004), discusses children’s (aged 9-15 years) personal barriers to asthma medication. The children frequently mentioned that they forgot to take their medication, were not motivated to take their medication, and the social constraints that taking their medication could cause (Penza-Clyve et al., 2004). Children found that if they stay somewhere other than their own home they often forgot to take the medication, as well as this, they found sometimes they could not recall if they had already taken their medication. Children’s lack of motivation for taking their asthma medication often panned down to them being preoccupied in another activity or that they felt their parents were ’nagging’ them to take the medication (Penza-Clyve et al., 2004). Children also found that taking their medication could cause social barriers in their lifestyles. Children discussed being embarrassed to take their medication in front of other children, not wanting to be asked questions about what or why they were taking the medication, and one child recalled being 'made fun of' because of the asthma limiting their physical abilities (Penza-Clyve et al., 2004). As well as these three main points, there were many others which included, unable to avoid triggers, inconvenience, and limited accessibility (Penza-Clyve et al., 2004).

Interview based studies have also been used to explore similar concepts. Peláez et al. (2015) interviewed 18 individuals between the ages of 15 to 76 and 6 parents of children aged 2 to 12. Similar barriers were found compared to the previous study, such as, forgetfulness, inconvenience, and lack of motivation, as well as many other barriers. Barriers such as fear, perceptions, and knowledge where included. Individuals mentioned that they were afraid of becoming addicted to their medication and that if they took their medication too much that the effectiveness would decrease, which could cause their dosage need to be increased (Peláez et al., 2015). Knowledge and perceptions of their medication could be classified as one category, as perceptions of their medication could be influenced by what knowledge of their asthma and medication. Some of the perceptions that individuals discussed were that they thought they were to take their medication in response to symptoms they could experience and taking their medication if they anticipate contact with triggers. The knowledge barrier covered unsure about medication technique, dose and whether they were taking the right/combination of medications. Knowledge also covered some aspects of fear, such as adverse affects and whether the medication was actually beneficial for them (Peláez et al., 2015). This study also looked into the relationships between the patient and their physician and how parents support the children. Having parental support can help increase a child's adherence and a good relationship and interactions with the physician can also benefit an individuals perceptions and adherence (Peláez et al., 2015). These barriers will be discussed further in the qualitative chapter (Chapter 5).

Mixed methods and surveys studies have also been used to understand non-adherence. A mixed methods study by Naimi et al. (2009), conducted two face to face interviews a month apart and measured their adherence between the visits electronically. The electronic measurements showed there was a difference in adherence for different ages, younger individuals adhered better. The interviews found that the main reasons for not adhering were, forgetting to take it, being too busy, and not feeling comfortable taking it in front of friends (Naimi et al., 2009). A survey study by Fuhrman et al. (2011) concluded that two thirds of children with asthma, who had experienced an exacerbation which hospitalised them, had poorly controlled asthma. It was found that these children were often uneducated on asthma and under treated (Fuhrman et al., 2011).

The studies discussed, even though they used different methods, reached similar conclusions. Developing methods to remind individuals to take their medication and education on asthma and the medication for the individuals and family members, are all tactics that could be implemented/used to help increase medication adherence.

3.7 Discussion

The main focus of the literature review was on seasonality, in particular, September, and adherence. These two topics are connected, as the lack of adherence in the summer could be why there is a peak in September in hospitalisations for children with asthma. Many of the articles found that asthma does follow a seasonal pattern, which normally involves a peak around September. This was found to be consistent across different countries and in New Zealand the opposite was found as their seasons are the other way around. Many of these articles looked at what the causes of the peaks and troughs could be. This included pollution, pollen, smoking, climate, and infection. The causes for the peak in September were also looked at. The majority of these studies concluded that there was an association between the school holidays, the return to school, and the passing of infections.

Some of these studies also looked at the prescription rates throughout the year and concluded that there was a decrease in preventer medication in August, during the summer holidays. This link could be associated with children not adhering to their medication, though this cannot be said for certain. This link between a decrease in prescriptions and the increase in September hospitalisations is why the PLEASANT study was created. However, this Ph.D. project will look at the factors that cause the increase in September and this includes looking at why children may not adhere to their medication plans. If children do not adhere, then understanding why was one of the keys strategies to potentially lessening the peak in September.

Children in the literature often spoke of barriers that they faced when it came to taking their asthma medication. Finding out what these barriers were in relation to September and the summer holidays could provide an opportunity to create an intervention, either similar to the PLEASANT one, or a new one, that could be targeted at the children who felt they have the largest barriers. The intervention could also be aimed at children who were found to be more at risk from the quantitative analysis, or a combination of both.

The age group for the PLEASANT study and this Ph.D. project was children aged 5-16. After reading the literature (Section 3.5.1.1) on how age can affect the seasonality, the ages that were affected the most by it were school-aged children. The age groups younger and older than this were least affected by seasonality, with the eldest age groups almost having no effect. This suggests that looking at ages 5-16 would provide the most information on why there is a peak in September as they are the ones who have the largest peak.

Children with asthma who are in school are the ones who have the most variation in the seasonal patterns, i.e, larger peaks and trough. The main peak is in September and understanding what causes this peak is key to this project. If knowing the reasons behind this peak, there is the potential to lessen it. This would mean less hospitalisations, fewer unwell children due to their asthma, potentially fewer unnecessary deaths and cost savings to the health services.

3.8 Conclusion

This chapter provided a narrative review of the literature focusing on the seasonality of asthma and adherence to asthma medication. The articles discussed in the chapter described the seasonal patterns of asthma which often included a peak in September. The factors potentially associated with this peak were also discussed, such as infection, climate and the return to school. Following that, the chapter explored the literature for reasons why children may not adhere to their asthma medication. There were a number of barriers discussed, such as lack of motivation, inconvenience and forgetfulness. The chapter also included the methods used for the systematic search which showed the gap in the research where this Ph.D. study fits.

The next chapter is the re-analysis of the PLEASANT study. This re-analysis was conducted to provide confidence in the methods and analyses as it was possible to compare the results to the original PLEASANT study. The re-analysis was also used to develop initial themes for the qualitative interview study (Chapter 5).

4. Analysis of PLEASANT

4.1 Introduction

The previous chapter provided a narrative review of the literature focused on the seasonality of asthma and adherence to asthma medication. This chapter focuses on the quantitative methods and analyses used in the original PLEASANT study. The aim of the quantitative analysis for this Ph.D. was to explore what factors increase a child with asthma's likelihood of having an unscheduled medical contact after the return to school in September. The results from the original PLEASANT trial analysis were used, alongside the literature in the previous chapter, to inform the development of the qualitative study.

4.2 Chapter Aims

The aims of this chapter are:

- To provide a short background to the methods used in the PLEASANT analysis.
- To present the re-analysis of the PLEASANT study on the complete dataset.
- To discuss the limitations of the PLEASANT study and how this information can be used in the further analysis.

4.3 Methods

4.3.1 Cluster Randomised Trials

PLEASANT was a Cluster Randomised Trial (CRT). CRTs are similar to standard Randomised Controlled Trials (RCT) but instead of randomising individuals to different treatment arms, groups of people are randomised (Hayes and Moulton, 2009). For example, these groups could be a town or a medical practice. An effective way of completing cluster randomised trials is to use the health care professionals to provide the intervention to the patients within the practice (Eldridge and Kerry, 2012). In the PLEASANT study, the clusters are the GP practices. Most of the background for this section on CRT is based on 'A Practical Guide to Cluster Randomised Trials in Health Services Research' by Eldridge and Kerry (2012).

The main purpose for having a CRT is the fear of contamination (Hayes and Moulton, 2009). Contamination can occur because individuals in the same group of people, for example, the same medical practice, are likely to receive similar intervention. Designing the trial as a CRT is a design option when contamination is likely. The analysis will then need to be undertaken knowing that it was a CRT. There are other advantages of having a CRT design such as, it is more convenient from an administration perspective, more ethical, it increases individual compliance and it is more real world.

There are two types of CRT, cohort and cross-sectional. A cohort study for a RCT is a study that follows up patients from exposure to outcome at the end of the study. A cross-sectional study for a RCT collects data for a population at a specific time point. A cohort CRT will follow the same subjects over time. A cross-sectional CRT will take a random sample of the study population before and after the intervention in both arms. This means that the baseline group before the intervention and the follow up group after the intervention are not the same. This is most useful when the analysis is aimed at cluster level. PLEASANT was a cohort CRT.

One of the main design features of a CRT is that it should be stratified by cluster size. This ensures that there are a similar number of individuals on each treatment arm. PLEASANT was stratified by GP practice size, which is the cluster size.

A key feature that needs to be accounted for with CRTs is that the outcomes are not independent. Patients who are from the same medical practice are more likely to be similar to each other in terms of outcomes than those treated by different doctors.

CRTs can be analysed at both individual and cluster level, depending on what outcome is of interest. However, careful consideration needs to be taken. Details of both are given in the next sections.

4.3.2 PLEASANT Statistical Analysis Plan

This section provides details of the statistical analysis plan for PLEASANT and the methods used for it. For the first part of the analysis for this project, the original PLEASANT analysis was repeated as this was used to develop the qualitative study. This analysis was completed on the complete dataset. This means practices that joined the study late or left early were excluded in the analysis.

As stated in Section 2.4, the PLEASANT study was an intervention Cluster Randomised Trial (CRT) with two treatment arms, an intervention and a control. The data variables collected by CPRD include:

- Month of Birth
- Gender
- GP ID
- Every appointment date
- Type of medical contact for every appointment
- Diagnosis given in every appointment
- Prescription details if required from the appointment

The appointments were categorised by the PLEASANT study team into scheduled and unscheduled medical contacts (Horspool et al., 2013). A scheduled medical contact is anything that is part of routine medical care, e.g, asthma review. An unscheduled medical contact is anything not considered routine which could be the result of an illness. The unscheduled medical contacts can be broken down further into A&E visits, walk in clinics, out of hours, etc. The primary endpoint for PLEASANT was the proportion of patients who have at least one unscheduled medical contact in September 2013 following the intervention.

The statistical analysis plan for the PLEASANT data set describes methods including Logistic regression random effects models and Negative Binomial random effects models (Horspool et al., 2013). Within each of these methods, gender, age, treatment arm, and previous year's contact were fixed covariates in the model. Random effects models were used in each method to take into account the clustering in the trial (Section 4.3.3.4). GP practice was used for the random effect. Logistic regression was used when the outcome was proportions. Negative Binomial regression was used when the outcome was count data. Negative Binomial has been used instead of Poisson regression because Negative Binomial assumes that each individual has a different rate, whereas Poisson assumes they are the same (Keene et al., 2007).

The analysis of each outcome was completed on three different study periods:

- September 2013
- September 2013 - December 2013
- September 2013 - August 2014

The analysis was completed on various subsets of the data:

- Unscheduled medical contacts
- Scheduled medical contacts (Aug 2013)
- Any relevant medical contacts (Scheduled and unscheduled contacts)
- Respiratory related unscheduled medical contacts

In addition to this, analysis was conducted on the number of prescriptions the children picked up. The analysis was focused on whether the children picked up a prescription for their asthma in August 2013, after the intervention.

The significance level was set to 5 % in this project. Tables in the analyses present the variable coefficient estimate and the 95 % confidence interval.

The methods used by PLEASANT are all focused at individual level which allows for the clustering of the data. Conventional analysis methods do not account for the extra variability that cluster trials induce. If these methods are applied to CRT data then this can lead to an underestimation of the standard error for the treatment effect, which leads to an over estimation of significance, this is a type 1 error. However, using appropriate methods, analysis of individual data can be conducted (Campbell and Walters, 2014).

4.3.3 PLEASANT Analysis Methods

This subsection provides background information to the methods used in the original PLEASANT analysis and how to analyse CRTs using cluster level data. Analysing at this level is important if it is believed that individual responses within a cluster are not independent. The lack of independence assumption is normal for a CRT. For example, a GP at a practice is likely to provide the same treatment to all their patients so there is more chance that the individuals in the cluster will have some similarities in responses. If there is dependence within the cluster and the study is analysed using methods used for RCT then the results could provide a false significant result. If there is dependence in the cluster, then this can lead to increased standard errors and P-values, which will lead to larger confidence intervals, which all decrease the effective sample size which will reduce the overall power of the study (Hayes and Moulton, 2009; Campbell and Walters, 2014).

First a description of the models used in PLEASANT is given, followed by methods of allowing for clustering within these models.

4.3.3.1 Logistic Regression

A simple way of modelling data is to use linear regression. Linear regression can be used to explain and model the linear relationship between the independent covariate(s) and the dependent continuous response variable (Kremelberg, 2010).

$$\begin{aligned} y_i &= \beta_0 + \beta_1 x_{i,1} + ... + \beta_k x_{i,k} + \epsilon_i \\ \boldsymbol{Y} &= \boldsymbol{X\beta} + \boldsymbol{\epsilon}. \end{aligned}$$

Where $\boldsymbol{Y}$ is the response vector for values $y_1, ..., y_n$, $\boldsymbol{X\beta}$ is the linear predictor for covariates $x_{1,1}, ..., x_{n,k}$ and parameters $\beta_0, ..., \beta_k$, and $\boldsymbol{\epsilon}$ is the error term vector for $\epsilon_1, ..., \epsilon_n$. However, this method assumes that the response variables have an error distribution that is Normal and this is not always true.

Generalised Linear Models (GLM) are an extension from linear regression models that allow the response variables to have an error distribution that is not Normal. A link function is used to connect the linear model to the response variable and this link function is determined by the assumed distribution of the response variable (Nelder and Baker, 1972; McCullagh and Nelder, 1989; Dobson and Barnett, 2008). The general form of a GLM is,

$$\mathbb{E}(\boldsymbol{Y}) = \boldsymbol{\mu} = g^{-1}(\boldsymbol{X\beta}). \tag{4.1}$$

Where $\boldsymbol{Y}$ is the response variable, $\boldsymbol{\mu}$ is the Expected Value of $\boldsymbol{Y}$, g is the link function, and $\boldsymbol{X\beta}$ is the linear predictor. The choice of link function is often determined by the range of the response variable (McCullagh and Nelder, 1989).

A special case of a GLM is logistic regression (Kleinbaum, 1994). Logistic regression can be used when the response outcome is of binary form and this estimates the probability of the binary outcome. Logistic regression is used to predict the odds of being a case, i.e. the binary outcome 1, $y_i = 1$ (Kleinbaum, 1994). The odds is defined as the probability of being a case over the probability of not being a case (Fulton et al., 2012). To constrain the response variable between 0 and 1, a logit link function is used,

$$\text{logit}(\pi_i) = \log\left(\frac{\pi_i}{1-\pi_i}\right) = \log\left(\frac{\mathbb{P}(y_i = 1)}{1 - \mathbb{P}(y_i = 1)}\right),$$

where $\pi_i = \mathbb{P}(y_i = 1)$. Consider y_i to be Binomially distributed then,

$$y_i \sim \text{Binomial}(m, p),$$

where $m = 1$ and $p = \pi_i$, therefore $\mathbb{E}(y_i) = \pi_i$. Using the logit link function,

$$\begin{aligned}
\text{logit}(\mathbb{E}(y_i)) &= \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} \\
\text{logit}(\pi_i) &= \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} \\
\log\left(\frac{\pi_i}{1-\pi_i}\right) &= \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} \\
\left(\frac{\pi_i}{1-\pi_i}\right) &= \exp(\beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k}) \\
\pi_i &= \frac{\exp\left(\beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k}\right)}{1 + \exp\left(\beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k}\right)}. \qquad (4.2)
\end{aligned}$$

This can be interpreted: Let's take β_1 as the parameter to be used in this example, $\beta_1 = -0.23$, then $\exp(\beta_1) = \exp(-0.23) = 0.795$ which is the odds ratio for that parameter. An odds ratio is a way of measuring the relationship between an exposure (the parameter) and the outcome (Szumilas, 2010). This suggests that as the explanatory variable $x_{i,1}$ increases by one unit, the overall odds of being a case, $\pi_i/(1-\pi_i)$, decreases by $20.5\%(= 100\% - 79.5\%)$. If a high response variable is considered better then $\beta_1 = -0.23$ would show a negative affect. If the value for $\beta_1 > 0$ then this would be a positive affect (Kleinbaum et al., 2013).

4.3.3.2 Negative Binomial Regression

Negative Binomial is another extension of GLM (Hilbe, 2011). Negative Binomial can be used when the the response outcome is count data, similar to Poisson. Negative Binomial is a special case of Possion. Whilst Poisson assumes that the mean and the variance are the same, Negative Binomial does not. The variance of Negative Binomial can be different to the mean. Often Negative Binomial is used instead of Poisson when there is over dispersion. This is when there is more variability in the data than expected (See mean count tables in analysis). Poisson also assumes that the rate would be the same for every individual. This however would not be the case in this study, as each child would be expected to be different. Negative Binomial regression allows for a different rate for every individual. With this in mind, Negative Binomial regression was used to model the count data for this analysis (Keene et al., 2007).

Similar to the Poisson model, the negative binomial model uses a log link function. This constrains the response variable to positive values as the data is count data (Cameron and Trivedi, 2013).

Let's start with the Poisson example. Consider y_i to be Poisson distributed then,

$$y_i \sim \text{Poisson}(\lambda_i), \qquad (4.3)$$

where $\lambda_i = \pi_i$, therefore $\mathbb{E}(y_i) = \pi_i$. Using the log link function,

$$\begin{aligned}\log(\mathbb{E}(y_i)) &= \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} \\ \log(\pi_i) &= \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} \\ \pi_i &= \exp(\beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k})\end{aligned}$$

The negative binomial distribution can also be referred to as the Gamma-Poisson distribution. The Gamma-Poisson distribution is made up of both the Gamma distribution and the Poisson distribution. The Poisson distribution in equation (4.3), has a rate λ_i, and this rate can be modelled as a Gamma distribution, $\lambda_i \sim \text{Gamma}(\mu_i, \frac{1}{\gamma})$ (Cameron and Trivedi, 1986). The marginal distribution of the Gamma-Poisson distribution can be shown to be the negative binomial distribution (Hausman et al., 1984), this version is also known as negative binomial distribution 2 (NB2) (Cameron and Trivedi, 1986). Allowing λ_i to follow a Gamma distribution enables the Poisson distribution to have a higher variance than the mean. The variance of the Gamma-Poisson model is $\text{Var}(y_i) = \mu_i + \gamma\mu_i^2$, where γ is the dispersion variable. If $\gamma = 0$ then the model is not dispersed, then the mean and the variance are equal, like in the Poisson model (Cameron and Trivedi, 1986, 1998; Keene et al., 2007). The Gamma-Poisson model can use a log link function where $\mu_i = \exp(\beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k})$ (Cameron and Trivedi, 1986).

However, applying these methods alone to individuals of clustered data could produce false significant results (Hayes and Moulton, 2009; Campbell and Walters, 2014). To avoid this, certain methods can be employed, which are detailed in the following sections.

4.3.3.3 Regression Analysis

One simple way of conducting regression analysis on clustered data is to use robust standard errors (Eldridge and Kerry, 2012). To perform regression analysis on a CRT, robust standard errors need to be used so that the analysis allows for clustering. A key assumption of linear regression is that the observations are independent. In a CRT this assumption does not hold as the observations within a cluster are not independent. Ignoring clustering will cause the standard errors to be too small which can lead to a false significant result (Campbell and Walters, 2014).

An example of a CRT regression model could be,

$$y_{i,j} = \beta_0 + \beta_1 x_{i,j} + \epsilon_{i,j}. \tag{4.4}$$

Where, $y_{i,j}$ is the response variable, i corresponds to the subject number and j is which cluster that subject is in, β_0 is the mean response outcome for the control arm and β_1 is the response outcome for the intervention arm, $x_{i,j}$ is an indicator variable which takes the value 0 for a subject in the control arm and the value 1 for the intervention arm. $\epsilon_{i,j}$ is the random error term which is assumed to be Normally distributed with mean 0 and variance σ^2 and that the correlation between error terms is 0 (Campbell and Walters, 2014).

Robust standard errors can be used as a solution to the clustering problem. The robust standard errors can be calculated for each parameter taking into account the variability of the data rather than calculating them based on the assumptions of the model. The robust standard errors will be larger which means they can deal with any assumptions that are violated, e.g. the lack of independence between observations (Campbell and Walters, 2014). The robustness of the standard errors effectively allows for when the error distribution is miss-specified. Most statistical packages have robust standard errors as a feature.

4.3.3.4 Random Effects Models

Another method that can be used is Random Effects Models. A random effects model will take into account the clustering within the data but still uses individual subjects level data. The models are created conditionally on the cluster which includes the correlation between the individuals in that cluster. This means that the comparisons are made between the patients within a cluster rather than all the patients included in the study (Hayes and Moulton, 2009; Campbell and Walters, 2014).

Random effects models can use GLMs and will include an effect which is specific for each cluster. Also, the variance of the outcome is treated a little differently, it is split to take into account both between and within variation for the clusters. This makes it possible to determine how much variability in the outcomes for the subjects is caused by the cluster they are in (Campbell and Walters, 2014).

An example of a CRT random effects model is,

$$y_{i,j} = \beta_0 + \beta_1 x_{i,j} + \alpha_j + \epsilon_{i,j}. \qquad (4.5)$$

The variables are the same as 4.4, the additional variable, α_j is the random effect of a patient being in cluster j. This effect is assumed to be distributed Normally with mean 0 and variance σ^2_α, this represents the between cluster variability. $\epsilon_{i,j}$ is the random error term which is still assumed to be Normally distributed with mean 0 and variance σ^2, this represents the within cluster variability.

Model (4.5) describes the random effects model for a continuous outcome. For the PLEASANT study, the outcomes are binary and count data. Therefore, similar to the models described in Sections 4.3.3.1 and 4.3.3.2, the random effects models for binary (4.6) and count (4.7) data are (Campbell and Walters, 2014):

$$\log\left(\frac{\pi_{i,j}}{1-\pi_{i,j}}\right) = \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} + \alpha_j. \tag{4.6}$$

$$\log(\pi_{i,j}) = \beta_0 + \beta_1 x_{i,1} + \ldots + \beta_k x_{i,k} + \alpha_j. \tag{4.7}$$

Where $\pi_{i,j}$ is the expected probability of success, for subject i in cluster j for Model (4.6) and $\pi_{i,j}$ is the expected count (or the shape paramater for the Gamma-Poisson distribution), for subject i in cluster j for Model (4.7). For the negative binomial model (Gamma-Poisson model) the dispersion variable is also estimated for each cluster, i.e. γ_j. There are many advantages to using random effects models for analysing CRTs. As the random effects model models the clustering fully, it is possible to explore the other sources of variability. Random effect models are also flexible, these can model many forms of clustering and can be adjusted to consider individual level and cluster level characteristics. Another advantage is that the results can be generalised to the population of interest. The model assumes that if a random sample of clusters was taken, they would be from the population, not from the trial (Campbell and Walters, 2014).

PLEASANT analysed the data using random effects models, which was continued in the analysis of this Ph.D. project. Both the logistic regression and negative binomial random effects models used Maximum Likelihood Estimation (MLE) methods to estimate the parameter coefficients.

4.4 Demographics

There were 12179 different children in the study who had multiple appointments within the two years which led to 440380 appointments. However, for this PhD, the complete dataset was used in the analysis. This means only the GP practices that were in the study for the full two years were included. There were 8849 children and 110 GP practices included in this analysis. The analysis was completed on the complete dataset as the number of GPs entering and leaving the study changes throughout the two year time period. Working on the complete dataset made the analysis much simpler.

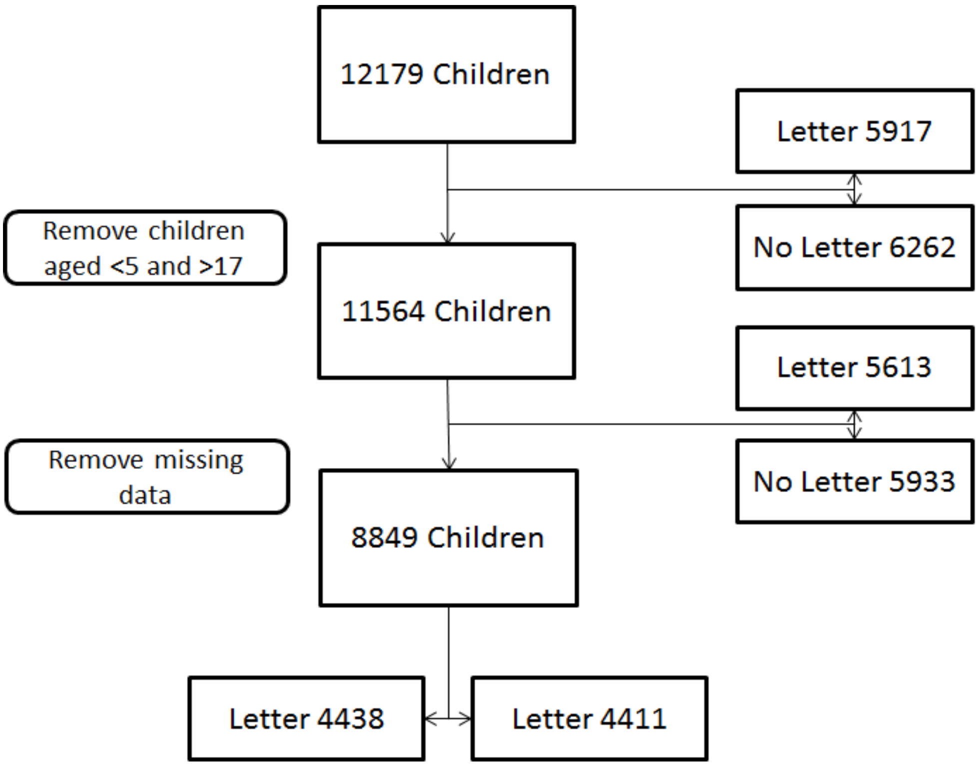


Figure 4.1: Consort diagram of complete cases

4.4.1 Individual Demographics

This first section of the demographic data looks at the individual patients. There is information on the letter allocation, gender distribution and the children's ages.

Figure 4.2: The number of children split by intervention arm

Figure 4.2 shows that there was a similar number of children in both arms of the study, 4411 in the letter arm and 4438 in the control arm.

4.4.1.1 Gender

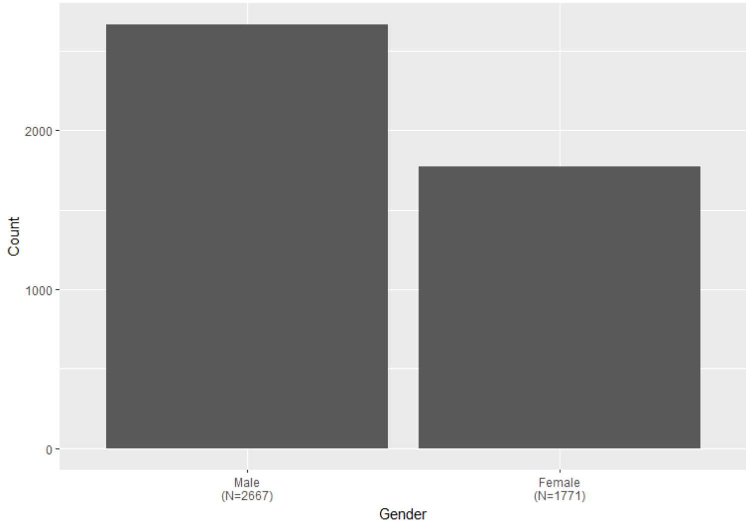


Figure 4.3: The number of children split by gender

Figure 4.3 shows that there were more males than females in the study, 5314 males and 3535 females. This imbalance in gender could be because there are more boys with childhood asthma than females in the population, which would agree with literature on the levels of asthma in children, as more younger males have asthma than females.

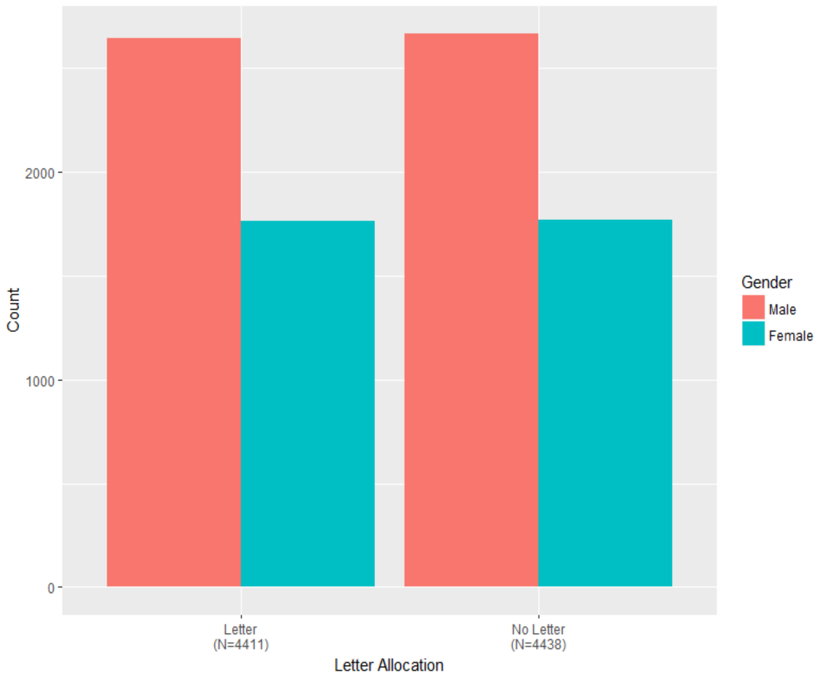


Figure 4.4: The number of children split by letter and gender

Figure 4.4 and Table 4.1 shows that the imbalance in gender was represented in both arms of the study. There are a similar number of males in both arms and a similar number of females.

	Letter	No Letter	Total
Male	2647	2667	5314
	60.0%	60.1%	60.1%
Female	1764	1771	3535
	40.0%	39.9%	39.9%
Total	4411	4438	8849

Table 4.1: Gender and intervention allocation

From Table 4.1 we can see that 60.1% of the study were males and 39.9% were females and 49.8% of the study received the letter and 50.2% did not receive the letter. For the male population in the study, there were 49.8% in the letter arm and 50.2% in the no letter arm. For the female population there were 49.9% in the letter arm and 50.1% in the no letter arm. The proportion of males in the letter arm is similar to the no letter arm, this is similar for the females too.

4.4.1.2 Age

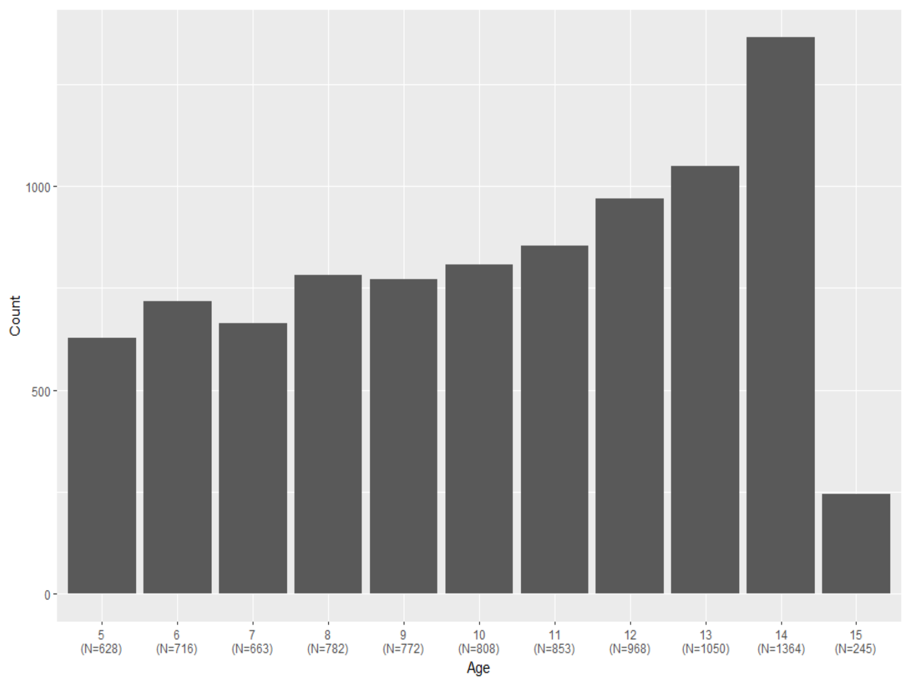


Figure 4.5: The number of children and their ages in the study

The age used in these demographics is the floor age, this means if a child is 7 years and 9 months, their age is recorded as 7. The minimum age is 5 in the study and the maximum age is 16, however the oldest children are 15 in the study. This is because the age of children is calculated from September 2013, the oldest the child could be was 15 as they would be 16 by the end of the study. Anyone older would then become too old for the study within in the follow up year. The most common age is age 14.

Figure 4.5 is a barchart of the number of children in each of the age groups.

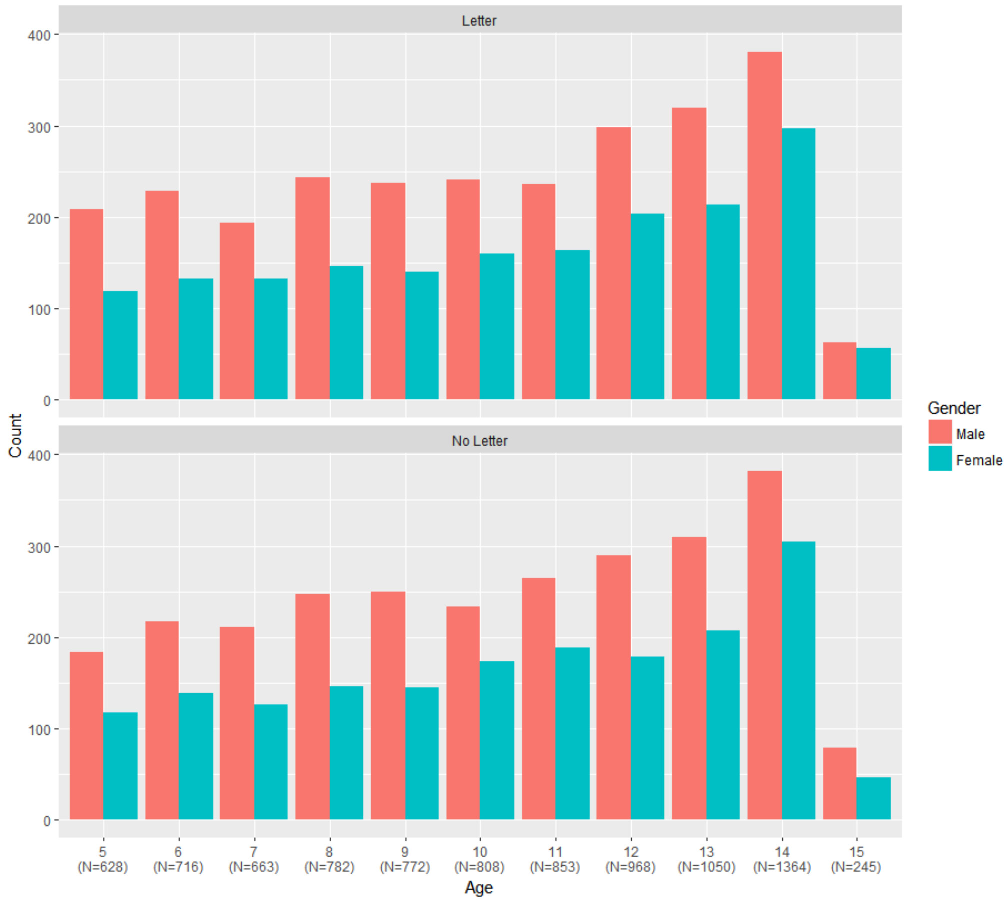


Figure 4.6: The number of children who recieved the intervention or not split by their genders and their ages

Figure 4.6 is a barchart of the number of children in each of the age groups split by letter allocation. This graph shows that even though there were different numbers of children in the age groups, there were similar proportions of the children on each letter arm. Figure 4.7 has two boxplots that look similar, this is because the one on the left is created from the rounded age values and the one on the right is made from the exact age values. The rounded age means that the age is rounded down to the full year, exact means the exact age. The two methods of recording age will give different values for the mean, median etc.

Table 4.2 contains the summary statistics for both the rounded age and exact age for the total study and the two letter arms. The summary statistics are similar for

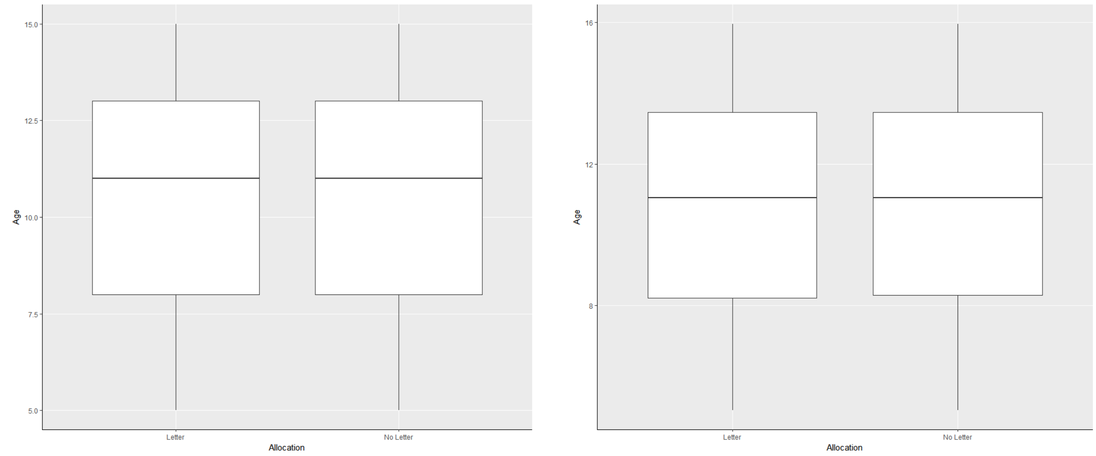


Figure 4.7: Left: Boxplot of the rounded age for the two letter arms Right: Boxplot of the exact age of the two letter arms

Summary Statistics	Total Rounded	Total Exact	Letter Rounded	Letter Exact	No Letter Rounded	No Letter Exact
Mean	10.26	10.81	10.25	10.80	10.27	10.82
Median	11.00	11.04	11.00	11.04	11.00	11.04
1st Quartile	8.00	8.29	8.00	8.21	8.00	8.29
3rd Quartile	13.00	13.46	13.00	13.46	13.00	13.46
Min	5.00	5.04	5.00	5.04	5.00	5.04
Max	15.00	15.95	15.00	15.95	15.00	15.95

Table 4.2: Summary statistics of age (rounded and exact) for the total study and the two letter arms

the two arms compared to the total study. As the exact age is more accurate, this will be used for the rest of the analysis.

4.4.2 Practice/Clusters Demographics

There were 141 practices in the study all varying in size. There were originally 142 but number 7 dropped out and had their data removed so there are no data on practice 7. This meant that there were 70 practices on the letter arm and 71 on the control arm.

For the complete dataset, there were 110 practices, 53 on the control arm and 57 on the intervention arm.

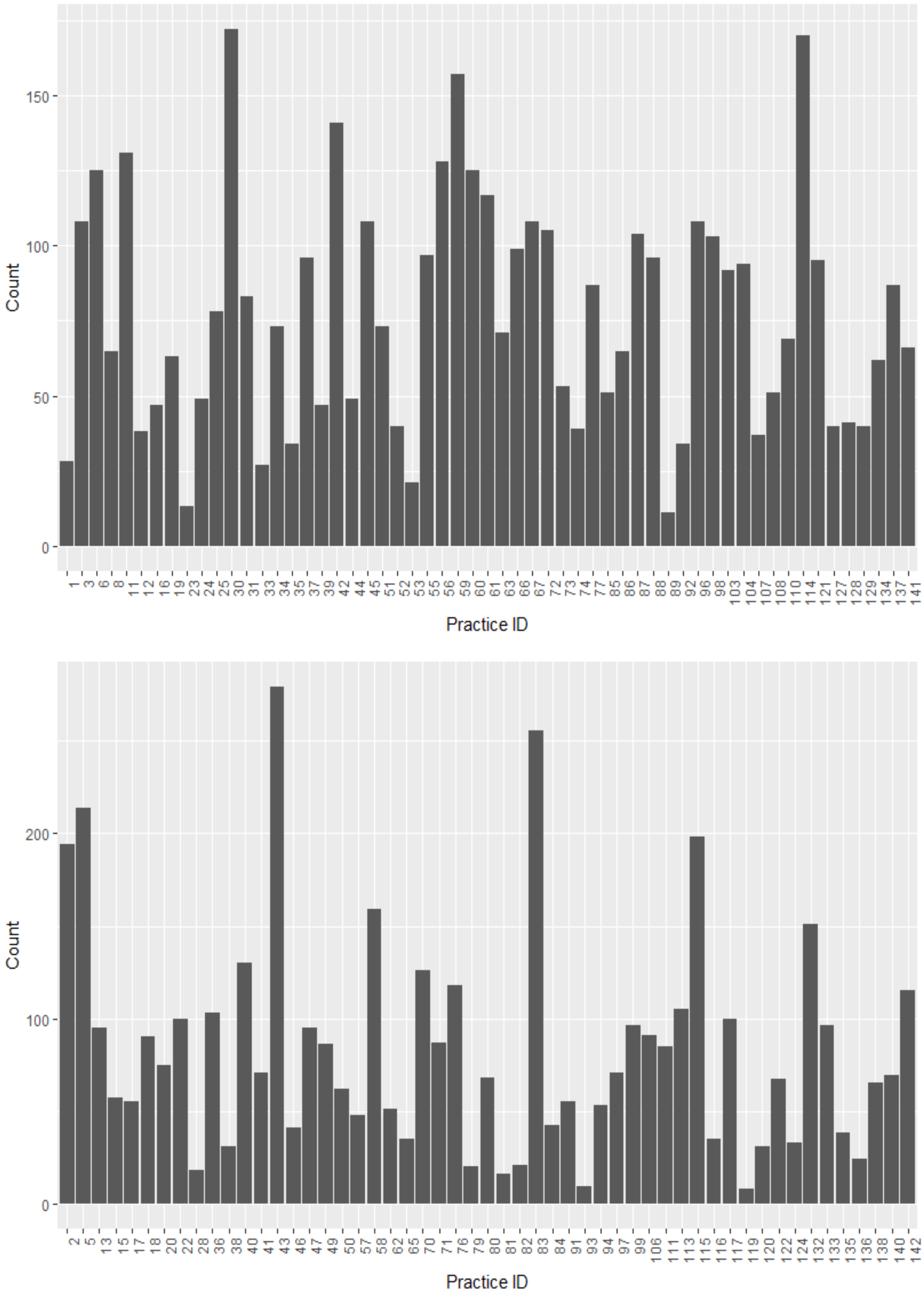


Figure 4.8: Top: The number of children in each of the GP practices for the intervention arm. Bottom: The number of children in each of the GP practices for the control arm

Figure 4.8 shows the number of children with asthma at each practice split for the two letter arms. For the letter arm, minimum surgery size was 11 and the maximum was 172. The letter arm has a mean size of 77.39 and a median of 73. The no letter arm has a minimum size of 8 and a maximum of 279. The no letter arm has a mean size of 83.74 and a median of 71.

Figure 4.9: Top: The number of children in each of the GP practices split by gender for the intervention arm. Bottom: The number of children in each of the GP practices split by gender for the control arm

Figure 4.9, the top graph shows how gender was represented in the surgeries who received the letter and the bottom graph shows how gender was represented in the surgeries who did not receive the letter.

Table 4.3 provides details of the summary statistics for each GP surgery (see end of Chapter 4). The statistics include mean age and standard deviation, the size of the surgery, how many males and females and whether they were on the letter arm or not. The number of males was larger than the number of females for 102 of the surgeries.

4.4.2.1 Contact Type

The primary end point of PLEASANT was the proportion of unscheduled medical contacts there were in September 2013. A simple graphic that can be looked at is the different contact types there were and how many throughout the whole study.

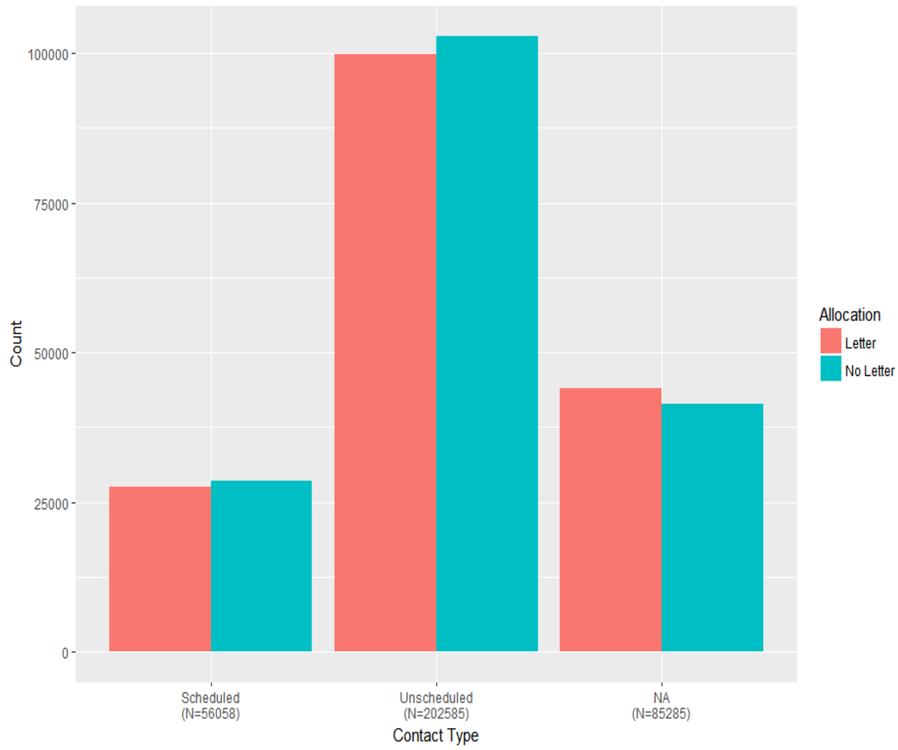


Figure 4.10: The number of contacts within the whole study split by type of contact

Figure 4.10 shows that the contacts were either recorded as scheduled or unscheduled. However, there are a lot of contacts what were not recorded as either, these are considered missing. From now on, these will not be recorded as they do not provide any further information. The graph shows the different contacts for each treatment arm. The number of contacts is similar for both letter arms, unscheduled has the most contacts and scheduled has the least.

Contact type	Letter	No Letter	Total
Scheduled	27456	28602	56058
	16.0%	16.6%	16.3%
Unscheduled	99826	102759	202585
	58.3%	59.5%	58.9%
Total	171185	172743	343928

Table 4.4: Contact type and letter allocation

Table 4.4 is a contingency table for the contact types and the two letter groups. The table shows that 58.9% of the contacts were unscheduled, 16.3% were scheduled and that means 24.8% are recorded as missing. Of all contact types, 49.8% were on the letter arm and 50.2% were on the no letter arm.

4.4.2.2 Consultation Type

As well as different contact types, there are also different consultation types. There were 43 different types of consultation recorded in the data set. Table 4.5 provides the details of how many of each consultation type there were (see end of Chapter 4).

4.5 Results

4.5.1 Prescription Analysis

As the aim of the PLEASANT study was to encourage children to take their medication over the summer holidays, this means that some of the children may need to collect a new prescription. It is of interest to see whether the children picked up a prescription in August 2013 after receiving the letter intervention.

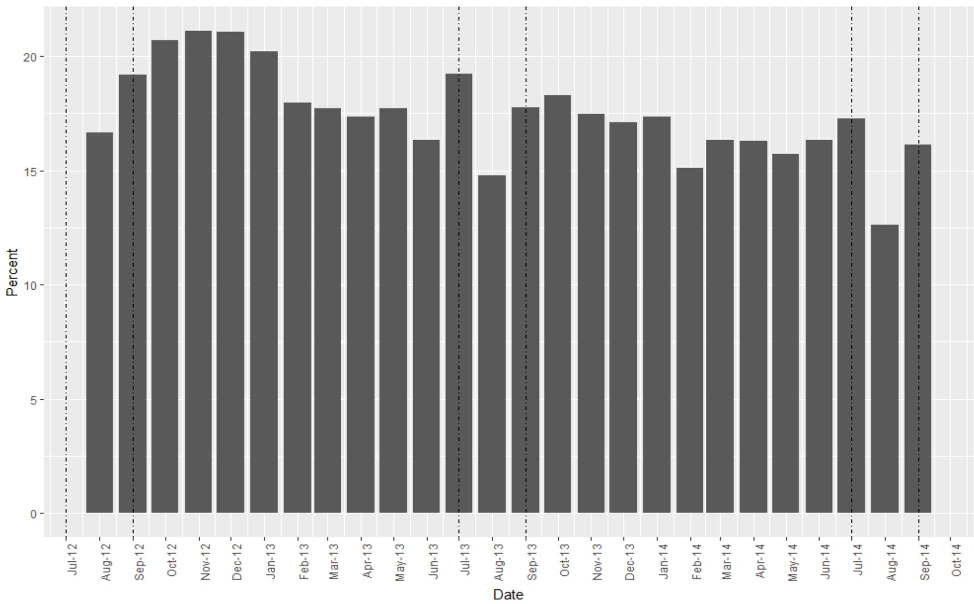


Figure 4.11: The number of children who collected a preventer prescription each month

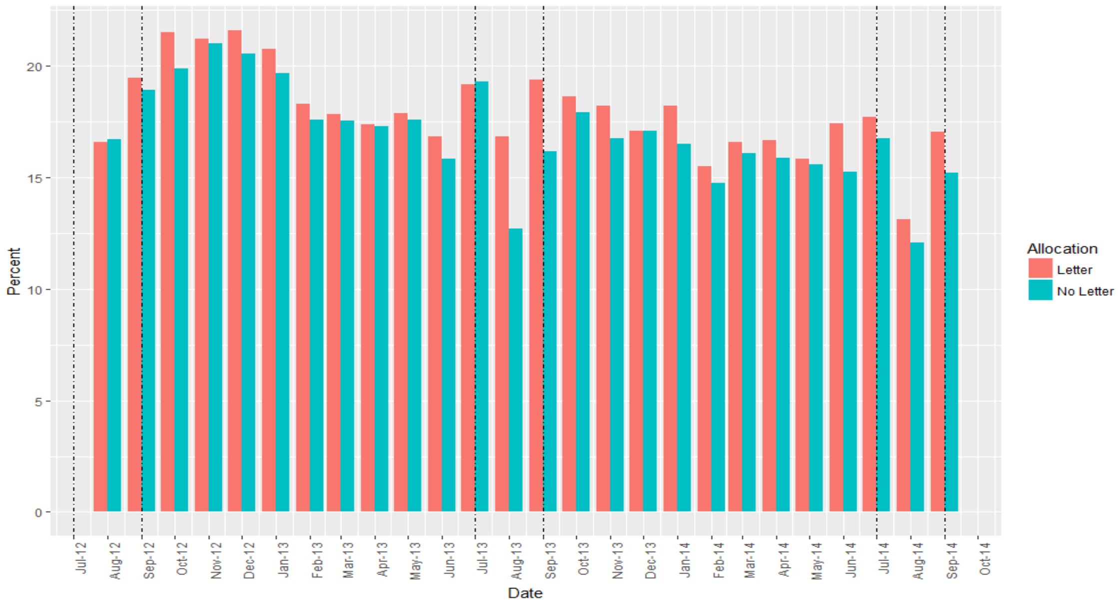


Figure 4.12: The number of children who collected a preventer prescription each month split by intervention arm

Figure 4.11 shows the number of children who picked up a prescription for their preventer inhaler each month. It is clear to see that there is a drop in the number of children who pick up inhalers in August each year. This is what the PLEASANT study is based on, and can still be seen in the PLEASANT dataset. Figure 4.12 shows the number of prescriptions picked up by the children split by letter arm. This figure was not presented in the the original PLEASANT analysis, however it clearly shows that in August 2013 more children collected their prescriptions on the letter arm. The plot also shows that this increase in prescriptions followed through into September 2013. This plot was included in the paper by Julious et al. (2018).

No. Prescriptions	Letter (N=4364)	No Letter (N=4361)
0	3621	3797
1	704	528
2	37	34
3	2	2

Table 4.6: Number of children who picked up a preventer prescription in August 2013

Table 4.6 shows the number of preventer inhalers picked up by the children in August 2013 split by allocation. There were similar numbers of children on each arm with regards to picking up prescriptions. More children on the letter arm picked up prescriptions. Figure 4.13 is a graphical representation of this.

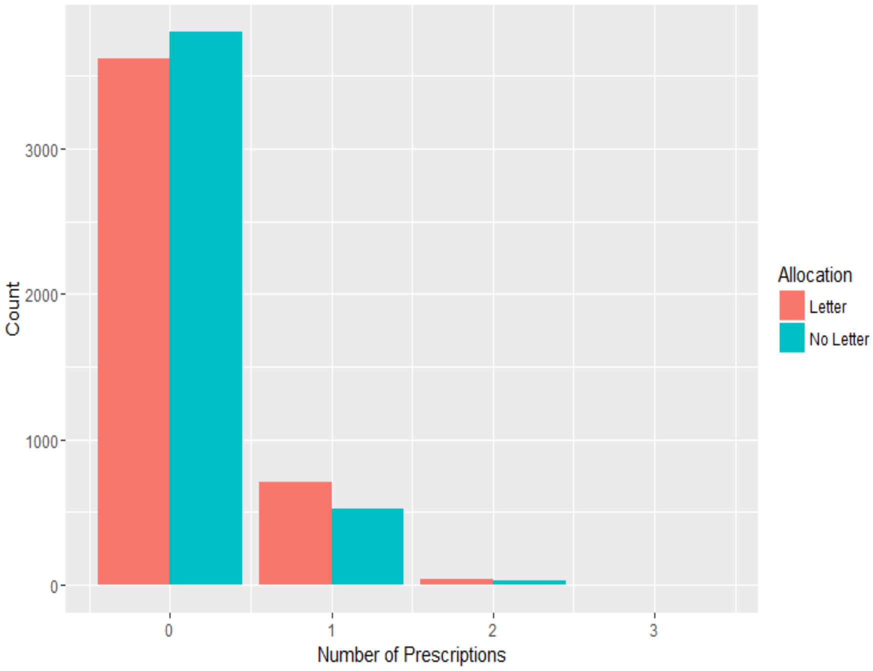


Figure 4.13: The number of children who collected a preventer prescription each month

4.5.1.1 Logistic Regression

Logistic regression was used to analyse whether the children picked up a prescription or not in August 2013.

	Dependent variable:
	Aug 13
Allocation (Letter)	1.44*
	(1.23, 1.69)
Age	0.98*
	(0.96, 0.99)
Gender (Female)	0.95
	(0.84, 1.08)
Aug 12	3.54*
	(3.09, 4.04)
Observations	8,725

Table 4.7: Logistic regression for prescriptions in August 2013 presenting odds ratios and 95 % confidence intervals

Table 4.7 presents the results from the prescription analysis. In this model the coefficient estimate for allocation is significant, suggesting that if a child was on the letter arm they were 1.442 times more likely to pick up a prescription in August 2013. Age was significant and suggested that as age increases, picking up a prescription decreases. Also, a child who picked up a prescription in August 2012 has increased odds of picking up a prescription in August 2013, this was estimated to be 3.535 times more likely.

4.5.2 Unscheduled Medical Contacts

The primary outcome was whether a child had an unscheduled medical contact in September 2013. Further secondary analyses were looking at unscheduled medical contacts within an extended period. For this section of the results, this endpoint at the different time periods are presented. First the number of contacts for each time period is provided, this is followed by the logistic regression results.

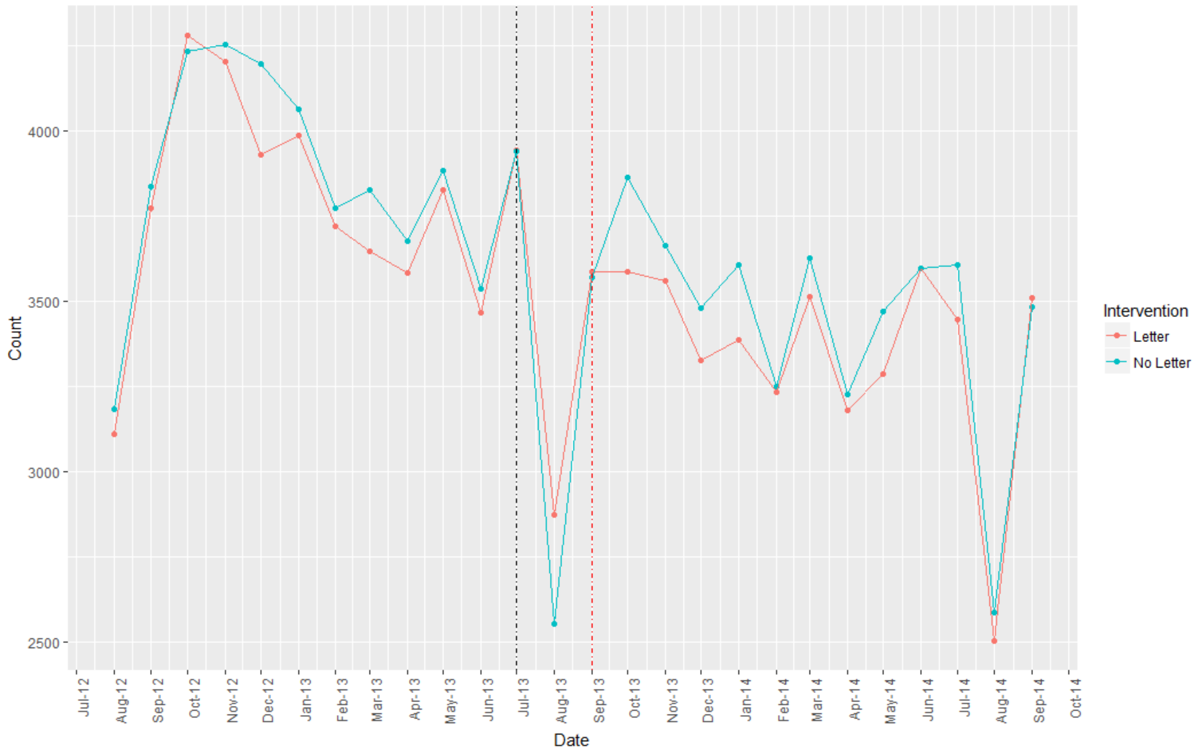


Figure 4.14: Time series plot for unscheduled medical contacts split by allocation

Figure 4.14 is a plot of the number of unscheduled contacts the children made each month within the study period. Again, this plot was not presented in the original PLEASANT analysis. This plot shows the peaks and troughs in the data set for unscheduled contacts. The plot shows that there was generally more contacts on the no letter arm compared to the letter arm. The plot also shows the difference in contacts for both arms after the return to school in September 2013; the peak was flattened out on the letter arm. This plot shows that in September 2013, there was little difference between the intervention and the control arm. However, the plot also shows that the wider interval, September to December 2013, has less contacts on the letter arm compared to the control arm. This plot was included in the paper by Julious et al. (2018).

	Contact Type	Letter	No Letter	Total
Sept 2013	Unscheduled	3586	3570	7156
		57.45 %	52.90 %	54.89 %
	Scheduled	1145	1299	2444
		18.34 %	19.12 %	18.74 %
Sept - Dec 2013	Unscheduled	14057	14575	28632
		54.91 %	54.74 %	54.82 %
	Scheduled	5034	5427	10461
		19.66 %	20.38 %	20.03 %
Sept 2013 - Aug 2014	Unscheduled	40206	41545	81751
		58.33 %	59.12 %	58.72 %
	Scheduled	10928	11725	22653
		15.85 %	16.68 %	17.04 %

Table 4.8: The number and percentage of any unscheduled medical contact

Table 4.8 shows the number and percentage of different contacts on the different intervention arms. The number of contacts between the the two arms are fairly balanced. There are slightly more unscheduled contacts on the letter arm, and slightly fewer scheduled contacts on the letter arm. Both extended endpoints (September - December 2013 and September 2013 - August 2014) show that again there is balance in the number of contacts on both the letter arms, but this time there are generally slightly more unscheduled contacts as well as scheduled contacts on the no letter arm.

	Contact Type	Letter	No Letter	Total
Sept 2013	Unscheduled	0.81 (1.54)	0.80 (1.68)	0.81 (1.61)
	Scheduled	0.26 (0.31)	0.29 (0.40)	0.28 (0.36)
Sept - Dec 2013	Unscheduled	3.19 (11.69)	3.28 (13.63)	3.24 (12.67)
	Scheduled	1.14 (2.19)	1.22 (2.13)	1.18 (2.17)
Sept 2013 - Aug 2014	Unscheduled	9.11 (71.62)	9.36 (86.30)	9.24 (78.99)
	Scheduled	2.48 (7.85)	2.64 (7.85)	2.56 (7.86)

Table 4.9: Mean (Variance) counts for unscheduled medical contacts

Table 4.9 shows the mean count of medical contacts at the different time points. In September 2013, the mean contacts is slightly higher for unscheduled contacts for the letter arm compared to the no letter arm. However, this changes as the endpoints are extended. For the extended endpoints, the mean contact is higher in the no letter arm. This is the case for both unscheduled and scheduled contacts. Table 4.9 also shows the variance of the data, which shows that the data is over dispersed as the variance is greater than the mean, suggesting that negative binomial regression is more appropriate than Poisson regression.

4.5.2.1 Logistic Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	1.12	1.15	0.95
	(0.96, 1.30)	(0.97, 1.36)	(0.79, 1.15)
Age	0.98 *	0.99	1.02
	(0.97, 0.99)	(0.98, 1.01)	(0.99, 1.05)
Gender (Female)	1.07	1.07	1.25
	(0.98, 1.16)	(0.96, 1.19)	(1.05, 1.49)
Sept 12	2.16*		
	(1.91, 2.36)		
Sept - Dec 12		3.07*	
		(2.68, 3.54)	
Sept 12 - Aug 13			6.18*
			(4.23, 9.02)
Observations	8,849	8,849	8,849

Table 4.10: Logistic regression with random effects for any unscheduled contact odds ratios and 95 % confidence intervals

Table 4.10 presents the results from the logistic regression model for the different time period endpoints. For all three models, allocation is not significant. However, the baseline previous contact is significant for all three models. For model (1) the odds ratio of having an unscheduled medical contact in September 2013, if you had one in September 2012 is 2.163. This means if a child had an unscheduled medical contact in September 2012, then they are 2.163 times more likely to have an unscheduled medical contact in September 2013 compared to those who did not have a September 2012 contact. Similarly for those who had a contact in the period September to December 2012, they are 3.076 times more likely to experience a contact in the period September to December 2013 compared to those who did not. And again for those who had a contact in September 2012 to August 2013, they are 6.178 times more likely. Another variable that was considered significant in model (1) was age. Age had the odds ratio of 0.984. This suggests as age increases by one unit, then the odds of having an unscheduled medical contact in September 2013 decreases by 0.016 %.

4.5.2.2 Negative Binomial Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	1.04	0.98	0.98
	(0.94, 1.14)	(0.92, 1.05)	(0.93, 1.02)
Age	0.99	1.00	1.01*
	(0.98, 1.00)	(0.99, 1.01)	(1.00, 1.01)
Gender (Female)	1.10*	1.06*	1.09*
	(1.04, 1.17)	(1.02, 1.12)	(1.06, 1.13)
Sept 12	1.25*		
	(1.22, 1.28)		
Sept - Dec 12		1.12*	
		(1.12, 1.13)	
Sept 12 - Aug 13			1.06*
			(1.06, 1.07)
Observations	8,849	8,849	8,849

Table 4.11: Negative binomial regression with random effects for any unscheduled contact presenting incidence rate ratios and 95 % confidence intervals

Table 4.11 presents the results for the negative binomial model for the number of unscheduled medical contacts the children had within different time frames. Similarly to the logistic regression results in Table 4.14 allocation is not significant and previous baseline medical contact is significant. For all three models, gender is significant, suggesting that being female increases the number of unscheduled medical contacts in the three different endpoints. For model (3) the extended time period, September 2013 to August 2014, age is significant, suggesting that as age increases, the more medical contacts.

4.5.3 Scheduled Medical Contacts

This section presents the results for scheduled contacts. The time point used for this was August 2013, as it was of interest to see whether the intervention caused the children to book an appointment to pick up their asthma medication after receiving the letter reminding them to do so.

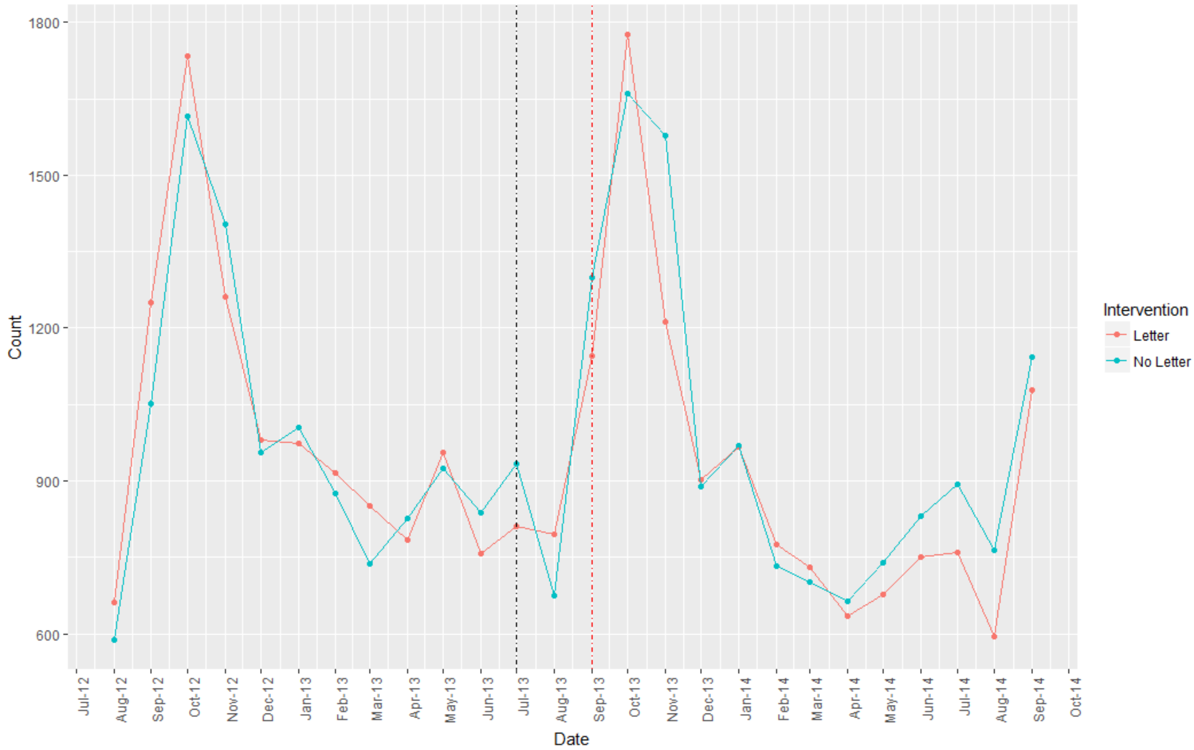


Figure 4.15: Time series plot for any scheduled medical contact

Table 4.12 shows that there were more scheduled and unscheduled medical contacts for those on the letter arm but a higher percentage on the no letter arm.

August 2013

Contact Type	Letter	No Letter	Total
Unscheduled	2871	2551	5422
	54.08 %	60.14 %	56.77 %
Scheduled	795	675	1470
	14.97 %	15.91 %	15.39 %

Table 4.12: The number and percentage of medical contacts in August 2013

Contact Type	Letter	No Letter	Total
Unscheduled	0.65 (1.00)	0.57 (1.10)	0.61 (1.05)
Scheduled	0.18 (0.22)	0.15 (0.18)	0.17 (0.20)

Table 4.13: Mean (Variance) counts for medical contacts in August 2013

Table 4.13 shows the mean counts for contacts in August 2013. The mean count of contacts is higher for both unscheduled and scheduled contacts for the letter arm compared to the no letter arm. The variance is greater than the mean, suggesting the data is over dispersed.

4.5.3.1 Logistic Regression

	Dependent variable:
	Aug 13
Allocation (Letter)	1.27
	(0.91, 1.78)
Age	1.02
	(0.99, 1.04)
Gender (Female)	0.95
	(0.84, 1.08)
Aug 12	2.01*
	(1.69, 2.38)
Observations	8,849

Table 4.14: Logistic regression with random effects for any scheduled contact presenting odds ratios and 95 % confidence intervals

Table 4.14 presents the results for the logistic regression model for whether the children had a scheduled medical contact in August 2013 or not. Again, allocation is not significant. Whether the child had a scheduled contact in August 2012 is significant, suggesting that those who did have a scheduled contact in the previous year are 2.006 times more likely to have a scheduled medical contact in August 2013.

4.5.3.2 Negative Binomial Regression

	Dependent variable:
	Aug 13
Allocation (Letter)	1.19
	(0.91, 1.56)
Age	1.01
	(0.99, 1.03)
Gender (Female)	0.95
	(0.85, 1.06)
Aug 12	1.44*
	(1.29, 1.56)
Observations	8,849

Table 4.15: Negative binomial regression with random effects for any scheduled contact presenting incidence rate ratios and 95 % confidence intervals

Table 4.15 presents the results for the negative binomial model for scheduled contacts in August 2013. Allocation was not significant and previous scheduled contact in August 2012 was significant.

4.5.4 Any Relevant Medical Contacts

This next section presents the analysis results for any relevant medical contact. This includes all contacts that were coded as scheduled or unscheduled, removing those that were coded as missing, which are considered as irrelevant.

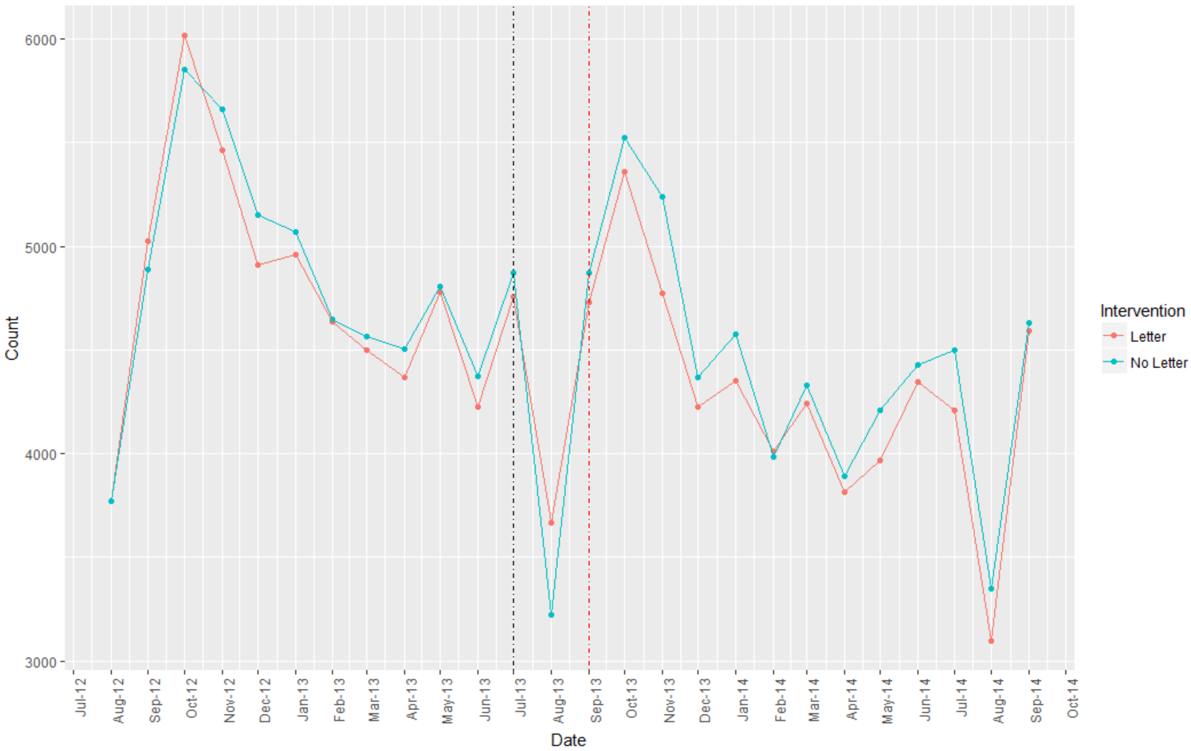


Figure 4.16: Time series plot for all relevant medical contacts

Table 4.16 shows that in general there were more contacts on the no letter arm for both relevant and irrelevant contacts. However, percentage of contacts suggest that there was a higher percent of relevant contacts on the no letter arm, and a higher percent of irrelevant contacts on the letter arm. Though this was not seen for September 2013 where there were more relevant on the letter arm and more irrelevant on the no letter arm.

	Contact Type	Letter	No Letter	Total
Sept 2013	Relevant	4731	4869	9600
		75.79 %	71.67 %	73.64 %
	Irrelevant	1511	1925	3436
		24.21 %	28.33 %	26.36 %
Sept - Dec 2013	Relevant	19091	20002	39093
		74.57 %	75.12 %	74.85 %
	Irrelevant	6510	6623	13133
		25.43 %	24.88 %	25.15 %
Sept 2013 - Aug 2014	Relevant	51134	53270	104404
		74.18 %	75.80 %	75.00 %
	Irrelevant	17800	17007	34807
		25.82 %	24.20 %	25.00 %

Table 4.16: The number and percentage of any relevant medical contact

	Contact Type	Letter	No Letter	Total
Sept 2013	Relevant	1.07 (2.10)	1.10 (2.45)	1.08 (2.27)
	Irrelevant	0.34 (0.66)	0.43 (0.72)	0.39 (0.69)
Sept-Aug 2013	Relevant	4.33 (17.62)	4.51 (19.83)	4.42 (18.73)
	Irrelevant	1.48 (4.73)	1.49 (4.60)	1.48 (4.66)
Sept 2013 - Aug 2014	Relevant	11.59 (103.96)	12.00 (121.84)	11.80 (112.96)
	Irrelevant	4.04 (24.40)	3.83 (23.11)	3.93 (23.76)

Table 4.17: Mean (Variance) counts for any relevant medical contacts

Table 4.17 shows the mean counts for the relevant medical contacts. For relevant medical contacts, the mean count in general is less in the letter arm compared to the no letter arm. The variance is greater than the mean, suggesting the data is over dispersed.

4.5.4.1 Logistic Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	1.00	1.09	0.89
	(0.78, 1.28)	(0.89, 1.34)	(0.70, 1.13)
Age	0.99	0.99	1.03
	(0.97, 1.00)	(0.97, 1.02)	(0.99, 1.06)
Gender (Female)	1.05	1.04	1.13
	(0.96, 1.15)	(0.92, 1.18)	(0.93, 1.37)
Sept 12	1.36*		
	(1.31, 1.41)		
Sept - Dec 12		3.69*	
		(3.09, 4.40)	
Sept 12 - Aug 13			6.39*
			(3.56, 11.47)
Observations	8,849	8,849	8,849

Table 4.18: Logistic regression with random effects for any relevant contact presenting odds ratios and 95 % confidence intervals

Table 4.18 presents the results for whether the children had a relevant contact at the different time period endpoints. Allocation was not significant and the previous baseline contact was significant. Age this time was not significant in any of the three models.

4.5.4.2 Negative Binomial Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	0.98	0.95	0.95*
	(0.87, 1.10)	(0.88, 1.02)	(0.91, 0.99)
Age	0.99	1.00	1.01*
	(0.99, 1.00)	(0.99, 1.01)	(1.00, 1.01)
Gender (Female)	1.07*	1.03	1.07*
	(1.01, 1.13)	(0.99, 1.07)	(1.04, 1.10)
Sept 12	1.21*		
	(1.19, 1.23)		
Sept - Dec 12		1.10*	
		(1.09, 1.10)	
Sept 12 - Aug 13			1.05*
			(1.05, 1.05)
Observations	8,849	8,849	8,849

Table 4.19: Negative binomial regression with random effects for any medical contact presenting incidence rate ratios and 95 % confidence intervals

Table 4.19 presents the results for the negative binomial model for any medical contacts the children had within different time frames. Allocation is not significant and previous baseline medical contact is significant. Models (1) and (3), gender is significant, both suggesting females have more medical contacts. For model (3) the extended time period, age is significant, suggesting that as age increases, the number of contacts increases.

4.5.5 Respiratory Related Unscheduled Medical Contacts

The next endpoint to be analysed was whether the children had an unscheduled respiratory related contact or not. Table 4.20 shows that the number of contacts are fairly consistent between the different time periods. Those on the letter arm have more unscheduled contacts and those on the no letter arm had more scheduled contacts.

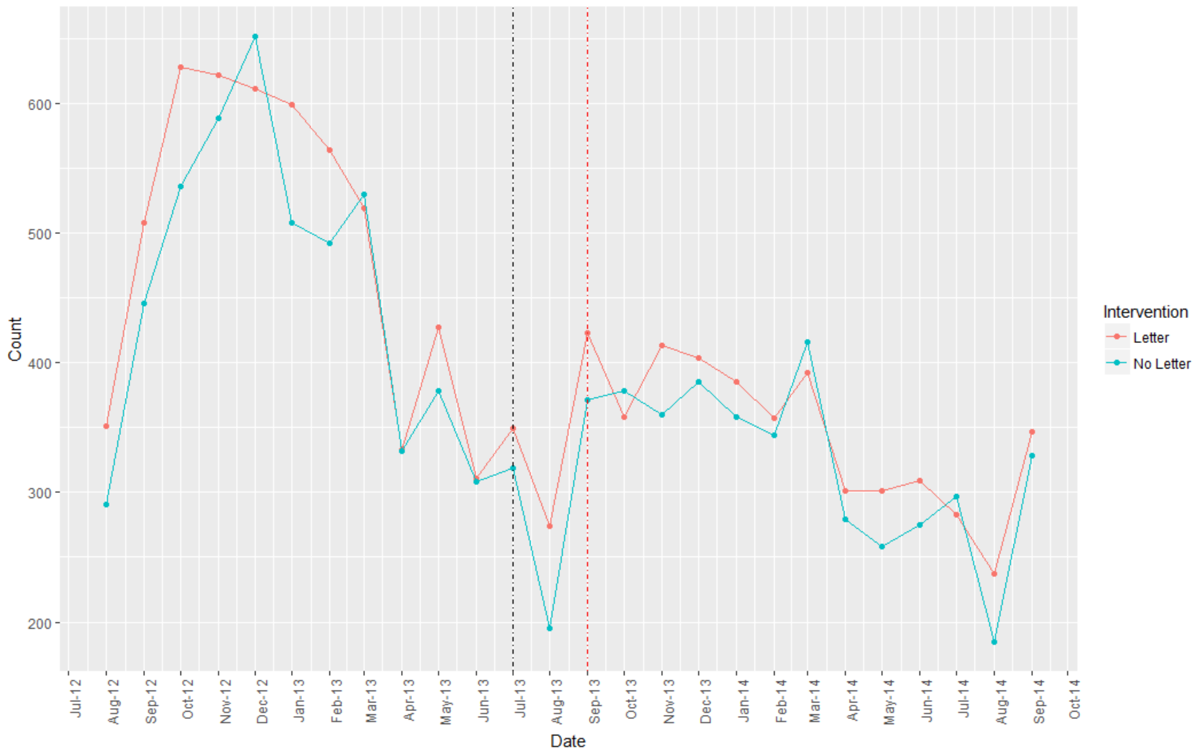


Figure 4.17: Time series plot for respiratory related unscheduled medical contacts

	Contact Type	Letter	No Letter	Total
Sept 2013	Unscheduled	423	371	794
		48.23 %	41.83 %	45.01 %
	Scheduled	356	403	759
		40.60 %	45.43 %	43.03 %
Sept - Dec 2013	Unscheduled	1598	1494	3092
		42.99 %	41.56 %	42.29 %
	Scheduled	1570	1637	3207
		42.24 %	41.56 %	43.86 %
Sept 2013 - Aug 2014	Unscheduled	4163	3906	8069
		42.39 %	42.14 %	42.27 %
	Scheduled	4137	4137	8274
		42.13 %	44.63 %	43.34 %

Table 4.20: The number and percentage of contacts for respiratory related medical contacts

	Contact Type	Letter	No Letter	Total
Sept 2013	Unscheduled	0.10 (0.13)	0.09 (0.12)	0.10 (0.12)
	Scheduled	0.09 (0.09)	0.10 (0.15)	0.09 (0.12)
Sept - Dec 2013	Unscheduled	0.39 (0.65)	0.36 (0.61)	0.37 (0.63)
	Scheduled	0.38 (0.54)	0.40 (0.59)	0.39 (0.57)
Sept 2013 - Aug 2014	Unscheduled	1.00 (2.28)	0.95 (2.18)	0.97 (2.23)
	Scheduled	1.00 (1.60)	1.00 (1.70)	1.00 (1.65)

Table 4.21: Mean (Variance) counts for respiratory related medical contacts

Table 4.21 shows the mean contacts for respiratory related contacts. The mean contact is higher in the letter arm for unscheduled contacts but there are fewer scheduled contacts for respiratory related contacts. The variance is greater than the mean, suggesting the data is over dispersed.

4.5.5.1 Logistic Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	1.17	1.10	1.05
	(0.95, 1.43)	(0.95, 1.28)	(0.89, 1.25)
Age	0.98	0.98*	0.99
	(0.95, 1.00)	(0.96, 0.99)	(0.98, 1.01)
Gender (Female)	1.05	1.14	1.08
	(0.89, 1.23)	(1.03, 1.26)	(0.96, 1.18)
Sept 12	1.98*		
	(1.59, 2.46)		
Sept - Dec 12		1.75*	
		(1.58, 1.94)	
Sept 12 - Aug 13			1.78*
			(1.62, 1.96)
Observations	8,276	8,276	8,276

Table 4.22: Logistic regression with random effects for any respiratory related contact presenting odds ratios and 95 % confidence intervals

Table 4.22 presents the logistic regression results for whether the children experienced an unscheduled respiratory related contact or not. The results show that allocation again is not significant for the three models. And again, the baseline previous contact is significant. Those who had a previous contact are more likely to experience a contact in same time period. Age was significant for model (2) which is the extended time period of September to December 2013. Again, this is a decrease, so as age increases, the odds of a medical contact in that time period decreases.

4.5.5.2 Negative Binomial Regression

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
	(1)	(2)	(3)
Allocation (Letter)	1.13	1.06	1.02*
	(0.92, 1.40)	(0.94, 1.20)	(1.09, 1.13)
Age	0.98	0.98*	9.99
	(0.96, 1.01)	(0.97, 0.99)	(0.99, 1.01)
Gender (Female)	1.11	1.17*	1.11*
	(0.94, 1.30)	(1.07, 1.28)	(1.04, 1.17)
Sept 12	1.69*		
	(1.44, 1.99)		
Sept - Dec 12		1.40*	
		(1.35, 1.46)	
Sept 12 - Aug 13			1.26*
			(1.24, 1.28)
Observations	8,276	8,276	8,276

Table 4.23: Negative binomial regression with random effects for any unscheduled respiratory related contact presenting incidence rate ratios and 95 % confidence intervals

Table 4.23 presents the results for the negative binomial model for the number of respiratory related medical contacts the children had within different time frames. Similary to the logistic regression results in Table 4.22 allocation is not significant and previous baseline medical contact is significant. For model (2) the extended time period, September to December 2013, age is again significant, suggesting that as age increases, the number of contacts decreases. Alongside this, gender has also been found to be significant, suggesting that being female increases number of medical contacts. Gender was also found to be significant in model (3).

4.6 Discussion

For the analysis of whether a child had an unscheduled medical contact or not, logistic regression was used. The results for the numerous endpoints were fairly consistent. Allocation was not statistically significant in any of the models, which suggests that being on the no letter arm or letter arm had no affect on whether the child had a medical contact or not. Whether the child had a medical contact in the previous year was significant in all of the models. This suggests that this is strong predictor as to whether a child will have a contact the following year. For a couple of models, age was found to be significant, suggesting that age could decrease the odds of having a medical contact, however this was not found in the other models.

Negative Binomial regression was used to analyse the number of medical contacts a child had at the different time frame end points. These results were similar to those of the logistic regression models, such that allocation was not found to be significant in any of the models and previous medical contact was. There were differences in the other variables. Gender was found to be significant in most of the models. It was found that being female increased the number of medical contacts in the different periods. This was not the case for scheduled contacts, this was not found to be significant, but the effect was the other way, being female decreased the number of scheduled medical contacts in August.

For the analysis of prescription data, logistic regression was used. This analysed whether a child picked up a prescription or not in August 2013 following the intervention. The results of this show that being on the letter arm did significantly increase the odds of picking up a prescription in August 2013. Age was also found to decrease the odds, and picking up a prescription the previous year also increased the odds.

4.6.1 Limitations

There are a number of limitations to the study analysis. The analysis of the study was used to look at how the letter had an affect on the results following the intervention. However, the analysis did not look any further than that.

The first limitation that can be discussed is the simplicity of the analysis. The data was daily counts for 2 years for 12,000 children. Looking at the graphs given in the logistic regression section of the results, the plots show the time series nature of the data. This is something that could be included in the further analysis of the data. Alongside this, interrupted time series could be used in this situation as the data has a time point when the time series pattern could change, which is when the intervention was sent out in July 2013. The analysis only looked at a snapshot in time and did not take time into consideration.

Another limitation of the study is that the primary endpoint was dichotomised. However, it was shown that PLEASANT may have increased the proportion of people who had contacts but in turn it reduced the mean number of contacts.

Another issue with the study is with the coding of scheduled and unscheduled contacts. It is believed that some of the contacts where a child picked up prescriptions, which may have been outside of their usual care routine and possibly a result of the letter, have been coded as unscheduled opposed to scheduled. The definition of an unscheduled contact includes contacts that were patient initiated, therefore contacts that were initiated by the patient as a result of the letter are likely to have been coded as unscheduled. This could have an impact on the results of the study, however, it is not possible to account for in any further analysis.

4.7 Conclusion

The results of this chapter suggest that the letter did not decrease the number of unscheduled contacts as hoped. However, the letter did increase the number of prescriptions picked up in August which was what the study also intended to achieve. As the number of contacts did not decrease when the number of prescriptions increased, this could imply that there is more to the September peak than just children not adhering to their medication. The results show that gender and age could play a role in the September peak, however, it is not clear how or why. This is what the next part of the study will look at in Chapter 5. The qualitative study was used to look at what else could be causing the children to have unscheduled medical contacts in September.

Practice ID	No. Patients	Mean Age	Std Dev Age	Females	Males	Allocation
1	28	12.56	2.65	8	20	Letter
2	194	10.59	3.30	71	123	No Letter
3	108	10.43	3.08	42	66	Letter
5	214	10.88	3.25	82	132	No Letter
6	125	11.09	3.23	53	72	Letter
8	65	10.35	2.85	27	38	Letter
11	131	11.33	2.86	56	75	Letter
12	38	10.53	3.14	15	23	Letter
13	95	11.30	2.97	35	60	No Letter
15	57	10.46	2.92	28	29	No Letter
16	47	10.48	3.21	24	23	Letter
17	55	10.13	3.03	24	31	No Letter
18	90	10.58	3.14	39	51	No Letter
19	63	10.25	3.21	23	40	Letter
20	75	10.69	2.90	23	52	No Letter
22	100	10.73	2.98	41	59	No Letter
23	13	11.08	2.31	8	5	Letter
24	49	11.12	2.95	18	31	Letter
25	78	11.17	3.15	29	49	Letter
28	18	10.80	4.02	9	9	No Letter
30	172	11.18	3.09	69	103	Letter
31	83	10.75	2.75	41	42	Letter
33	27	10.45	3.22	13	14	Letter
34	73	10.88	3.05	29	44	Letter
35	34	10.25	3.28	13	21	Letter
36	103	11.19	3.09	42	61	No Letter
37	96	11.59	2.98	40	56	Letter
38	31	10.83	2.87	13	18	No Letter
39	47	11.43	2.92	18	29	Letter
40	130	11.21	2.94	53	77	No Letter
41	71	10.79	3.07	24	47	No Letter
42	141	10.70	3.06	71	70	Letter
43	279	10.88	2.90	102	177	No Letter
44	49	10.65	3.35	17	32	Letter
45	108	10.89	3.03	43	65	Letter
46	41	12.14	2.75	17	24	No Letter
47	95	10.48	3.20	40	55	No Letter
49	86	10.99	3.25	33	53	No Letter
50	62	10.66	2.82	21	41	No Letter
51	73	11.02	3.16	28	45	Letter
52	40	11.40	3.33	21	19	Letter
53	21	11.10	3.31	7	14	Letter
55	97	10.58	3.10	33	64	Letter

Practice ID	No. Patients	Mean Age	Std Dev Age	Females	Males	Allocation
56	128	11.11	3.22	47	81	Letter
57	48	11.11	3.09	16	32	No Letter
58	159	10.51	2.92	62	97	No Letter
59	157	10.66	3.21	72	85	Letter
60	125	10.57	3.21	51	74	Letter
61	117	11.38	3.14	48	69	Letter
62	51	11.53	3.50	20	31	No Letter
63	71	10.87	3.13	28	43	Letter
65	35	11.05	3.11	16	19	No Letter
66	99	10.77	3.21	36	63	Letter
67	108	11.16	3.19	37	71	Letter
70	126	10.73	3.33	57	69	No Letter
71	87	11.50	3.13	35	52	No Letter
72	105	10.46	3.15	46	59	Letter
73	53	11.22	2.91	23	30	Letter
74	39	10.40	3.34	13	26	Letter
76	118	10.86	3.12	51	67	No Letter
77	87	11.00	3.29	37	50	Letter
79	20	11.61	3.44	8	12	No Letter
80	68	10.90	2.75	19	49	No Letter
81	16	9.70	3.10	7	9	No Letter
82	21	10.97	3.24	7	14	No Letter
83	256	10.53	3.16	96	160	No Letter
84	42	11.42	3.00	23	19	No Letter
85	51	9.51	2.74	23	28	Letter
86	65	10.62	3.21	22	43	Letter
87	104	10.56	3.07	33	71	Letter
88	96	11.19	3.17	38	58	Letter
89	11	10.68	3.19	5	6	Letter
91	55	11.54	3.10	20	35	No Letter
92	34	9.81	3.18	16	18	Letter
93	9	8.50	2.90	5	4	No Letter
94	53	11.20	2.90	21	32	No Letter
96	108	10.84	3.31	44	64	Letter
97	71	10.62	3.14	29	42	No Letter
98	103	10.68	3.46	48	55	Letter
99	96	10.98	3.39	35	61	No Letter
103	92	10.68	3.22	37	55	Letter
104	94	11.22	3.17	33	61	Letter
106	91	10.31	3.01	41	50	No Letter
107	37	11.14	2.70	14	23	Letter
108	51	11.44	2.89	18	33	Letter
110	69	10.39	3.31	23	46	Letter

Practice ID	No. Patients	Mean Age	Std Dev Age	Females	Males	Allocation
111	85	10.77	3.18	44	41	No Letter
113	105	11.04	2.96	42	63	No Letter
114	170	10.78	2.98	73	97	Letter
115	198	10.45	3.03	89	109	No Letter
116	35	11.70	3.01	9	26	No Letter
117	100	11.91	2.98	41	59	No Letter
119	8	12.89	2.30	5	3	No Letter
120	31	11.49	3.39	12	19	No Letter
121	95	10.70	3.13	34	61	Letter
122	67	11.41	2.93	20	47	No Letter
124	33	9.70	3.24	11	22	No Letter
127	40	10.87	3.06	13	27	Letter
128	41	10.26	3.68	18	23	Letter
129	40	10.11	3.06	11	29	Letter
132	151	10.88	3.13	64	87	No Letter
133	96	10.48	3.18	38	58	No Letter
134	62	10.09	3.18	24	38	Letter
135	38	10.37	2.93	17	21	No Letter
136	24	11.41	3.45	10	14	No Letter
137	87	11.65	3.07	24	63	Letter
138	65	11.49	2.98	27	38	No Letter
140	69	11.38	3.04	29	40	No Letter
141	66	10.94	3.40	29	37	Letter
142	115	10.95	3.28	48	67	No Letter

Table 4.3: GP practice demographics

Consultation Type	Letter	No Letter	Total
Acute visit	35	38	73
Administration	43068	35839	78907
Casualty Attendance	322	35	357
Children's Home Visit	1	2	3
Clinic	5754	3891	9645
Co-op Home Visit	2	1	3
Co-op Surgery Consultation	0	210	210
Co-op Telephone advice	0	112	112
Data Transferred from other system	0	2	2
Day Case Report	5	4	9
Discharge details	331	363	694
Emergency Consultation	920	1328	2248
Follow-up/routine visit	2	17	19
Home Visit	26	43	69
Hospital Admission	48	0	48
Letter from Outpatients	1076	547	1623
Mail from patient	114	11	125
Mail to patient	5106	6758	11864
Medicine Management	1608	1836	3444
Minor Injury Service	6	7	13
NHS Direct Report	4	3	7
Night visit, Local rota	0	1	1
Non-consultation data	47	59	106
Non-consultation medication data	87	104	191
Nursing Home Visit	1	0	1
Other	20663	16832	37495
Out of hours, Non Practice	1990	1990	3980
Out of hours, Practice	2	18	20
Radiology Result	4	0	4
Referral Letter	129	13	142
Repeat Issue	20375	22723	43098
Residential Home Visit	11	5	16
Results recording	5315	6082	11397
Surgery consultation	35351	42863	78214
Telephone call from a patient	1550	1707	3257
Telephone call to a patient	1560	3221	4781
Telephone Consultation	1	4	5
Third Party Consultation	22886	22207	45093
Triage	2700	3857	6557
Twilight Visit	1	4	5
Walk-in Centre	84	6	90
Total	171185	172743	343928

Table 4.5: Consultation types

5. Qualitative Study

5.1 Introduction

The previous chapter included the re-analysis of the PLEASANT study data. This chapter concluded that there were potentially factors, other than lack of adherence, that could be contributing to the peak in September medical contacts. This chapter looks further into what these other factors could be by exploring the views of children with asthma in an interview study.

Quantitative research methods are good at finding *the which, the who* and *the what* in data but they are not good at finding out *the why*. Quantitative approaches can be used to find who are more likely to have an unscheduled medical contact and what factors put people at a higher risk, but it cannot explain why (Crombie and Davies, 1996). Qualitative research can use different methods to gain perspectives of different individuals to try to understand *the why* in the research topic.

The qualitative interview study consisted of interviews with children aged 5 to 15 who had been diagnosed with asthma. The aim of the qualitative interview study was to speak to children with asthma to get their perspective on the factors that cause asthma exacerbations and possible reasons as to why they may not take their medication. The children were able to provide their own insight as to why there is a peak in unscheduled medical contacts at the start of the new school year. The results from the interview study were then used to determine potential 'at risk' sub-groups, which were tested in the quantitative analysis.

5.2 Chapter Aims

The aims of this chapter are:

- To provide a description of various qualitative methods that could be used for the study and reasoning for the methods chosen.
- To provide details of the methods used, the analysis and the results from the qualitative study.
- To discuss the results and how these results were used to inform the next phase of the Ph.D. study.

5.3 Methodology

This section provides a description of different data collection methods, other processes that are involved in the data collection methods, sampling techniques and sample sizes that are used in qualitative research, and finally, different analyses that can be used.

5.3.1 Data Collection Methods

There are a number of different methods that can be used to collect data in qualitative research. These include interviews, focus groups, ethnographies, surveys, text documents, and the internet (Silverman, 2013).

Some of the methods mentioned, such as ethnographies, text documents, and internet are not suitable methods of data collection for this research project. Ethnography involves the researcher immersing themselves in the daily lives of the population of interest. The researcher will watch what is happening, listen to what people are saying, and ask questions (Hammersley and Atkinson, 2007). This approach suggests that the only way the researcher will truly understand the topic and population of interest is to submerse themselves into the populations lives. Nevertheless, it can be difficult to gain access to the peoples lives. This method is not suited to this research project as it would involve the researcher going to the homes of children with asthma or their schools and observing them for a great amount of time to see whether they have an asthma exacerbation in September. This would involve following the life of a small number of individuals which would not give the depth or breath of information required for this study.

Similarly for narrative analysis, of texts documents and internet sources, it would be difficult to find the answers needed to inform the quantitative level of this study which requires the insight of children with asthma on unscheduled medical contacts as opposed to generic data on asthma. Narrative analysis looks at the way people tell the story of their past experiences, rather than the facts (Sandelowski, 1991). This is not the interest of this study therefore narrative analysis was not suitable.

5.3.1.1 Interviews

Interviews are used in qualitative research as a method of collecting data. A research interview is defined as:

> "An interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena." (Kvale, 1996, p. 5-6)

Which essentially means, an interview is a structured conversation with a purpose and an aim (Kvale, 1996). There are three different types of interview that can be used in qualitative research, these are:

- Structured Interview.
- Semi-Structured Interview.
- Unstructured Interview.

A structured interview is as it describes, an interview that follows a structure with fixed questions which tend to be closed questions. Closed questions means that there is a choice of answers to be chosen from for each question. This would be of limited value to this study which needs to obtain information on a predominately unexplained topic. Although, open questions can also be used in a structured interview, which are more suitable for qualitative analysis, they are more of a challenge to interpret (Wilkinson et al., 2004; Bryman, 2012).

A semi-structured interview is similar to a structured interview, as it has a set of questions that will be asked of the participants but they give the interviewer the flexibility to adapt the order or focus in response to the information provided by the participants. The questions created for a semi-structured interview are more of a guide/reminder for the interviewer when conducting the interview; Not all questions will be asked. Usually for a semi-structured interview, a topic guide will be used for the questions (Discussed in section 5.4.1.1). The main purpose of a semi-structured interview is to address the research topic from the participants perspective (Bryman, 2012).

An unstructured interview uses, at most, a brief set of topics to guide the interview. The unstructured interview is conducted like a conversation where the interviewer will ask questions which build upon the interviewee responses allowing for additional probing to gain the perspectives of participants (Bryman, 2012).

Semi-Structured Interviews (SSI)

As the interviews were with children, SSI seemed more suitable for this project, compared to structured or unstructured as it provides the children with the opportunity to talk more freely. In SSI it is important to use open ended questions where possible to prevent the interviewee only answering yes or no to the question (Wilkinson et al., 2004). They aim to prompt the interviewee to discuss and describe their response in detail. Structured interviews with children would be limited to only answering set questions. It would not give children the opportunity to mention something that is important to them. Therefore, using the SSI method allows the interviewer to ask questions related to what is important to the child and allows the child to raise topics the interviewer had not considered relevant or important. It also enables future interviews to explore new unexpected issues/themes that develop during the interviews. An unstructured interview is more favourable in this setting compared to a structured interview, but an unstructured interview has less focus than a SSI. Using a SSI provides a focus and creates some consistency in the questions asked between interviews (Wilkinson et al., 2004; Bryman, 2012). Conducting unstructured interviews with children would require a strong facilitator to guide the children to stay on track of the topic information. As a Ph.D. student having some structure to the interview would be an advantage (Wilkinson et al., 2004; Greene and Hogan, 2005; Gibson, 2012).

Conducting interviews can be challenging. The interviewee, for example may be reluctant to speak. To encourage participants to speak it is important to provide support. This can include asking them generic introductory questions to start, followed by specific questions with further probing to gain a greater understanding of their views. Allowing for some silence, can signal to the interviewee that the interviewer would like more information or give time for the interviewee to consider the question (Bryman, 2012; Green and Thorogood, 2014). Sometimes it can be difficult to keep the interviewee on track with the topic that is being researched. In this situation, the interviewer could ask more direct questions to regain the focus of the interviewee or simply remind them of the focus of the interview 'Can I just go back to x'. Other problems can occur; the interviewee could contradict themselves which requires the interviewer to be alert and to probe further, otherwise it could make analysis difficult. They could talk about a sensitive topic (Wilkinson et al., 2004); if this happens then this may need to be removed from the transcript if they are not happy with it being used for the research.

5.3.1.2 Focus Groups

A focus group is a discussion which has more than one participant, ideally around 4-8 (Wilkinson et al., 2004), but there can be more and can be less (Barbour, 2007; Bryman, 2012). Having more people in the interview can create richer data and it is a more efficient method of collecting lots of data. For this project, a focus group is defined as a group interview which has more of a focus, so includes participants that have experience in the area which is being covered in the interview (Bryman, 2012). The aim of a focus group is to allow the participants to 'bounce' ideas off one another and develop them together, the interviewer is to play as little part in the interview as possible (Bryman, 2012).

Focus groups benefit from allowing the participants to develop ideas together, challenge each other, giving participants the opportunity to discuss and share experiences and explore different perspectives and prompt others to recall similar experiences (Bryman, 2012). However, focus groups and individual interviews can suffer from the participants responding with what they think the interviewer wants to hear. Having more than one person participating has advantages, as they might mention something of relevance that others might not have considered bringing up but there may be consensus of the importance of the topic (Bryman, 2012). Participating in a group setting can give participants the confidence they need to speak, it provides participants the opportunity to discuss similar and different views they might have, and being in a group provides a more natural setting (Green and Thorogood, 2014).

Focus groups do have their disadvantages though, as some people might not want to express their views if they disagree with what everyone is saying. Participants with a confident personality may dominate the discussion, causing others to remain silent. As there will be a few people in the group discussing what is being said, they may all speak over each other making analysis difficult. Again, managing these situations requires a strong facilitator who must try to encourage all individuals to participate in the focus group and set ground rules at the start of the focus group to maintain order within the focus group setting (Gibson, 2012). Organising focus groups can be difficult when trying to coordinate a number of people to attend. The main ethical issue with focus groups can occur when participants share personal/sensitive information. The participants would be asked to treat such information as confidential, however the researcher has no control over this aspect.

Focus groups are useful when exploring a wide range of similar and opposing perspectives. Focus groups that can be with people with similar characteristics, such as an illness, or with people with different characteristics. For example, different age groups, different severities or different professions (Green and Thorogood, 2014).

5.3.1.3 Chosen Method

Prior to the interview study, a pilot study was planned to test children's preference for either a focus group or an individual interview. However, the pilot was not undertaken as work by Stevens (2008) explored the option of doing an individual interview or in a small group with children. Of the 76 children, 74 chose individual interviews and the remaining two completed the interview as a pair. Alongside this, work by Heary and Hennessy (2006) suggested that there is no preference to which method should be used, it is dependent on the nature of the work. Also, as the topic area was asthma this could be deemed sensitive, therefore semi-structured interviews were chosen over focus groups.

As qualitative work is new to the project researcher, the use of a topic guide to facilitate the interviews was considered advantageous to support the conduct of semi-structured interviews.

5.3.2 Sampling

Probability and non-probability sampling are the two main types of sampling used for qualitative research. Probability sampling is used more in quantitative methods, although it can be used in qualitative methods. Probability sampling is used to create a probability sample which is defined in Bryman (2012) Social Research Methods as:

> "A sample that has been selected using random selection so that each unit in the population has a known chance of being selected. It is generally assumed that a representative sample is more likely to be the outcome when this method of selection from the population is employed." (Bryman, 2012, p. 187)

Non-probability is used to create a non-probability sample which is again defined by Bryman (2012) as:

> "A sample that has not been selected using a random selection method. Essentially, this implies that some units in the population are more likely to be selected than others." (Bryman, 2012, p. 187)

Non-probability sampling will be the main focus of this sections as it is applied more in qualitative methods (Green and Thorogood, 2014).

5.3.2.1 Non-Probability/Purposive Sampling

Non-probability sampling or purposive sampling is used when selecting participants to be used in the study, keeping the research question in mind when choosing them. The aim of purposive sampling is to include 'information-rich cases' in the study. The participants are chosen on purpose based on relevant characteristics to be included in the study (Bryman, 2012; Green and Thorogood, 2014; Silverman, 2013).

Typical Case Sampling (Bryman, 2012, p. 419) defines typical case sampling as "Sampling a case because it exemplifies a dimension of interest" . This means that the participants are typical (normal) participants that will be similar and comparable to each other. So in terms of this project, the sample would be children with mild to moderate asthma symptoms. Children with severe asthma would not be included as these could be classed as an extreme case, which is defined in the next paragraph.

Extreme or Deviant Case Sampling The definition for extreme or deviant case sampling given by (Bryman, 2012, p. 419) is "Sampling cases that are unusual or that are unusually at the far end(s) of a particular dimension of interest". Where the researcher would recruit atypical cases (Silverman, 2013). For this project that could be children with severe or uncontrolled asthma at one end of the scale and those with extremely well controlled or mild asthma at the other end of the scale. This method allows the data to be compared and contrasted and also enables the researcher to determine whether certain views are related to severity rather than just having asthma.

Maximum Variation Sampling Maximum variation sampling is defined as "Sampling to ensure as wide a variation as possible in terms of the dimension of interest" (Bryman, 2012, p. 419). This means the sample will include the whole range of participants to get a large variation in the characteristics of the participants included in the study. In terms of the project, this would be children with all different severities of asthma or different ages.

Snowballing Sampling Snowball sampling involves starting with a small sample of participants and then they suggest future participants for the study. This is because the participants are likely to know other people who would also be suitable for the study (Bryman, 2012).

Snowballing works particularly well in samples that are hard to reach, for example drug users and homeless, where it is difficult to have a sampling frame (Bryman, 2012).

With regards to this project, typical case, maximum variation and snowballing would be the most suitable. Having just the extreme cases would be unlikely to answer the research question, as this group would be too focused. However, having the extreme cases as well as typical, in other words, maximum variation would provide the demographics required to answer the aims of the study.

5.3.2.2 Sample Size

When performing interviews, the aim is to reach saturation during qualitative analysis. This means, interviews are conducted until no more new themes/topics emerge from discussions. Prior to the data collection it is difficult to know how many interviews it would take to reach saturation and produce conclusive results (Kvale, 1996; Bryman, 2012; Silverman, 2013; Green and Thorogood, 2014).

An article by Guest et al. (2006) discusses reaching data saturation in a study conducted in two countries in West Africa which was interested in how women in these countries talk about sex and their perceptions on accuracy of self reporting. For the study, 60 interviews were completed, 30 in Ghana and 30 in Nigeria. The aim of the study was to determine at what point this study actually reached saturation. They first worked through the 30 Ghanaian interviews and then worked through the 30 Nigerian interviews. After looking at the first 12 interviews, 92% of the themes for the Ghanaian interviews had already been discovered and 88% of all the themes had been found. They also noted that there were only 5 new topic codes that emerged from the Nigerian interviews, but of these 5 codes, 4 of them were considered variations of existing codes rather than new codes. The writers of this article believe that if the aim of the research interviews is to gather shared belief, behaviour or perception in a homogeneous group or people, they recommend a sample of 12 interviews (Guest et al., 2006). However if the aim is to find how groups differ over a particular characteristic then a sample of 12 interviews is needed for each group.

5.3.3 Analysing Qualitative Data

For this study, thematic analysis was considered the most suitable for the research aims when compared to content analysis, grounded theory and discourse analysis.

Content analysis process is similar to thematic analysis but differs at steps 5 and 6 (described in section 5.3.3.1). Instead of analysing what people said and using quotes as evidence to explain different concepts, the codes are counted. This can be used to determine which codes are considered more important based on their frequency in the dataset (Marks and Yardley, 2004; Bryman, 2012). Therefore, this method is considered partly quantitative as it turns the qualitative words into numbers (Marks and Yardley, 2004). As the research project wants to explore what a range of individual children have to say about their asthma and the details of the concepts, contents analysis was not considered appropriate.

Grounded theory develops theories from the data where no preconceived theories exist (Bryman, 2012; Green and Thorogood, 2014). The methods used in grounded theory are similar to those used in thematic analysis, however grounded theory requires that the researcher does not start with any prior hypotheses and theories should develop solely from the data (Silverman, 2013; Smith, 2015). As this research project was testing pre-existing theories and looking for further details, grounded theory was not appropriate for this study.

Discourse analysis looks at the way people say things and the use of language (Bryman, 2012; Smith, 2015), rather than the content of the views. This project is interested in what causes the peak in September and why children might not take their medication, not the way children articulated their views.

5.3.3.1 Thematic Analysis

Thematic analysis is a method used with qualitative data that looks for distinct themes in the data (Marks and Yardley, 2004; Braun and Clarke, 2006; Bryman, 2012; Green and Thorogood, 2014). A theme is something that is important to the research question and participants and has some repetition and pattern throughout the data set (Braun and Clarke, 2006; Bryman, 2012). The article by Braun and Clarke (2006) provides a 6 steps description of thematic analysis, these steps are:

1. **Immerse Yourself in the Data** - This step requires the researcher to familiarise themselves with the data set. This includes the researcher transcribing the audio recordings and reading the transcripts fully before starting the coding.

2. **Creating Codes** - After getting to know the data set, the researcher can begin to create codes for parts of the data set that appear important in regards to the research questions. General advice is to create as many relevant codes as possible in the time available, the codes may become more important later on.

3. **Creating Themes** - This involves grouping the codes together under common themes. This is done by looking at codes that are similar or related in some way and this connection could be one of the overall themes for the analysis.

4. **Checking the Themes** - This involves checking the themes that have already been created. This can be done in two stages: The first stage is looking at the codes and the corresponding text and seeing whether they fit within the theme they are under. The second stage is looking at the themes within the context of the whole data set.

5. **Theme Definitions and Names** - This involves 'defining and refining' what the theme means by looking at what each theme is about and what it explains

about the data set. Within each theme, analysis is conducted including looking at how the themes help answer the research questions.

6. **Write it up** - The final step includes writing up the report for the analysis to explain how the data and the analysis answer the research question. This will involve taking quotes from the dataset to support the interpretation of the findings.

For this project the analysis used both deductive and inductive approaches to enable exploration and testing of themes that had already been identified and also the development of further themes from the data set (Creswell, 1994; Fereday and Muir-Cochrane, 2008).

5.3.4 Further Considerations

Throughout the whole qualitative data collection and analysis process it is important for the researcher to be reflective about how their actions and personality can be reflected in the data (Silverman, 2013). It is important that the researcher tries to prevent their values and opinions biasing the data, for example, by asking certain or leading questions. The researcher should take into consideration their beliefs and assumptions when conducting the analysis and writing it up and should reflect on how this could have affected the results (May and Perry, 2010).

5.4 Methods

The interviews were conducted in two stages, the first stage was completed in June - July 2016 before the summer break and the second stage was completed in September 2016 - January 2017 following the summer break. There were two main reasons why the interviews were completed in two rounds. Firstly, to test the theories on the impact of the summer holidays emerging from PLEASANT. Secondly, allowing for a break between the interviews to undertake analysis and interpretation and testing of emerging theories in the second set.

This section will first provide information on other methods that are used alongside interviewing, followed by details on the methods used in the study.

5.4.1 Interview Procedure Methods

Interviews involve a number of related tasks such as developing a topic guide, recording and transcribing. As this research project involved children, games and tasks were created for use in the interview to maintain the children's focus and make the whole process more interesting.

5.4.1.1 Topic Guide

An interview topic guide is not too dissimilar to a set of questions for a structured interview. However, an interview topic guide is used more as a reminder to the interviewer during the interview. The interview topic guide can consist of a list of questions in topic areas that should aim to be covered, with prompts for the interviewer to refer to (Bryman, 2012).

To ensure the participant's perspective on the study is obtained, the interview topic guide is informed by the research question and relevant literature. Alongside the research question, topic areas are created which are used to cover the research question. Within these topics, questions and prompts are constructed to be used in the interview as questions, reminders or as a guide (Bryman, 2012).

When creating the interview questions, it is important to use open ended questions where possible. Questions should avoid introducing bias in the results by not asking leading questions. The language used in the questions should be suitable for the audience. Also, it is useful for the interview that the questions be grouped into a suitable order on the topic guide as this will make the interview process easier (Bryman, 2012).

5.4.1.2 Recording

During the interviews it can be difficult to take notes on everything that is said because the interviewer is focusing on the discussion, responses and ensuring appropriate engagement. Note taking takes a lot of concentration from the interviewer, decreasing their ability to observe interactions and body language and vital cues from the participant could be missed. Audio recording allows what the interviewee said to be analysed and the way they said it to be analysed. Transcribing the interview verbatim provides an accurate account of the discussion.

There can be some disadvantages to audio recording. Firstly, the participant may not feel comfortable with being recorded (Bryman, 2012) and may withdraw their consent to recording at any stage during the process. Participants can act differently when they know they are being recorded (Bryman, 2012) and they may choose not to express as much information and detail as they would off the record. Secondly, background noise can make it difficult to accurately transcribe (Hammersley and Atkinson, 2007). Finally, the recording device might fail, therefore it is important to use two to provide a backup.

At the end of the interview, it is a good idea to keep the recorder on, participants can often add extra information at the end of the interview that they forgot during the interview.

Consent for audio and video recording from the participants needs to be obtained before the interview has started with participants being made aware that they are being recorded. This is normally included in the interview consent process which gives an opportunity to explain how anonymous responses will be used in the research project and possibly future research projects (Green and Thorogood, 2014). To prevent others identifying participants it is important to anonymise the details of the interview giving alternative names or initials. Participants should be reminded that they are allowed to withdraw consent at any point after they have entered the study (Bryman, 2012). If this situation occurs, then it should be dealt with in the appropriate manner which would be defined in the methods of the protocol.

5.4.1.3 Reflective Diary

Keeping a reflective diary or field notes is a process normally done by ethnographers (Hammersley and Atkinson, 2007) but it can be taken up by any qualitative researcher. A reflective diary allows the researcher to take notes of what occurred during the interviews and to record their thoughts immediately after. This ensures that important information or observations are not forgotten especially if data collection occurs over an extended time frame or when multiple interviews are conducted within a short time frame. It is also a good idea for the researcher to write their own reflection of the event in the diary as soon as possible after the event. This is helpful when looking back through the diary and to support the interpretation of the data; it can also be useful to jog the researchers memory of the interview participants (Silverman, 2006; Bryman, 2012)

5.4.1.4 Transcription

It is suggested that one hour interview can take 5 to 6 hours to transcribe (Bryman, 2012) which should be taken into consideration when planning interviews. It is preferable that the researcher to transcribe the interviews straight after the interview. This can make it easier to transcribe as they will recall the content of the interview. It can be very daunting for the researcher to leave all the transcribing until all the interviews are completed; if left too long they may also forget the participant (Bryman, 2012). Transcribing the interviews throughout the process will help the researcher start to notice themes that are developing in the interviews which could be explored in later interviews providing the opportunity to develop greater depth and breadth of insight.

5.4.1.5 Research Paradigm

Using a mixed methods approach makes it difficult to pick a research paradigm or philosophical world view that can incorporate both the quantitative and qualitative research methods.

A pragmatic world view is often suggested for mixed methods research. Creswell (2013) defines pragmatism as a world view that is more concerned about what works and provides a solution to the research problem. This world view takes an approach which involves all approaches and methods that can be used to understand the research problem (Rossman and Wilson, 1985; Patton, 1990).

Creswell (2013) states that a pragmatic world view is not confined to one philosophical world view. This allows the researcher to pick methods that are best suited for their research purposes (Teddlie and Tashakkori, 2009). Given the freedom associated with the pragmatic world view, it would be sensible to conduct this mixed methods research project under this paradigm. Pragmatism can be thought of as problem centred and as a real-world practice oriented view (Creswell, 2013). This is an appropriate paradigm for this project as it is looking at why there is an increase in the number of unscheduled medical contacts in September.

5.4.2 Study Methods

5.4.2.1 Sample

Purposive sampling was used to recruit children aged 5-16 for the study through local primary and secondary schools in South Yorkshire and Derbyshire. To enable a comparison between primary and secondary school, an attempt was made to recruit equal numbers of children in each school age group, including gender. All children except those who could not communicate in English and those with special needs who were excluded based on the schools or parents judgement of their ability to participate, were invited to take part. Although the Ph.D. study did not have sufficient resources to facilitate employment of a translator it was not anticipated that this to cause a problem due to the schools recruited. Siblings were recruited to compare any differences or similarities.

In the initial planning stages, the aim was to recruit 24-30 children, 12-15 children in each age group, or until thematic saturation was reached (Guest et al., 2006). However, 38 children were recruited into the study giving a wider sample and a larger dataset to analyse. A larger sample of children was recruited to explore the new emerging themes from the first part of the study.

Table 5.1 and Table 5.2 provide demographic information for the children in both sets of interviews. The first table provides information on the sample as a whole and the second has information about each individual child including information on asthma severity. This variable was defined by the researcher based solely on the inhaler information provided by the children and by national guidelines (Colice, 2004). In the consent form children were asked to say which medications they were on and were given 6 options; blue inhaler, brown inhaler, green inhaler, purple inhaler, steroids and other. The children were asked to tick all that applied. This information was used to categorise the children's asthma severity.

- Mild asthma - Blue inhaler only
- Moderate asthma - Blue and brown inhaler
- Severe asthma - Blue and green or purple inhaler and/or other
- Very severe asthma - Blue and brown or green or purple and/or other AND steroids

Inhaler information was used to define severity as this was the information available. However, asthma treatment does not necessarily define asthma severity. Severity is also based on asthma control. For example, a child could be taking a blue and a brown inhaler but having frequent asthma episodes which would suggest that their asthma is not controlled and therefore severe. Similarly, for a child using a green or a purple inhaler, they may experience very infrequent asthma symptoms because their asthma is under control and therefore mild. However, given the data available on their asthma medication this was a potential marker for severity.

Variable	Category	Total (N=38)	Before Summer (N=17)	After Summer (N=21)
Gender	Female	25 (65.8%)	8 (47.1 %)	17 (81.0 %)
	Male	13 (34.2 %)	9 (52.9 %)	4 (19.0 %)
Age	5-7	6 (15.8 %)	5 (29.4 %)	1 (4.8 %)
	8-11	17 (44.7 %)	8 (47.1 %)	9 (42.9 %)
	12-14	14 (36.8 %)	4 (23.5 %)	10 (47.6 %)
	15-16	1 (2.6 %)	0 (0 %)	1 (4.8 %)
School	State	20 (53.6 %)	13 (76.5 %)	7 (33.3 %)
	Independent	18 (47.4 %)	4 (23.5 %)	14 (66.7 %)
	Primary	20 (53.6 %)	13 (76.5 %)	7 (33.3 %)
	Secondary	18 (47.4 %)	4 (23.5 %)	14 (66.7 %)
Severity	Mild	7 (18.4 %)	3 (17.6 %)	4 (19.0 %)
	Moderate	19 (50.0 %)	8 (47.1 %)	11 (52.4 %)
	Severe	8 (21.1 %)	5 (29.4 %)	3 (14.3 %)
	Very Severe	4 (10.5 %)	1 (5.9 %)	3 (14.3 %)

Table 5.1: Demographic information for the sample of children

The children/parents were likely to record which asthma medication the child was currently receiving, this could explain why there is an unexpectedly high number of children taking oral steroids (Table 5.1). It is most likely that these children were receiving a course of steroids, or had previously.

Interview	Name	Gender	Age	Severity	School
Interview 1	James	Male	13	Severe	Secondary Independent
Interview 2	Harry	Male	13	Mild	Secondary Independent
Interview 3	Henry	Male	14	Moderate	Secondary Independent
Interview 4	Dylan	Male	14	Mild	Secondary Independent
Interview 5	Goldie	Female	7	Moderate	Primary State
Interview 6	Jack	Male	7	Moderate	Primary State
Interview 7	Lily	Female	6	Moderate	Primary State
Interview 8	Pizza	Male	10	Severe	Primary State
Interview 9	Jonathon Cena	Male	10	Moderate	Primary State
Interview 10	Cal Jackson	Male	10	Moderate	Primary State
Interview 11	Joseph	Male	9	Moderate	Primary State
Interview 12	Daisy	Female	9	Severe	Primary State
Interview 13	Rhianna	Female	9	Moderate	Primary State
Interview 14	Lizzie	Female	5	Very Severe	Primary State
Interview 15	Cherry Blossom	Female	6	Mild	Primary State
Interview 16	Teddy-Rose	Female	8	Severe	Primary State
Interview 17	Poppy	Female	8	Severe	Primary State
Interview 18	Jessica	Female	14	Mild	Secondary State
Interview 19	Joseph	Male	14	Moderate	Secondary State
Interview 20	Ruby	Female	15	Moderate	Secondary Independent
Interview 21	Rachel	Female	13	Mild	Secondary Independent
Interview 22	Jane	Female	12	Moderate	Secondary Independent
Interview 23	Hannah	Female	12	Moderate	Secondary Independent
Interview 24	Sophie	Female	11	Severe	Secondary Independent
Interview 25	Nicola	Female	11	Mild	Secondary Independent
Interview 26	Erika	Female	12	Moderate	Secondary Independent
Interview 27	Louise	Female	12	Moderate	Secondary Independent
Interview 28	Sarita	Female	11	Very Severe	Secondary Independent
Interview 29	Joanne	Female	13	Severe	Secondary Independent
Interview 30	Lilly	Female	8	Moderate	Primary Independent
Interview 31	Lil	Female	10	Moderate	Primary Independent
Interview 32	Lizzy	Female	9	Moderate	Primary Independent
Interview 33	Laura	Female	14	Moderate	Secondary State
Interview 34	Bob	Male	7	Moderate	Primary State
Interview 35	Jake	Male	8	Very Severe	Primary State
Interview 36	Amy	Female	10	Very Severe	Primary State
Interview 37	Poppie	Female	10	Mild	Primary State
Interview 38	James	Male	14	Severe	Secondary Independent

Table 5.2: Demographic information for the individual children

5.4.2.2 Recruitment and consent

A range of methods were used to recruit local primary and secondary schools, including emails, postal letters and telephone calls. The letters and emails to the head teachers explained what the study was about and which children could be involved. If the head teacher or designee was happy for their pupils to take part, then invitations, consent forms, information sheets and reply slips were sent to the school to give to children with asthma to take home to their parents. If the child and parents/guardians were happy for the child to take part in the study then, depending on the schools preference, they could either return the slip to the school or post the reply slip and consent form back directly in the stamped and addressed envelope. The reply slip and consent form needed to be signed by both the parent and the child. If the child was at primary school then there was a different information sheet and invitation for the child and parent. If the child was at secondary school then the same information sheet and invitation was provided for both the child and parent.

Recruiting the schools was much more difficult than originally anticipated. A total of 20 schools were approached in the hope that this would provide enough children to be recruited in the study.

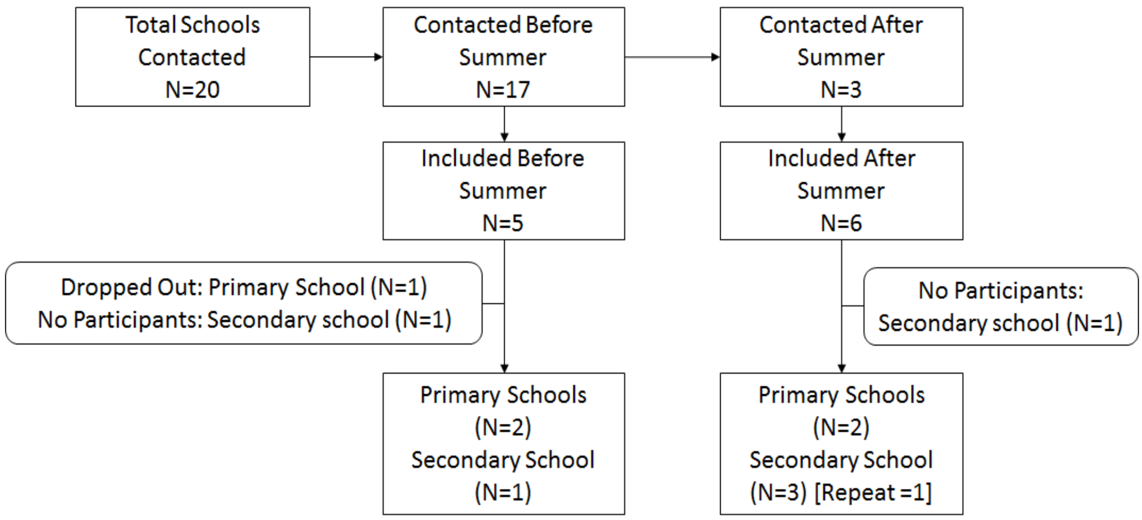


Figure 5.1: Recruitment flow diagram for the qualitative study

For the first set of interviews it was necessary to contact 12 primary schools to recruit 3 of which one withdrew with no explanation, and 5 secondary schools were contacted to recruit 2 into the study, with one struggling to get children to sign up. Unfortunately, one child did sign up but when it came to the interview the consent form had not been completed by the parent therefore the interview could not be completed. All these schools were recruited through personal contacts linked to the supervisors and colleagues.

Recruitment for the second study required contacting three additional schools, two primary and one secondary school to get three secondary schools and two primary schools involved. One secondary school had been approached in the first round and came back saying they were now interested and the other was a repeat and one of the primary schools was recruited through the Public and Patient Involvement (PPI) group.

One child was involved in both parts of the study (before and after summer) and came from one of the secondary schools. The interest in the second round of recruitment at that school was limited and only one child consented to take part and he had already taken part previously. The researcher and the supervision team discussed in whether the second interview should be conducted. It was agreeded that this was an opportunity to ask him questions which may have been previously missed and build on anything he had said in the previous interviews. However, it was found that repeating the interview so close in time did not add much more to the data therefore no further repeat interviews were conducted.

On acceptance of responses from the children, a mutually convenient time and date(s) was arranged with the school to conduct the interviews. When the children arrived for the interview, the researcher talked through the key points of the information sheet, answered any questions they had and made sure they understood what they were taking part in. Although the children had already signed the consent form, they were asked again verbally if they were still happy to take part. The child was also given the opportunity to ask any questions before the interview started. No children refused consent at the time of the interview or withdrew during the interview.

5.4.2.3 Setting

The interviews took place at the child's school in a quiet place, when possible, to minimise distractions; often in the school library. All interviews were completed within the school day hours within sight/earshot of school staff. To comply with the necessary regulations related to safe guarding, if the school could not provide someone to accompany the child during the interview a colleague of the students would have been available to support the student by being present in the room. However, this was not needed as the schools provided a location where the interview was conducted within sight/earshot of a member of staff.

5.4.2.4 Expenses

The researcher and her supervisory team had agreed either a £5 'Amazon' or 'Love 2 Shop' gift voucher was a suitable incentive. Primary school children also received a certificate of participation which was felt inappropriate for older children.

5.4.2.5 Topic Guide

The topic guide for the interviews was developed by the researcher based on previous literature (Chapter 2 and Chapter 3) and the results from the re-analysis of PLEASANT (Chapter 4).

The PLEASANT Public and Patient Involvement (PPI) group were used to develop the questions on the topic guide before the interviews started (more details can be found in Section 5.5). They helped to develop the style and type of questions that they felt children with asthma should be asked in an interview. The PLEASANT PPI group were also used to test the proposed topic guide; this provided an opportunity for the researcher to improve her skills in interviewing children including how the questions should be worded for different age groups.

5.4.2.6 Data Collection

The semi-structured interviews aimed to give the children more freedom to speak with a set of questions that were not fixed in the way they were asked. The intention of this was to give the child and researcher the opportunity to develop topics that were not considered in the topic guide. The topic guides for both primary and secondary school can be found in the Appendix D.

In order to avoid overburdening the children, it was planned that the interviews would last no more than half an hour; they lasted between 10 - 20 minutes.

5.4.2.7 Games and Ice Breakers

Games and icebreakers used in interviews with primary school children involved asking the children to choose what they would like to be called in the interview and to create a sticker with felt tip pens for them to wear. The researcher also created a sticker with a fake name. This was done at the start of the interview after the researcher had explained the interview process and how their information would be anonymised in the transcripts. This was only done with primary school children as it was deemed unsuitable for secondary school children by the PPI group, see section 5.5.

A flash card game was created and used in some of the interviews to make the interview more fun. The game involved a number of pictures of triggers, for example sport, and the children were asked to place the pictures into different categories, 'Better', 'Worse' and 'I don't know'. The children seemed to enjoy the game in the interviews, however after listening to the audio recordings of the game it added very little to the data, therefore the game was removed in the second set of interviews.

5.4.2.8 Recordings

The interviews were audio recorded on two digital recorders. This was highlighted in the information sheet and consent form and the participants were reminded of this when they arrived for the interview. Participants were given the opportunity to change their mind about the recording before or during the interview with the option to stop recording and continue the interview with note taking only. All participants were also given the opportunity to end the interview at any point if they felt they wanted to. There were no issues regarding audio consent and participant consent with all interviews being recorded in full.

5.4.2.9 Analysis

After the interviews had taken place, the recordings were transcribed verbatim and anonymised. The PhD supervisors were involved in supporting the stages of the coding and of data analysis. One member of the supervisory team is a qualitative research expert.

Throughout the study process, a reflective diary was used to write notes immediately after the interview on details of how the children behaved and any key points that were raised.

As detailed in section 5.3.3.1, thematic analysis was used to analyse the interview data using N-Vivo to manage the data (Braun and Clarke, 2006). Initially themes were based on the questions in the topic guide, however new themes emerged from the interviews. Quotes from children were used to support themes within the data and presented alongside a coding tree which was used as visual aid (See section 5.6.1).

5.4.2.10 Ethics

This project was ethically approved by the University of Sheffields School of Health and Related Researchs ethics review committee (Application Reference Number 008174).

5.5 Patient and Public Involvement (PPI)

A Patient and Public Involvement (PPI) event took place on the 14th June 2016 to provide an opportunity to obtain opinions from children with asthma on the questions planned for the interviews. It was important to check whether the children felt the questions included in the draft topic guide were relevant, if the language was suitable for different age groups and whether they felt there was anything that had been missed.

The event included the researcher, Ph.D. supervisor, two boys with asthma, aged 13 and 14, and the parent of one of the boys, who was also a GP. The researcher started the session by explaining what was wanted from the event and then asked if the participants were comfortable with the session being audio recorded. Everyone gave their permission for the session to be recorded and the boys seemed comfortable to talk. Recording the session enabled the researcher to fully participate in the discussion and then listen back to review what people said. It was also an opportunity to test the recorder; the researcher placed the recorder next to the sheets of paper resulting in background noise. The researcher learnt the importance of placing the audio recorder in-between then interviewer and the interviewee, away from any papers or books.

The session began by working through the topic guide question by question. The researcher asked the children the question to see if they both could answer it and then they discussed whether it was important or not, or whether it was an easy question to answer. This proved useful as one of the first questions was 'How long have you had asthma?'; both the boys were unsure of the answer, they both had had asthma for as long as they could remember. This resulted in the question being changed to 'Do you remember when your asthma started?'. Most of the questions were considered appropriate, but they suggested some questions about pets and feeling unwell with colds. The researcher gave them all the picture sheet she was planning on bringing to the interview to allow the children to point out which medications they take for their asthma. After taking on board the feedback from both the children and the parent that the picture was confusing due to the number of medications shown, a simpler version was created. At the end of the event, one of the children suggested that the children being interviewed may ask the researcher about the project and wondered what they would be told so that too much information is not given away. The researcher had not previously considered this and thought through what the children could be told without introducing bias; this was done at the end of the interview if a child asked.

The boys both suggested that the planned ice breaker may be too 'young' for secondary school children. The icebreaker involved asking the children to pick a name for the interview and create a sticker with felt tip pens for them to wear. The researcher also created a sticker with a fake name. The boys suggested for secondary school children that the researcher just asked them to pick a name or choose one from a list. One of the children had a younger brother in primary school so the researcher was able to ask his opinion on the ice breaker task and he said he would enjoy it.

The PPI event was an invaluable experience supporting preparation for the actual interviews. It helped decrease anxiety about conducting interviews and made the interviews seem less daunting. It also provided reassurance that the children would be willing to talk openly about their asthma, both boys were very honest about their medication and asthma, even in front of one of their parents.

5.6 Results

Three main themes from the first set of interviews, triggers and factors, impact, and adherence and medication emerged from both the revised topic guide structure and the interview data. There were many sub and sub-sub themes amongst these three themes and a few themes that crossed within themes, such as routine and sports (Section 5.6.1 for full revised framework following second set of interviews).

- **Triggers and Factors** - This theme is built upon any comments that the children had based on what they think makes their asthma worse or better.
- **Impact** - This theme is built upon how their asthma impacts on their lives.
- **Adherence and Medication** - This theme is built upon on any comments the children provide about their medication.

Further interviews were conducted after the summer holiday between September and January which built upon the results from the first set of interviews. The previous results suggested that some children may do less exercise during the summer break which could be contributing to the September peak. A second set of interviews were undertaken after the summer break to help the children more accurately recall what they did over the holiday. The topic guide was extended to allow a focus on exercise, the summer holidays and returning to school in September. When analysing the data for this set of interviews, the old framework was applied but new themes and sub-themes were added when they occurred. The final new framework was then reapplied to the old data to account for anything that was missed previously. Both topic guides, before and after summer, are given in Appendix D.

Alongside the previous themes a further fourth main theme was added to the framework; sport and exercise. This was expected as the interviews were more focused on sport and exercise in this round.

- **Sport and Exercise** - This covered anything the children said about the sport and exercise they did. This included what exercise they did throughout the whole year, not just focused on the summer holidays.

5.6.1 Frame Work

Factors which influence children with asthma having asthma exacerbations at the start of the new school year	**Impact**	Symptoms	Hospitalisation	
			Impression	
		Sport		
		Routine		
		Impact on others		
		Others not understanding		
		Others seeing it as a weakness		
		Location	Home	
			School	
			Holiday	
		Fear/Emotion	Self-Conscious	
			Sad	
			Anxiety	
			Anger	
			Jealously	
			Well-Being	
			Worry	
	Triggers/Factors	Time	Day	Morning
				Afternoon
				Evening
				Night
			Year	Seasons
				Months
		Weather	Cold Weather	
			Warm Weather	
			Wet Weather	
		Allergies	Pets	
			Atopic	

			Hay fever	
			Dust	
		Family		
		Characteristics	Age	
			Gender	
		Stress		
		Sport		
		Return to School	Change in Routine	
			More Sport	
			Changing School	(Primary – Secondary)
		Unwell		
		Other		
		Talking		
		Location	Home	
			School	
			Holiday	
			Other	
	Adherence/Medication	Routine	Home	
			School	
			Holiday	
			Lost	
			Forget	
			Independence	
			Reminders	
		Support Network	Family	
			Friends	
			Teachers	
		Diagnosis	Experience/Length	
		Barriers	Worried	

			Weakness	
			Lack of Knowledge	
		Knowledge	Control	Breathing Exercises
				Adherence
				Keeping Warm
				Rest
				Correct medication use
				Other
			Preparation	Flu Jabs
			Explanations	
			Fear/emotion	Overuse
		Progression	Impression	
		Distractions	Forgetting medication	
			Forget about asthma	
		Hospital	Traumatic Incidence	
		Seen as a weakness		
		Don't take if feeling well		
	Sport/Exercise	Type	Running	
			PE	
			Swimming	
			Indoor	
			Outdoor	
		Amount		
		Activeness		
		Holiday	Sport	
			Lack of Sport	
			Sedentary Behaviour	

5.6.2 Triggers and Factors

Children asked 'What are the factors which influence children with asthma having asthma exacerbations at the start of the new school year?' reported that the main triggers for asthma were, sport, allergies, weather and illnesses.

5.6.2.1 Sport

Children frequently mentioned sport when they were asked what makes their asthma better or worse. Children had conflicting views on how sport and exercise could affect their asthma. Some children said sport and exercise made their asthma worse, whereas others said sport and exercise made their asthma better. The children gave a range of views on how different sport including the frequency affected their asthma symptoms.

The following quotes from the children are used to illustrate the range of views:

> *"It's really annoying because when you want to run you always get out of breath because yeh the asthma and sometimes when we do out big run I always have to not join in because my asthma is so bad"* (Teddy-Rose, girl, aged 8)

> *"I sometimes get quite asthmatic so I can't do that much sport ... well, sometimes, if you have done sport, you'll just get really wheezy"* (Henry, boy, aged 14)

> *"Once when I was playing football, I had a like an asthma attack and I fainted"* (Joseph, boy, aged 9)

It appears that sports that involve running seemed to be the worst trigger for asthma. One active child suggested that his asthma was only affected by some of the sports but not all:

> *"When I do football, cricket and baseball, erm, I start to cough a lot, but boxing and thai boxing I am fine"* (Jack, boy, aged 7)

Whereas another active child explained that it required a lot of exercise to exacerbate his asthma symptoms:

> *"Only if I do a lot of exercise, then my asthma kicks in ... So even when I did the 15 hundred, I wasn't too wheezy"* (James, boy, aged 13)

On the other hand, some children did talk about how they felt better when they were doing exercise, for example:

> *"Exercise, that calms it [my asthma] down"* (Pizza, boy, aged 10)

The children all reported that sport would be a trigger for them, but the level was different for different children.

> *"It's alright, just sometimes, it affects you in PE because if you can't breathe, you've gotta sort of slow down and you can't go to the ability that you could do"* (Ruby, girl, aged 15)

> *"When I do a bit of, like a lot of exercise, it gets, I sometimes can't breathe properly and it just, erm I feel like I can't actually like keep breathing"* (Hannah, girl, aged 12)

Similarly to the first set of interviews, the children talked about how weather can have an effect on their asthma symptoms, however in the second set they also talked about how the different weather can affect their sports. Children expressed different views on what weather can affect their asthma when doing sports. Most children talked about cold weather. For example:

> *"But as it gets colder it gets worse usually and especially when we are doing sports outside...I sometimes feel a bit wheezy when we are doing sports outside"* (Louise, girl, aged 12)

> *"Well sometimes in the winter it gets quite bad on my chest...I haven't like stopped, and the asthma doesn't really bring me down, it doesn't give me a disadvantage to my sport, so I don't really find it any, difficult, sometimes I do struggle in the winter, but I am not like, having an asthma attack every lesson, I just get quite out of breath"* (Jane, girl, aged 12)

Other children explained that the cold affects them most when they are running.

> *"My asthma is alright [when doing sports] sometimes, like depending on what the weather is like, like if it's cold then I would need it a bit, but mostly it's fine unless I have done like a lot of running, and then I would need to take my Ventolin"* (Joseph, boy, aged 14)

However, other children explained that hot weather can impact on doing sport as well.

> *"Sometimes in PE and in the summer when it gets too hot...I get it [asthma] really bad"* (Amy, girl, aged 10)

5.6.2.2 Allergies

Some children believed that allergies such as hay-fever, pets/animals, and dust made their asthma worse.

Hay-fever

A few children mentioned that hay-fever made them feel unwell. However, it was not always clear whether the hay-fever made their asthma worse or whether it was just the hay-fever symptoms making them feel unwell.

> *"Hay-fever is a culprit"* (James, boy, aged 13)

Only one child reported that hay-fever affected his asthma:

> *"I have hay-fever and I believe that made my asthma worse because when it flares up at, my asthma, I was quite bad ... I was, when my hay-fever tablets are wearing out towards the evening time, I do get a bit more wheezy ... recently since I have been taking the controller, the green one, and my hay-fever tablets it's been much better, and I have only been getting wheezy like once a week or something"* (Henry, boy, aged 14)

Pets

As an icebreaker in the interviews the children were asked if they had any pets, which provided an opportunity to ask if the pets had any effect on their asthma. Again, like the previously discussed triggers, the impact of pets varied between children with, most reporting that pets such as guinea pigs, horses and rabbits had no affect on their asthma.

> *"The hair doesn't affect me or anything"* (James,boy, aged 13)

> *"I am with them [horses] a lot and I around them quite a lot... I don't think it would be the actual horses that would do it ... just the actual riding of the horse"* (Harry, boy, aged 13)

However, there were children who said that being around their pets made their asthma symptoms a bit worse, causing them to cough and sneeze.

> *"I kinda cough a little bit when I am stroking [her dog]"* (Lilly, girl, aged 6)

> *"[Her cat] makes me sneeze"* (Cherry Blossom, girl, aged 6)

All children were asked about the impact of animals on their asthma in the second set of interviews.

> *"I'm allergic to dogs, rabbits, and horses and stuff like that, so, if I go near them I get really really bad asthma,... but it is triggered by pets, like horses are really bad like, I can be like 10 metres, and I don't even touch them ... my eyes just puff up and my asthma, it triggers my asthma"* (Jane, girl, aged 12)

Dust

Some of the children reported that pets were not a trigger but found that they were affected by dust. For example:

> *"I think if it's very dusty then it [my asthma] gets bad"* (James, boy, aged 13)

> *"Normally it would be quite a dusty hall or somewhere the air is not quite clean, and that room, will quite affect my asthma a little bit coz it would make it a bit harder to breathe"* (Harry, boy, aged 13)

> *"If I am in like, a really dusty area like, my, if, I stop at a friends and like they have got stuff under the bed, then it affects me"* (Joanne, girl, aged 13)

The main trigger for one boy, Pizza, with severe but controlled asthma, was dust. He reported that he was very active and that exercise made him feel better. The quote below outlines what he had to say about dust affecting his asthma:

> *"When I go into a dusty carpetty house, that's when it gets set off but for now I am generally fine... dust is definitely a big one, pretty sure there are some like hairs, they might do it, but generally it's just dust "* (Pizza, boy, aged 10)

5.6.2.3 Weather

Another key trigger reported was weather and how different types of weather, hot versus cold, can affect their asthma.

During the interviews, some children found that hot weather improved their asthma whereas others found that hot weather made their asthma worse. For example:

"Sometimes when I am running about in hot weather it [my asthma] can start" (Joseph, boy, aged 9)

"It's normally on sunnier days when I get asthma attacks...now we are getting to the summer it is getting a bit more frequent, when I am having wheezy chest and asthma" (Harry, boy, aged 13)

One child describes how the hot weather can alter his ability to do sport with his asthma, saying that *"Sometimes when I am running about in hot weather it can start"*. Another child suggested that he has more frequent asthma symptoms on sunny days. Whereas other children find the hot weather improves their asthma but are unsure why. For example:

"Think maybe warm weather actually improves, you know, my asthma because, dunno why, I think it just does. I can't explain why though" (Jonathon Cena, boy, aged 10)

A few children described how they found that the cold weather made their asthma worse:

"Going out in real cold temperatures, where I start coughing quite a bit" (Cal Jackson, boy, aged 10)

"There's not really too much of an affect, unless it's a cold place...but if it's a hot place I'd be fine, but if it's a cold place, sometimes, if it's really bad, I get a bit wheezy" (James, boy, aged 13)

Some children found that both hot and cold weather made their asthma worse so preferred milder weather.

"Well, if it's cold, you cough a lot, sneezing a lot makes you wheezier because your body is having to work a lot more with your lungs, but, if it's like really hot, then it gets a bit wheezy because you're panting all the time and trying to get your self cooler, but like, nice weather like it is today, it's fine, it's, nice weather" (Nicola, girl, aged 11)

"It's got worse because it's like getting towards the time where it is colder but, it's all controlled ... in the summer, I like, it seems, to get worse for me in the summer because of the hot weather, like the weather makes it

really hard for like, I dunno like dust and things, and that's what makes my asthma get worse, but, it was alright, I just took my asthma sprays and stuff to make it better ... it's either really hot or really cold, and in the middle it's fine" (Laura, girl, aged 14)

Alongside hot and cold weather, other types of weather were discussed, this included how clear the air was, and how the weather differs in England compared to abroad:

"Obviously if it's a quite a clear day like, maybe today, I probably wouldn't take it [inhaler] because it's, the airs not as hot and it's, it's just a nice sunny day. So, the air is quite clear "(Harry, boy, aged 13)

"I like hot weather, and sometimes it does, it depends really, because if your at like Turkey, then it will probably make it worse in summer, like in England, it's ok England, I guess, it's very rainy here"(Rhianna, girl, aged 9)

After playing the triggers flash card game she had said that hot weather had made her asthma better but later contradicted herself. On probing she explained about how the more extreme hot weather would make her worse, but the milder hot whether that we have in England would make her feel better.

5.6.2.4 Illness

When speaking to the children about being unwell and how that affected their asthma, most of the children referred to colds and flu. All the children who talked about having colds and the flu agreed that it made their asthma symptoms worse.

"When I get a cold it gets quite bad...I keep coughing and it's really annoying" (Teddy-Rose, girl, aged 8)

"When it's really cold, erm and I get colds and stuff really easily, and I start. When I feel all ill then that just, that triggers, that makes me, my breathing like a bit hard...in the summer holidays, I had a chest infection and that affected [my asthma] a lot and sometimes, even when I was like doing nothing it, it er, it made my breathing go like really hard for me to breathe" (Hannah, girl, aged 12)

"I find when I do get colds, or a flu or something, that I do get asthma a lot more...obviously you can't breathe through your mouth or you nose

so it makes it quite hard to actually breathe" (Harry, boy, aged 13)

"Especially in the winter if I have a cold or something, the it gets really bad as well" (James, boy, aged 13)

One child talked about the consequences of having pneumonia to her asthma stating that she never fully recovered and was later diagnosed with dysfunctional breathing, but since then she has been working to control her asthma and is on the way to recovery.

"I got pneumonia and then after, I, my asthma was, it was like, it never got better...I don't really know but something changed, I went to this, the hospital to find out what, and then I got diagnosed with dysfunctional breathing so then I had to work on, like, getting my asthma back so now, it's actually, it's actually getting a lot better" (Joanne, girl, aged 13)

5.6.2.5 Return to School

The second set of interviews were a good opportunity to ask the children how their asthma was when they returned to school after the summer holidays. Some of the children had not noticed any difference. For example:

"It's been fine, I have not had any asthma attacks or anything like that" (Jessica, girl, aged 14)

"Fine, really, I've not had any problems recently at all" (Louise, girl, aged 12)

Another child explained that her asthma was under control so was fine when she returned to school.

"I am usually able to control it, so it hasn't changed that much" (Hannah, girl, aged 12)

However there were some children who found that going back to school affected their asthma, suggesting it was due to a change in weather, viruses or an increase in the amount of sport.

"There's a bit of difference, because I have to be like using my inhaler a bit more...I think, in the holidays it was like, it was a lot warmer and it's getting colder" (Joanne, girl, aged 13)

"It's got, a bit worse, because from the summer holidays it was like, summer, and yeh, it's, it was summer and it was much warmer so I didn't really need to have it but now, I have to take it really often, like, 5 times a day, or something like 2...because it cold...I think in that time I start to get really cold and I started needing it" (Amy, girl, aged 10)

"I had to have a couple of days off because I had a cold and it went to my chest but otherwise I have been fine" (Sarita, girl, aged 11)

"I think it's a bit worse because at school we do more PE and sports" (Poppie, girl, aged 10)

Whereas others expressed that change in sport was most noticeable when they transitioned from primary school to secondary school or changed year group.

"We have got more difficult sports as well, especially hockey, we do more like higher level of it, trampolining especially more higher level, so yeah it has affected it quite a lot" (Rachel, girl, aged 13)

"In year 7 they kept us all in like one place, I was in one corridor, but now, like, obviously I have got friends in different classes and they have got all their form rooms are like in different places and it kinds juggles up a bit and we have to move more around the school, so especially when I am running, like to the science block up there, there's a few flights of stairs and like I need to rest a bit when I get up there, and like when I came down here, obviously, I was up in the T rooms, and this is quite a long way and like, when I running, to get a laptop for my lesson like, it's them kinda occasions, more than in year 7" (Rachel, girl, aged 13)

5.6.2.6 Anxiety

Some children expressed that anxiety was a trigger for their asthma.

"Sometimes I just have asthma attacks if I am nervous about something" (Jane, girl, aged 12)

Jane also provides an example of when this has happened to her. The example is about a time when she received some sad news which then caused her to have an asthma attack.

> *"One of my best friends had asthma, and, she passed away...I heard that news, I actually had an asthma attack, because I got like scared, like, you know like, it's all in your head, and you think, well she's had it, I am gonna have it, so I had an asthma attack there"* (Jane, girl, aged 12)

Another child described how going to roller coasters could trigger her asthma, this could be due to adrenaline or anxiety.

> *"We did go to like Drayton Manor and Alton Towers, when I am on roller coasters, I don't know, like I can't breathe on roller coasters, I like it, but like, I can't breathe, because of the shock and then I do need my inhaler after I am on a roller coaster because obviously I can't breathe any more"* (Rachel, girl, aged 13)

5.6.2.7 Fear

Two children discuss how they found it scary when they had an asthma attack or found they were unable to breathe:

> *"I felt horrible (laughs) yeh I missed a couple of days of school because of that, but I like that, I like that bit (laughs). It was quite hard to breathe so I'd be going (does impression of being out of breath) like that and yeh it was quite um a bit scary"* (James, boy, aged 13)

> *"If you have done sport, you'll just get really wheezy...all of a sudden, and it will be really hard to breathe. And, it feels like you can't get enough air.... it's sometimes quite scary"*(Henry, Boy aged 14)

5.6.2.8 Other

During some of the later interviews the children either said cigarette smoke had no effect on their asthma or they said that it made their asthma worse:

> *"Smoking makes it worse"* (Teddy-Rose, girl, aged 8)

> *"It [cigarette smoke] does make me cough"* (Poppy, girl, aged 8)

Children also talked about how they perceive different types of food to affect their asthma.

> *"When I had dried apricots, ma, my cough started to get a little bit better"* (Lilly, girl, aged 6)

> *"If I am having an ice cream or something, often after I have a cold drink it can make me quite wheezy. So, if I just eat some ice cream and I have not had anything cold, then it might like, I'd get quite wheezy after that"*(Harry, boy, aged 13)

At the end of the factors game, the children were given the opportunity to suggest anything they felt may have been missed. They were also given the option to draw what they thought should have been included. One child explained that when she has too much of her inhaler, it makes her asthma worse:

> *"A lot of inhaler, because it makes me worse a bit"* (Cherry Blossom, girl, aged 6)

5.6.3 Impact

The second theme, 'Impact' emerged from the children talking about how their asthma affects themselves and their lives. This could be how their asthma affects their health and symptoms, it can also be how it impacts on what they do and their day-to-day life. Under this theme, firstly there are examples of what symptoms their asthma causes and how often. Secondly, there are further examples of how their asthma can affect their ability to do sport and how it impacts on their daily routine, which can be at home, at school, or on holiday. Finally there are examples of how their asthma can affect their emotions.

5.6.3.1 Symptoms

The symptoms sub-theme was used to cover the different types and frequency of symptoms the children with asthma can suffer. The examples are symptoms normally associated with asthma; wheezing and finding it hard to breathe.

> *"It's actually really bad, I was wheezing a bit this morning, which is like, like a one off"* (James, boy, aged 13)

"It like gets, it builds up, so it like, sort of like closes my throat, so I can't really breathe" (Jessica, girl, aged 14)

"Your chest feels like it's closing in and it's a bit, feel like it's tickling, like struggle to breathe sometimes" (Dylan, boy, aged 14)

Children articulated how their symptoms impact on their daily life. For example Joseph felt wheezy when he woke up, he just took his inhaler and got on with his day as normal, whereas Joanne talks about not being able to do sports because her asthma makes her breathless and Rachel talks about how often she has asthma attacks in a year.

"I woke up, this morning, felt a bit wheezy, after I had a shower, I took my Ventolin, and then just carried on"(Joseph, boy, aged 14)

"It's not very nice, like it stops you from doing a lot of things, you get out of breath a lot easier than everyone else, then when you are doing sport that, that's when it like, when you are running around then it like stops you from doing it as much, especially when you've like having bad days with it"(Joanne, girl, aged 13)

"I think this year I had [asthma attacks] 4 or 5, last year 2 or 3"(Rachel, girl, aged 13)

Children discussed how their asthma often makes them feel unwell during the year. For example, Dylan experiences symptoms *'twice, maybe three times a year, not many times"* compared to Henry who reports being unwell about 50 times a year.

5.6.3.2 Sport

This sub-theme explores how asthma affects their sport and exercise rather than how sport causes their asthma symptoms. Similarly to the previous theme, some children discussed how having asthma did not have much, if any, effect on their ability to take part in sport and physical activities whereas others disagreed stating that they were unable to do much sport because of their asthma.

Some children found that their asthma stops them doing the sport that they would like to do.

"It's really annoying because when you want to run you always get out of breath because yeh the asthma and sometimes when we do out big run

I always have to not join in because my asthma is so bad ... when we bounce [trampolining] for like 2 minutes, it really flares up ... I just sit on the bench or do a different activity" (Teddy-Rose, girl, aged 8)

Others discussed how their asthma has not stopped them from doing sports but they find their asthma can limit their sporting ability.

"It just sort of slows me down in, like running, I can't go as fast as I probably could do because I get out of breath easily" (Ruby, girl, aged 15)

"I would like to do more sport, but with my asthma I can't really"(Henry, boy, aged 14)

Some children talked about how their asthma affecting their sports can impact on them emotionally:

"A bit sad because I really like doing sports" (Cherry Blossom, girl, aged 6).

Some children described times when they do sport and they have had to take time out to take their medication when they are becoming breathless.

"[Take blue inhaler] if I am getting out of breath or I am like, when like during exercise" (Jessica, girl, aged 14)

"There was one indoor one, when it, it got a bit hot and then I got a little sweaty and then a bit wheezy, but it didn't stop me from playing, I just took it and carried on" (Joseph, boy, aged 14)

Another child expressed how she dislikes taking her medication during PE lessons because she does not want to miss her lesson.

"I really do try to like not take my inhaler too much because I don't wanna like miss my [PE] lesson" (Rachel, girl, aged 13)

5.6.3.3 Impact on Others

During the second batch of interviews the children discussed how having asthma actually impacts on others around them. Children emphasised that it can be distressing for others to see them suffering with their asthma symptoms.

> *"It really affects my friends, they start worrying about me, my teachers are worrying about me, I start worrying about myself...I was really sad and all my friends were crying and my teachers, really like, because like it was the first time it had ever happened to me, I've never had, ever had an asthma attack before"* (Rachel, girl, aged 13)

> *"I kept on coughing and coughing and coughing and so the doctor took me from preschool and he [doctor] knew I had asthma, and it was really really bad and I was gonna have an asthma attack any minute to he said to, he phoned, my nan who was looking after me, phoned my mum crying saying that I was gonna go to hospital, she rushed over from her job and, I was about to go to hospital"* (Jonathon Cena, boy, aged 10)

Children also talked about how others spend time reminding the child with asthma to take their medication.

> *"My friends, they, they really support me, erm I think on Tuesday we were like doing a hockey match and I was really getting into it, but I have like this look of my own and I was out of breath and my friends were like 'oh (Rachel) you need your inhaler'...at the end I did need it"* (Rachel, girl, aged 13)

The last example is from Amy, who is talking about how her siblings sometimes get upset when she cannot play with them because of her asthma.

> *"We have a trampoline in the back yard, so my brot, my little brother and my younger sister, they want me to go on the trampoline with them but I say no because I have got asthma and yeh, and yeh I can't do it with them and and so I feel kinda sorry for them"* (Amy, girl, aged 10)

5.6.3.4 Others not understanding

It can be hard for those who do not have asthma to understand fully what asthma actually is and how they should support the children.

> *"You know what you're doing, whereas my teachers never had asthma or anything so they're always like 'you either have asthma or you don't' but it's kinda gradual...but they kind of treat it the same, so like my friend, she's got really really bad asthma so she would probably take all those inhalers...I have not very bad asthma and she has really bad asthma, teachers used to treat it exactly the same, which is a bit unfair on both of us"* (Nicola, girl, aged 11)

5.6.3.5 Emotions

Most of the emotions the children talked about were negative ones such as, worry, anger, sadness, jealously and anxiety. This also included children talking about their well-being and being self-conscious. However, not all the emotions were negative; one child talked about being comforted by experiences.

Worry

Children often worried about what will happen to them because of their asthma. This can be in terms of worrying that they do not have their inhaler or worried in terms of what their asthma could do to them. For example:

> *"I am one of those people who thinks about stuff that can kill you so like if I couldn't, if I didn't, if I needed my inhaler, and I couldn't use it because I had left it in my bag or something then, I'd just suffocate"* (Joseph, boy, aged 14)

One child discussed how he has to pack his inhaler every day and how he has his inhaler at school just in case he needs it. He feels that having to think about taking his inhaler every day to school is affecting his day and also he is worrying about having an asthma attack and not knowing when or if it could happen:

> *"Affects me day, maybe a little bit because obviously I have to pack my inhaler, think about where it has to be if I could have an asthma attack, where you know, or where could I get one, but I think I might have got one in matron, so it is a backup, but normally I carry one with me, and sometimes, if you do, do get an asthma attack in the day, which you could always happen "* (Harry, boy, aged 13)

However, simply knowing that the child has their inhaler can be enough to reassure them.

> *"Maybe having my inhaler with me, like if I know I have got that, and I know that like, if it does happen, I know that it's gonna be ok"* (Jessica, girl, aged 14)

Some children were worried about having an asthma attack away from home or their family.

> *"I just like sometimes wheezed and then I'd get a bit scared that it [running] might trigger it like I am away from my parents and stuff, but I was fine"* (Jane, girl, aged 12)

Anger

One child felt anger and felt annoyed that nobody was telling her what was wrong with her when everyone around her seemed to know that she had asthma.

> *"I felt really annoyed that they weren't diagnosing me with asthma because my mum was convinced, my dad was convinced and most of the people at the hospital were convinced but they just didn't give me anything yet…I was really young as well so I think they just thought I was, I had a weak chest"* (Sarita, girl, aged 11)

Sadness

Some children expressed feeling sad and lonely when recalling their asthma experiences.

> *"Many times [going to the hospital], yes, before I had my brown inhaler…I had to miss a lot of school so I felt a bit lonely"* (Sarita, girl, 11)

Though, the children feeling sad does not have to coincide with going to hospital, they felt sad in their general day to day life.

> *"I do feel kinda upset because let's say when, other people, my friends are like playing tig or something like that, I can't join because I have got asthma and it can get really bad"* (Amy, girl, aged 10)

Jealousy

As children with asthma can find they are limited by what they are able to do some of the children expressed that they felt jealous of other children.

> *"I wanna be like my friends who can run and like not have an asthma attack, I wanna, I wanna feel like my brother who's really sporty, and who can just keep running for ages and ages, who can do football for ages and ages and doesn't feel like he needs to stop and he can keep going, but I, it's too difficult for me"* (Rachel, girl, aged 13)

Another child talked about when visiting her friend with asthma in hospital how her friend sometimes would say *"Why can't it be you this time?"* (Nicola, girl, aged 11).

Anxiety

Some children talked about their asthma causing anxiety.

> *"When you have an asthma attack, I don't think it's actually the fact that you can't breathe, I think it's just that you think 'oh god I can't breathe' and then they start hyperventilating, so sometimes, I don't think it's the asthma that's actually giving you the asthma attack, I think it's because your like hyperventilating and starting to like panic a lot"* (Jane, girl, aged 12)

Well-Being

Some of the experiences the children with asthma go through can be traumatic which could have an impact on their well-being. Rachel describes when she was admitted to hospital after her first asthma attack and she had thoughts about whether it is worth continuing.

> *"I just have these thoughts, so why don't I just end it now. I know in year 6, oh my god, that time when I was in hospital, I just felt like, I felt, I just felt I wanted to go now, I don't want to do anything more because you get so tired, you sort of sweating and everybody around you is crying and I all want to end it now. No point carrying on. For like, I want to, my mum and dad, I can't leave them"* (Rachel, girl, aged 13)

Whereas Joanne who has been hospitalised a number of times knows that she will feel better afterwards and does not appear concerned about her well-being.

> *"It's a weird feeling like, because I am used to it [going to hospital], I quite like it because then I feel like, when I get better, when I get back, I'll feel fine, because I don't like not being able to breathe so when I get back home and I, and it's all normal, it's a lot better"* (Joanne, girl, aged 13)

5.6.3.6 Medication

Medication can impact on the children through side effects and when the dosage is not correct:

> *"It's good, but I had to, because I had Montelukast tablets, I had to stop them because I was starting getting headaches, and it might be them, so I just had to stop them for the moment and see if it is them"* (Sophie, girl, aged 11)

"It hasn't held me back at all apart from when I was really little, and I couldn't really do anything, because my asthma wasn't under control" (Sarita, girl, aged 11)

5.6.3.7 Time of Year

A further sub-theme emerged from children discussing their general routine; time of year. Children talked about the different times of year their asthma can impact on them.

"I used to go to hospital about once a year, so I'd have an asthma attack around November, October and then I'd go (does a choking action and sound) and then couldn't breathe so I would have to go to A & E... I would say about 6 times it gets really bad, or especially in the winter if I have a cold or something" (James, boy, aged 13)

Children were also asked if there was any time of year they felt their asthma was better. The children had a range of views of when they felt best. Some children expressed that they felt better in the summer with a number of reasons why.

"Probably, summer holidays, because when I am at school, you can't really. It is a lot better if you like doing sports at school where as in the summer holidays you can stay at home, means it would be better" (Dylan, Boy, aged 14)

"Probably summer I am always outside, running around, playing with my friends, playing with my sister on the trampoline, doing sports" (Pizza, boy, aged 10)

Whereas, others expressed that they felt better in the winter.

"Well, it's probably, when we don't do a lot of sports, I think maybe, in winter, now many people say it would be the summer because coldness can make your asthma worse, but in winter, it's raining a lot, and to be honest, the school are so like paranoid about health and safety and stuff they keep everyone indoors when it's raining. When it's like in winter, it's raining a lot and snowing which means that we can't go outside, because we can't go outside it means I do way more less active stuff and if I do way more less active stuff I don't get worn out quicker so I think it's probably winter" (Jonathon Cena, boy, aged 10)

5.6.4 Adherence and Medication

This theme was related to adherence which was informed by the PLEASANT intervention. They hypothesised that the children may not take their medication during the summer holidays, resulting in a peak in unscheduled medical contacts in September for children with asthma. The theme explored the children's perspectives on why some 'other' children might not adhere to their medication. They described taking their medications in their daily routine and in different situations, when they go to the doctors, whether they had ever been to the hospital for their asthma, how they feel their asthma has progressed and any barriers they feel they or others could face when it comes to taking their medication.

5.6.4.1 Routine

This first sub-theme starts by looking at how the children incorporate their asthma medication into their routine.

As an icebreaker the children were often asked to describe their daily routine. Only some of the children needed to be prompted about when their medication was included in that routine, most of the children volunteered that information on their own accord. The children have well established routines.

> *"I get up at, at 25 past 7 then I'll have my breakfast, and I, I'll use my green puffer, take my hay-fever tablets"* (Henry, boy, aged 14)

> *"Do our teeth, and my sprays, then I get dressed, then I go back down stairs, and, I just have some relaxing, then it's time to go...and we walk back home and then we have our tea and then brush my teeth and do my spray, we get in our pyjamas and we go to bed"* (Goldie, girl, aged 7)

> *"I get up in the morning, I would do my inhaler, then, get changed, go downstairs, have breakfast, get my scooter out, then I would go to school on my scooter, I do the school work at school, then I will come home, then I will probably go on the ipad for an hour, then I'll come off, play on the trampoline or read, then it would be tea time, so then I'll go and have tea, then, my dad will probably have, put on some cycling, or some football on the TV, so I'll watch some of that with my dad, then, then, I will go upstairs, have my inha, do my inhaler, clean my teeth, erm then read in my bed, and then yeh, for 20 minutes and then go to sleep"* (Pizza, boy, aged 10)

"I get up, go down, have breakfast, and then I'll take my brown inhaler, so two puffs, and then I brush my teeth and get ready, and then school, and then when I get home I'll have tea, do homework and then watch a bit of TV, and before bed I always take my blue inhaler because I always get a bit wheezy before bed" (Ruby, girl, aged 15)

One child described how their parents had incorporated taking the inhaler into the brushing teeth routine; Telling them 'puffer and teeth'.

"She says puffer and teeth, so she reminds us every time we do our teeth" (Lil, girl, aged 10)

However, a change in routine, for example going on holiday, could impact on the children's ability to control their asthma. Harry did not take his inhaler with him when he went skiing so had to use someone else's when he found he needed it.

"The first day I had an asthma attack, so I did have to, get my inhaler because I, because of the altitude I think. That's what, the hospi, the doctor told me, because I had quite a bad one whilst I was skiing so I had to use someone else's [inhaler]" (Harry, boy, aged 13)

Most of the children did not report any issues with taking their inhalers as it only takes a couple of seconds:

"It doesn't really bother me too much (laughs), normally, it's good, I'll have it once a day, so it's not too bad... it's only a couple of seconds, just a couple of puffs and that's it" (James, boy, aged 13)

"It's not that different from being like normal or anything, you just take an inhaler like twice a day or whatever" (Erika, girl, aged 12)

5.6.4.2 Support Network

Having a support network around the child with asthma is very important. This could be family, friends or anyone at the school that they work with, for example teachers. If the child feels they have support then this could contribute to their adherence to their medication. The support can be simply encouraging them to take their inhaler when they need to, but can also lead to the child not wanting to take their medication.

> *"Teachers, definitely, because when they see your medication and there like 'oh you've got asthma you can't play' but it's, it's not, it helps prevent your asthma instead of causing it, it's more, because, they're, kinda not understanding that it's helping my asthma me not having asthma attack or anything, but then like just saying 'oh you have asthma, it's gonna make you have an asthma attack straight away' and it's just, it doesn't work like that, it's more, when you have your medication it helps prevent it, so you can play, so probably taken it for nothing"* (Nicola, girl, aged 11)

Nicola expressed her anger towards her teachers and their attitude towards her asthma because the teachers stop her taking part in sport if they see her taking her medication.

Previously the sport sub-theme included examples where the children have said how their asthma does or does not affect their sport. This time the examples are from a child who has found that it is not her asthma directly stopping her from doing sports, it is her teachers stopping her because she has asthma.

> *"Teachers don't really understand, they're saying 'oh you can't take part because you have asthma' and 'I think it might be a bit too hard on you', but it's different, you can take part, it's just you need to make sure that what you do won't affect it so much that you have to go to hospital...My teachers have been like sometimes 'if you've not got your inhaler you can't play, you'll just have to watch' or 'you had something wrong with your asthma I heard, a few days ago, you better not play' and it just gets a bit annoying because teachers are forever saying it...because you want to take part because you're fine after it's happened, it's happened but can't really do much about it"* (Nicola, girl, aged 11)

Nicola also described differences in the teacher's attitudes towards asthma after changing schools. Secondary school teachers are no longer limiting what she does and it has now become her responsibility to take her medication when she needs to and stop doing sports when she is getting over-tired and wheezy.

> *"The teachers are less on top of you for your asthma, they are saying it's your responsibility now, but where as in junior school here, it was more, you can't play or you can play, or you have to have your inhaler all the time, it's no, because I lost it and we are still trying to get a new one, my teachers are really relaxed about it, just as long as I take charge of what I am doing...they were more on top of you saying, telling you*

what to do, but now more, you're responsible your own actions, like more grown up" (Nicola, girl, aged 11)

However, their support network includes their friends and family as well. For example:

> *"You need supportive people around you, that's the most important, like, like if I didn't have my friends, if I didn't have like my mum and dad with me, I don't know how I would have coped, like my teachers, they know that I have got asthma, they really do encourage me in my sports to take it if I do need"* (Rachel, girl, aged 13)

5.6.4.3 Progression

This progression sub-theme explores how the children's asthma changed over time; whether it has become milder or more severe. It also tests the children's ability to determine the severity of their asthma using the medication prescribed as a guide for severity.

Some children found that their asthma has become milder, whereas others are finding that their asthma is getting worse. For example:

> *"I do go to the doctors quite a lot...because they think my asthma, getting worser"* (Poppy, girl, aged 8)

> *"I'm going to the GP like in a couple of weeks to talk about which inhalers I use, and we might have to change it because sometimes the brown one doesn't help me that much, so I might have to change it but apart that it's fine"* (Hannah, girl, aged 12)

The next examples are of children who are finding their asthma severity is getting milder.

> *"I used to have the brown and the blue....it occurred more frequently, and, it was more of a problem when I was doing sports, but now it seems to have faded away"* (Dylan 4, boy, aged 14)

> *"It was worse back then [really young] but now not really"* (Pizza, boy, aged 10)

"I went to the asthma appointment like, halfway through the year and, they said like if my asthma carries on being this good then I can be off medication or start it like, only take my brown inhaler in the morning and not the night, something like that, once a day, but I haven't had to take my blue inhaler for about, I don't know, like 2 months, so it's really good, I am not wheezing or anything and I have not woke up in the night or anything struggling to breathe" (Jane, girl, aged 12)

The next couple of quotes illustrate how the children perceive their asthma as getting better even though they are on the stronger medications. One boy describes that:

"Recently since I have been taking the errr controller, the green one, and my hay-fever tablets it's been much better, and I have only been getting wheezy like once a week or something" (Henry, boy, aged 14)

The second boy takes the purple inhaler and thinks his asthma is mild as he is able to do the 1500 metres without too many problems. Suggesting that even though his asthma requires him to have stronger medication, it does not stop him doing what he wants to do.

"I used to have it really badly , so I used to be wheezy quite a bit but it's, I think it's getting better as I grow older...so it is not as bad now. So even when I did the 1500, I wasn't too wheezy, so...so it's getting milder" (James, boy, aged 13)

5.6.4.4 Hospital and Doctors

This sub-theme explored when the child had been to the hospital or the doctors because of their asthma. Only a few children had been to the hospital before because of their asthma.

"I think I have had about 6 asthma attacks, one whilst being on holiday, that was one of the worst, like I was like, I was on like, really like medication, and on like a breathing machine and stuff, that was quite like a severe asthma attack, but that was like really bad like I was close to like dying and stuff, but yeh I have been quite a few times, sometimes people say my asthma is really bad, I have been to the hospital twice, but I have been like 6 times, so, but I have not been for about three years" (Jane, girl, aged 12)

Children understood the need to attend the GP for a routine asthma review *"I have an asthma appointment, twice a year, and that's it"* (Teddy-Rose, girl, aged 8) or times when they were using their blue inhalers too much indicated poor control of their asthma *"I think I have had the odd occasion, where I have been...I think it was when I needed to take the blue inhaler a lot"* (Cal Jackson, boy, aged 10)

Some demonstrated how to monitor lung function between appointments.

> *"I have my appointment, I think, I think, it's like twice every year, I am actually going to one next week, or two weeks, but, yeah I go and they just test my breathing but sometimes if I find my asthma bad I actually have this like tube, you blow through it, like, I don't know if you have seen it, there are tubes to blow through with your inhaler and you take a puff, but there is also this tube, when you blow through it, it has numbers all the way up to 600, normal like, girl my age would probably get like about 400, 600 for a really healthy adult, and I, my last appointment I actually got like a 360, so it's like getting really better, and then sometimes I check it, sometimes I take it just to like check how my asthma is, and I did it the other day and I got 400 and something so it's getting a lot better and I am just getting like my asthma is getting a lot better"* (Jane, girl, aged 12)

5.6.4.5 Knowledge/Understanding

This sub-theme is used to explore any advice given or methods the children use to control their asthma. The children were very knowledgeable when it comes to asthma, they appear to know better than anyone what they can do to control their asthma, and they believe this does not always require the use of an inhaler. They also understand the importance of preparing; taking their medication, and how it needs to be the correct amount.

> *"If you don't take the medication, it will get worse and stuff, so if people don't take their education, the medication, like they'll get worse, so they need to remember to take it"* (Jane, girl, aged 12)

> *"Don't let it get too out of control otherwise it's really hard to get back"* (Pizza, boy, aged 10)

Breathing Exercises/Control

Harry talks in detail about the different types of exercises he does to try to get his asthma back under control. He also recognises that it is important to take a breather when struggling and that he should stop exercising until he feels he has fully recovered.

> *"Unless it's extreme, really severe, and then I would probably, say we were doing rugby training and we were running, I would have to sit out for a little bit, and take a break and, I do some breathing techniques, to try get it back to normal...putting my arms above my head letting my lungs breathe a bit more, deep breathing, just trying not to kinda panic in a way, and take short breaths, try and be deep breaths and, and just kinda, trying to expand your lungs a bit more...well it kinda stops me sometimes, a little bit from sports, because I'd have to, if taking, quite a big, if it's a bad one, I'd have to take quite a big breather, at the side, do quite some, like, put my arms above my head, breathe, and then deep breaths, and, till I fully, fully get all my breath back because sometimes if I just kinda do it and it's slightly gone, and I feel a bit better and, I can, you know play again, it can sometimes come back and make it a bit worse, if I don't fully recover"* (Harry, boy, aged 13)

Others describe controlling their asthma by wearing a scarf to keep the warm air in their bodies.

> *"Sometimes in the winter it gets quite bad on my chest, and my mum always says like, it's a bit silly, but like you need to wear a scarf to cover up your neck and it helps you like, like, keep all the warm air in you, like in your body"*(Jane, girl, aged 12)

> *"If I get a scarf and cover up my mouth and just breath in warm air, if I don't have my inhalers around me at that time I'll just use a scarf or something that's on me, I'll use it"* (Amy, girl, aged 10)

Preparation

The children take responsibility for their asthma in many ways ensuring they take their medication on school trips; on holiday; before sports. They also take measures to prevent catching colds and flu which exacerbate their symptoms.

> *"The residential trips, I am not allowed to go on a residential trip with out my inhaler...so I need to bring it everywhere on like trips and sport"* (Poppie, girl, aged 10)

They also try to limit the impact of their asthma by taking their inhaler 15 minutes before doing PE just in case.

"I take it before, because it takes 15 minutes to like kick in and then if I have take it then I should be alright for the lesson, and obviously if I do like really long runs in cross country then it gets worse, because obviously you run out of breath but, if you control it then, it's alright" (Laura, girl aged 14)

"I would take it after I have done sport if I am particularly wheezy, or maybe sometimes before I play sport, just to make sure" (Dylan, boy, aged 14)

When its comes to the cold and flu season, the children have different methods of preparing for it.

"The intense cold around Christmas time and everyone is quite ill around that sort of time as well so, just had to double the sort of doses of my inhalers and hope for the best" (James, boy, aged 14)

Laura understood it is important for people with asthma to have the flu jab, which should prevent an exacerbation of symptoms due to flu.

"Making sure you have like flu jabs and stuff, because that's what I had the other day because if you get flu it just makes it so much harder for someone with asthma because, you just seemed to get it a lot worse...so if you have things like prevent flu and other diseases I suppose then, it would just make your life so much easier" (Laura, girl, aged 14)

Factors and Control

Another way of controlling a person's asthma is to know what factors and triggers could make it worse; not knowing what factors make the asthma worse could be a knowledge barrier. For example, some of the children knowing that dust was a trigger for their asthma, meant that they could take the precautions needed to avoid dust.

"Probably just not having too much dust around" (James, boy, aged 13)

Henry knows that he has very bad hay-fever and if that is not under control it can make his asthma worse and takes hay-fever tablets to prevent his asthma symptoms becoming worse.

"Recently since I have been taking the controller, the green one, and my hay-fever tablets it's been much better, and I have only been getting wheezy like once a week or something" (Henry, boy, aged 14)

5.6.4.6 Barriers

There were many barriers to medication adherence which were uncovered during the interviews that could stop the children from taking their medication.

Fear

The fear theme was used to explore any situations when the children's emotions or worries caused them to not take their asthma medication. One child was scared of asking the teacher to let him go to take his asthma medication, so he did not take it.

> *"The only reason, thing I can think of, is when I am younger and I can't, I am slightly scared about asking the teacher, but other than that, not really"* (Pizza, boy, aged 10)

Medication

Simply not knowing how to take the medication properly can cause poor adherence to their medication due to incorrect use. Most of the children seemed to understand which inhalers to take and when:

> *"Sometimes people can have the spray, the brown spray, morning and night, and the blue one is just for emergencies, for me"* (Goldie, girl, aged 7)

> *"The blue is just when I need it"* (Jack, boy, aged 7)

> *"I think that one [purple] every morning and night, that one [blue] if I ever get, like slightly wheezy or in a dusty house and that one [green/white tube] just taking it round and about"* (Pizza, boy, aged 10)

> *"Purple, morning, twice every morning, and night, blue when I am need it, and the orange in the summer when my hay-fever starts off my asthma"* (Daisy, girl, aged 9)

Even though most children demonstrated the correct knowledge of when to take their asthma medications, some however did not.

> *"I take them two [blue and brown] in the morning and at night and that one [purple] if I had, if I have a bad cold"* (Teddy-Rose, girl, aged 8)

Sometimes the medication itself can be a barrier for not taking it. Some children can dislike the taste or the feeling of having to take the medication. For example.

> *"I never really wanted to take it cause it's quite a strong medication, if you puff it in to your chest, I didn't really like it very much"* (Erika, girl, aged 12)

Forgetting

Often children can just simply forget to take their medication and this was usually because they were in a rush. All five of these children said that they find they are often in a rush in the morning before school so can forget to take their medication then or when their routine changes.

> *"I've, forgot to put the inhaler in my bag, or I have misplaced it or anything and that is"*(Harry, boy, aged 13)

> *"Only if I forget or I am in a rush to get to school, sometimes"* (Cal Jackson, boy, aged 10)

> *"In the morning, especially if I am late for school, I'll forget and then I will remember and I'll take them"* (Henry, boy, aged 14)

> *"If I forget it and not take it to school by accident or, forget to take it to a sport if I have been rushed or I am late for something, forget to pick it up"* (Joseph, boy, aged 14)

> *"Sometimes I might like forget, but that's like, that's not like for a whole week, that's only for like one night if I go to a party and come back late, like I might forget sometimes, but I never purposely miss my medication or anything"* (Jane, girl, aged 12)

Inconvenience

Not taking medication because it is inconvenient/burden was also given as a reason why children may not adhere.

> *"I have so much, it's really annoying and it gets in my way"* (Teddy-Rose, girl, aged 8)

Another girl suggested that it was inconvenient for her to take her medications to social events, such as parties and sleepovers.

> *"If, I am going, if a night time, like I'm on like, I get to go to a party or something and I stay up quite late then, like I went to a sleep over and I don't take my medication then"* (Rhianna, girl, aged 9)

Self-conscious

Some children expressed feeling self-conscious about having asthma, they felt it makes them look weak which can result in the child not taking their medication.

> *"I hate using my inhaler, I don't want other people to know that I have asthma, I don't want people to feel sorry for me, I want to be strong, I want to be strong, so I really try not to take it... I tell myself I don't want it, because I don't want people to feel sorry for me, I don't like people feeling sorry for me, I wanna say 'I am strong, I am fine'."* (Rachel, girl, aged 13)

Feeling Well

PLEASANT also hypothesised that in the summer children are feeling well so do not feel they need to take their asthma medications. Some children detailed times when they are feeling well so may not take their medication.

> *"Sometimes if it's good, I'll just do it in the evening"* (James, boy, aged 13)

> *"If I feel fine, that morning, really clear headed, you know, not wheezy at all, and like breaths, I won't take it that day"* (Harry, boy, aged 13)

> *"Sometimes if, my, if my, if there's nothing really happening with my asthma, I don't take it, because I think 'oh nothings going to happen' "* (Erika, girl, aged 12)

Change in Routine

Children did not report any change in their pattern of adherence during the summer holidays except that when they go on holiday they do not always need their inhaler implying that they do not understand the importance of prevention.

"If I go on holiday, it's just, sometimes I just don't bother" (James, boy, aged 13)

Reminders

Some children require reminders whereas others would not take their medication as often as they should without parental influence.

"At school I take it a lot less than I do at home because my parents remind me to do it" (Dylan, boy, aged 14)

Lost

One child reported losing her reliever inhaler.

"I don't have my blue inhaler on me at the minute because it went through the wash...so it doesn't work any more, so getting a new one...but for now I am just using the brown one, like every day or every other day, just to make sure I don't get too wheezy" (Nicola, girl, aged 11)

5.6.5 Sport and Exercise

Sport and exercise was a theme that was developed further in the second set of interviews. This theme was used to cover anything the children said with regards to sport and exercise. The interview topic guide was used to focus the interviews and direct the questions more towards sporting activities. The results from the first set of interviews indicated that sport could be playing a role in the September increase in medical contacts. To test this theory, the topic guide was changed to ask the children what sports they would normally do in the year and what sort of sports they did in the summer break. This theme was used to include any changes in sporting activity over the year and also used to cover the generic sport related answers including different types of sport and how much sport they did.

5.6.5.1 Type

Sport that included more physical activity such as, running appeared to have more of an effect on some children's asthma.

Running

"We did this thing where you have to run different laps between like the playground, and we do, we have to run for a whole minute without stopping, and we have to see how many laps we can do...I was running quite

fast and it, my breath just stopped and I just couldn't breathe because I was, I was getting like out of breath, out of breath, out breath and it just stopped and I just like literally collapsed because I couldn't breathe any more…a couple more lessons I didn't do it because I literally felt like, if I did it then I couldn't breathe but then afterwards I was like, I started doing it a bit, little by little, then I just started jogging again and doing stuff like that" (Hannah, girl, aged 12)

"In year 6, I remember we were doing athletics, so we were running around the track and suddenly I just couldn't breathe quite well so I had to just stop for a minute" (Erika, girl, aged 12)

The next examples are children comparing running to other sports and how it can affect them differently.

"When I like do running I sometimes like quickly stop like quickly like get out of breath but, but when I like just, when I do things like erm, skipping or things like that, then I am alright" (Lilly, girl, aged 8)

"When I do swimming it's fine, because I am not running, but the other three, two, football and basketball, if I am playing it for a long time I start to get wheezy" (Bob, boy, aged 7)

"Running, err the rest are really fine because you don't do that much, like netball you it's a very short court and you just need to pass and throw" (Poppie, girl, aged 10)

"When I am biking I don't really get that much, when I am biking and walking I don't really get that much out of breath, but when I am running, and doing other things, I do" (Jonathon Cena, boy, aged 10)

Swimming

Swimming seems to be the same as most triggers of asthma, it affects some and not others.

"Sometimes I go swimming which can sort of set it off but it doesn't really set it off…I used to do competitions in swimming, but when I got to like a certain age, that it started to build up more so I didn't do it very often" (Jessica, girl, aged 14)

Whereas others found swimming had no affect on their asthma.

> *"If you're like running it can be bad but then if it's like swimming it doesn't get bad for me"* (Sophie, girl, aged 11)

Indoor

Most children found that indoor sports such as ice skating, gymnastics, trampolining and boxing had less of an affect on their asthma.

> *"I do ice-skating but that doesn't really affect it at all"* (Jessica, girl, aged 14)

> *"When I do football, cricket and baseball, erm, I start to cough a lot, but boxing and Thai boxing I am fine"* (Jack, boy, aged 7)

However, Rachel explains that she is able to do gymnastics but she struggles with trampolining as it requires her to jump around which is using more physical exertion.

> *"Well trampolining because I move a lot, I have to jump a lot, obviously my breath gets caught up and I just have to take a bit of a rest, in gymnastics not that much, because obviously I am not running, like I am not doing as much as I would be moving, I just have to do a few positions but yeh, it's better in gymnastics"* (Rachel, girl, aged 13)

5.6.5.2 Amount/Activeness

The theory developed from the first interviews was that the children that do not like exercise may not do exercise over the summer holidays, therefore finding out how active the children were the rest of the year was important. The child's level of activity during the school year may correspond to activity levels during the holidays. Three examples will be used to illustrate the findings.

Joseph is an active child throughout the whole year, he talks about the numerous sports he does in the week, and this includes, basketball, football, diving, swimming and football.

> Year:
> *"I play football, for a team...a bit of basketball every now and then, not like for teams or anything...diving, I do diving every week, I do do a bit of swimming but not like competitions and that...Sometimes I play*

hockey for school but not in like matches, just like, training and then, and then I walk home every day, for about an hour or so"
Summer:
"When there was like, the competitions at the camps...there was a football one, the was a rug, tag rugby one, there was a mini golf one, and, yehh there was like loads of activities to do" (Joseph, boy, aged 14)

Whereas James reduces the amount of sport he does over the summer.

Year:
"I do rugby on, about 2 hours on Wednesday and an hour and a bit on Sunday, and then sometimes Saturday...also Thursday an hour and a half as well, so it's a lot, and then I don't really have much time to go to the gym, so maybe only once a week or so"
Summer:
"[Did you do much sport over the summer?] Not really actually, you know, the odd bit of football, running around, but nothing too serious" (James, boy, aged 14)

Erika was another example of this, however she stopped all activities over summer completely. When asked what sport she did, she said *"I do a lot of badminton, erm every, I do training every, 4 times a week, and I do PE at school"* (Erika, girl, aged 12) but when asked if she did any sports over the summer break, she said no.

Sarita is someone who does not consider herself to be active and prefers to spend her free time singing, reading and playing on the computer.

Year:
"I am not a very sporty person...I like to run around with my friends and the asthma has never held me back with that...I like to sing, I like to read, and I like to play on my computer"
Summer:
"Not much, I did some canoeing with my friend on the lake...I went on lots of walks as well but I didn't do much of sport" (Sarita, girl, aged 11)

In addition to the quotes above, presented below is a further example of children exhibiting sedentary behaviours in the summer.

"We would, we just went to the park and yeh stayed at home watched TV and all that" (Amy, girl, aged 10)

In contrast to the sedentary behaviour example, here are a few further examples to show how much sport some children did in the summer break.

> *"I have like tournaments and stuff, like netball tournaments, I had like, I think I had like one big netball tournament"* (Jane, girl, aged 12)

> *"Lots of trampolining, lots of gymnastics, I did, I didn't do much hockey because I usually play like with a team but loads of people were away…and I did quite a bit of netball"* (Nicola, girl, aged 11)

> *"Probably summer I am always outside, erm, running around, playing with my friends, playing with my sister on the trampoline, doing sports"* (Pizza, boy, aged 10)

5.7 Discussion

The previous sections provided an outline of the results of the qualitative study, introducing the themes that were developed during the interviews. This section discusses the themes in detail.

5.7.1 Triggers and Factors

During the interviews the children were asked what made their asthma better or worse in the general sense rather than asking them specifically about the new school year, which would be leading. The children had many different responses however there were a few which were shared by the majority. The key triggers identified were sport, allergies, weather and other illnesses and are consistent with those previously reported in the literature (Asthma UK, 2014b) and were introduced previously in Chapter 2.

With most of the triggers, children reported contradicting views about the role of triggers. Some children found that sport and weather could be a trigger but for others they reported it actually improved their asthma symptoms. Most of the children associated exercise as a trigger as it caused them to be wheezy, breathless and to start coughing. The children often complained that they would sometimes have to sit out of the sport they were doing to catch their breath. Sports that involve more running were more likely to cause the children's asthma symptoms to worsen. However, some of the children suggested that doing exercise actually improved their asthma symptoms, with one child saying that doing exercise *"calmed his asthma down"*. The children who found exercise helped their asthma tended to do a lot of sport, whereas those who reported that their asthma was triggered by sport, tended to do much less physical activity. Exercise may improve asthma control, but those who exercise are more likely to already have their asthma under control so exercise is no longer a trigger. Studies have shown that continual exercise increases control of asthma symptoms. Two papers, one based in Canada with adults and one based in Taiwan with children, both suggest that exercise can actually increase asthma control (Lin et al., 2008; Bacon et al., 2015) and the adults who exercised the most during the week were 2.5 times more likely to have control over their asthma. The paper also found that adults with asthma who exercised in the winter were more likely to have control compared to those who exercised in the summer; they suggest that maintaining a constant exercise routine throughout the whole year will increase asthma control (Bacon et al., 2015). The children who are physically active are more likely to have a constant exercise routine with well controlled asthma. If less active children get used to doing exercise then their body and lungs may no longer find exercise an irritant.

Another key trigger that the children discussed was allergies, such as hay-fever, pets and dust. During the interviews not many of the children offered information about their hay-fever symptoms unless they were severe with most needing to be prompted to recall. The children often forgot to mention they had hay-fever. This could be due to the time of the year, as the first set of interviews were conducted after the hay-fever season had ended. The children who did have hay-fever had mixed views on whether it affected their asthma. A few children mentioned that the hay-fever could affect their asthma a little bit, as you tend to sneeze when you have hay-fever but did not cause too many issues with their asthma symptoms. However, this could be dependent on the severity of the hay-fever. One child described that he was able to take control of his asthma once he had taken control of his hay-fever. Pollen is a known trigger (Rees, 2010), however the results of the study show that it is a trigger for a small sample of these children which is consistent with the literature. A study conducted in China found that pollen was ranked 6th for causing asthma attacks, which was about 11 % of the sample (Xu et al., 2016). Another study in the US found that a higher percentage of children had hay-fever (Mirabelli et al., 2016) but this was still only a sample of the population.

Pets were another trigger and this included the associated dust and animal hair. Unfortunately the question was phrased incorrectly in the first set of interviews; the children were asked if they had any pets, and if they did not, no further questions were asked about the trigger. This may have introduced bias in the answers received from the children. However, this was corrected in the second set of interviews. The children had a range of pets, from guinea pigs to horses with variable reports of impact and symptoms with some reporting that it had no effect on their asthma. Animal exposure is a known trigger for asthma, it is also known that different animals can affect different children (Anderson and Brannan, 2001). There are studies which have found that exposure to different animals in early life can de-sensitise them to that particular trigger (Hugg et al., 2008). However keeping other animals, such as cats, in early childhood can sensitise children to that particular trigger (Hugg et al., 2008; Medjo et al., 2013). Nevertheless, the results from studies looking at this exposure are not consistent, some found that there is no evidence for early exposure de-sensitising or sensitising to that trigger (Carlsen et al., 2012). The inconsistency of the results in these studies could explain the inconsistency in this study.

Dust could be related to animals, however some children who explained that they were fine with their pets, suffered when it came to dust. As with most of the triggers, children reported contrasting views. The children affected by dust said that they found it difficult to breathe if they were in a dusty hall.

Like sport, weather was another trigger resulting in contradicting views about the impact different weathers had on their asthma. Some children said that they found that their asthma improved on days when the weather was warmer, but none were able to explain why. Whereas others suggested that they found their asthma was worse on hot days. One child reported that when it is hot and he is running around, it would cause his asthma to flare up. Another child found that he experienced more asthma attacks and wheeziness on sunnier days. This could be due to children being outside more when it is sunnier and other factors such as more exercise and hay-fever could be confounding. Studies that were discussed previously often looked at seasonality of asthma which often coincided with weather. Most of the studies concluded that there was normally a trough in the summer which is often when the weather is warmer and a peak in the winter when the weather is cooler (Xirasagar et al., 2006) which was consistent worldwide (Kimbell-Dunn et al., 2000). The dip in contacts in the summer and a peak in winter suggest that children's asthma may be triggered by the colder weather more so than the warmer weather.

Similarly for cold weather, children had different views on whether it was a trigger or not. Children described that cold weather would cause them to become more wheezy and cough more. As the second set of interviews had more of a focus on sport, this was then combined with weather when the children were talking about triggers. Most of the children said that they found it harder to do exercise with their asthma when the weather was colder. This could coincide with the return to school and exercise where they are doing exercise again when the temperature is cooler. However, not every child shared this view, some children found that doing exercise in the warm weather impacted on their asthma. This is similar to what has been found previously in the literature where a number of studies have found that different climates can cause exercise induced asthma and other respiratory related conditions, most concluding that cold weather is worse (Carlsen, 2012; Driessen et al., 2012; Marefati et al., 2016).

Illness was the one of triggers that the PLEASANT study was based upon. They suggested that one of the biggest challenges the children face at the start of new school year is the viral challenge. Children were asked whether being unwell had any effect on their asthma symptoms, they often responded to this in terms of colds and flu like viruses. They all concluded that having a cold made their asthma symptoms worse. One child went on to try to explain why and suggested that having a cold or flu meant that he was unable to breathe through his mouth or nose which in turn made it harder for his asthma. This concurs with the PLEASANT trial hypothesis relating to the impact of a viral challenge (Horspool et al., 2013).

There were mixed views on how being at school affected their asthma when compared with being off school. Some children found that returning to school had no effect on their asthma whereas others found that it did, and this was down to a number of reasons. One child who found it had no effect on her asthma explained that this could be due to the fact that her asthma was under control, she was the only child to provide a potential reason why. If a child found that going back to school had an effect on their asthma, this could be caused by a change in weather, being unwell, change in routine or they were doing more sports. As the summer holiday months tend to be warmer than in September, this means that the children are having to deal with a drop in temperature when they go back to school. The children who commented on this said that they were having to use their inhalers more to deal with the cold weather now they were back at school. At the start of the school year the children were also having to deal with a change in routine especially when moving from primary to secondary school.

The PLEASANT study did not include sport in their original hypothesis. The children all commented that their routine has changed as they all had to take part in sport when they got back to school. For some children this often included more sport than they did over the summer break. Although some found the return to sport at school made their asthma worse, others said it had no effect. The affect of this was greater as the sports they do at secondary school required them to exercise at a higher level or intensity. For some changing year group, for example year 7 to year 8, within the same school, meant they also had to adjust to new sporting levels. Some children also talked about how their form rooms and classrooms were more spread out in year 8 which means they were having to move around more.

The final trigger to be discussed is how stress and emotions could impact on their asthma. This was briefly touched upon in the first set of interviews but became much more apparent in the second set. It was also discussed briefly in Chapter 2. This could be due to the interview sample in the second batch consisting of more teenage girls (Table 5.2). Emotional factors such as anxiety and stress are known trigger for asthma symptoms (Lehrer et al., 1993; Wood et al., 2006; Vazquez et al., 2017). Emotional factors were not specifically questioned in the interviews, however it was apparent when talking to the children.

As with all the triggers, the effect it has on the child is dependent on the child. Not all children with asthma are the same. One trigger that affects one child does not necessarily affect the next child. However, from the small sample of children included in the qualitative study it is not possible to look for or associate any links between characteristics of the children and whether they will be affected by specific triggers or not.

5.7.2 Impact

During the interviews children talked about the impact of asthma on their lives. The main sub-themes that this theme was built upon were symptoms, sport, routine, and fear and emotions.

Children described their asthma symptoms, how often their asthma can make them feel unwell and how they can impact on their lives. The children often described their asthma symptoms in terms such as ‘becoming wheezy’ or ‘finding it hard to breathe’. The symptoms experienced vary from child to child, some children had fairly mild symptoms whereas others had more severe symptoms which impacted more on their lives. In addition the number of times symptoms occurred was different for every child, some children could be affected a few times a year whereas others were affected on a daily basis. The symptoms that the children experience could heighten the belief that their medication is a necessity, if the children adhere to their medication then they may not experience these symptoms.

Previously sport was discussed as a trigger, however having asthma can also impact on their ability to do sport. The children had different viewpoints on how their asthma impacts on their sport, some children found that there was no impact whereas others found that it stopped them doing sport. Some children explained that their asthma affects them only if they had done too much sport or if they had not taken their inhaler. Other children found that they are unable to join in as much as they would like as they have to take breathers when they felt their asthma symptoms flaring up. These results are similar to those found in the paper by Williams et al. (2010).

Children also reported that sometimes it was not their asthma directly causing the child to not take part in the sport, it was whoever was in charge of their care that was stopping it even though they felt they were capable. This demonstrated a lack of understanding about asthma with some treating asthma the same for all children. This results in some people treating asthma as a weakness which again can impact on what the child is allowed to do as the others may feel the child is too weak to do certain activities, which has been found in previous studies. One study by Bevis and Taylor (1990) surveyed a number of teachers at schools in London about their asthma knowledge. The results of the study showed the the teachers had a very limited knowledge about asthma (Bevis and Taylor, 1990). However another study by Williams et al. (2010) interviewed teachers, among others, about children with asthma exercising and found the teachers were more cautious about the children with asthma exercising as they felt they did not have the confidence to assess the capability of the child but they understood the benefits of children with asthma exercising.

The children, on the whole, demonstrated a high level of knowledge on how to manage their asthma, taking responsibility for ensuring they had their medication with them at school, sports and trips. The children also showed how they had built their medication into their daily routine, with limited support or reminders from their parents; especially in secondary school children. This is consistent with the literature, which has previously suggested that having a family routine can facilitate medication adherence (Fiese and Wamboldt, 2000; Rand, 2005).

Children with asthma can experience asthma attacks of various severities. Not only is this hard for the child with asthma, it is also hard for the people around the child. Some children discussed how they did not want others being upset and worried about them. The impact on the others can go from being upset because the child cannot play on the trampoline to the family and friends having to deal with a child dying because of their asthma. An article by Nocon (1991) suggested similar results; they found that siblings of children with asthma and parents may be affected as the whole family may have restrictions on what they can do. The article also discusses how parents are always worrying about their child because of the asthma.

Children can feel a range of emotions when it comes to their asthma; some felt worried that they could have an asthma attack at any point and worried that they might not have their blue inhaler if they did start to feel more wheezy. The children reported being scared of what could happen to them when they experience an asthma attack and the feeling of not being able to breathe. The children also felt sad that they were unable to do things that they would like to do as their asthma prevented them. A meta-analysis by Dudeney et al. (2017) concluded that children with asthma were three times more likely to suffer from some form of anxiety disorder compared to their non-asthmatic peers. The emotions the children talked about tended to be negative ones, however one child did talk about feeling comforted when she was in hospital after an asthma attack, knowing that she would recover soon.

5.7.3 Medication and Adherence

The third theme to be discussed is the medication and adherence theme. As stated in the results section, this theme was an important theme in regards to the PLEASANT study (Horspool et al., 2013). The Ph.D. was built upon the PLEASANT study; the qualitative study aimed to explore the findings of the PLEASANT study from the perspectives of the children. The children were asked about how their medication fits in their daily routine at home or elsewhere, how their medication regime has changed as their asthma has progressed and how they viewed their asthma severity. Children were also asked to describe the history of their condition and their experiences with routine and non-routine health care. The theme also explored barriers to adherence.

When the children talked about their medication and routine at home, most of the children provided details of when they take their asthma medication without a prompt from the interviewer. The children who were taking some form of preventer inhaler would take their medication once or twice a day, normally in the morning and evening before bed. The children all had well established routines which incorporated their asthma medication explaining how they would take their medication and then would brush their teeth as the inhaler contains sugar. The children all had well established routines which incorporated their asthma medication. Most studies look at monitoring adherence using various methods or uncovering the barriers to non-adherence (Penza-Clyve et al., 2004; Fiese et al., 2005; Peláez et al., 2015), however the results from this study support the importance of having an established routine for adherence to asthma medication. Having an established routine also reduces the potential for the children to, unintentionally, not adhere to their medication.

A good support network can play a key role in helping children adhere to their medication, as it has the potential to discourage any intentional non-adherence. This support can come from friends, family and teachers. Having family support can increase asthma control and quality of life (Rhee et al., 2010). Teachers have a key role in the child's support network, however, sometimes this support network can fail. There were many examples of children not wanting to take their medication because of the teachers. This was because they were scared to ask if they could take their medication, or because the teachers do not fully understand what asthma is or the role of the medication. The latter example given is a situation where the children have made the decision to intentionally not adhere. They believe that the teachers will prevent them from taking part in sport if they are seen using their inhaler. Hence, the children do not take their medication so that they can take part in the sport activities. Bevis and Taylor (1990) surveyed a number of teachers about their asthma knowledge and concluded that teachers do have a lack of knowledge, especially when it comes to medication. Teachers also showed a lack of understanding when it came to asthma and sporting activities. The study recommended that primary school teachers should receive asthma training when completing their teacher training.

Children described how their asthma had changed over time, which could be getting better, getting worse, or it could stay constant. Some children described how their asthma medication had changed to a higher prescription and how they went to the doctors a lot because their asthma was getting worse. For children whose asthma was getting better, they explained that their asthma has less of an impact on their lives now and they are more able to do things without their asthma affecting them. They also talked about how their asthma medication had been/could be decreased. These are examples of intentional non-adherence, the children believe they do not need to take their medication as planned. These are also examples of the childrens necessity beliefs decreasing. They see that their asthma is getting better so no longer feel that it is a necessity to take their asthma medication. A review by Spahn and Covar (2008) looks at the factors which can influence children with asthma going into asthma remission and what percentage of children do go into remission. They concluded that factors such as being male, mild asthma and infrequent episodes of wheeze are likely to influence remission. They also concluded that 10% - 70% of children with asthma will go into remission (Spahn and Covar, 2008). Another study by Fu et al. (2014) concluded that the onset of puberty is associated with the progression of asthma symptoms in both genders and is also linked to the gender switch in asthma severity (Fu et al., 2014)

The children also had different perceptions of their asthma symptoms, one child reported that he had recently increased his asthma medication and started taking hay-fever tablets which improved his asthma; he was now only wheezy once a week. Experiencing symptoms once a week could be considered very frequent however he regarded it as an improvement. This child is an example of someone who feels their medication is a necessity, they know that if they do not take their hay-fever tablets and their increased prescription asthma medication then their asthma symptoms become more frequent. Another child who was taking strong asthma medication explained how he was able to run 1500 metres without becoming too wheezy and that his asthma was getting better as he got older. Even though the medication these children are on is strong, they have well controlled asthma which is enabling them to do things that they may not have been able to do previously which is giving them the impression that their asthma is better as it is impacting less on their ability to do activities. This phenomenon is known in the literature as 'underperceivers', 'overperceivers' and 'normalperceivers' (Janssens et al., 2009; Loh and Teh, 2009; Cukier, 2010). Overperceivers are those who see their asthma symptom as worse than they are, and underperceivers are those who see their symptoms as being better than they are.

During the interviews, the children were asked if they had been to the doctors or hospital because of their asthma. All the children talked about how they go to the doctors for routine asthma reviews once or twice a year and a few went when they were feeling a bit more unwell. Some children were very articulate when it came to talking about their asthma and the tests they underwent at the doctors appointments. Only a few children had experienced an asthma attack which resulted in them being hospitalised. Children were unable to explain what caused them to have an asthma attack.

Barriers was the main sub-theme under the adherence and medication theme which covers anything that could stop the children from taking their medication. This was previously introduced and discussed in Chapter 3 Section 3.6.

Fears and emotions were used to cover any time the children provided an emotional reason as to why they might not take their medication, the example used in the results is when a child said that he used to feel scared to ask his teacher for his medication so this resulted in him not always taking his medication when he may have needed it. This is an example of unintentional non-adherence, this child would like to take their medication but is unable to because they are scared to ask the teacher. Some children gave the impression that they were self-conscious of taking their medication. This is an example of intentional non-adherence, the children are choosing to not take their medication.

Understanding how to take the medication properly and how to adhere correctly were all important factors in controlling asthma symptoms. Most of the children knew when, how many times and at what time of the day they should take each inhaler and most of the children were able to differentiate between taking the preventer inhalers every day and taking the reliever inhaler when they find they are struggling with their asthma symptoms. This is an example of a positive impact on intentional non-adherence, suggesting that knowledge can increase adherence. However, this was not the case for every child as some were not clear about the role of medication. A few children described taking the reliever inhaler at the same time as the preventer inhaler every day. This is an example of unintentional non-adherence, the children are trying to take their medication but do not understand the medication instructions. Most studies have looked at whether the child has the correct inhaler technique (Milgrom et al., 1996; Alexander et al., 2016) rather than their understanding of the different inhalers. However, a study by Gibson et al. (1995) surveyed a number of adolescences (with and without asthma) and teachers about their asthma knowledge and found that the general level of asthma knowledge in all groups was poor.

Understanding which factors affect the individual helps them to take control of their asthma avoiding potential triggers such as dust and hay-fever. Children going to a place that could potentially be dusty, reported taking the precautions, such as taking extra preventer medication or making sure they have their reliever inhaler with them. Those affected by hay-fever used hay-fever tablets to control hay-fever symptoms which then in turn can help with the asthma symptoms. Again, these are some examples of children believing that their medication is a necessity.

Children sometimes found themselves in the situation where they did not have their reliever inhaler with them or they were struggling to take control of the symptoms with their inhaler. The children demonstrated knowledge of how to use breathing exercises to control their asthma or by sitting out and taking a rest from sport. Breathing exercises are known in the literature and there are various different methods that can be used for different situations (Thomas et al., 2009; Thomas and Bruton, 2014). However, the trial by Thomas et al. (2009) concluded that whilst breathing exercises are helpful for relieving asthma symptoms, they should not replace medication.

Children often forget to take their medication usually because it slipped their mind, they were too busy or when they were in a rush in the morning before school. These are examples of unintentional non-adherence, they simply forgot to take their medication, but not intentionally. Having an established routine, as discussed previously, can potentially prevent unintentional non-adherence. However, the next example is a case of intentional non-adherence, the children are purposely not taking their medication for various reasons. Sometimes the children found that taking their medication to be an inconvenience. Having too many medications to take gets in *"the way"* especially at a social event where they purposely do not take their medication with them. Forgetting and inconvenience are barriers which were found in previous studies (Leickly et al., 1998; Buston and Wood, 2000; Blaakman et al., 2014).

PLEASANT hypothesised that children feel better in the summer holidays therefore they may not take their medication during this break (Julious et al., 2011). The children interviewed confirmed that they would sometimes reduce the amount they would take that day if they were feeling better than usual. This was particularly apparent if they were away on holiday they would sometimes not bother taking their inhaler, with one child not even taking his inhaler with him.

5.7.4 Sport and Exercise

The first set of interviews suggested that exercise could be playing a role in the increase in September contacts for children with asthma, which was explored further in the second set of interviews.

The results have shown that the majority of children have found that sport is a trigger for their asthma which is supported in the literature (Cypcar and Lemanske, 1994; McFadden and Gilbert, 1994). However, what became more clear in the second set of interviews was that different sports affected the children more than others. The sport that had the biggest impact on the child's asthma symptoms was running; a view that was shared by all children. Also, the children seemed to find doing sports outdoor more difficult than indoor sports. It is possible that the reason why children find outdoor sports more difficult could be that when they are outside, the weather can be colder compared to being indoors. Outdoor sports such as, football, rugby and hockey, all require more running which could be another confounder. However, sports completed indoors could be done in a dusty school hall which could also make children's asthma worse, However, this was only mentioned by one child. This was also found in the review by Hughes (2014).

Since the children had been asked about the sport they did over the summer holidays versus when they are school, it was then easy to make a comparison between the two. Only some of those who did a lot of sport at school maintained this over the summer holidays, others decreased their exercise uptake over the summer or stopped completely over the summer break. The children who do little or no exercise showed a similar pattern with some decreasing and some stopping. Therefore the level of activity at school is not a prediction of the level of activity during the school holidays.

5.7.5 Theories Developed from the Results

Exercise was one of the key triggers of asthma that was reoccurring in the majority of interviews. The children either found running/exercise made their asthma worse or caused them to become breathless, or they found that running/exercise actually made them feel better. This trigger appears to have no correlation with the severity of the child's asthma. Some of the children who took more medication for their asthma did a lot of sport as well as some of the children doing the minimum possible. This could be that once the children have got used to doing exercise they are able to do more, whereas if they do very little exercise, they are able to do very little (Lecomte, 2002; Basaran et al., 2006). However, it could be related to asthma control, if a child has their asthma under control, then this may enable them to take part in more physical activity (Seys et al., 2013).

A lot of the children commented on how they feel better during the summer or when they are on holiday. This corresponds to the PLEASANT trial hypothesis, that the children feel better during the summer holidays. PLEASANT also hypothesised that children do not take their medication when they are feeling well. However, from the interviews, the children do not support this hypothesis as they claim to adhere to their medication most of the time, apart from when they forget, go on holiday or are in a rush.

For children with asthma there are many benefits of exercising, however studies have found that they are less active than other children (Ram et al., 2000a; Chiang et al., 2006; Glazebrook et al., 2006). Although exercise is a known trigger for asthma (Cypcar and Lemanske, 1994; McFadden and Gilbert, 1994), there is also a culture of over protection (Williams et al., 2010). However, research has found that continually exercising over a period of time can improve quality of life and exercise capacity for children with asthma. A study conducted in Turkey found that children with asthma who took part in 8-weeks of submaximal exercise were more likely to increase their exercise capacity and their quality of life compared to those who did not exercise (Basaran et al., 2006). Studies have also shown that exercise can increase asthma control (Lin et al., 2008; Eijkemans et al., 2012; Bacon et al., 2015). There have been previous studies looking at exercise interventions for children with asthma as they should be encouraged to exercise (Jago et al., 2017). A pilot study by Westergren et al. (2016) tested an exercise intervention on 6 children aged 10-12. The intervention involved two exercise sessions a week for 6 weeks. The study concluded that the children felt their asthma, fitness and HRQoL had improved after the 6 weeks and suggested a full RCT should be conducted.

There are a number of studies looking at how the summer holiday break affects children's health. The studies are looking at many different factors that could influence the change in health: diet, physical activity, sleep time, sedentary behaviour, and the background characteristics of the child/person (Cox et al., 2006; Duncan et al., 2007; Baranowski et al., 2014; Staiano et al., 2015; Wang et al., 2015). However, the results of the papers seem to be inconsistent, some found that the summer holiday increases the children's BMI and they become less physically fit (Baranowski et al., 2014), whereas others claim that children actually do more physical activity during the summer holidays (Staiano et al., 2015). Studies have also found that there is a difference in gender for physical activity; boys tend to take more steps a day than girls (Yiallouros et al., 2015; Lu et al., 2016). However, these studies relate to children who do not have asthma.

The data suggests that doing exercise/running increases asthma symptoms when they do not include exercise in their weekly routine. The general consensus in the data was that the children tended to feel better in the summer holidays. The children who tended to exercise more and maintained this during the summer holidays would also benefit from all the other benefits the summer holidays provided. They would have better weather, less pollen, summer holidays away, time off relaxing and mixing with fewer children. The children who exercise less and continue to not exercise during the summer holiday break may also feel better during the summer, they do not have to take part in the school physical activities and exercise clubs tend to also have a summer break.

Some of the less active children felt that they would feel better with their asthma if they could stay inside and not have to do much exercise.

> *"Probably, summer holidays, because when I am at school, you can't really. It is a lot better if you like doing sports at school where as in the summer holidays you can stay at home, means it would be better"* (Dylan, boy, aged 14)

And,

> *"Well, it's probably, when we don't do a lot of sports, I think maybe, in winter, now many people say it would be the Summer because coldness can make your asthma worse, but in winter, it's raining a lot, and to be honest, the school are so like paranoid about health and safety and stuff*

they keep everyone indoors when it's raining. When it's like in winter, it's raining a lot and snowing which means that we can't go outside, because we can't go outside it means I do way more less active stuff and if I do way more less active stuff I don't get worn out quicker so I think it's probably winter" (Jonathon Cena, boy, aged 10)

Dylan and Jonathon both said they would feel better if they were doing less sport and were able to stay inside. Dylan associated this with the summer holidays, he says that being at home in the summer is good for those who do not like sport as they do not have to do sport whereas they would have to at school. Jonathon says that he would feel better in the winter but for the same reason, the school would make them do less sport when it is cold and wet outside so he finds that he can feel better then.

In contrast, some of the more active children expressed that they feel better when they have more to do.

> *"Probably summer I am always outside, running around, playing with my friends, playing with my sister on the trampoline, doing sports"* (Pizza, boy, aged 10)

This led to conclude that some children who like exercise are more likely to continue with it over the summer holidays so then the return to school and doing exercise could be less of a challenge for this group of children.

Given the previous literature on physical activity in the summer holidays compared to the school term and how it can affect the children's health, weight and fitness, the change in activity level may be what is causing the children with asthma to experience issues with their asthma when they return to school. Not only are they faced with the challenges that it brings, such as, mixing with children, change in temperature, change in routine, colds and flu, undertaking exercise again after 6 weeks may be another challenge. Exercise was the key trigger for most of the children interviewed which is supported by the literature (Cypcar and Lemanske, 1994; McFadden and Gilbert, 1994). Children who exercise less may be more at risk of an unscheduled medical contact in September. This information was sought out in the second set of interviews undertaken straight after the summer holidays. Children reported a mixture of responses as to how they felt upon the return to school. Although some found it was the same. Others who found that it was different, explained that is was due to weather changes, illness and an increase in the amount of sport they did.

> *"No I think it's a bit worse because at school we do more PE and sports"* (Poppie, girl, aged 10)

> *"As it gets colder it gets worse usually and especially when we are doing sports outside"* (Louise, girl, aged 12)

The PLEASANT intervention was a reminder for the children to keep taking their medication over the summer holidays. The children interviewed reported being compliant to their medication plan during the summer break but that does not necessarily mean that their asthma is controlled. It seems that exercise could is more likely to play a part in the return to school challenge resulting in unscheduled medical contacts.

5.7.6 Reflections and Possible Limitations

5.7.6.1 Study Design

Interview Type

The interviews with the children were semi-structured which gave the children and the interviewer the opportunity to discuss topics that had not been covered in the topic guide. However, it did cause the children to lose focus in the interview but it was not difficult to get back on track. Hence semi-structured interviews with children were advantageous compared to unstructured interviews which would have required an experienced interviewer. Semi-structured were also advantageous over structured because it allowed the development of new themes.

Batch Interviewing

One of the main flaws in the study design is that the interviews were done in batches (n=1-10). The most interviews conducted in one day was 10 which did not allow time to reflect after each interview, transcribe and then make changes to the following interview. Therefore topics that emerged that could have been asked in future interviews were not explored in any of the subsequent interviews within that batch. It was also very tiring for the interviewer making it difficult to distinguish the difference between the interviews after they have happened and caused confusion between what each participant said during the interviews and topics were repeated or missed completely.

It would have been ideal to leave a couple of days between each interview, which would have given time to complete the interview, reflect straight after, transcribe and then apply any changes to the future interviews. However, given that the interviews were done in schools, it was not possible to plan the interview schedule. It required a lot of time and effort from the school and the children to take part so I had to reflect what suited the school to cause as little disruption as possible.

Some of the schools did not want the children to miss their lessons, hence interview slots were given at break and lunchtimes which created a time restriction for the interview session due to having a number of interviews to complete, resulting in the interviews being rushed or not completed in that time frame.

Interview Location

The interviews were conducted at the child's school within the school day. Most of the interviews were conducted in a quiet location, such as the school library, to minimise distractions and reduce background noise. Unfortunately this was not always an option for the school. Some of the interview locations were not ideal. In some of the primary schools, the interviews would take place in a large open area between classrooms. The setting complied with safeguarding regulations and it was also somewhere familiar for the children, which meant that they were comfortable. However, these areas were noisy and had many distractions. This was a problem for some interviews as the distractions and noise required the interview to be paused until the disruption was over. This made the interview difficult and resulted in losing the conversation flow. The interviews that were conducted in the libraries or a quiet room were ideal as there were minimal distractions which made transcribing easy.

Schools

The aim was to recruit schools in the middle deprivation level, in the hope that this would provide a mixture of children. Before the study started, the local council was contacted for a list of the local schools and their deprivation level. However, after contacting these schools, it proved difficult to recruit them as most either declined or ignored the request. After trying and failing with this approach, the recruitment strategy was extended to include any school in South Yorkshire and Derbyshire which also proved difficult. The schools that were recruited were through personal contacts. Unfortunately, this means the sample is not generalisable as the schools were either good state schools or independent schools.

Study Sample

The first set of interviews included an all-boys independent school, this meant that there were no secondary school girls. When trying to recruit secondary girls and boys from a state school, the children showed little interest in the study and although one girl did volunteer to take part, there were ethical issues (Section 5.7.6.1). This resulted in the study sample for the first part of the study consisting of four secondary school boys and 13 mixed primary school children. Therefore, in the second study secondary school children, in particular girls, were targeted. We were overwhelmed by the number of girls willing to take part in the study, in the second part of the study there were 17 girls and 4 boys. This imbalance is due to the schools that were recruited in the study, and also could be down to gender differences in willingness to take part in studies.

The interview sample ranged in age (5-16) which is what PLEASANT included in their study. However, after interviewing some of the younger children, these may have not provided much data, so having a cap on the lower age limit may have been a good idea. Children seemed to be more aware from the ages 7 upwards. This could also be related to the length of time the children had had asthma.

The interview sample also had no restrictions on the asthma severity. This was good as it allowed a full range of children with different severities to be interviewed. Nevertheless, the children with mild asthma, those who only took the blue inhaler, found it difficult to answer some of the questions as they did not relate to them. The original intention of the interviews was to find out why children may not take their medication over the summer holidays. This was difficult for the blue inhaler children as they would only take their inhaler when they needed. The questions were more aimed at the children on preventer inhalers. This means the data produced from these children was very limited. This was less of an issue in the second study as the focus was more on exercise and less on adherence.

Ethics Protocol

There were a couple of situations in the study where the ethics protocol became a limitation. The first being a situation when a child could have been interviewed but was not able to because her mother had only filled in one side of the form. We tried ringing the mother a couple of times and after no response we had to cancel the interview.

5.7.6.2 Positionality

Not having asthma

Being a researcher who does not have asthma had its advantages and disadvantages. The advantages are: I have no experience of what it is like to have asthma, therefore there were no personal biases of what I perceived it should be like or how they should manage their asthma. This meant that when I spoke to the children I had no prior belief of what is right or wrong. Another advantage of not having asthma is that I could tell the children I do not have asthma, therefore they are the expert. This may have made them feel more comfortable and at an advantage as they knew much more than I did. Hopefully this meant they were more willing to talk to me about it and explain it to me. However, the children may have not been willing to speak to someone who may not understand as they have had no experience. The disadvantage of not having asthma was that I have no experience of what it is like to manage the medication, take an inhaler or the symptoms that a child with asthma would experience.

Being young

The children I interviewed were within the age range 5-16. As I am young and look young for my age, this could have been both good and bad. For the younger children, I looked older than them and potentially a similar age to their school teacher. This may have meant I had some authority over them, so they may not misbehave. On the other side, I might look young enough that they were happy to talk to me and less worried that they will say something wrong and be told off. For the younger children I chose to dress casually like their teachers do as I felt this could make them more relaxed and make the interview feel a little less daunting.

With the older children in secondary school, I do not look that much older than them. This could have meant that I had less authority over them as it could have felt like an older sister was asking them questions about their asthma. Again, this could have been a good thing as they may have been more willing to open up to someone their own age. For the interviews at the secondary school, I decided to dress more formally so that it felt more like a formal interview for them, which is possibly what they are used to with the teachers at their school.

Being Female

The majority of the first set of interviews were with boys, 9 out of 17. This had the potential to affect the responses as children may feel more comfortable speaking to others of the same sex especially for the older children. Younger children may be more likely to speak to a female as they are used to speaking to their mothers. Nevertheless the older boys were happy to discuss their asthma in the interviews, this could be down to their age and level of maturity.

Not used to speaking to children

Being the one of the youngest in my small family means I do not have much experience of working with and interacting with children. Though I have had some experience such as helping coach gymnastics, this was a long time ago and since then I have only interacted with adults. With the secondary school interviews this was less of an issue, as they were 11-15, it was like talking to young adults. The hurdle for me was when interviewing children aged 5-11. I was still using the vocabulary that I would use for the secondary school children, looking back this may have been too difficult for them and they might not have understood what I was asking them. However after conducting and transcribing the interviews, it seemed they understood as they answered most of the questions. However, if I had phrased the questions more simply, I may have got more detailed answers.

Before starting the interview study, I tried to get experience of interacting with children. This included visiting colleagues with children and baking or playing games with them. This happened on two occasions, one with a child aged 6-7 and another with a children aged 11-13. The PPI event, discussed in Section 5.5, was also another opportunity for me to gain experience of interacting with children.

As I had no experience in trying to get information from children or how to ask questions my intention was to over recruit and use the first few interviews as pilots. As time went on and I did more interviews, this became less of a problem and the situation became more natural and easy to handle.

Not done interviews before

Alongside the lack of interaction with children, not doing many proper interviews before was a disadvantage. The only experience I have had of doing interviews before these was during an MPH qualitative module. Before I conducted the interviews, I piloted the topic guide and interview plan on friends which helped me realise what I had missed when I designed the interview plan. The flaw with these interviews was that they were with non-asthmatic adults. They had to pretend to be young children with asthma, which was not ideal. As there was no real way of getting proper practical experience of interviewing before I started the study, this had to be a learn on the job situation.

5.8 Conclusion

As the project is a mixed methods project, this involves incorporating the results from the qualitative analysis into the quantitative analysis. Below are some of the subgroups found in the data that could be potentially at a higher risk of having unscheduled medical contacts in September. These subgroups are analysed in the next chapter to see whether they are more 'at risk' of medical contacts in September.

The 'at risk' subgroups were:

Exercise - Those who do less exercise during the summer holidays may be more at risk.

Secondary School Females - Secondary school females seems to be much more anxious and worried than boys of the same age. The girls talked about how being anxious can trigger their asthma.

Secondary School children - Children talked about how the sporting level changed when they changed to secondary school from primary. Children also talked about how the teachers were more involved with their asthma when they were at primary school, whereas they had more independence when they moved to secondary schools.

Children changing from primary to secondary school - Similar to the reasons given for the secondary school subgroup, though this one is more focused on the initial change over year.

6. Subgroup Analysis

6.1 Introduction

The previous chapter found subgroups in the qualitative study who were children who were considered to be potentially more ‘at risk’ of having medical contacts at the start of the new school year. This chapter looks at analysing further the subgroups defined at the end of the qualitative chapter (Section 5.8). These potential ’at risk’ children were: those who do less exercise during the summer holidays, secondary school females, secondary school children and those in the transition year changing from primary to secondary school. This chapter explores these subgroups further within the PLEASANT dataset to see whether they are at a higher risk. The results from these subgroup analyses will be used in the next chapter (Chapter 7) to see whether the intervention worked better on these subgroups of children.

The subgroups that will be analysed in this chapter are females versus males, primary versus secondary school and also compare whether there are gender differences within the different school age groups and visa versa. Alongside these, the year when children transitioned from primary school to secondary school, the impact of exercise and those who had a previous medical contact, will also be analysed.

6.2 Chapter Aims

The aims of this chapter are:

- To analyse the potential at risk subgroups in the PLEASANT dataset.
- To determine which subgroups are more at risk of various medical contacts.

6.3 Analysis Plan

A number of subgroups emerged from the qualitative interview data that could potentially be at higher risk of having medical contacts when they return to school.

The data from the PLEASANT study were used to explore further these subgroups to see whether the children were at a higher risk.

For this analysis, only the control arm was used. This left 4438 children who were in the control arm and had complete data.

The subgroup analysis was completed on the following subgroups:

- Primary and Secondary School (Looking at gender effect)
- Females and Males (Looking at age effect)
- Transition year from Primary to Secondary School
- Exercise (Looking at reliever inhalers)
- Previous September Unscheduled Medical Contact

The end points used for the analysis were those of the original PLEASANT study:

- September 2013
- September - December 2013
- September 2013 - August 2014

6.4 Methods

The methods used were the ones that were used in the original PLEASANT analysis. Logistic regression was used when the outcome was binary, for example a child having a contact or not, and negative binomial was used when the outcome was count, for example the number of contacts a child had. The methods used for the analysis were described previously in detail in Section 4.3.3.

6.4.1 Subgroup Analyses

The subgroup analyses were used in an exploratory manner, looking to see whether there were any directional trends within the subgroups. These subgroups emerged from the qualitative study and the exploratory statistical analyses were used to investigate the various hypotheses from the qualitative results. For example, seeing whether gender had an effect within different age groups. To do this the subgroup would be one of the different age groups and the variable of interest would be gender. This was done for a number of subgroups.

As the analysis was using one arm of the data, the number of clusters in the data was more than halved, then within this smaller number of clusters, the subgroup analyses were undertaken, which considerably reduces the sample size. Flynn et al. (2002) show that power is impacted more by a change in the number of clusters compared to a change in the size of the clusters. The subgroup analyses often had unequal groups, more males than females, which also impacts on the power of the study (Campbell and Walters, 2014). As the subgroups were often much smaller, and unequal, than the original study size, with half the amount of clusters, the analysis will have have reduced power so the direction of the trend was looked at rather than the significance as it is possible that significant effects are missed when they actually exist (Dijkman et al., 2009). The original PLEASANT trial was powered to have a total sample size of 140 clusters. Based on PLEASANT's original sample size calculations, it is estimated that the maximum power this study would have to conduct cluster analyses with 53 clusters is 54%, which would decrease when the groups were unequal. As the study has reduced power, but at a maximum of 54% there is still reasonable precision on the confidence intervals.

Alongside the coefficient estimate, a 95% confidence interval was provided. These confidence intervals may suggest that there is no association in the population. However, due to the reduced power this analysis was used to exploratory investigate the hypotheses generated from the qualitative study, therefore only the direction of the estimate and confidence intervals were looked at. The original study aimed to detect a 5% reduction in unscheduled contacts, 30% minus 25%, which corresponds to an odds ratio of 0.78, or 1.28 (for an increase in contacts). This percentage difference was used for all endpoints, unscheduled, total contacts, respiratory, scheduled and prescriptions. It is expected that the 'at risk' subgroups show increases in unscheduled and total contacts, but decreases in scheduled contacts and prescription uptake. If these odds ratios are within the confidence interval, then this has the potential to be clinically important. The minimum clinically important difference is the smallest improvement that is worthwhile for the patient (Copay et al., 2007). A result can be found to be not significant but potentially clinically important.

As there were a number of hypotheses being tested, there was a potential for multiple hypothesis testing issues. When a number of statistical tests have been conducted, there is a higher probability of a false positive result (Wang et al., 2007; Lipkovich et al., 2018). However, as the analyses were exploratory, methods were not adopted to account for multiple hypothesis testing as significance levels were not used in the analysis.

6.5 Subgroup Analysis

6.5.1 Gender Effect

The first analysis looked at whether there was a difference between females and males in the control arm data. The qualitative study found that there were differences in gender as the children got older. Secondary school females were found to be much more anxious than males which could impact on their asthma. Therefore the data was then broken down further to see whether there was any difference in gender at primary or secondary school. The analysis was used to determine whether males or females were more at risk of having medical contacts at the start of the new school term.

6.5.1.1 Demographics

This section shows the demographic information of the children split by gender.

Gender

Figure 6.1 shows the gender disposition of the children within the control arm of the PLEASANT dataset. The plot shows that there are more males within the sample compared to females. There are 2667 males and 1771 females.

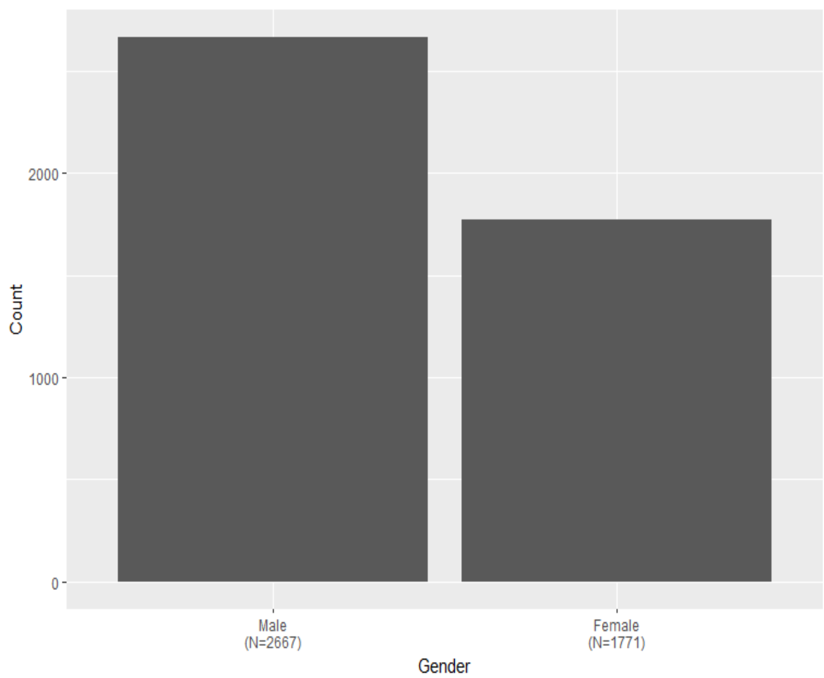


Figure 6.1: Gender difference within the data

Age

Figure 6.2 shows the number of males and females at different ages. In every age group there are fewer females than males. The distribution of age is similar for both male and female, with a peak of children with asthma being aged 14. Age 15 has very few children due to the date that the data was collected. These children will have just turned 15 in September 2013.

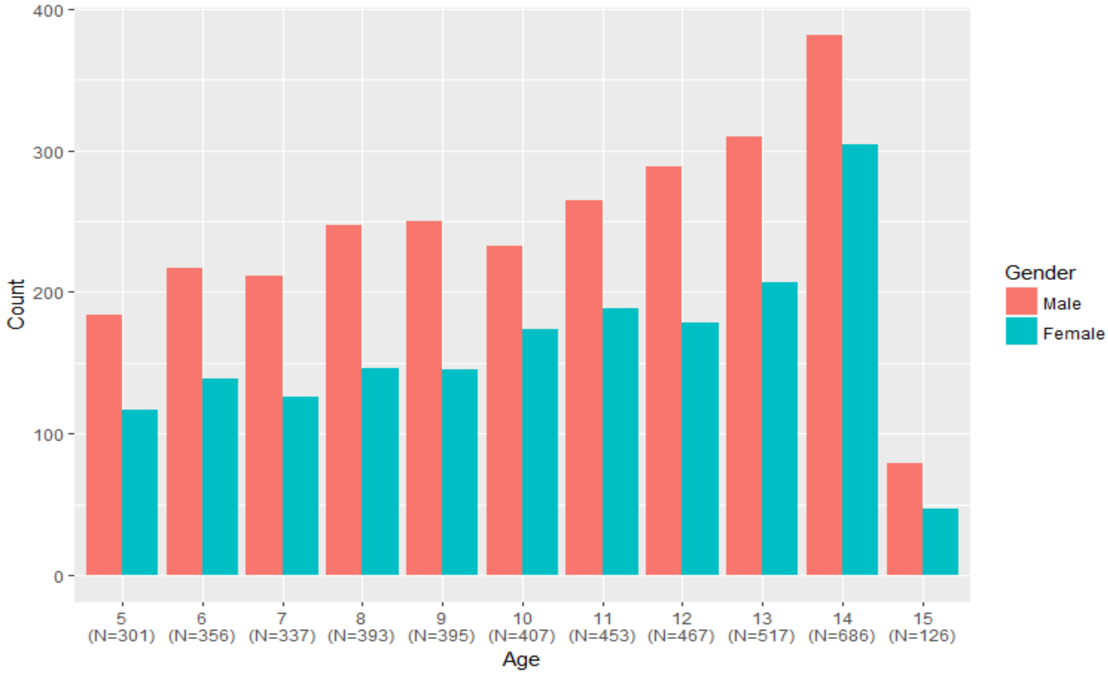


Figure 6.2: Age split by gender

Practice Information

Figure 6.3 shows how many males and females were in each GP practice. There were 53 GP practices in the the control dataset, 49 of these had more males than females.

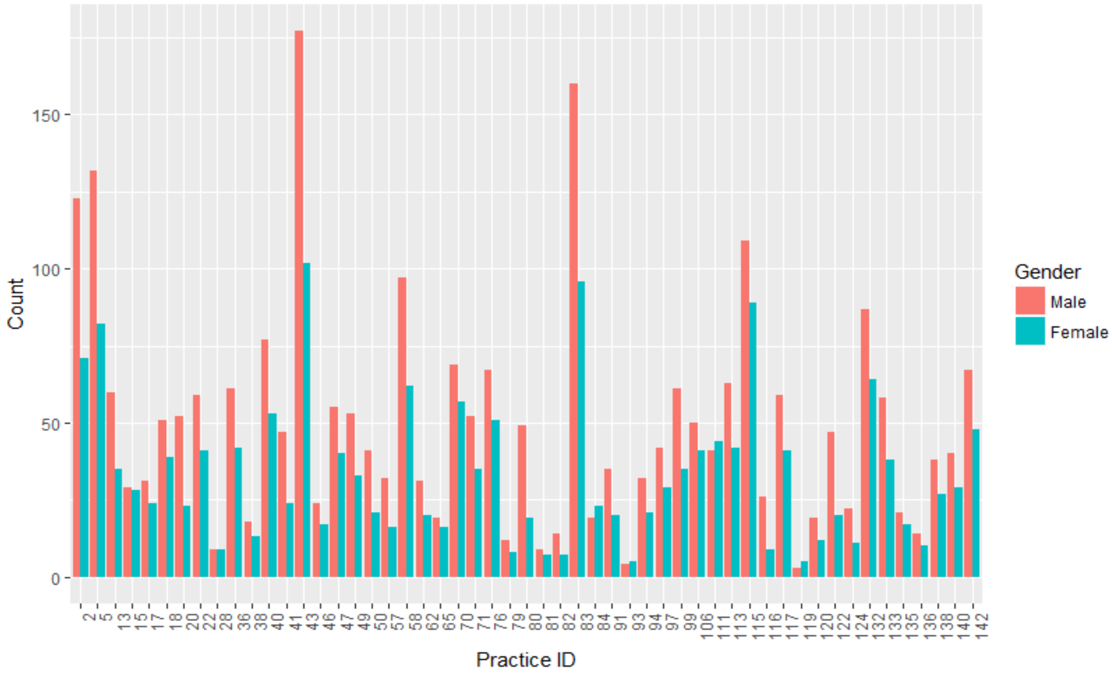


Figure 6.3: The number of children in each of the GP practices split by gender

Contact Type

Table 6.1 shows the percentage of contacts for the males and females. The percentages are similar for males and females, however there are more scheduled contacts for males and more unscheduled contacts for females.

Contact Type	Male	Female	Total
Scheduled	17247	11355	28602
	17.0%	15.9%	16.6%
Unscheduled	59895	42864	102759
	59.1%	60.1%	59.5%

Table 6.1: The number and percentage of contacts split by gender

6.5.1.2 Prescription Analysis

The prescription analysis looked at whether children picked up a prescription of a preventer inhaler in August 2013 or not. The analysis first looked at gender differences within the full dataset, then in primary and secondary school children.

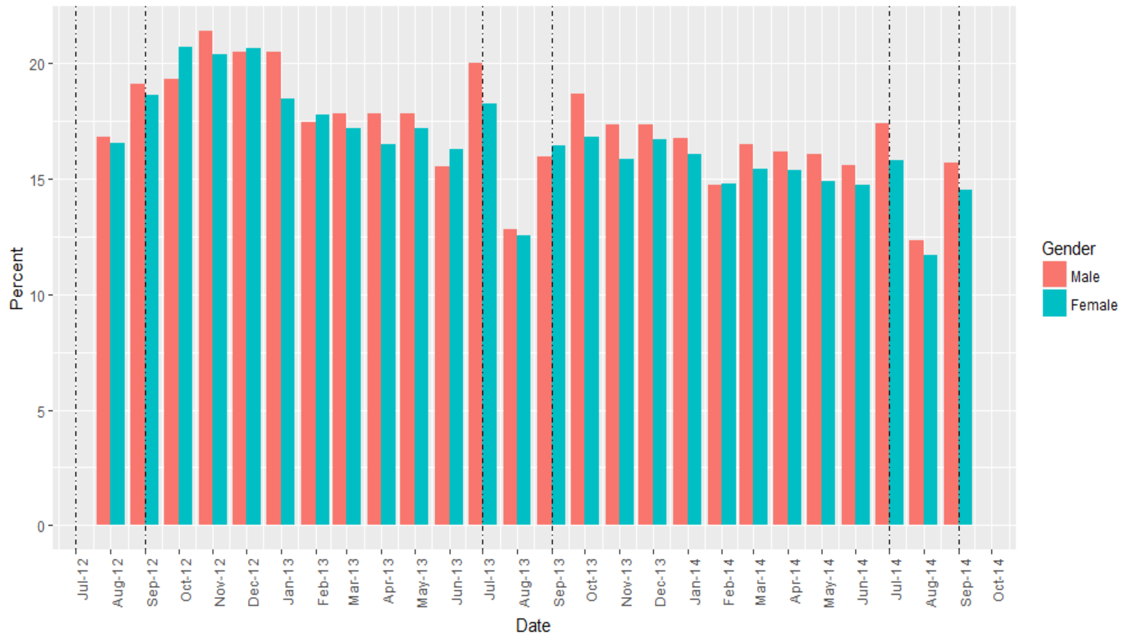


Figure 6.4: Percentage of prescriptions picked up by children split by gender

Figure 6.4 shows the percentage of children who picked up a prescription each month split by gender. In August 2013, a slightly higher percentage of males picked up a prescription than females. This was echoed in August 2012 and 2014.

	All		*Primary*		*Secondary*	
No. Prescript	Female (N=1751)	Male (N=2610)	Female (N=836)	Male (N=1315)	Female (N=915)	Male (N=1295)
0	1529 (87.3 %)	2268 (86.9 %)	721 (86.24 %)	1136 (86.39 %)	808 (88.31 %)	1132 (87.41 %)
1	207 (11.8 %)	321 (12.3 %)	105 (12.56 %)	170 (12.93 %)	102 (11.15 %)	151 (11.66 %)
2	15 (0.9 %)	19 (0.7 %)	10 (1.20 %)	9 (0.68 %)	5 (0.55 %)	10 (0.77 %)
3	0 (0 %)	2 (0.08 %)	0 (0 %)	0 (0 %)	0 (0 %)	2 (0.15 %)

Table 6.2: Number of children who picked up a preventer inhaler in August 2013

Table 6.2 shows the number of prescriptions picked up by children in August 2013. In general, the percentage of children who picked up prescriptions is similar for males and females, more females did not pick up a prescription compared to males and more males picked up prescriptions.

Logistic Regression

The results from the logistic regression models for prescription uptake can be found in Table 6.3. Logistic regression was used to analyse whether females are more likely to pick up a prescription or not. The table shows the coefficient estimate for females. The results show female children are less likely to pick up a prescription in August 2013. For primary school children females are more likely, however for secondary school children females are less likely compared to males. The results for primary school females and secondary school females are potentially clinically important. The confidence interval for primary school children contains 1.28 suggesting that prescription increase for primary school female children is potentially clinically important. The confidence interval for secondary school female children is again potentially clinically important but for a decrease in prescriptions, the confidence interval contains 0.78.

	Dependent variable:
Gender (Female)	Aug 13
All	0.98
(N=4361)	(0.81, 1.18)
Primary	1.02
(N=2151)	(0.79, 1.33)
Secondary	0.93
(N=2210)	(0.71, 1.21)

Table 6.3: Logistic regression for prescriptions in August 2013 for gender presenting odds ratios and 95 % confidence intervals

6.5.1.3 All School Children

This section of analysis looked at the differences in gender for different medical contacts for all children. Figure 6.5 is a time series plot of the percentage of unscheduled medical contacts split by gender. For the majority of the study period females have more unscheduled contacts, especially in the second year (September 2013 - August 2014).

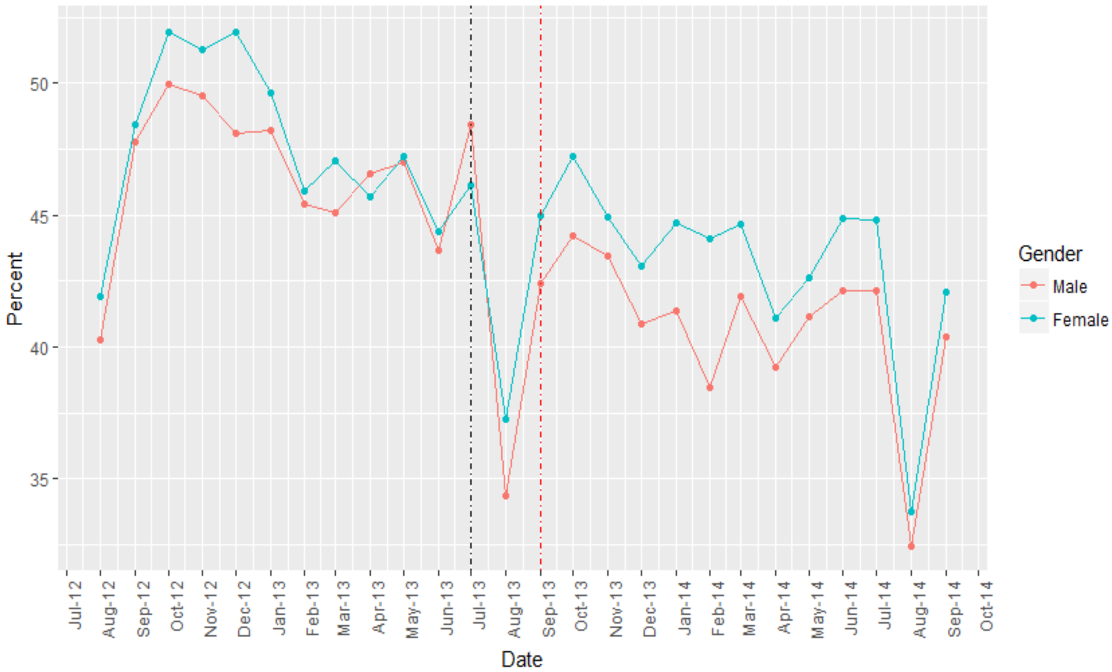


Figure 6.5: Time series plot of unscheduled medical contacts for all children split by gender

Table 6.4 shows the number and percentage of contacts at each endpoint split by gender for scheduled and unscheduled contacts. Females have a higher percentage of unscheduled contacts and males a higher percentage of scheduled contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	1478	2092	3570
		53.0 %	52.2 %	52.5 %
	Scheduled	505	794	1299
		18.1 %	19.8 %	19.1 %
Sept - Dec 2013	Unscheduled	6131	8444	14575
		55.4 %	54.3 %	54.7 %
	Scheduled	2164	3263	5427
		19.5 %	21.0 %	20.4 %
Sept 2013 - Aug 2014	Unscheduled	17488	24057	41545
		59.9 %	58.6 %	59.1 %
	Scheduled	4636	7089	11725
		15.9 %	17.3 %	16.7 %

Table 6.4: Number and percentage of contacts split by gender of all children

Table 6.5 displays the mean count of contacts split by gender. The results are similar to those in Table 6.4. Females have a higher mean count of unscheduled contacts compared to males and males have more scheduled contacts. Females also have higher mean counts for total contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	0.83	0.78	0.80
	Scheduled	0.29	0.30	0.29
Sept - Dec 2013	Unscheduled	3.46	3.17	3.28
	Scheduled	1.22	1.22	1.22
Sept 2013 - Aug 2014	Unscheduled	9.87	9.02	9.36
	Scheduled	2.62	2.66	2.64

Table 6.5: Mean count for contacts split by gender for all children

Logistic Regression

Logistic regression was used to analyse whether a child had a medical contact or not within the various time frame endpoints. Table 6.6 shows the results from the logistic regression analysis. The table displays the coefficient estimate for females. For unscheduled, respiratory and relevant contacts, being female increased the odds of having a medical contact for all time points. The size of the effect tends to increase as the time frame of the endpoint increases. These results, especially for the long term endpoints, are potentially clinically important as the confidence intervals contain 1.28. For scheduled contacts, in general being female decreases the odds of having a medical contact.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.10	1.16	1.39
	(0.97, 1.25)	(0.99, 1.35)	(1.08, 1.80)
Respiratory	1.10	1.26	1.10
	(0.87, 1.40)	(1.09, 1.46)	(0.97, 1.25)
Relevant	1.11	1.15	1.26
	(0.98, 1.27)	(0.96, 1.37)	(0.94, 1.68)
Scheduled	1.02	0.99	0.98
	(0.87, 1.20)	(0.87, 1.14)	(0.84, 1.14)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.84	1.05	
	(0.69, 1.01)	(0.88, 1.25)	

Table 6.6: Logistic regression for all medical contacts comparing gender presenting odds ratios and 95 % confidence intervals (N=4438)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.7 shows the results from the negative binomial regression. Again, the table shows the coefficient estimate for females. The results show that being female increases the number of medical contacts for unscheduled, respiratory and relevant. The size of the effect is more constant over the time frames for the negative binomial regression compared to the logistic regression results. Being female in general decreases the number of scheduled contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.06	1.05	1.05
	(0.96, 1.16)	(0.99, 1.11)	(1.00, 1.09)
Respiratory	1.12	1.25	1.11
	(0.89, 1.42)	(1.10, 1.41)	(1.02, 1.21)
Relevant	1.04	1.03	1.03
	(0.96, 1.12)	(0.98, 1.09)	(0.99, 1.08)
Scheduled	0.96	0.99	1.10
	(0.86, 1.08)	(0.93, 1.06)	(1.05, 1.16)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.85	0.96	
	(0.72, 1.01)	(0.82, 1.13)	

Table 6.7: Negative binomial regression for all medical contacts comparing gender presenting incidence rate ratios and 95 % confidence intervals (N=4438)

6.5.1.4 Primary School Children

This section of the analysis looks at the gender difference within primary school aged children. Figure 6.6 is a time series plot of the percentage of unscheduled contacts for primary school children split by gender. The percentage of contacts for primary school children is similar for males and females.

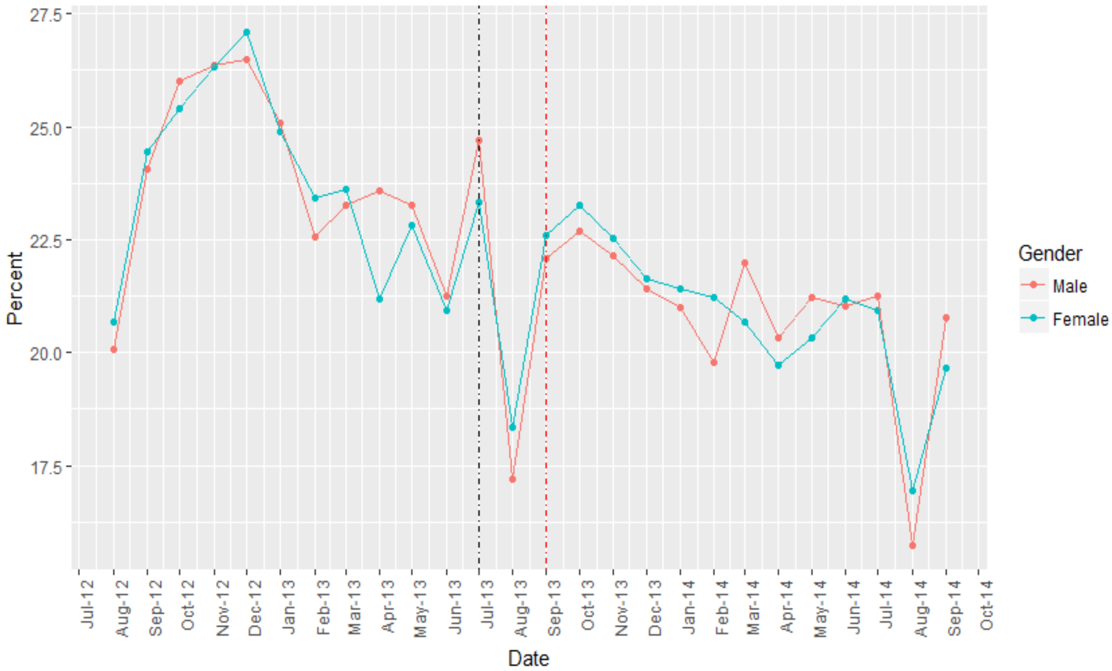


Figure 6.6: Time series plot for unscheduled contacts for primary school children split by gender

Table 6.8 shows the number and percentage of contacts at each time point split by gender for scheduled and unscheduled contacts. For primary children, females have more unscheduled contacts and males have more scheduled contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	734	1104	1838
		54.2 %	53.2 %	53.6 %
	Scheduled	226	411	637
		16.7 %	19.8 %	18.6 %
Sept - Dec 2013	Unscheduled	3040	4480	7520
		57.1 %	56.2 %	56.6 %
	Scheduled	1017	1645	2662
		19.1 %	20.6 %	20.0 %
Sept 2013 - Aug 2014	Unscheduled	8307	12394	20701
		61.7 %	59.9 %	60.6 %
	Scheduled	2132	3479	5611
		15.8 %	16.8 %	16.4 %

Table 6.8: Number and precentage of contacts split by gender for primary school children

Table 6.9 displays the mean count of contacts split by gender. The results are similar to those in Table 6.8. Females have a higher mean count of unscheduled contacts and males have more scheduled contacts. Females also have higher mean counts for total contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	0.87	0.82	0.84
	Scheduled	0.27	0.31	0.29
Sept - Dec 2013	Unscheduled	3.59	3.34	3.44
	Scheduled	1.20	1.23	1.22
Sept 2013 - Aug 2014	Unscheduled	9.81	9.24	9.46
	Scheduled	2.52	2.59	2.56

Table 6.9: Mean count for contacts split by gender for primary school children

Logistic Regression

Logistic regression was used to analyse whether a child had a medical contact or not within the various time frame endpoints. Table 6.10 shows the results of the logistic regression model for gender within primary school aged children. The results are similar to those seen in all children, being female increases the odds of having unscheduled medical contacts generally whereas, being female tends to decrease the odds of having scheduled contacts. These results are potentially clinically important, apart from the longer term endpoints for scheduled contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.12	1.17	1.46
	(0.94, 1.34)	(0.94, 1.46)	(1.00, 2.12)
Respiratory	1.22	1.26	1.06
	(0.88, 1.68)	(1.03, 1.55)	(0.88, 1.27)
Relevant	1.14	1.19	1.40
	(0.95, 1.37)	(0.92, 1.53)	(0.92, 2.14)
Scheduled	0.89	1.04	0.99
	(0.70, 1.13)	(0.86, 1.27)	(0.80, 1.22)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.82	0.95	
	(0.62, 1.07)	(0.73, 1.23)	

Table 6.10: Logistic regression for all primary medical contacts comparing gender presenting odds ratios and 95 % confidence intervals (N=2189)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.11 presents the results of the negative binomial results for gender within primary school age children. Being female, in general, increases the number of medical contacts for unscheduled, respiratory and relevant. Being female decreases the number of scheduled medical contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.06 (0.94, 1.21)	1.02 (0.94, 1.11)	0.99 (0.93, 1.06)
Respiratory	1.28 (0.93, 1.76)	1.27 (1.07, 1.51)	1.10 (0.98, 1.24)
Relevant	1.03 (0.92, 1.15)	1.01 (0.94, 1.09)	0.99 (0.93, 1.05)
Scheduled	0.90 (0.76, 1.07)	0.98 (0.89, 1.07)	1.07 (0.99, 1.15)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.88 (0.68, 1.129)	0.83 (0.65, 1.06)	

Table 6.11: Negative binomial regression for all primary medical contacts comparing gender presenting incidence rate ratios and 95 % confidence intervals (N=2189)

6.5.1.5 Secondary School Children

This section of the analysis looks at the gender difference within secondary school aged children. Figure 6.7 is a time series plot of the percentage of unscheduled medical contacts for secondary school children split by gender. Unlike primary school children, there is a large difference in gender for secondary school aged children. Females have a higher percentage of unscheduled contacts.

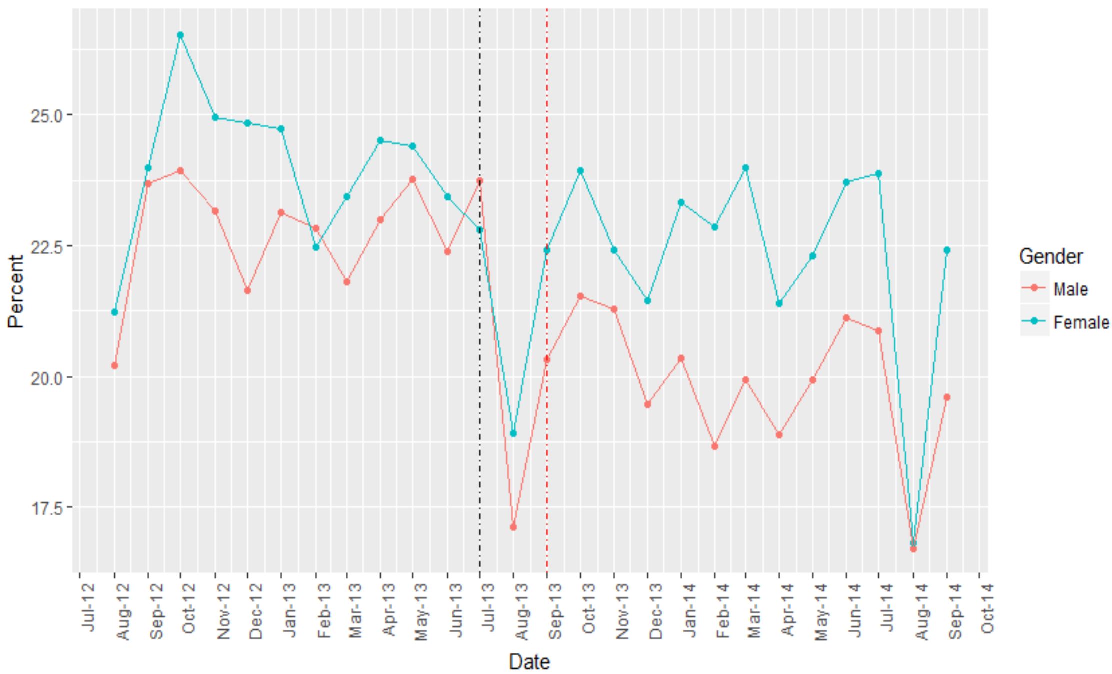


Figure 6.7: Time series plot of unscheduled medical contacts for secondary school children split by gender

Table 6.12 shows the count and percentages of contacts split by gender for secondary school children. The percentage of unscheduled contacts is higher for females and males have a higher percentage of scheduled contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	744	988	1732
		51.84 %	51.27 %	51.52 %
	Scheduled	279	383	662
		19.44 %	19.88 %	19.69 %
Sept - Dec 2013	Unscheduled	3091	3964	7055
		53.73 %	52.30 %	52.92 %
	Scheduled	1147	1618	2765
		19.94 %	21.35 %	20.74 %
Sept 2013 - Aug 2014	Unscheduled	9181	11663	20844
		58.34 %	57.22 %	57.71 %
	Scheduled	2504	3610	6114
		15.91 %	17.71 %	16.93 %

Table 6.12: Number and percentage of contacts split by gender for secondary school children

Table 6.13 shows the mean counts for contacts split by gender for secondary school aged children.Unlike seen previously, in general for both scheduled and unscheduled contacts females have a higher mean count of contacts.

	Contact Type	Female	Male	Total
Sept 2013	Unscheduled	0.81	0.75	0.77
	Scheduled	0.30	0.29	0.29
Sept - Dec 2013	Unscheduled	3.35	2.99	3.14
	Scheduled	1.24	1.22	1.23
Sept 2013 - Aug 2014	Unscheduled	9.94	8.80	9.27
	Scheduled	2.71	2.72	2.72

Table 6.13: Mean count for contacts split by gender for secondary school children

Logistic Regression

Logistic regression was used to analyse whether a child had a medical contact or not within the various time frame endpoints. Table 6.14 shows the results of the logistic regression model for gender in secondary school age children. These results are potentially clinically important. Again, being female in general increases the odds of having medical contacts for unscheduled, respiratory and relevant. For scheduled contacts, being female in general decreases the odds of having scheduled contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.10	1.14	1.36
	(0.92, 1.31)	(0.92, 1.41)	(0.96, 1.92)
Respiratory	0.99	1.24	1.13
	(0.71, 1.41)	(1.01, 1.53)	(0.95, 1.36)
Relevant	1.11	1.13	1.15
	(0.93, 1.33)	(0.88, 1.45)	(0.77, 1.72)
Scheduled	1.16	0.98	0.99
	(0.92, 1.46)	(0.81, 1.18)	(0.81, 1.23)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.85	1.14	
	(0.65, 1.10)	(0.90, 1.46)	

Table 6.14: Logistic regression for all secondary medical contacts comparing gender presenting odds ratios and 95 % confidence intervals (N=2249)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.15 shows the results from the negative binomial regression model for gender in secondary school aged children. The results are similar to those of the logistic regression model, being female increases the number of unscheduled, respiratory and relevant contacts, however being female in general also increases the number of scheduled contacts. This is different to what was found for all and primary school children.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Gender (Female)	(1)	(2)	(3)
Unscheduled	1.06	1.08	1.11
	(0.93, 1.20)	(0.99, 1.17)	(1.04, 1.18)
Respiratory	0.98	1.22	1.12
	(0.70, 1.386)	(1.02, 1.47)	(0.99, 1.27)
Relevant	1.05	1.06	1.08
	(0.94, 1.18)	(0.98, 1.14)	(1.02, 1.15)
Scheduled	1.02	1.03	1.12
	(0.87, 1.20)	(0.94, 1.12)	(1.04, 1.20)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.84	1.09	
	(0.67, 1.05)	(0.878, 1.36)	

Table 6.15: Negative binomial regression for all secondary medical contacts comparing gender presenting incidence rate ratios and 95 % confidence intervals (N=2249)

6.5.1.6 Discussion

This section of the analysis looked how gender impacted on medical contacts for all children, primary school children and secondary school children. Following the qualitative study (Chapter 5), there were potential differences between males and females that could have impacted on medical contacts. Secondary school females were found to be much more anxious than males, which could either cause more asthma attacks or it could cause the females to take more control of their asthma medication. The literature around exercise had suggested that males may be more active than females, which could again either lead to more control over their asthma or could cause them to have more asthma attacks.

The first analysis that was completed looked at prescription uptake in August 2013. The results suggested that being female could decrease the odds of picking up a prescription in all children and secondary school, however for primary school children being female could increase the odds of picking up a prescription. This contradicts what was previously suggested following the qualitative study, which was that secondary school females can be more anxious than males which could of lead to females picking up more prescriptions in August 2013. However, females could be more self conscious than males so they are not using their inhalers as much so do not need to collect prescriptions as often.

The next analysis looked at gender effect on medical contacts within all children of the study. The percentage data suggested that females had more unscheduled contacts and males had more scheduled contacts. This result was echoed in the mean count data. The logistic regression models suggested that on the whole being female increased the odds of having all medical contacts apart from scheduled contacts where being female decreased the odds. The scheduled contacts could correspond to picking up prescriptions which was already found to decrease for females. Following that, the results for the negative binomial models were presented which found similar results to the logistic regression model. The results for all school children suggest that being female could increase the number of unscheduled contacts and decrease the number of scheduled contacts, this implies that females are potentially at a higher risk of having unscheduled contacts after the return to school.

Primary school children were looked at in the next medical contacts analysis. Again, females had a higher percentage of unscheduled contacts and males had a higher percentage of scheduled contacts and this was also shown in the mean count data. The logistic regression and negative binomial results were similar to those for all children, being female could increase the odds of all contacts apart from scheduled contacts where the odds were decreased.

The results for secondary school children was also similar to primary and all children. However for scheduled contacts, the negative binomial model showed that in general being female could increase the number of scheduled contacts which was not seen previously. This suggests that for a secondary school female the odds of a scheduled contact is decreased but if they do have a contact, they are more likely to have more. This leads back to what was found in the interview study, that being a secondary school female could increase scheduled contacts as they are more anxious, so are more worried about their asthma compared to males. Or they are having more unscheduled contacts than males so the doctors are asking them to attend more scheduled appointments to check their asthma, but they are self conscious about taking their medication so are not taking it which could be why there are less prescriptions being collected for females.

These results are discussed in further detail in Chapter 8.

6.5.2 School Age Effect

The next subgroup analysis looked at whether there were any differences relating to school age. The qualitative results suggested that there was potentially a difference in primary school children compared to secondary school. Secondary school children are much more independent compared to primary school school which could impact on their asthma medication adherence. Primary school children were defined as anyone under the age of 11 and secondary school was anyone aged 11 and above. This analysis was first done on all children and then analysed within males and females separately.

6.5.2.1 Demographics

Figure 6.8 shows how the children in PLEASANT were split by primary and secondary school. There were 2189 primary school children and 2249 secondary school children.

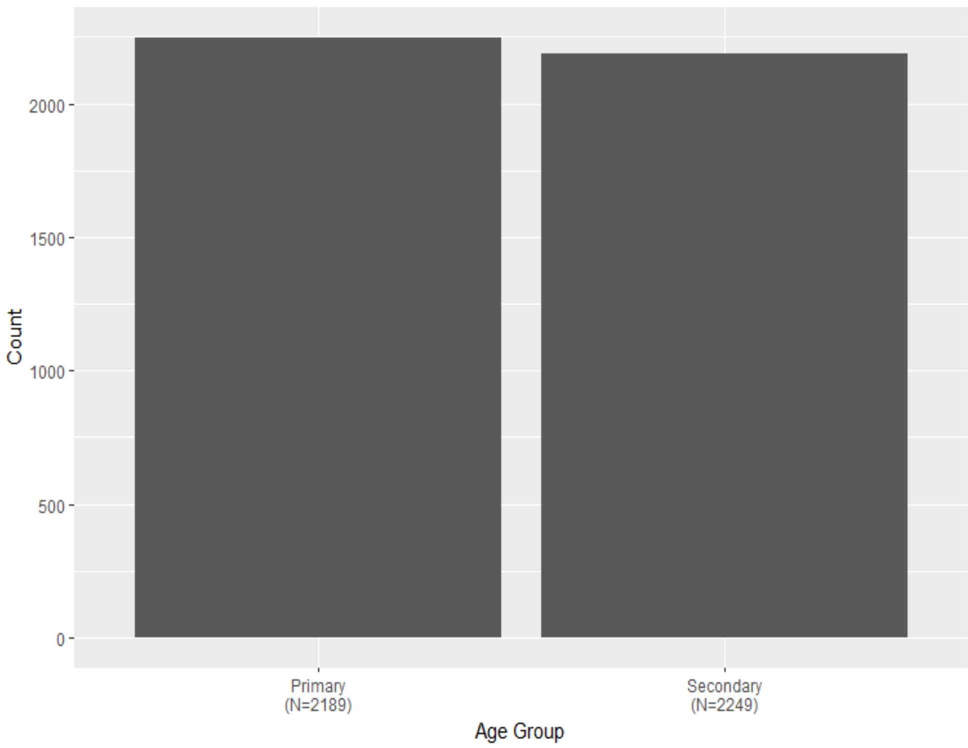


Figure 6.8: Primary and secondary school groups

Gender

Figure 6.9 shows how school age was split by gender. There are more primary school males and more secondary school females.

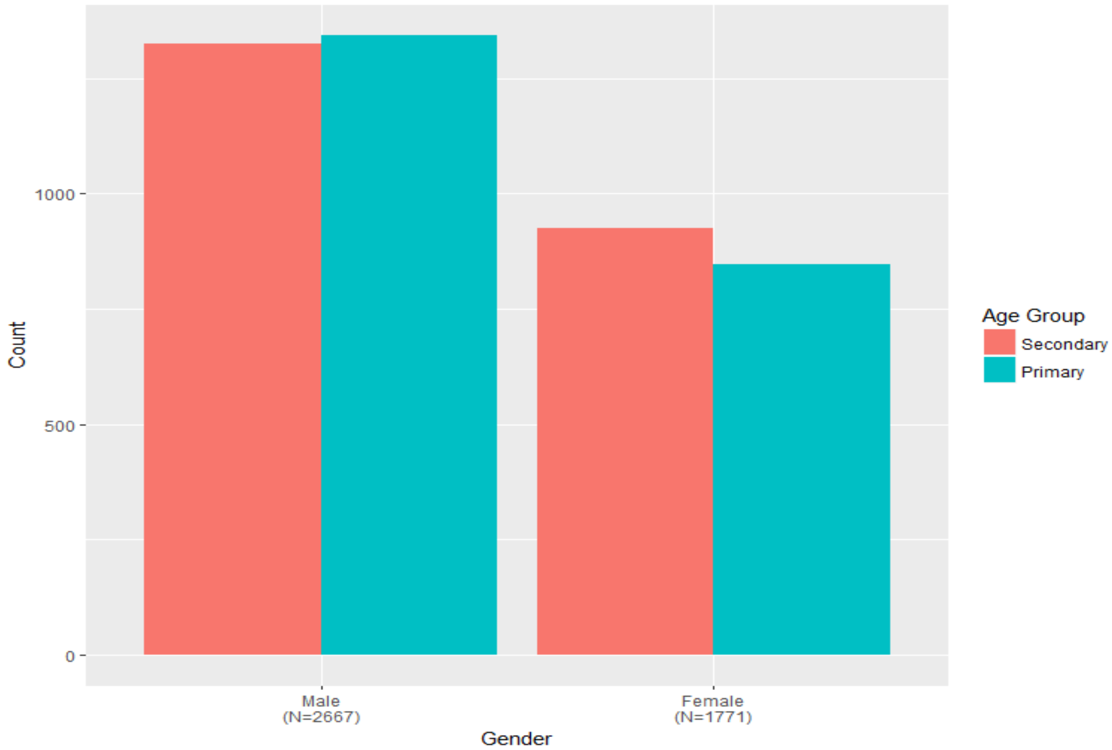


Figure 6.9: Gender split by school group

Age

Figure 6.10 shows how age was split by school. Primary school are aged 5 - 10 and secondary school are aged 11 - 15. The mode for primary school children was 10 years and the mode for secondary school was 14 years.

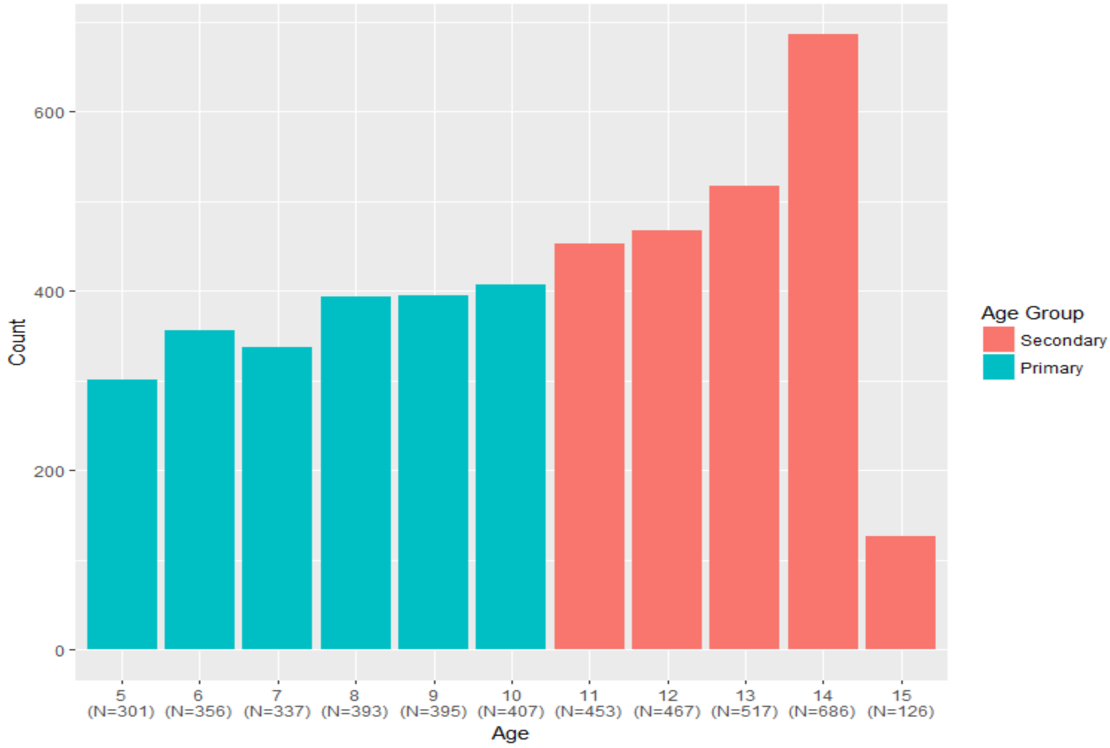


Figure 6.10: Age split by school group

Practice Information

Figure 6.11 shows how how many children in the GP practices are at primary school or secondary school. There were 30 GP's with more secondary school children than primary school.

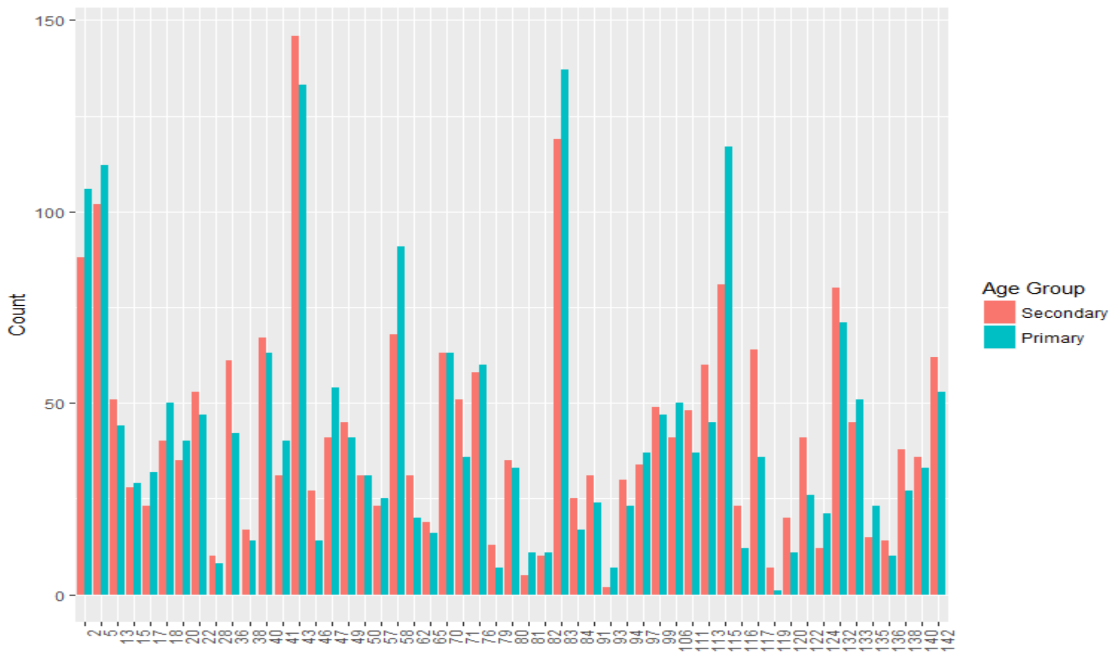


Figure 6.11: The number of children in each of the GP practices split by school group

Contact Type

Figure 6.12 shows the number of contacts within the PLEASANT data for scheduled and unscheduled contacts split by which school age group. There were more scheduled contacts for secondary school children and there were more unscheduled contacts for primary school children.

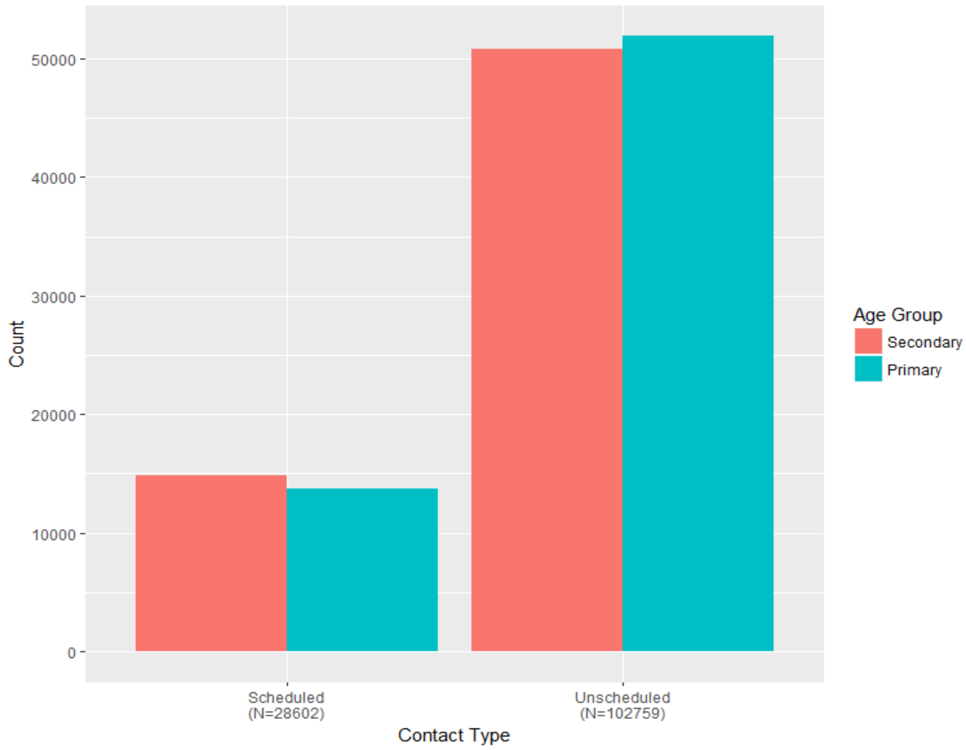


Figure 6.12: The number of contacts split by school group

6.5.2.2 Prescription Analysis

The prescription analysis looked at whether school age had an affect on whether a child picks up a prescription in August 2013. Figure 6.13 shows the percentage of prescriptions picked up by children during the study period split by school age. Primary school children pick up more prescriptions compared to secondary school children. This is consistent for all months.

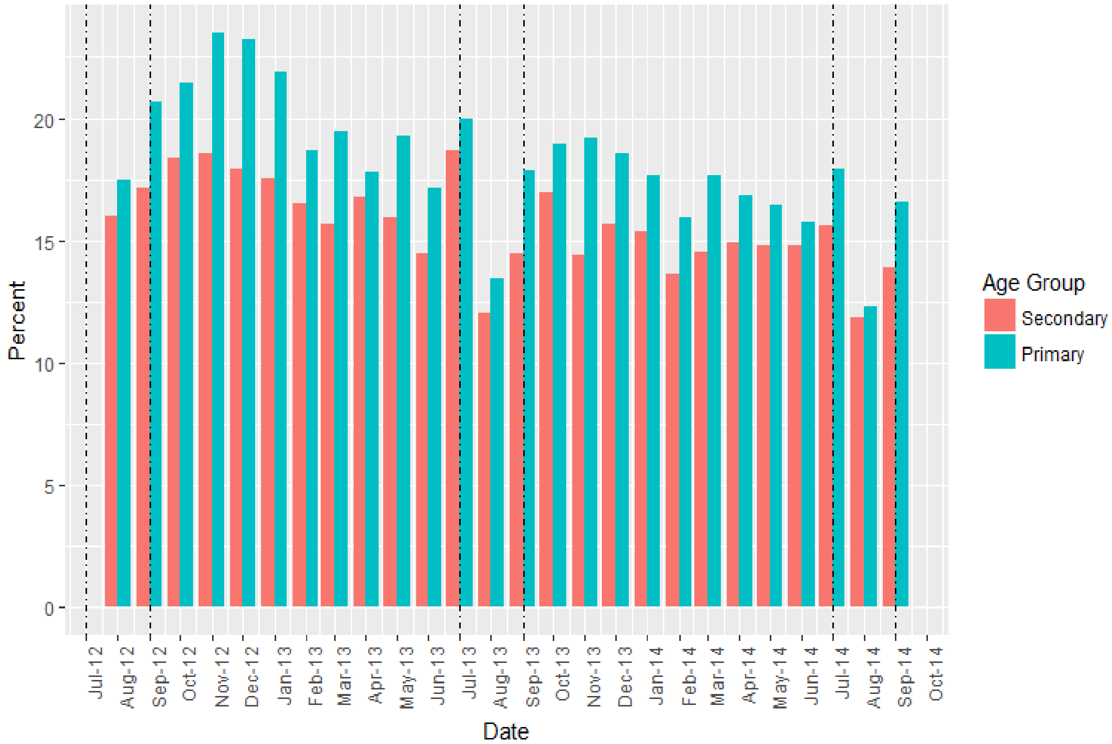


Figure 6.13: Percentage of prescriptions picked up by the children split by school group

Table 6.16 shows the percentage of prescriptions picked up by children in August 2013 for all children and then split by male and female. For all children, primary school children picked up more prescriptions. For females, again more primary school children picked up prescriptions compared to secondary. This result was the same for males, except for children who picked up 2 or more prescriptions, secondary school children picked up more prescriptions.

	All		*Female*		*Male*	
No. Prescript	Primary (N=2169)	Secondary (N=2210)	Primary (N=836)	Secondary (N=915)	Primary (N=1315)	Secondary (N=1295)
0	1857 (85.6 %)	1940 (87.8 %)	721 (86. 24 %)	808 (88.31 %)	1136 (86.39 %)	1132 (87.41 %)
1	275 (12.7 %)	253 (11.4 %)	105 (12.56 %)	102 (11.15 %)	170 (12.93 %)	151 (11.66%)
2	19 (0.9 %)	15 (0.7 %)	10 (1.20 %)	5 (0.55 %)	9 (0.68 %)	10 (0.77 %)
3	0 (0 %)	2 (0.09 %)	0 (0 %)	0 (0 %)	0 (0 %)	2 (0.15 %)

Table 6.16: Number of children who picked up a preventer inhaler in August 2013

Logistic Regression

Logistic regression was used to analyse whether school age had an effect on whether a child picked up a prescription in August 2013, the results can be found in Table 6.17. All results suggest that being in primary school increased the odds of picking up a prescription in August 2013. This effect was smallest in males and greatest in females. These results are potentially clinically important.

	Dependent variable:
School (Primary)	Aug 13
All	1.12
(N=4361)	(0.93, 1.34)
Female	1.19
(N=1751)	(0.88, 1.59)
Male	1.07
(N=2610)	(0.85, 1.35)

Table 6.17: Logistic regression for prescriptions in August 2013 for gender presenting odds ratios and 95 % confidence intervals

6.5.2.3 All Children

This section of the analysis presents the results for all children to see whether school age has an effect on various medical contacts. Figure 6.14 is a time series plot for unscheduled medical contacts for all children split by school age. In general primary school children experience more unscheduled medical contacts compared to secondary school.

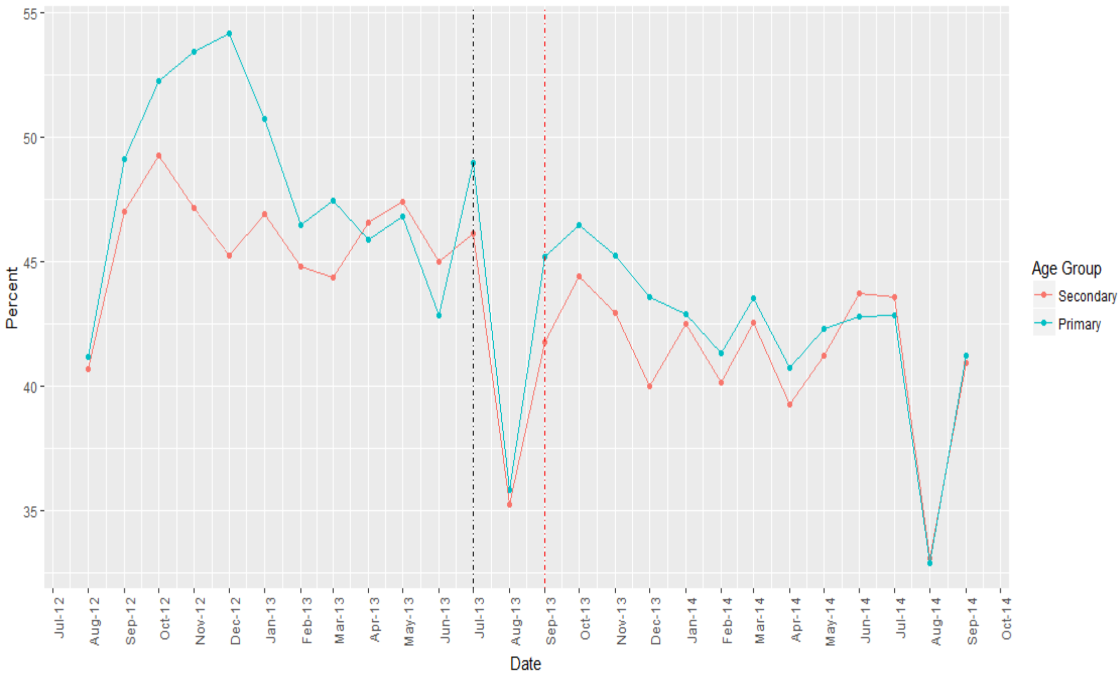


Figure 6.14: Time series plot for unscheduled contacts split by school age

Table 6.18 shows the number and percentage of unscheduled and scheduled contacts for September 2013 and the extended time periods for primary and secondary school. Primary school children had a higher percentage of unscheduled contacts, whereas secondary school children had a higher percentage of scheduled contacts.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	1838	1732	3570
		53.55 %	51.52 %	52.55 %
	Scheduled	637	662	1299
		18.56 %	19.69 %	19.12 %
Sept - Dec 2013	Unscheduled	7520	7055	14575
		56.57 %	52.92 %	54.74 %
	Scheduled	2662	2765	5427
		20.03 %	20.74 %	20.38 %
Sept 2013 - Aug 2014	Unscheduled	20701	20844	41545
		60.60 %	57.71 %	59.12 %
	Scheduled	5611	6114	11725
		16.43 %	16.93 %	16.68 %

Table 6.18: Number and percentage of contacts comparing schools for all children

Table 6.19 shows the mean count of contacts for unscheduled and scheduled contacts in September 2013 and the extended periods for primary and secondary school children. The mean count of unscheduled contacts was greater for children in primary school compared to secondary school. The mean count of scheduled contacts was similar for primary and secondary contacts, except for the period September 2013 to August 2014 where the mean count is higher for secondary children.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	0.84	0.77	0.80
	Scheduled	0.29	0.29	0.29
Sept - Dec 2013	Unscheduled	3.44	3.14	3.28
	Scheduled	1.22	1.23	1.22
Sept 2013 - Aug 2014	Unscheduled	9.46	9.27	9.36
	Scheduled	2.56	2.72	2.64

Table 6.19: Mean counts for contacts comparing schools for all children

Logistic Regression

Table 6.20 shows the results from the logistic regression models for school age effect for all children. This analysis was used to see whether school age had an effect on whether a child would have a medical contact or not. The results showed that being in primary school is likely to increase a child's odds of having an unscheduled or a respiratory related medical contact at the various time periods. These results are generally potentially clinically important. The results for relevant and scheduled contacts are less consistent but suggest that being in primary school is likely to decrease the odds of having a medical contact at the various time periods.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.15	1.04	1.11
	(1.01, 1.30)	(0.90, 1.21)	(0.88, 1.42)
Respiratory	1.14	1.14	1.06
	(0.91, 1.44)	(0.99, 1.32)	(0.93, 1.20)
Relevant	1.07	0.93	0.98
	(0.95, 1.22)	(0.78, 1.10)	(0.75, 1.30)
Scheduled	1.00	1.05	0.99
	(0.85, 1.18)	(0.92, 1.20)	(0.85, 1.15)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.92	0.87	
	(0.77, 1.10)	(0.73, 1.04)	

Table 6.20: Logistic regression for all medical contacts comparing school presenting odds ratios and 95 % confidence intervals (N=4438)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.21 shows the results for the negative binomial models for school age effect for all children. The results are less consistent compared to those from the logistic regression model. For September 2013 and September - December 2013 being in primary school could increase the number of unscheduled medical contacts and relevant medical contacts, whereas for September 2013 - August 2014, being in primary school could decrease the number of contacts. Being in primary school is likely to increase the number of respiratory related medical contacts. For scheduled contacts, being in primary school in general is likely to decrease the number of medical contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.08	1.02	0.97
	(0.98, 1.18)	(0.96, 1.08)	(0.93, 1.02)
Respiratory	1.12	1.09	1.04
	(0.89, 1.41)	(0.96, 1.24)	(0.95, 1.13)
Relevant	1.05	1.01	0.98
	(0.97, 1.13)	(0.96, 1.06)	(0.94, 1.02)
Scheduled	0.99	0.99	1.05
	(0.88, 1.11)	(0.93, 1.05)	(0.999, 1.10)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.96	0.88	
	(0.82, 1.13)	(0.75, 1.03)	

Table 6.21: Negative binomial regression for all medical contacts comparing school presenting incidence rate ratios and 95 % confidence intervals (N=4438)

6.5.2.4 Female

This section of the results looks at whether there is a difference in primary school and secondary school aged children for females. Figure 6.15 is a time series plot for unscheduled contacts for females split by primary and secondary school. There is no clear difference between primary and secondary school, the percentages are changeable.

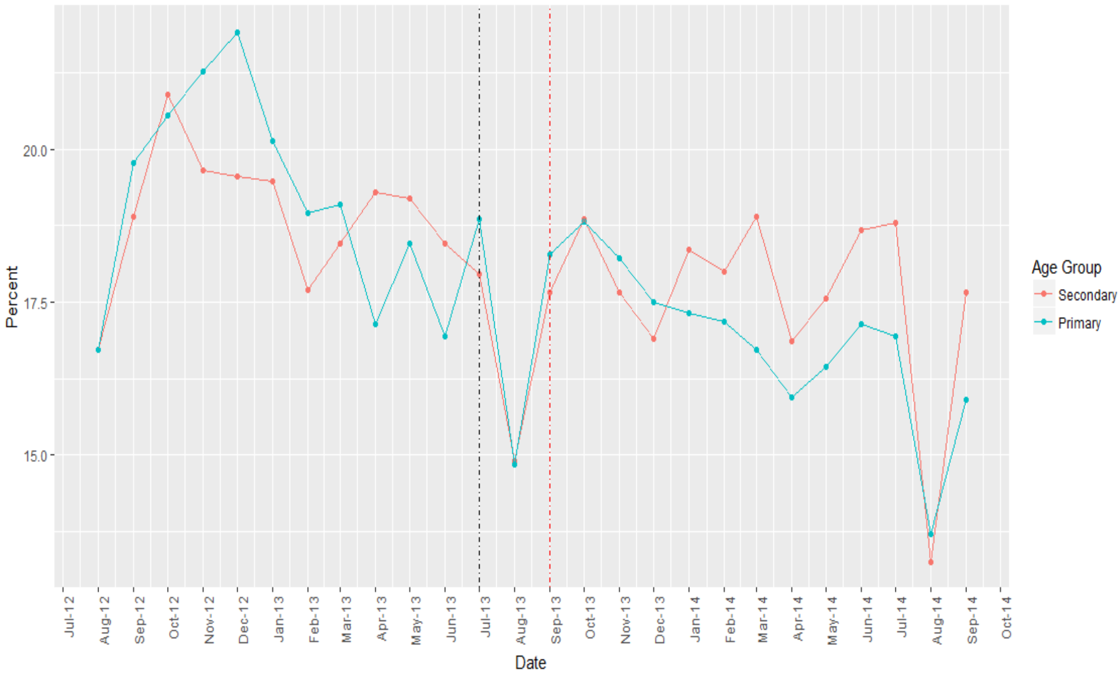


Figure 6.15: Time series plot for unscheduled medical contacts for females split by school age

Table 6.22 shows the number and percentage of scheduled and unscheduled contacts for primary and secondary school females. Primary school females had a higher percentage of unscheduled contacts compared to secondary school females, however secondary school females had a higher percentage of scheduled contacts compared to primary school females.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	734	744	1478
		54.17 %	51.85 %	52.97 %
	Scheduled	226	279	505
		16.68 %	19.44 %	18.10 %
Sept - Dec 2013	Unscheduled	3040	3091	6131
		57.14 %	53.72 %	55.37 %
	Scheduled	1017	1147	2164
		19.11 %	19.93 %	19.54 %
Sept 2013 - Aug 2014	Unscheduled	8307	9181	17488
		61.70 %	58.34 %	59.89 %
	Scheduled	2132	2504	4636
		15.83 %	15.91 %	15.88 %

Table 6.22: Number and percentage of contacts comparing schools for females

Table 6.23 shows the mean count of scheduled and unscheduled contacts for female primary and secondary school children. The mean count for unscheduled contacts was generally higher for primary school females and the mean count for scheduled contacts was generally higher for secondary female children.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	0.87	0.81	0.83
	Scheduled	0.27	0.30	0.29
Sept - Dec 2013	Unscheduled	3.59	3.35	3.46
	Scheduled	1.20	1.24	1.22
Sept 2013 - Aug 2014	Unscheduled	9.81	9.94	9.87
	Scheduled	2.52	2.71	2.62

Table 6.23: Mean counts for contacts comparing schools for females

Logistic Regression

Logistic regression was used to analyse whether a child had a medical contact or not within the various time frame endpoints. Table 6.24 shows the results from the logistic regression model for the primary school variable for females. For unscheduled and respiratory medical contacts being in primary school is likely to increase the odds of having a medical contact in September 2013, and the two extended time periods. These results are generally potentially clinically important. Relevant medical contacts the results were less consistent. For September 2013 and September 2013 - August 2014 being in primary school increased the odds whereas for September - December 2013 being in primary school decreased the odds. For scheduled contacts, in general being in primary school decreased the odds of having a medical contact at the various time periods. These results, especially for the short term endpoints, are potentially clinically important.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.16	1.06	1.18
	(0.95, 1.41)	(0.83, 1.34)	(0.77, 1.79)
Respiratory	1.29	1.15	1.02
	(0.90, 1.85)	(0.92, 1.44)	(0.83, 1.24)
Relevant	1.08	0.95	1.13
	(0.89, 1.32)	(0.72, 1.26)	(0.70, 1.82)
Scheduled	0.86	1.08	0.98
	(0.67, 1.10)	(0.88, 1.33)	(0.77, 1.23)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.88	0.77	
	(0.65, 1.19)	(0.58, 1.01)	

Table 6.24: Logistic regression for all female medical contacts comparing school presenting odds ratios and 95 % confidence intervals (N=1771)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.25 shows the results for the negative binomial model for the primary school variable for females. For unscheduled and relevant medical contacts, in general, being in primary school is likely to decrease the number of medical contacts. For respiratory related contacts, being in primary school is likely to increase the number of contacts. For scheduled contacts, being in primary school is likely to decrease the number of medical contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.08	0.99	0.92
	(0.94, 1.24)	(0.90, 1.08)	(0.85, 0.98)
Respiratory	1.32	1.13	1.03
	(0.92, 1.89)	(0.93, 1.36)	(0.90, 1.17)
Relevant	1.03	0.97	0.93
	(0.92, 1.17)	(0.90, 1.05)	(0.87, 0.99)
Scheduled	0.91	0.95	1.02
	(0.76, 1.09)	(0.86, 1.05)	(0.94, 1.10)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.98	0.75	
	(0.75, 1.27)	(0.58, 0.95)	

Table 6.25: Negative binomial regression for all female medical contacts comparing school presenting incidence rate ratios and 95 % confidence intervals (N=1771)

6.5.2.5 Male

This section of the results looked at whether there was a difference in primary and secondary school aged children for males. Figure 6.16 is a time series plot for unscheduled contacts for males split by primary and secondary school. Compared to females, there is a much more clear distinction between primary and secondary school for males with primary school children experiencing more contacts than secondary school children.

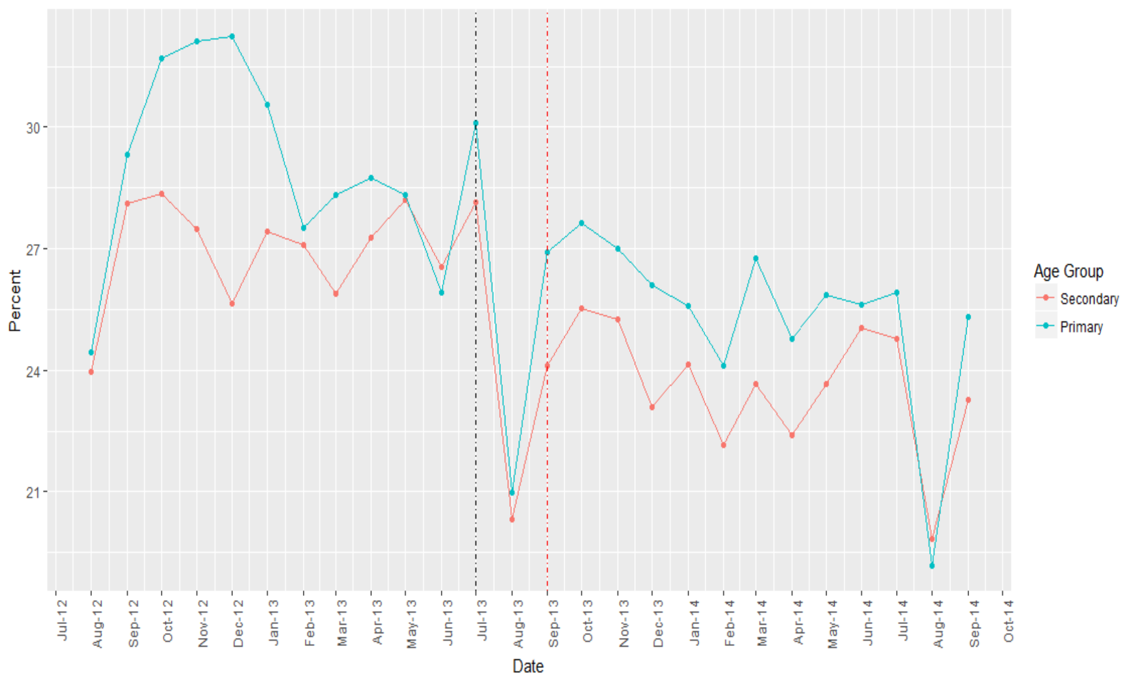


Figure 6.16: Time series plot of unscheduled contacts for males split by school age

Table 6.26 shows the number and percentage of scheduled and unscheduled contacts for primary and secondary school males. Primary school males had a higher percentage of unscheduled contacts and secondary school males had a higher percentage of scheduled contacts.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	1104	988	2092
		53.15 %	51.27 %	52.25 %
	Scheduled	411	383	794
		19.79 %	19.88 %	19.83 %
Sept - Dec 2013	Unscheduled	4480	3964	8444
		56.19 %	52.30 %	54.30 %
	Scheduled	1645	1618	3263
		20.63 %	21.25 %	20.98 %
Sept 2013 - Aug 2014	Unscheduled	12394	11663	24057
		59.89 %	57.22 %	58.57 %
	Scheduled	3479	3610	7089
		16.81 %	17.71 %	17.36 %

Table 6.26: Number and percentage of contacts comparing schools for males

Table 6.27 shows the mean count of scheduled and unscheduled contacts for male primary and secondary school children. The mean count for unscheduled contacts was higher for primary school males. Scheduled contacts were similar for primary and secondary males, with slightly more for primary school children except for September 2013 - August 2014 where secondary school children had a higher mean count.

	Contact Type	Primary	Secondary	Total
Sept 2013	Unscheduled	0.82	0.75	0.78
	Scheduled	0.31	0.29	0.30
Sept - Dec 2013	Unscheduled	3.34	2.99	3.17
	Scheduled	1.23	1.22	1.22
Sept 2013 - Aug 2014	Unscheduled	9.24	8.80	9.02
	Scheduled	2.59	2.72	2.66

Table 6.27: Mean counts for contacts comparing schools for males

Logistic Regression

Logistic regression was used to analyse whether a child had a medical contact or not within the various time frame endpoints. Table 6.28 shows the results from the logistic regression model for the primary school variable for males. For unscheduled and respiratory medical contacts being in primary school is likely to increase the odds of having a medical contact. Relevant medical contacts the results were less consistent. These results in general are potentially clinically important. For September 2013 being in primary school increased the odds whereas for September - December 2013 and September 2013 - August 2014 being in primary school decreased the odds. For scheduled contacts, August 2013 and 2014 being in primary school decreased the odds of contacts, whereas the remaining three endpoints suggest that being in primary school increases the odds of a scheduled contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.14	1.04	1.08
	(0.97, 1.33)	(0.86, 1.25)	(0.81, 1.46)
Respiratory	1.05	1.14	1.09
	(0.77, 1.43)	(0.94, 1.38)	(0.92, 1.28)
Relevant	1.06	0.91	0.92
	(0.90, 1.24)	(0.74, 1.13)	(0.65, 1.30)
Scheduled	1.10	1.04	1.01
	(0.90, 1.36)	(0.87, 1.23)	(0.83, 1.22)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.94	0.94	
	(0.75, 1.18)	(0.75, 1.18)	

Table 6.28: Logistic regression for all male medical contacts comparing school presenting odds ratios and 95 % confidence intervals (N=2667)

Negative Binomial Regression

Negative binomial regression was used to analyse how many contacts the children had at the various endpoints. Table 6.29 shows the results for the negative binomial model for the primary school variable for males. For unscheduled, respiratory related contacts and relevant medical contacts, being in primary school in general is likely to increase the number of contacts. For scheduled contacts in August, being in primary school is likely to decrease the number of medical contacts, however for scheduled contacts in the September and the extended endpoints, being in primary school is likely to increase the number of contacts.

	Dependent variable:		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Primary School	(1)	(2)	(3)
Unscheduled	1.07	1.04	1.01
	(0.95, 1.21)	(0.97, 1.13)	(0.96, 1.07)
Respiratory	0.99	1.07	1.05
	(0.73, 1.35)	(0.90, 1.26)	(0.94, 1.17)
Relevant	1.06	1.03	1.01
	(0.96, 1.17)	(0.96, 1.10)	(0.96, 1.07)
Scheduled	1.03	1.02	1.08
	(0.88, 1.19)	(0.94, 1.10)	(1.01, 1.15)
	Dependent variable:		
	Aug 13	Aug 14	
	(5)	(6)	
Scheduled	0.95	0.98	
	(0.77, 1.17)	(0.79, 1.21)	

Table 6.29: Negative binomial regression for all male medical contacts comparing school presenting incidence rate ratios and 95 % confidence intervals (N=2667)

6.5.2.6 Discussion

This section of the analysis looked at how school age impacted on the various outcomes. This was analysed overall and then for females and males separately. Following the qualitative interviews, it was thought that there could be differences in children's asthma at primary school and secondary school. Primary school children are less independent at school and at home compared to children in secondary school. This could impact on the prescription uptake of their medication. Often male children grow out of their asthma this could impact on unscheduled medical contacts.

This analysis was explored further within gender as females are known to develop asthma later in life and males are more likely to grow out of their asthma (Almqvist et al., 2008; Tantisira et al., 2008; Arathimos et al., 2017; Laffont et al., 2017). Splitting the analysis by gender allowed a comparison of school age within each sex.

The prescription analysis showed that primary school children are potentially more likely to pick up prescriptions. This was also shown in the logistic regression models. For all children being in primary school could increase the odds of picking up a prescription, this was also seen for males and females with it being more evident in females. This follows on from what was hypothesised following the interviews with the children (Chapter 5). Younger children more often had help with their asthma regime from their parents compared to those in secondary school. These results could imply that the children's parents are more likely to be in charge of the child's asthma, taking them for asthma reviews. It could also suggest that the younger children have less control of their asthma so need to pick up their prescriptions more often.

The next analyses looked at medical contacts. The first section looked at all children. The data showed that primary school children had a higher percentage and mean count of unscheduled contacts and secondary school were higher for scheduled contacts. The logistic regression results suggested that being in primary school could increase a child's odds of having an unscheduled or respiratory related medical contact. However for relevant and scheduled contact, primary school children, on the whole, were less likely to have a contact. These results were echoed in the negative binomial regression models. The results imply that primary school children are more likely to have unscheduled contacts and less likely to have scheduled contacts. This could suggest that primary school children have less control over their asthma so are having more unscheduled contacts compared to secondary school children and the primary school are picking up prescription on their unscheduled contacts rather than having a scheduled contact. This could also be due to coding errors of the data, primary school children may have less control of their asthma which causes them to have more patient initiated scheduled contacts which have been coded as unscheduled whereas secondary school children only have their routine scheduled asthma review (Discussed in Section 4.6.1).

The analysis then focused on females. The percentage of contacts was consistent with what was found for all children; primary school children have more unscheduled contacts and secondary have more scheduled contacts. The logistic regression results showed that for unscheduled and respiratory related contacts being female in primary school could increase the odds of a contact. The results for relevant contacts were inconsistent with primary school increasing the odds for September 2013 and September 2013 - August 2014 and decreasing the odds for the remaining endpoint. For scheduled contacts, in general, being in primary school and female could decrease the odds of having a medical contact. The negative binomial regression model showed different results compared to the logistic regression model. For respiratory and scheduled contacts, the results agreed, however for unscheduled and relevant contacts the results were different. For unscheduled contacts, being in primary school and female, in general, could decrease the number of medical contacts and similarly for relevant contacts. This suggests that primary females could be more likely to have an unscheduled or relevant medical contact but if they do they are more likely to have fewer of these contacts.

Males were found to have more unscheduled contact in primary school. The logistic regression model suggested that being in primary school and male could potentially increase the odds of unscheduled and respiratory related medical contacts. For relevant medical contacts, being in primary school could increase the odds in September 2013 and for the extended endpoints decreased the odds. For scheduled contacts, being in primary school could increase the odds for all contacts apart from August 2013 and 2014. The negative binomial results were similar, however, for relevant medical contacts being in primary school could increase the number of contacts for all end points and for scheduled contacts only the August endpoints decreased the number of contacts.

Primary school children could be more likely to have unscheduled medical contacts for both male, female and overall. They are also more likely to pick up a prescription in August, however, secondary school children could be more likely to have a scheduled contact in August and less likely when they are back at school. This could suggest that secondary school children are having their scheduled contacts but are not picking up their medication because their asthma is more under control compared to primary school children so do not need to use their inhaler as much. This is consistent with what was discussed previously in Chapter 3 that children aged 4-10 have the most variable seasonal trend, compared to children aged 11-16.

Combining the analyses on the age differences in gender and the gender differences in age, and looking at the times series plots, the results suggest that for females their asthma is consistent through primary and secondary school, whereas this may not be the case for males. There are no differences between school ages for females. However, there was a difference between school age for males, where primary school males were shown to have more unscheduled contacts than secondary school children. This difference was also shown when comparing gender within school ages. In primary school there was no difference between males and females, however for secondary school there was a difference. Males had much fewer contacts than females. This suggests that secondary school males are the unusual case, they have a decrease in unscheduled contacts.

6.5.3 Transition from Primary to Secondary School

One 'at risk' subgroup that was found in the qualitative study was children in the transition year when they changed from primary school to secondary school. When the children change school they can experience a wide range of changes such as a larger school, more children, different sports and more independence. For this section of the results, this subgroup of children were analysed to see whether they were at a higher risk of having medical contacts. As the data was collected for two years, there is a subgroup of children who were in primary school in the first year and then in secondary school in the second year after the intervention was sent. For this analysis, September 2014 was included as an extended endpoint to enable a comparison between the year the children started secondary school and the second year of secondary school.

6.5.3.1 Demographics

Figure 6.17 shows the number of children who changed school in the data and those who did not. There were 453 children who changed and 3985 who did not change.

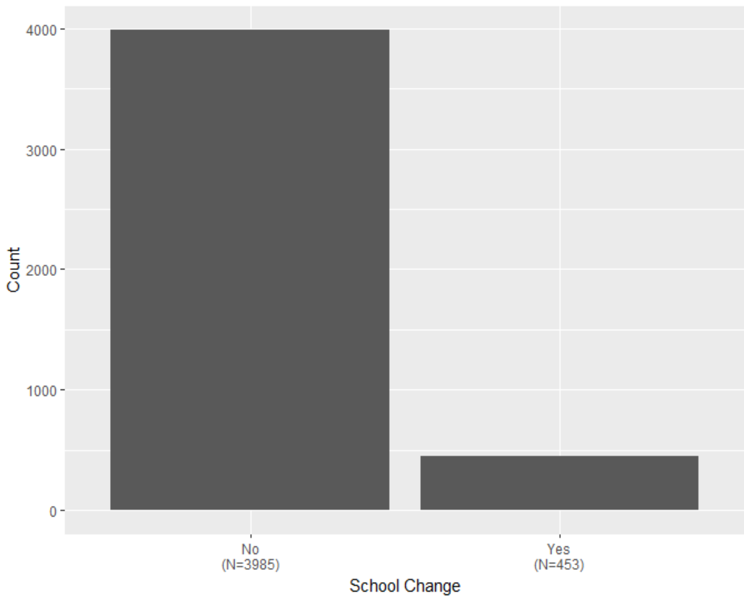


Figure 6.17: School transition group

Gender

Figure 6.18 shows how gender was split by those who changed school. For both male and female there were more who did not change school compared to those who did.

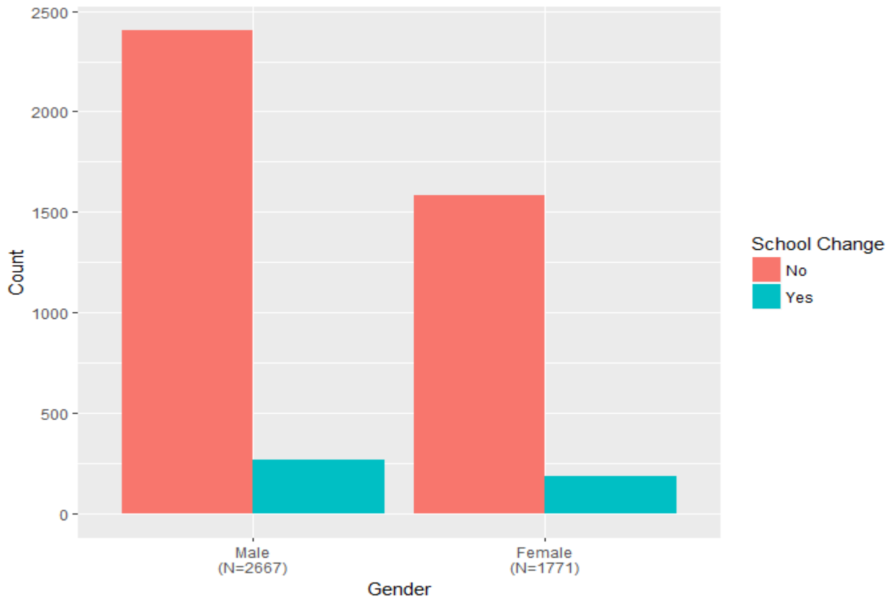


Figure 6.18: Gender split by transition group

Practice Information

Figure 6.19 shows the GP practices and how many children within each practices changed school. Most GP practices had children who were in the changing school subgroup.

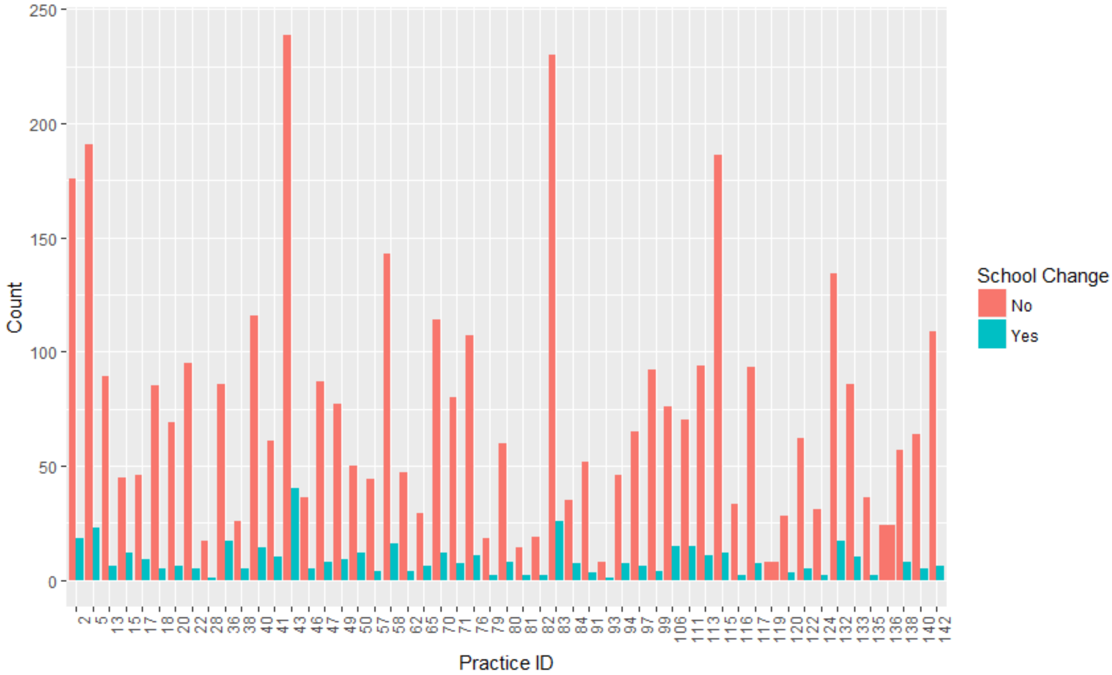


Figure 6.19: The number of children in each of the GP practices split by transition group

Contact Type

Figure 6.20 shows the distribution of contacts and how they were split by who changed school or not. There were more unscheduled contacts compared to scheduled contacts for those who changed school.

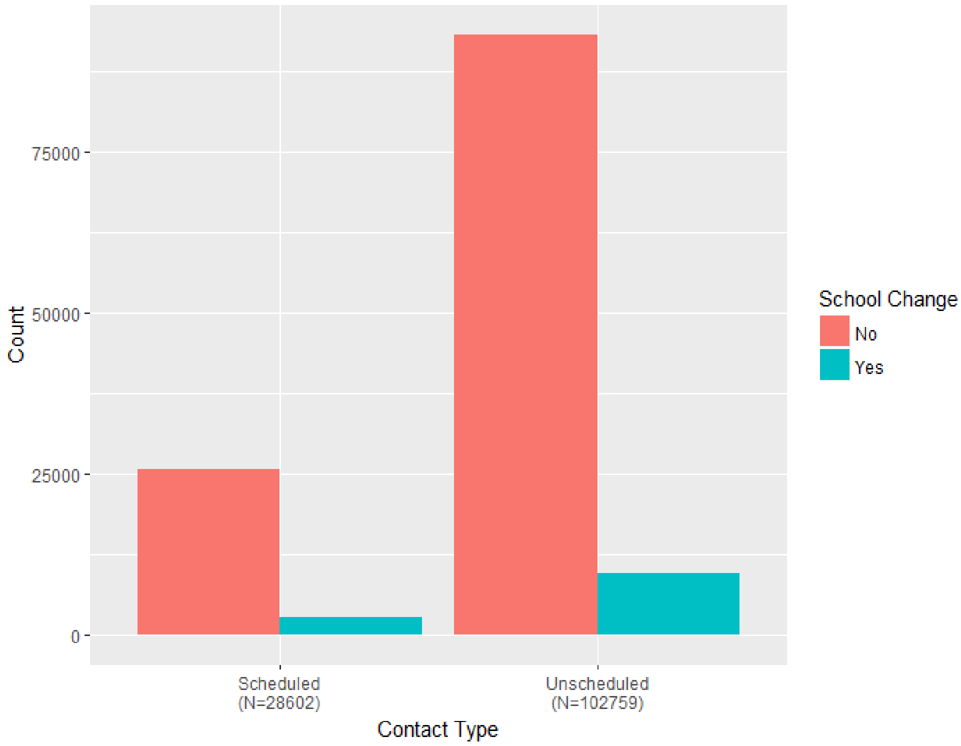


Figure 6.20: The number of contacts split by transition group

6.5.3.2 Prescription Analysis

This section of the results is for the prescription analysis of the children who changed school. Figure 6.21 shows the percentage of children who picked up a prescription split by whether they changed school or not. In August 2012, there was a higher percentage of children picking up prescriptions for the children who did not change school in 2013, compared to those who did. In August 2013, this changed and those who did change had a higher percentage, and in August 2014 this was even more apparent.

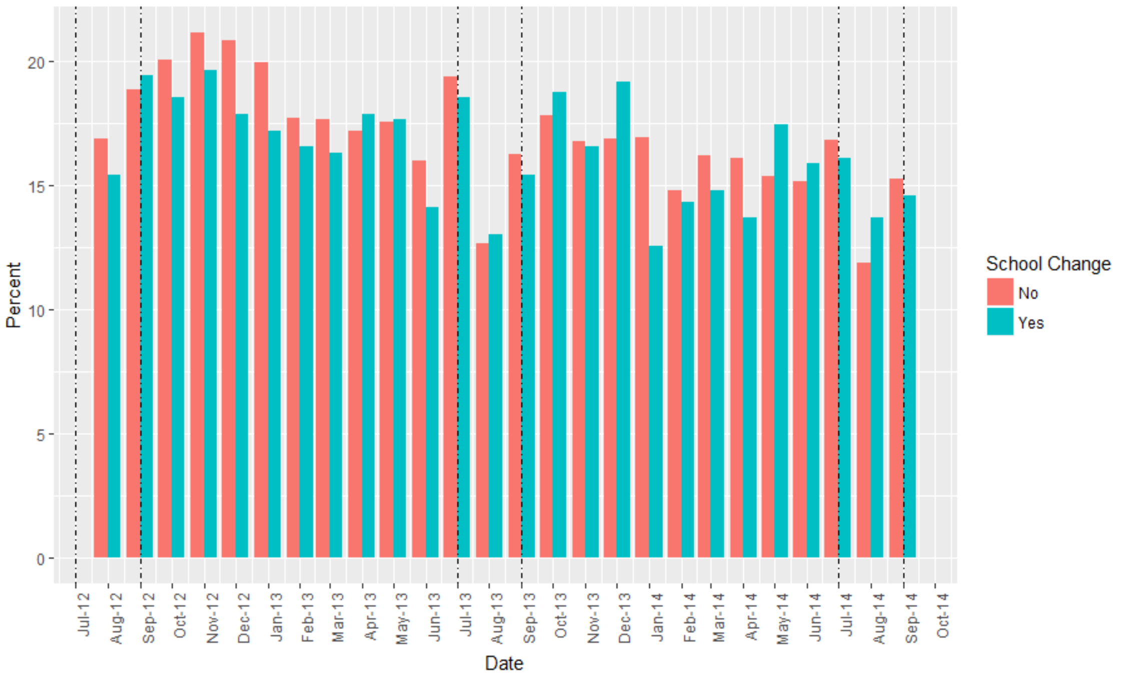


Figure 6.21: The percentage of children who picked up a prescription split by transition group

Table 6.30 shows the number and percentage of children who picked up a prescription in August 2013. The results are similar for those who changed school and those who did not. There was a slightly higher percentage of children not picking up prescriptions for those who did not change school, and a slightly higher percentage of children who did change school who picked up one prescription, but again there was a higher percentage of those who did not change school picking up two or more prescriptions.

	Change in School	
No. Prescript	Yes (N=447)	No (N=3914)
0	388 (86.8 %)	3409 (87.1 %)
1	56 (12.5 %)	472 (12.1 %)
2	3 (0.7 %)	31 (0.8 %)
3	0 (0 %)	2 (0.05 %)

Table 6.30: Number of children who picked up a preventer inhaler in August 2013

Logistic Regression

Logistic regression was used to analyse whether a child picked up a prescription or not in August 2013. Table 6.31 shows the results from the logistic regression model for picking up a prescription in August 2013 or not. The variable estimate for changing school suggests that there is an increased odds for picking up a prescription and this result is potentially clinically important.. Being female suggests a decrease in odds of prescription uptake. Previous year prescription uptake suggests an increase in the odds of picking up a prescription.

	Dependent variable:
	Aug 13
Change School (Yes)	1.05
	(0.78, 1.42)
Gender (Female)	0.97
	(0.81, 1.17)
Aug 12	4.09
	(3.37, 4.97)
Observations	4,361

Table 6.31: Logistic regression for prescriptions in August 2013 presenting odds ratios and 95 % confidence intervals

6.5.3.3 Medical Contacts

This section of the analysis looks at whether a child in the transition year which they change school is at higher risk of having medical contacts after the summer holidays. Figure 6.22 is a time series plot of unscheduled medical contacts split by whether children were in the transition year in September 2013. In the first half of the study, August 2012 - September 2013, there appears to be more contacts for those who did not change school and after September 2013 it is interchangeable.

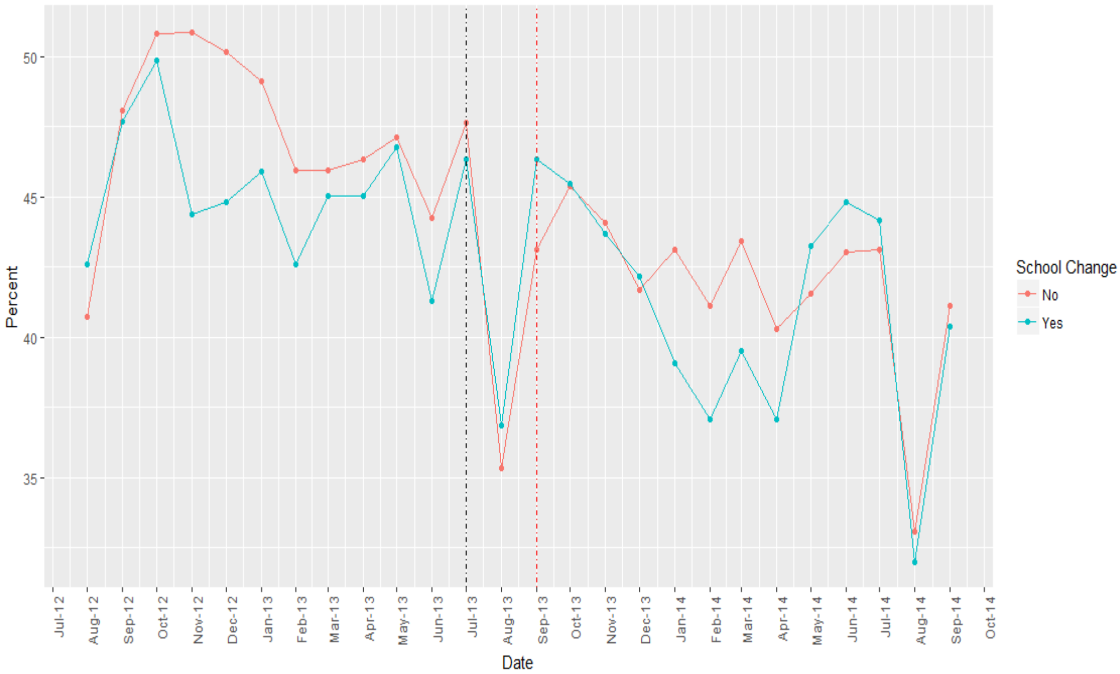


Figure 6.22: Time Series plot for unscheduled medical contacts split by school transition children in September 2013

Table 6.32 shows that in September 2013, there was a higher percentage of unscheduled contacts for the children who did not change school, however for the extended endpoints and scheduled contacts there was a higher percentage for the children who did change school.

	Contact Type	*Change in School* Yes	No	Total
Sept 2013	Unscheduled	340	3230	3570
		51.75 %	52.63 %	52.55 %
	Scheduled	132	1167	1299
		20.09 %	19.02 %	19.12 %
Sept - Dec 2013	Unscheduled	1393	13182	14575
		55.61 %	54.65 %	54.74 %
	Scheduled	521	4906	5427
		20.80 %	20.34 %	20.38 %
Sept 2013 - Aug 2014	Unscheduled	3866	37679	41545
		60.35 %	58.99 %	59.12 %
	Scheduled	1099	10626	11725
		17.16 %	16.64 %	16.68 %

Table 6.32: Number and percentage of medical contacts comparing those who changed school and those who did not

Logistic Regression

Table 6.33 shows the results of the logistic regression model for the school change variable. For unscheduled and relevant medical contacts, the variable estimate suggests being in the year which changes school in 2013 increases the odds of having a medical contact for September 2013, September - December 2013 and September 2013 - August 2014. However, for September 2014 decreases the odds. Respiratory related contacts follows a similar pattern however the estimate for September 2013 - August 2014 also decreases the odds. For scheduled contacts in August 2013 and 2104 the variable estimates suggest that being in the school change year will increase the odds of a contact. This is also seen for September 2013, however for the remaining three endpoints, the variable estimate suggests that the school change year decreases the odds of scheduled contacts. The majority of these results are potentially clinically important.

	Dependent variable:			
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14	Sept 14
Change in School (Yes)	(1)	(2)	(3)	(4)
Unscheduled	1.15	1.29	1.19	0.98
	(0.94, 1.41)	(0.99, 1.66)	(0.79, 1.81)	(0.80, 1.20)
Respiratory	1.18	1.00	0.99	0.88
	(0.81, 1.71)	(0.79, 1.28)	(0.81, 1.23)	(0.58, 1.35)
Relevant	1.15	1.39	1.18	0.92
	(0.93, 1.42)	(1.02, 1.89)	(0.72, 1.91)	(0.75, 1.12)
Scheduled	1.03	0.94	0.82	0.78
	(0.79, 1.34)	(0.76, 1.17)	(0.65, 1.04)	(0.59, 1.03)
	Dependent variable:			
	Aug 13	Aug 14		
	(5)	(6)		
Scheduled	1.02	1.01		
	(0.76, 1.37)	(0.76, 1.35)		

Table 6.33: Logistic regression for all medical contacts comparing those who changed school or not in September 2013 presenting odds ratios and 95 % confidence intervals (N=4438)

Negative Binomial Regression

This section of the analysis uses negative binomial regression to estimate the school change effect on the number of medical contacts. Table 6.34 shows the mean count data for contacts in September 2013, September - December 2013 and September 2013 - August 2014 split by school change. The data shows that the mean count for children who did not change school was higher for all contact types for all time periods.

	Contact Type	*Change in School* Yes	No	Total
Sept 2013	Unscheduled	0.75	0.81	0.80
	Scheduled	0.29	0.29	0.29
Sept - Dec 2013	Unscheduled	3.08	3.31	3.28
	Scheduled	1.15	1.23	1.22
Sept 2013 - Aug 2014	Unscheduled	8.53	9.46	9.36
	Scheduled	2.43	2.67	2.64

Table 6.34: Mean counts for medical contacts for those who changed school in September 2013 or not

Table 6.35 shows the results for the negative binomial regression model for the school change effect. Unlike the results for the logistic regression model, unscheduled, relevant and scheduled medical contacts, at all endpoints, being in the school change year decreases the number of medical contacts. The results for respiratory related contacts are different, for the first 3 endpoints being in the school year change increased contacts whereas September 2014 the number of contacts is likely to be decreased.

	Dependent variable:			
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14	Sept 14
Change in School (Yes)	(1)	(2)	(3)	(4)
Unscheduled	0.96	0.99	0.99	0.97
	(0.83, 1.11)	(0.91, 1.10)	(0.92, 1.06)	(0.82, 1.13)
Respiratory	1.05	1.05	1.05	0.91
	(0.71, 1.55)	(0.85, 1.29)	(0.91, 1.20)	(0.60, 1.39)
Relevant	0.97	0.99	0.97	0.94
	(0.85, 1.10)	(0.91, 1.07)	(0.91, 1.04)	(0.82, 1.09)
Scheduled	0.97	0.94	0.92	0.92
	(0.80, 1.17)	(0.84, 1.04)	(0.85, 0.99)	(0.75, 1.13)
	Dependent variable:			
	Aug 13	Aug 14		
	(5)	(6)		
Scheduled	0.93	0.99		
	(0.70, 1.22)	(0.76, 1.29)		

Table 6.35: Negative binomial regression for all medical contacts comparing those who changed school or not in September 2013 presenting incidence rate ratios and 95 % confidence intervals (N=4438)

6.5.3.4 Discussion

This section looked at whether children with asthma were more likely to experience medical contacts if they were in the year that changed school in September 2013. The qualitative study found that when children change from primary school to secondary school they experience a number of other changes. They are expected to be more independent with their asthma medicine, they are taking part in a number of different sports which are often more intense than those at primary school and their new schools are often much bigger which would require more movement and spending time with larger groups of children.

The prescription analysis looked at whether this subgroup of children were more likely to pick up their prescription in August before they started secondary school in September. The results showed that the children in this year group were potentially more likely to pick up a prescription in August 2013. This could be because the children are preparing for the big change in changing school and are collecting their medication before they start the new school in September.

The following analysis looked at medical contacts. The percentage of counts showed that for all scheduled and unscheduled contacts, apart from unscheduled September 2013, those in the year that changed school had more contacts. However, this was not echoed in the mean count data. The mean count data showed that the mean counts were higher for all the children who did not change school. This suggests that the children who change school are less likely to have a contacts, but if they do, they are likely to have less.

The logistic regression results showed that for unscheduled medical contacts being in the year that changed school could increase the odds of having a medical contact apart from September 2014. September 2014 would be the year the children started their second year of secondary school which means they were no longer in the sub-group. This was also found for relevant medical contacts and similar results were found for respiratory related contacts. For scheduled contacts the results suggested that being in the year that changed school could increase the odds of a contact in September 2013 and August 2013 and 2014 and decreased the odds for the remaining end points. This could be because the children are having their review/picking up prescription in August 2013 and 2014 before they go back to school in September, and this could be followed through to September 2013.

Nevertheless, these results were not consistent with the negative binomial model. The results showed that for unscheduled, relevant and scheduled contacts the number of contacts were potentially decreased if the child was in the year that changed school. This is different to what was seen previously in the logistic regression results. This suggests the children changing school are more likely to have a medical contact, but when they do, they are likely to have fewer contacts.

The children could be more likely to pick up a prescription in August before returning back to school. They could also be more likely to experience an unscheduled contact after going back to school. However, even though the children are potentially more likely to experience most types of medical contacts, they are more likely to have fewer of them. This could suggest that following any medical contact they experience, they are more likely to take control again of their asthma. However, as discussed previously, this could be due to the coding issues in the data. The children are initiating asthma reviews before they go back to school which is coded as being unscheduled when it is a scheduled contact. This could explain why they have less subsequent contacts when they do have a contact. The children are also less likely to have a medical contact in 2014, in their second year of secondary school.

These results are discussed further in detail in Chapter 8 in Section 8.3.2.

6.5.4 Exercise (Blue Inhalers)

6.5.4.1 Prescription Analysis

The qualitative study results suggested that children who did not exercise in the summer holidays may be at a higher risk of contacts in September. Unfortunately, the PLEASANT dataset does not contain data on exercise. A potential marker for exercise is an increase in use of reliever (blue) inhalers (Jafer et al., 1991), as children may use their blue inhaler more when they start to exercise more again when they return back to school. This can be analysed by looking at the prescription uptake in September of reliever inhalers.

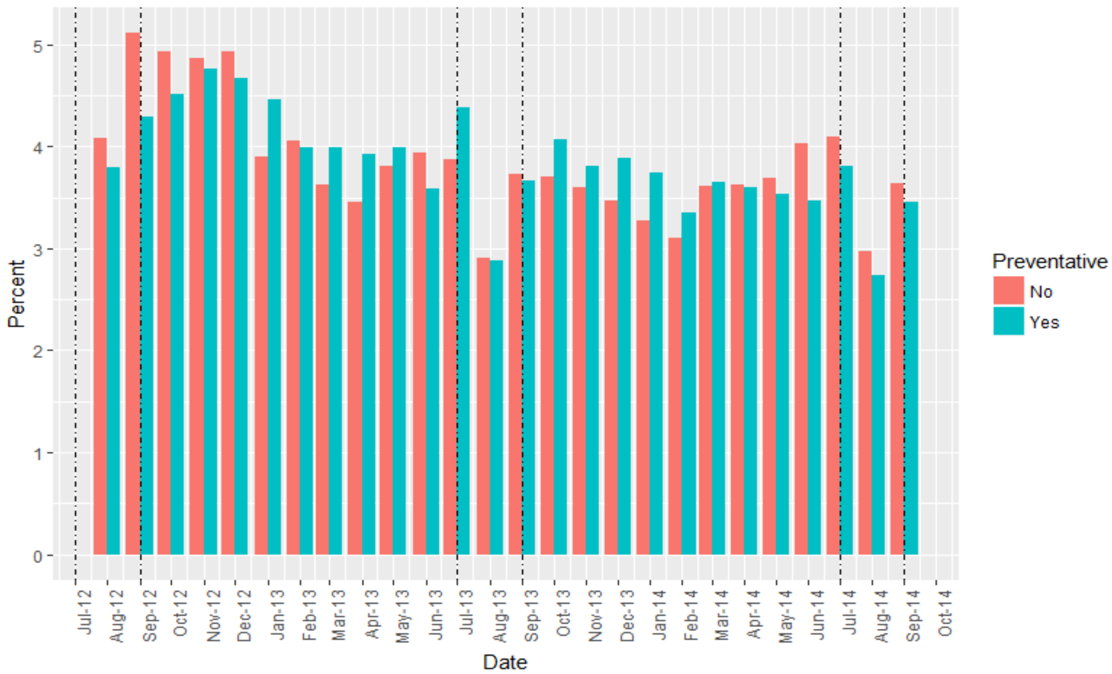


Figure 6.23: The percentage of prescriptions picked up split by inhaler type

Figure 6.23 shows the percentage of prescriptions picked up by children for each month split by inhaler type. In August and September for all three years there was a higher percentage of reliever inhalers picked up. This was less pronounced in 2013.

Logistic Regression

Logistic regression was used to analyse whether a child picked up a prescription or not in August 2013. Table 6.36 shows the logistic regression results for the prescription analysis for August and September 2013. The results suggest that being female decreases the odds of picking up a blue inhaler in August but increases the odds in September, these results are potentially clinically important. Age has little effect on prescription uptake. Picking up a prescription the previous year is likely to increase the odds of picking one up the following year.

	Dependent variable:	
	Aug 13	Sept 13
	(1)	(2)
Age	1.03	1.00
	(0.98, 1.07)	(0.97, 1.04)
Gender (Female)	0.96	1.20
	(0.74, 1.25)	(0.96, 1.52)
Aug 12	4.95	
	(3.66, 6.70)	
Sept 12		3.10
		(2.34, 4.09)

Table 6.36: Logistic regression for prescriptions in August 2013 and September 2013 presenting odds ratios and 95 % confidence intervals (N=4361)

6.5.4.2 Discussion

Figure 6.23 shows that there is an increase in reliever inhaler prescriptions compared to preventer inhaler in August and September 2013, with the difference being larger in September. This is what was hypothesised in the qualitative study; children are exercising more when they return to school so are using their inhalers more, therefore they need to get a new reliever inhaler prescription. This increase in reliever inhaler prescriptions was also seen in June and potentially in July. This is around the time when the weather is better so children may be playing outside more and taking part in activities at school such as sports day.

Logistic regression was used to analyse whether a child picked up a reliever inhaler or not in August and September 2013. The results showed that age had little affect on whether a child picked up an inhaler. However, there was a difference for gender. Being female could decrease the odds of picking up an inhaler in August but increased the odds in September. Previous literature has shown that males are more active that females (Bailey, 2005; Yiallouros et al., 2015; Lu et al., 2016), so this could be what is being shown in these results. Females are doing less sport in the summer so not using their reliever inhalers and then when they return to school they are finding they are doing more sport so need to use their reliever inhaler more.

These results were discussed previously in Chapter 5 Section 5.7.5 and again in Chapter 8 Section 8.3.1.

6.5.5 Previous September 2013 Unscheduled Contact

Previous medical contact is another subgroup that was found to be at higher risk, however this was found in the original PLEASANT analysis rather than the qualitative analysis, Chapter 4. In this analysis, the data were limited to those who had a previous medical contact and this was used to see how gender and age differs within this group.

6.5.5.1 Demographics

This section presents the demographics for children who had a previous September contact. Figure 6.24 shows the distribution of children who had a previous contact and those who did not, 2306 children did not have a previous September contact and 2132 children did.

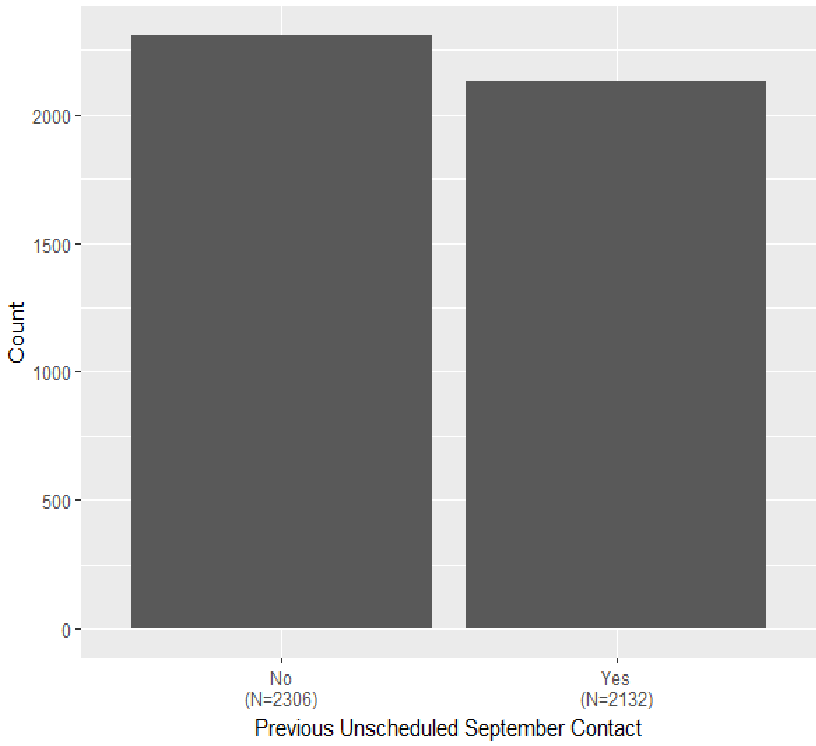


Figure 6.24: The number of children who had a unscheduled medical contact in September 2012

Figure 6.25 shows the how previous September contact is split across gender. For both males and females there were more who did not have a previous September contact.

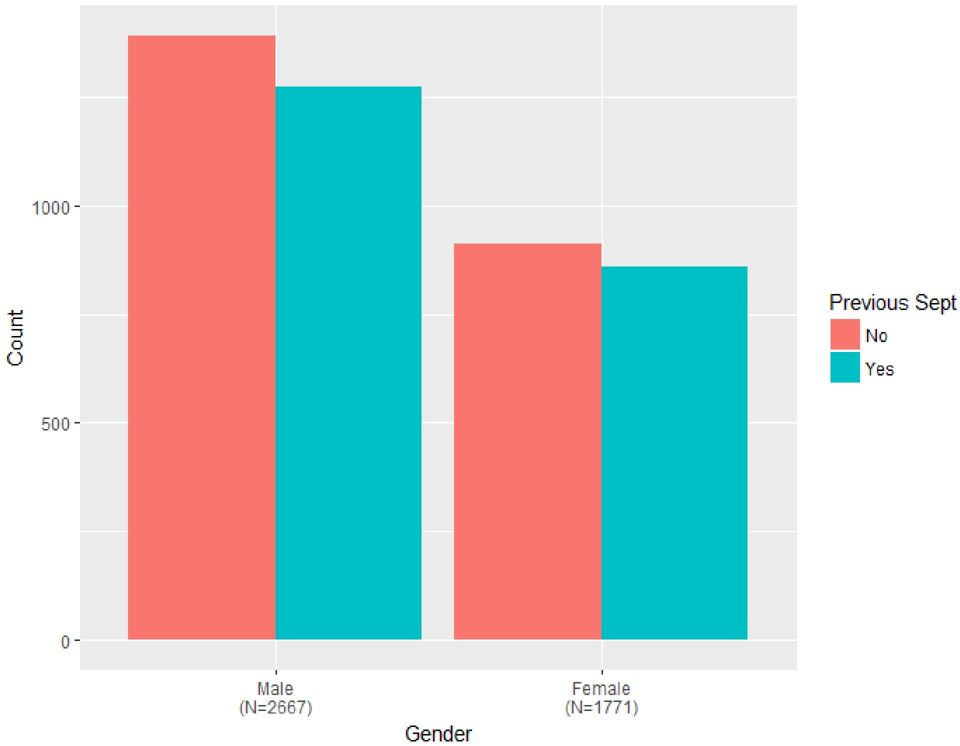


Figure 6.25: Gender split by who had a unscheduled medical contact in September 2012

Age

Figure 6.26 shows how previous September contact was split over the different ages. For ages 7 - 15, there were more children who had not had a previous September contact. For ages 5 - 6 there were more children who did have a previous September. However, all these children will have been a year younger when they experienced the September contact, suggesting that under 5 there were more children who had a contact that September.

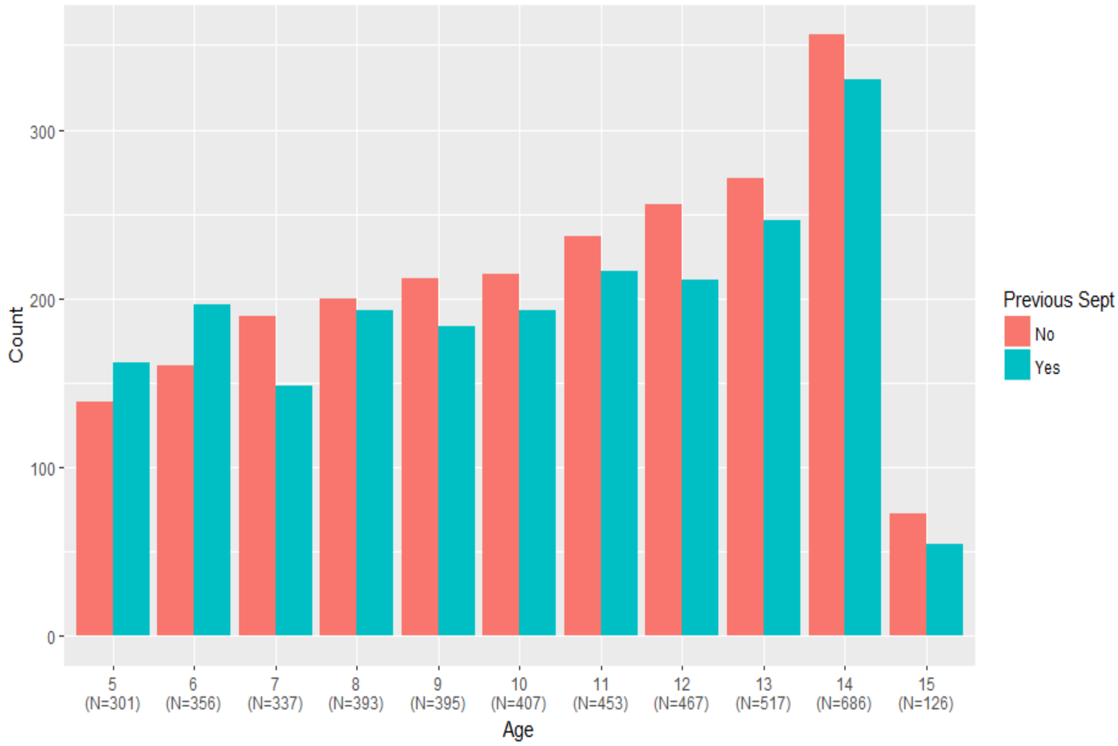


Figure 6.26: Age split by who had a unscheduled medical contact in September 2012

Practice Information

Figure 6.27 shows the number in each practice who had a previous September contact. There were 17 practices that had more children who had had a previous September contact and 36 who had not.

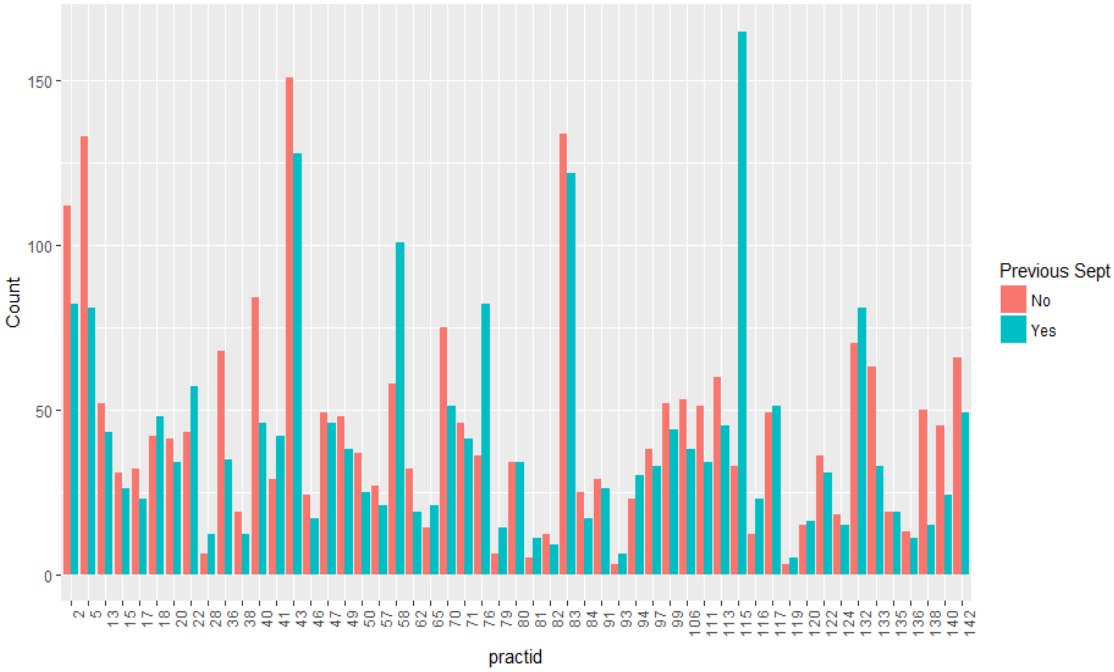


Figure 6.27: The number of children in each of the GP practices split by who had a unscheduled medical contact in September 2012

Contact Type

Figure 6.28 shows how many of the scheduled and unscheduled contacts in the study were an unscheduled contact in September 2012.

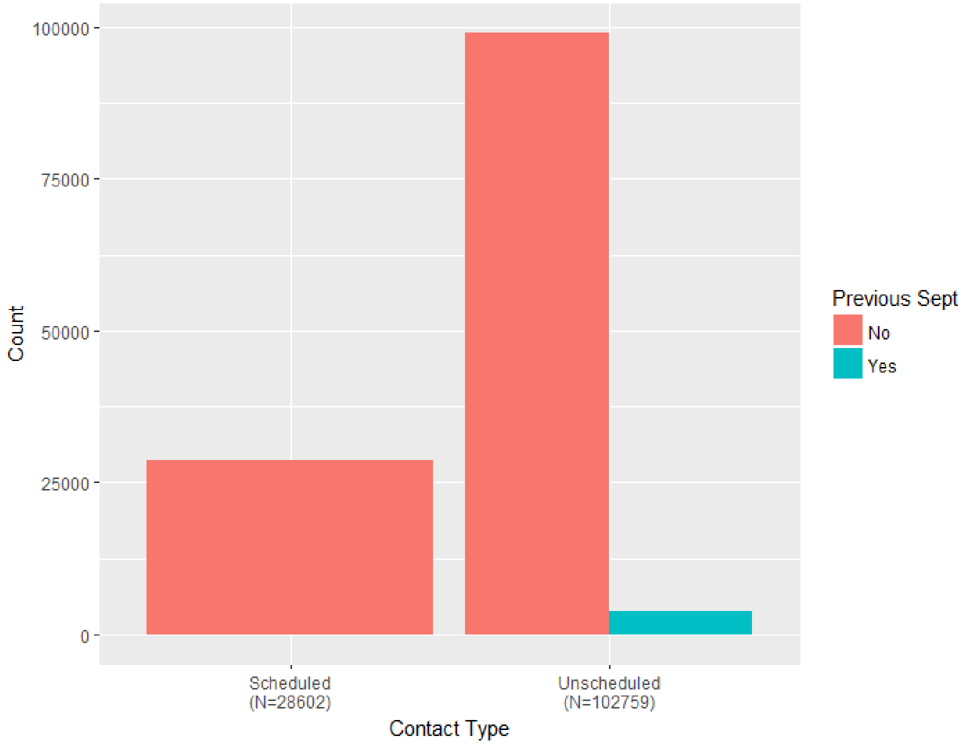


Figure 6.28: The number of contacts split by who had a unscheduled medical contact in September 2012

6.5.5.2 Prescription Analysis

This section of the analysis looked at how previous September contact impacted on picking up a prescription the following August. Figure 6.29 shows the percentage of children who picked up a prescription split by those who had a previous September contact or not. There was a much higher percentage of children picking up prescriptions all year if they had had a contact in September 2012. The difference is greatest in September 2012, those who had a contact also picked up a prescription.

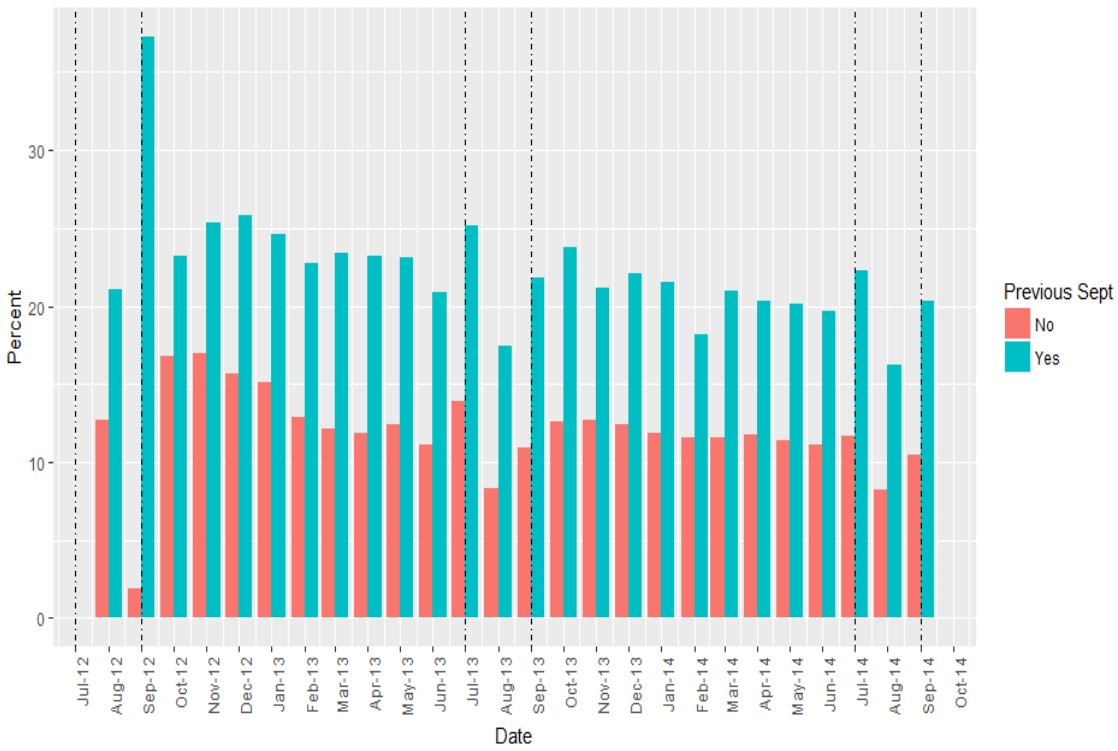


Figure 6.29: The number of children who picked up a prescription split by who had a unscheduled medical contact in September 2012

Table 6.37 shows the number and the percentage of children who picked up prescriptions in August 2013. There was a higher percentage of children not picking up prescriptions if they had not had a previous September contact. For picking up prescriptions, the percentage and count was almost double for those who had a previous September contact.

	Previous Sept Contact	
No. Prescript	Yes (N=2123)	No (N=2238)
0	1751 (82.5 %)	2046 (91.4 %)
1	348 (16.4 %)	180 (8.0 %)
2	22 (1.0 %)	12 (0.5 %)
3	2 (0.1 %)	0 (0 %)

Table 6.37: Number of children who picked up a preventer inhaler in August 2013

Logistic Regression

Logistic regression was used to analyse whether a child picked up a prescription or not in August 2013. Table 6.39 shows the logistic regression results for picking up a prescription in August 2013. Model (1) is on the full data and looks at whether previous contact as a variable had an affect on prescription uptake and Model (2) is on the subset of data and looks at how gender and age impacts on prescription uptake for those who had a previous medical contact. For Model (1) previous September suggests that if a child had a contact in September 2012 they are more likely to pick up a prescription in August 2013 and this result is clinically important. Previous August 2012 prescription also suggests an increase in odds. The variable estimates suggest that being female and age getting older decrease the odds of picking up a prescription in August 2013. For Model (2), of those who had a medical contact in September, they are more likely to pick up a prescription in August 2013 if they did in August 2012. For age and gender again the variable estimates suggests that being female and age are likely to decrease the odds. The result for gender is potentially clinically important.

	Dependent variable:	
	Aug 13	Aug 13
	(1)	(2)
Age	0.98	0.97
	(0.95, 1.01)	(0.94, 1.01)
Previous Sept	2.07	
	(1.71, 2.52)	
Gender (Female)	0.97	0.98
	(0.80, 1.17)	(0.77, 1.24)
Aug 12	3.77	3.61
	(3.10, 4.59)	(2.83, 4.62)
Observations	4,361	2,123

Table 6.38: Logistic regression for prescriptions in August 2013 presenting odds ratios and 95 % confidence intervals

6.5.5.3 Medical Contacts

Logistic Regression

Logistic regression was used to analyse whether age and gender of children who had a previous September contact had an affect on having a medical contact or not. The results can be found in Table 6.39. For unscheduled contacts, age is likely to decrease the odds of having a medical contact in all endpoints. Being female is likely to increase the odds of a contact for all end points apart from September 2013 - August 2014. For respiratory related contacts, age is likely to decrease the odds of having a medical contact and being female to increase the odds. For relevant contacts, the results are less consistent, for September 2013 and September - December 2013 age could decrease the odds but for September 2013 - August 2014 it could increase the odds. Being female is likely to increase the odds of a relevant medical contact. For scheduled contacts, the variable estimates for September, September - December 2013 and September 2013 - August 2014 suggest age decreases the odds and, for August 2013 and 2014 suggest age increases the odds of a scheduled contact. Being female in general decreases the odds of having a scheduled medical contact. These results, for females, in general are potentially clinically important.

		Dependent variable:		
		Sept 13	Sept - Dec 13	Sept 13 - Aug 14
		(1)	(2)	(3)
Unscheduled	Age	0.97	0.98	0.98
		(0.94, 0.99)	(0.94, 1.02)	(0.92, 1.05)
	Gender (Female)	1.06	1.01	0.97
		(0.89, 1.26)	(0.79, 1.30)	(0.64, 1.47)
Respiratory	Age	0.95	0.92	0.93
		(0.87, 1.05)	(0.86, 0.99)	(0.87, 1.00))
	Gender (Female)	1.02	1.27	1.09
		(0.56, 1.84)	(0.82, 1.96)	(0.70, 1.69)
Relevant	Age	0.98	0.99	1.01
		(0.96, 1.00)	(0.97, 1.03)	(0.97, 1.06)
	Gender (Female)	1.11	1.15	1.26
		(0.98, 1.26)	(0.97, 1.37)	(0.95, 1.68)
Scheduled	Age	0.98	0.98	0.99
		(0.94, 1.01)	(0.95, 1.01)	(0.96, 1.03)
	Gender (Female)	1.05	0.91	0.80
		(0.84, 1.31)	(0.76, 1.12)	(0.63, 0.99)
		Dependent variable:		
		Aug 13	Aug 14	
		(5)	(6)	
Scheduled	Age	1.01	1.03	
		(0.97, 1.05)	(0.99, 1.07)	
	Gender (Female)	0.92	0.96	
		(0.72, 1.18)	(0.76, 1.22)	

Table 6.39: Logistic regression for children who had a previous September contact presenting odds ratios and 95 % confidence intervals (N=2132)

Negative Binomial Regression

Negative binomial regression was used to analyse whether age and gender of children who had a previous September contact had an affect on the number of medical contacts the children experienced. The results can be found in Table 6.40. For unscheduled and relevant medical contacts, being female is likely to increase the odds of having medical contacts for all time points. Age is likely to decrease the odds for contacts in 2013, the year after the previous contact. For respiratory related contacts, the impact of being female is not clear, for September and September - December the odds are increased and then following that the odds decrease. Age in general is likely to decrease the number of medical contacts. For scheduled contacts, the results are similar to those for unscheduled and relevant contacts and for scheduled contacts in August being female is likely to reduce the number of contacts and age is likely to increase the number of contacts.

		Dependent variable:		
		Sept 13	Sept - Dec 13	Sept 13 - Aug 14
		(1)	(2)	(3)
Unscheduled	Age	0.99 (0.97, 1.01)	0.98 (0.97, 0.99)	1.00 (0.99, 1.01)
	Gender (Female)	1.02 (0.91, 1.15)	1.07 (0.99, 1.16)	1.10 (1.02, 1.18)
Respiratory	Age	0.97 (0.88, 1.07)	0.97 (0.92, 1.02)	0.97 (0.93, 1.01)
	Gender (Female)	1.01 (0.56, 1.83)	1.16 (0.83, 1.62)	0.92 (0.72, 1.19)
Relevant	Age	0.99 (0.98, 1.00)	0.99 (0.98, 0.99)	1.00 (0.99, 1.01)
	Gender (Female)	1.04 (0.96, 1.12)	1.06 (0.99, 1.12)	1.06 (1.01, 1.12)
Scheduled	Age	0.98 (0.96, 1.00)	0.99 (0.98, 1.00)	1.00 (0.99, 1.01)
	Gender (Female)	0.93 (0.80, 1.09)	0.95 (0.87, 1.04)	1.10 (1.02, 1.18)
		Dependent variable:		
		Aug 13	Aug 14	
		(5)	(6)	
Scheduled	Age	1.01 (0.97, 1.04)	1.03 (0.99, 1.06)	
	Gender (Female)	0.92 (0.74, 1.15)	0.88 (0.71, 1.09)	

Table 6.40: Negative binomial regression for children who had a previous September contact presenting incidence rate ratios and 95 % confidence intervals (N=2132)

6.5.5.4 Discussion

This section of the results looked at the analysis of how gender and age of children who had a previous September contact could impact on future medical contacts. These children were previously found to be at a higher risk of medical contacts in the initial PLEASANT analysis (Chapter 4) and this analysis was exploring this group of children further.

For the prescription analysis, two different analyses were conducted, the first looking at how having a September contact in 2012 affected children picking up a prescription in August 2013. The second analysis looked at gender and age within this subgroup and how that impacted on picking up a prescription. Those who had a previous September contact could be more likely to pick up a prescription in August 2013. Within this subgroup for age and gender the variable estimates showed a potential decrease in odds. Females being less likely to pick up a prescription and as children got older they were less likely as well.

The analysis of medical contacts was conducted on the previous September contact subgroup only. The results were fairly consistent, that age could decrease the odds/number of contacts and being female could increase the odds/number of contacts except for scheduled contacts where being female decreased the odds/number of scheduled contacts.

These results suggest that younger females who had had a previous medical contact are potentially more likely to have a medical contact in the future. However older females are potentially less likely to pick up a prescription or have a scheduled contact.

6.6 Conclusion

The results from the subgroup analysis in this chapter have shown a number of groups who could potentially be more at risk of having medical contacts at the start of the new school year. A summary diagram of the results from this chapter can be found in Section 6.6.1. The results suggest that females could be more likely to have unscheduled medical contacts, and less likely to have scheduled contacts or pick up a prescription. This could be because females are more likely to be self conscious about taking their medication so are not taking it which means they do not need as many prescriptions and are having more unscheduled contacts because their asthma is not well controlled.

The results also suggest that primary school children could be more likely to pick up a prescription but less likely to have a scheduled contact. They also could be more likely to have an unscheduled contact. This could be because primary school children have not had asthma that long so it is not well controlled which is why they are picking up more prescriptions and having more unscheduled contacts. The decrease in scheduled contacts could be due to some scheduled contacts potentially being coded as unscheduled depending on whether they were patient initiated or not.

The analysis results suggested that the patterns of female contacts were consistent over the two age groups, whereas males showed a decrease in unscheduled medical contacts when they go to secondary school. This could be because males are more likely to grow out of their asthma compared to females (Almqvist et al., 2008; Tantisira et al., 2008; Arathimos et al., 2017; Laffont et al., 2017).

Children who change from primary school to secondary could be more likely to pick up a prescription in August before they start secondary school. They could also be more likely to experience a medical contact in September when they start secondary school, however they are less likely to have a medical contact the following September. These children are likely to be preparing for the school transition which is why they are more likely to pick up a prescription in the summer. The children also have to adjust to the changes the transition can bring which could cause the increase in contacts in September. This increase is not echoed the following year, this could be because the children are used to their new school.

The prescription analysis showed that children could be more likely to collect a prescription for their reliever inhaler compared to their preventer inhaler in August and September. The regression results also showed that females are potentially less likely to collect a reliever inhaler in August but potentially more likely to in September. It is thought this could be related to the amount of exercise females do compared to males. There is evidence to suggest that females are less active than males (Bailey, 2005; Yiallouros et al., 2015; Lu et al., 2016), so they may do less exercise in the summer and then have to do PE when they return back to school which could mean they do not use their reliever inhaler until they are back to school.

Having a previous September contact increases the odds of collecting a prescription in August. This is an example of children believing that their medication is a necessity. Children do not want experience contacts in September again, therefore they collect their medication in August in order to prevent it happening again. Within this subgroup of children, older females are potentially less likely to pick up a prescription. It was also found that younger females who had a previous medical contact are potentially more likely to experience another September contact. This is consistent with what was seen previously in the gender and school age subgroup analyses.

The next chapter includes analysis of the original PLEASANT intervention on the ‘at risk’ subgroups to determine whether the intervention had any affect on the children. The analysis was also used to determine which subgroups the intervention did not work on, as these child could benefit from an alternative intervention.

6.6.1 Chapter Summary Diagram

The summary diagram presented on the next page is a summary of all the results from this chapter. The table shows the different outcomes for each subgroup and the variable of interest and shows whether the direction of the result for the variable of interest was positive (green) or negative (red) depending on the outcome. For example, for unscheduled medical contacts, the aim is to reduced contacts therefore, a reduction is considered positive (green) and an increase is considered negative (red).

Subgroup	Effect	Prescriptions		Unscheduled Contacts						Relevant Contacts						Scheduled Contacts				Comments (In general)
		Logistic Regression		Logistic Regression			Negative Binomial			Logistic Regression			Negative Binomial			Logistic Regression		Negative Binomial		
		Aug 13	Sept 13	Sept 13	Sept-Dec	Sept-Aug	Sept 13	Sept-Dec	Sept-Aug	Sept 13	Sept-Dec	Sept-Aug	Sept 13	Sept-Dec	Aug 13	Aug 13	Sept 13	Aug 13	Sept 13	
All Children	Gender (Female)	Red	No analysis	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Females are more likely to have unscheduled medical contacts and more likely to not pick up prescriptions.
Primary	Gender (Female)	Green	No analysis	Red	Red	Red	Red	Red	Green	Red	Red	Red	Red	Red	Green	Red	Red	Red	Red	Primary females are more likely to have unscheduled medical contacts but more likely pick up prescriptions.
Secondary	Gender (Female)	Red	No analysis	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red	Green	Red	Secondary females are more likely to have unscheduled medical contacts and are more likely to not pick up prescriptions.
All Children	School (Primary)	Green	No analysis	Red	Red	Red	Red	Red	Green	Red	Green	Green	Red	Red	Green	Red	Green	Red	Red	Primary school are more likely to have unscheduled medical contacts but are more likely to pick up a prescription.
Female	School (Primary)	Green	No analysis	Red	Red	Red	Red	Green	Green	Red	Green	Red	Red	Green	Green	Red	Red	Red	Red	Primary school females are more likely to have unscheduled medical contacts but are more likely to pick up a prescription.
Male	School (Primary)	Green	No analysis	Red	Red	Red	Red	Red	Red	Red	Green	Green	Red	Red	Red	Red	Green	Red	Green	Primary school males are more likely to have unscheduled medical contacts but are more likely to pick up a prescription.
All Children	Change in school	Green	No analysis	Red	Red	Red	Green	Green	Green	Red	Red	Red	Green	Green	Green	Green	Green	Red	Red	Children who change school are more likely to have an unscheduled contact but are more likely to have less of them. They are more likely to pick up a prescription. They are more likely to have a scheduled contact, but less of them.
Exercise (Blue)	Age	Green	Green	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	As children age, they are more likely to pick up a reliever inhaler in both August and September.
	Gender (Female)	Red	Green	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	Females are less likely to pick up a reliever inhaler in August but more likely to in September.
All Children	Previous Sept	Green	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	No analysis	Those who had a unscheduled medical contact in September 2012 are more likely to pick up a prescription in August 2013.
Previous Sept	Age	Red	No analysis	Green	Green	Green	Green	Green	Red	Green	Green	Red	Green	Green	Red	Green	Red	Green	Red	Those who had a previous medical contact, as they age, they are less likely to pick up a prescription but also less likely to have unscheduled or relevant contacts
	Gender (Female)	Red	No analysis	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Those who had a previous medical contact, if they are female, they are less likely to pick up a prescription and more likely to have unscheduled or relevant contacts

Key

- Green: Direction of coefficient: Increase in prescription or a decrease in unscheduled contacts or an increase in scheduled contacts
- Red: Direction of coefficient: Decrease in prescription or an increase in unscheduled contacts or a decrease in scheduled contacts
- No analysis: No analysis was done

7. Intervention Analysis

7.1 Introduction

The previous chapter looked at different subgroups that could be at a higher risk of medical contacts in September. This chapter looks at whether the original PLEASANT intervention had any affect on these subgroups. The subgroups of children found to potentially be at a higher risk were: primary school children, females, children changing from primary school to secondary and those who had a previous September contact. The final aim of this Ph.D. was to find subgroups that the PLEASANT intervention may have worked better on, or propose new interventions.

In this chapter, analyses were done on the various subgroups to test whether the intervention had any affect on them. The methods used were those used previously, alongside interrupted time series methods.

7.2 Chapter Aims

The aims of this chapter are:

- To provide a description of how to conduct interrupted time series analysis.
- To analyse the intervention effect on the various at risk subgroups.
- To use Interrupted Time Series as an alternative method of analysing the full PLEASANT dataset and within the subgroups.

7.3 Intervention Analysis Plan

The intervention analysis was conducted in two parts. Firstly, using previous analysis methods. Secondly, using Interrupted Time Series (Details in Section 7.4.1). Unlike the previous chapter, the intervention analysis was conducted on both the control and the intervention arm.

The analysis was conducted on a number of subgroups:

- Females and Males
- Primary and Secondary School
- Transition year from Primary to Secondary School
- Previous September Unscheduled Medical Contact

Unfortunately, it was not possible to test the intervention on the exercise group.

The Interrupted Time Series analysis was conducted on the full data as well as the subgroups as this has not been done previously.

Previously the analyses were conducted on a number of endpoints. However, for this analysis only unscheduled contacts, all medical (relevant) contacts and prescriptions were used as these are the end points the intervention was meant to have an affect on.

7.4 Intervention Analysis Methods

Some of the methods used in this analysis were the ones used previously, logistic regression and negative binomial regression, which were detailed in Section 4.3.3.

7.4.1 Interrupted Time Series

A new method that was not used in previous analyses is Interrupted Time Series (ITS). ITS is used to analyse whether an intervention had an affect after it was implemented at a specific point in time (Bernal et al., 2017). To conduct ITS analysis, segmented regression can be used (Wagner et al., 2002). Segmented regression allows for the regression analysis to be conducted over two or more segments of time, where the segments are broken by a change point. A change point is a point in time when the previous trend may no longer follow after that point. Using segmented regression for ITS enables a formal statistical test to be conducted to estimate whether there was a change in trend (Wagner et al., 2002).

The following model is used for segmented regression ITS analysis:

$$Y_t = \beta_0 + \beta_1 Time + \beta_2 Intervention + \beta_3 Time\ after\ intervention + \epsilon_t,$$

where Y_t is the outcome of interest, β_0 is the intercept, β_1 is the baseline slope, prior to the intervention, $Time$ is the time from the start of the study (1,2,3,...), β_2 is the change in level after the intervention, $Intervention$ is an indicator of whether the time is before the intervention (= 0) or after the intervention (= 1), β_3 is the slope after the intervention, $Time\ after\ intervention$ is the time after the intervention was implemented (0 before the intervention and 1,2,3,... following the intervention), and finally, ϵ_t is the error term (Fretheim et al., 2015).

Usual regression methods such as Ordinary Least Squares can be used in segmented regression. However, as the data is time series, these methods may not be sufficient as the data can be autocorrelated and/or seasonal (Nistal-Nuño, 2017). To account for seasonality, the following model can be used:

$$Y_t = \beta_0 + \beta_1 Time + \beta_2 Intervention + \beta_3 Time\ after\ intervention + \beta_4 Month + \epsilon_t$$

Where $Month$ is a factor, therefore will have a coefficient estimate for each month of the year (Nistal-Nuño, 2017). Using month as a factor variable will decrease the number of degrees of freedom as month will add a further 12 parameters to the model, totalling the number of parameters in the model to 15. Given that there are 26 monthly data points, this reduces the degrees of freedom to 10, which could lead to over parametrisation. However, given that month is a strong predictor of asthma medical contacts it was important to have month as a factor. It has also been shown that for OLS linear regression, only two data points are needed to adequately estimate one parameter coefficient (Austin and Steyerberg, 2015), which this model is just shy of. With this in mind, it was believed that over parametrisation would not be an issue. There are various other methods to account for autocorrelation such as, fitting an ARIMA time series model. However, after accounting for seasonality, autocorrelation was not an issue in the PLEASANT data.

The F-test was used to determine whether the model including the intervention effect (Alternative Model) was a better fit for the data compared to the model which just included time (Null Model). The test would determine whether the intervention had an effect or whether the data can be simply modelled by time.

$$\begin{aligned} \text{Null} : Y_t &= \beta_0 + \beta_1 Time + \epsilon_t \\ \text{Alternative} : Y_t &= \beta_0 + \beta_1 Time + \beta_2 Intervention + \beta_3 Time\ after\ intervention + \epsilon_t \end{aligned}$$

The F-Statistic can be used for the F-test. The F-statistic was calculated using the following formula:

$$F = \frac{\left(\frac{RSS_1 - RSS_2}{DF_1 - DF_2}\right)}{\left(\frac{RSS_2}{DF_2}\right)}$$

Where RSS_1 and DF_1 are the residual sum of squares and degrees of freedom for the null model and RSS_2 and DF_2 for the alternative model. The F-Statistic was compared to the critical value of the F-Distribution, $F_{(DF_1 - DF_2, DF_2)}$. If the value was less than the critical value, then there was no evidence to suggest the alternative model was better at modelling the data compared to the null. The p-value for the F-test was calculated using the 'pf' function in R. The significance level was set to 0.05.

Two types of ITS were used in the analysis, single arm and controlled arm. Single arm was conducted on the intervention arm only, and controlled arm uses both arms. Single arm is the standard method of ITS as it is common to use ITS when there is no control arm. ITS is often used to investigate how an intervention, such as a change in law or policy, impacts on the population (McDowall, 1980; Bernal et al., 2017). However, controlled armed ITS allows for a comparision between the intervention arm and the control arm if one is available. The paper by Fretheim et al. (2015) shows the importance of testing with the control arm. The changes seen after the intervention could be due to population changes. These changes would been seen in the control and intervention arm, and could have been missed if it was analysed as a single arm ITS.

Conducting controlled armed ITS is relatively simple. This analysis involves taking the difference between the control and the intervention at each time point, leading to a new time series of the differences. This series is then analysed using the methods previously discussed. This will account for any similarities in the intervention and the control (Fretheim et al., 2013). Table 7.1 shows when a positive or a negative value for the intervention coefficient suggests the intervention had worked for the endpoints and analyses used in the study.

Endpoint	Single arm ITS	Control arm ITS
Prescription	Positive good	Negative good
Unscheduled	Negative good	Positive good
Relevant	Negative good	Positive good

Table 7.1: How to interpret the different ITS results

The intervention was sent out at the end of July/start of August, the start of the school holidays, with the intention of reducing contacts after the summer holidays. This implies that there will be a lag from the time the intervention was sent to when it is likely to have an affect. Wagner et al. (2002) provides two methods to account for the lag. Either the data within the lag can be removed, or provided there are enough data points, the lag period can be classified as another segment. There are different views on the number of time points a segment should contain for it to be reliable for analysis. Some researchers say 6 points (Fretheim et al., 2015), whereas others say 12 (Wagner et al., 2002). They also suggest a minimum value of 100 at each time point (Wagner et al., 2002). Both these conditions are satisfied with the PLEASANT data as the data was collected for 2 years, 12 months pre and post intervention. However, the lag period is only one time point (August 2013) which is not sufficient to be modelled as a separate section, therefore this period will be removed for the analysis. For the prescription analysis, as the intervention aimed at increasing prescription in August, no time points will be removed for this analysis. As the data was not powered for conducting ITS, the ITS analyses took an exploratory approach. However, if a result was considered significant at 5 % then this was stated in the table with '*'.

Clustering of the data does not need to be accounted for as the analysis is done at the top aggregate level.

To assess how the intervention worked within different subgroups, the analysis can be conducted on each group separately (Wagner et al., 2002).

The PLEASANT data is available for daily, weekly and monthly counts for medical contacts, but only available in months for prescriptions. However, given the intervention aimed at decreasing contacts in the month of September and for consistency in analyses, monthly data were used for the ITS analysis. Also, monthly counts satisfied the requirement of at least 100 at each time point.

7.5 Subgroups Intervention Analysis - Original PLEASANT Methods

7.5.1 Prescription Analysis

This section presents the prescription analysis for August 2013, looking at the intervention effect on the various subgroups.

Logistic Regression

The results of the logistic regression model are presented in Table 7.2. Results show that for all subgroups the intervention had a positive affect, increasing the odds of picking up a prescription in August 2013 on the intervention arm compared to control. All these results are potentially clinically important.

Subgroup	*Dependent variable:*
Allocation (Letter)	Aug 13
Female (n=3497)	1.08 (0.85, 1.37)
Male (n=5237)	1.44 (1.20, 1.72)
Primary (n=4314)	1.43 (1.14, 1.78)
Secondary (n=4420)	1.43 (1.18, 1.73)
Primary Female (n=1660)	1.50 (1.12, 2.03)
Primary Male (n=2654)	1.34 (1.02, 1.76)
Secondary Female (n=1837)	1.31 (0.96, 1.79)
Secondary Male (n=2583)	1.48 (1.19, 1.85)
Change School (n=841)	1.44 (0.93, 2.24)
Previous Sept (n=4265)	1.35 (1.10, 1.65)

Table 7.2: Logistic regression for prescription contacts for the different subgroups presenting odds ratios and 95 % confidence intervals

7.5.2 Unscheduled Medical Contacts

The intervention aimed to decrease the number of unscheduled medical contacts in September 2013 following the return to school after the summer break. Those on the letter arm should be less likely to have a medical contact in September.

7.5.2.1 Logistic Regression

Logistic regression was used to analyse whether the intervention decreased the odds of having an unscheduled medical contact in the various subgroups. The results are presented in Table 7.3. The results show that for all subgroups, the odds of having a medical contact in September 2013 are slightly higher in the letter arm. This result is echoed in the interval September - December 2013 for most subgroups, however, for the children who changed school, the odds decreased on the letter arm. Children who changed from primary school to secondary school were less likely to have a medical contact in September - December 2013 if they were on the letter arm.

The results for September 2013 - August 2014 are less consistent. Females, primary school children, primary females, primary males, children who change school and those who had an unscheduled contact in September 2012 were less likely to have a contact in that time period if they were on the letter arm compared to the control. The remaining subgroups: Males, secondary school children, secondary females, and secondary males were more likely to have an unscheduled contact if they were on the letter arm compared to the control. The majority of these results are potentially clinically important.

Subgroup	*Dependent variable:*		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Allocation (Letter)	(1)	(2)	(3)
Female	1.10	1.08	0.85
(n=3535)	(0.89, 1.35)	(0.84, 1.39)	(0.62, 1.17)
Male	1.13	1.18	1.02
(n=5314)	(0.97, 1.33)	(1.01, 1.39)	(0.83, 1.25)
Primary	1.09	1.12	0.79
(n=4369)	(0.92, 1.31)	(0.93, 1.34)	(0.62, 0.99)
Secondary	1.14	1.14	1.16
(n=4480)	(0.96, 1.35)	(0.92, 1.42)	(0.89, 1.52)
Primary Female	1.08	1.09	0.63
(n=1677)	(0.82, 1.41)	(0.79, 1.50)	(0.40, 0.99)
Primary Male	1.10	1.15	0.89
(n=2692)	(0.91, 1.32)	(0.95, 1.40)	(0.66, 1.18)
Secondary Female	1.08	1.01	1.14
(n=1858)	(0.87, 1.35)	(0.76, 1.34)	(0.77, 1.69)
Secondary Male	1.17	1.22	1.19
(n=2622)	(0.97, 1.41)	(0.96, 1.54)	(0.85, 1.66)
School Change	1.10	0.81	0.88
(n=853)	(0.83, 1.45)	(0.55, 1.20)	(0.49, 1.56)
Previous Sept	1.03	1.10	0.91
(n=4997)	(0.88, 1.22)	(0.88, 1.37)	(0.68, 1.20)

Table 7.3: Logistic regression for all unscheduled medical contacts for the different subgroups presenting odds ratios and 95 % confidence intervals

7.5.2.2 Negative Binomial Regression

Negative binomial was used to analyse whether the intervention decreased the number of contacts for the various subgroups. The results are presented in Table 7.4.

The results show that for unscheduled contacts in September 2013, being male, primary male, secondary male and having a previous September contact reduced the number of contacts in September 2013 if they were on the letter arm. For female, primary school children, secondary school children, primary female, secondary female and changing school, being on the letter increases the number of contacts compared to the control arm.

For September - December 2013, most of the subgroups there is a decrease in the number of medical contacts if on the letter arm. However, being female, secondary school child or secondary female, increased the number of contacts on the letter arm.

The results for September 2013 - August 2014 are similar to those for September - December 2013. However, primary school female also increased the number of contacts in that time period and secondary school children decreased the number of contacts.

Subgroup	*Dependent variable:*		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Allocation (Letter)	(1)	(2)	(3)
Female	1.09	1.01	1.03
(n=3535)	(0.96, 1.24)	(0.92, 1.10)	(0.96, 1.09)
Male	0.99	0.97	0.94
(n=5314)	(0.89, 1.11)	(0.90, 1.03)	(0.90, 0.99)
Primary	1.02	0.96	0.97
(n=4369)	(0.91, 1.15)	(0.90, 1.03)	(0.92, 1.02)
Secondary	1.05	1.01	0.98
(n=4480)	(0.93, 1.18)	(0.93, 1.09)	(0.93, 1.05)
Primary Female	1.04	0.99	1.04
(n=1677)	(0.90, 1.22)	(0.89, 1.09)	(0.96, 1.12)
Primary Male	0.99	0.94	0.93
(n=2692)	(0.87, 1.12)	(0.87, 1.01)	(0.88, 0.99)
Secondary Female	1.11	1.01	1.01
(n=1858)	(0.95, 1.31)	(0.90, 1.13)	(0.93, 1.10)
Secondary Male	0.99	0.99	0.96
(n=2622)	(0.86, 1.15)	(0.91, 1.10)	(0.90, 1.03)
Change School	1.02	0.91	0.95
(n=853)	(0.83, 1.25)	(0.77, 1.07)	(0.85, 1.05)
Previous Sept	0.99	0.98	0.98
(n=4997)	(0.89,1.10)	(0.90, 1.07)	(0.90, 1.05)

Table 7.4: Negative binomial regression for all unscheduled medical contacts for the different subgroups presenting incidence rate ratios and 95 % confidence intervals

7.5.3 Any Relevant Medical Contacts

Similar analyses were conducted on the endpoint variable any relevant medical contacts.

7.5.3.1 Logistic Regression

Table 7.5 shows the results of the logistic regression model for relevant medical contacts. The results show that for September 2013, being on the letter arm decreases the odds of having a relevant medical contact for females, secondary school, secondary females and those changing school. The remaining subgroups increase the odds. The results are echoed for September - December 2013.

For September 2013 - August 2014, being on the letter arm decreases the odds of a relevant medical contact for most of the subgroups. However, for secondary school children, secondary males and secondary females, the odds of a relevant medical contact are increased if they are on the letter arm. The majority of these results are potentially clinically important.

Subgroup	*Dependent variable:*		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Allocation (Letter)	(1)	(2)	(3)
Female	0.96	0.99	0.78
(n=3535)	(0.74, 1.25)	(0.76, 1.29)	(0.53, 1.15)
Male	1.05	1.15	0.95
(n=5314)	(0.81, 1.37)	(0.94, 1.40)	(0.75, 1.21)
Primary	1.07	1.20	0.78
(n=4369)	(0.82, 1.38)	(0.94, 1.52)	(0.58, 1.06)
Secondary	0.98	0.98	1.02
(n=4480)	(0.76, 1.27)	(0.77, 1.26)	(0.73, 1.43)
Primary Female	1.06	1.14	0.61
(n=1677)	(0.76, 1.46)	(0.80, 1.62)	(0.36, 1.04)
Primary Male	1.07	1.22	0.90
(n=2692)	(0.82, 1.41)	(0.95, 1.57)	(0.65, 1.25)
Secondary Female	0.88	0.85	1.03
(n=1858)	(0.66, 1.17)	(0.63, 1.16)	(0.66, 1.61)
Secondary Male	1.08	1.08	1.05
(n=2622)	(0.81, 1.44)	(0.82, 1.42)	(0.67, 1.63)
Change School	0.99	0.79	0.82
(n=853)	(0.72, 1.36)	(0.50, 1.24)	(0.43, 1.57)
Previous Sept	1.04	1.10	0.82
(n=4997)	(0.80, 1.34)	(0.88, 1.38)	(0.60, 1.13)

Table 7.5: Logistic regression for any relevant medical contacts for the different subgroups presenting odds ratios and 95 % confidence intervals

7.5.3.2 Negative Binomial Regression

The results for the negative binomial model for relevant medical contacts can be found in Table 7.6. The results show that being on the letter arm decreases the number of contacts in September 2103 for most subgroups except for females, primary females and secondary females.

The results for September - December 2013 are consistent, being on the letter arm decreases the number of contacts in that time period for all the subgroups. The results are similar for September 2013 - August 2014, however being on the letter arm increases the number of contacts for primary school females.

Subgroup	*Dependent variable:*		
	Sept 13	Sept - Dec 13	Sept 13 - Aug 14
Allocation (Letter)	(1)	(2)	(3)
Female	1.03	0.96	0.99
(n=3535)	(0.89, 1.18)	(0.88, 1.05)	(0.94, 1.06)
Male	0.95	0.94	0.93
(n=5314)	(0.83, 1.04)	(0.87, 1.01)	(0.89, 0.97)
Primary	0.99	0.95	0.95
(n=4369)	(0.87, 1.13)	(0.88, 1.02)	(0.90, 1.01)
Secondary	0.98	0.95	0.96
(n=4480)	(0.85, 1.13)	(0.87, 1.04)	(0.90, 1.02)
Primary Female	1.03	0.97	1.01
(n=1677)	(0.87, 1.21)	(0.88, 1.06)	(0.94, 1.09)
Primary Male	0.96	0.94	0.93
(n=2692)	(0.83, 1.11)	(0.87, 1.01)	(0.88, 0.98)
Secondary Female	1.01	0.94	0.99
(n=1858)	(0.86, 1.19)	(0.85, 1.05)	(0.91, 1.08)
Secondary Male	0.95	0.95	0.94
(n=2622)	(0.80, 1.13)	(0.86, 1.05)	(0.88, 1.00)
Change School	0.95	0.88	0.93
(n=853)	(0.78, 1.16)	(0.76, 1.03)	(0.84, 1.03)
Previous Sept	0.99	0.98	0.97
(n=4997)	(0.88, 1.12)	(0.90, 1.06)	(0.90, 1.05)

Table 7.6: Negative binomial regression for any relevant medical contacts for the different subgroups presenting incidence rate ratios and 95 % confidence intervals

7.5.4 Discussion

The analysis for this section looked at the intervention effect for the various subgroups that were considered to be at a higher risk of medical contacts following the return to school. The intervention had the potential to work better within these groups as they were at higher risk of having a contact in the first place.

The first analysis looked at prescription uptake in August 2013 after the intervention was sent. The results showed that for the all the subgroups the odds of picking up a prescription were potentially increased.

The next endpoint that was analysed was unscheduled medical contacts. PLEASANT's intervention aimed to decrease the number of unscheduled contacts after the return to school, however for the full dataset this was not achieved. As discussed previously in Chapter 4, the intervention increased the number of unscheduled contacts. This subgroup analysis looked to see whether the intervention worked better in any of the subgroups.

The logistic regression results showed that for unscheduled contacts in September 2013 all the children within the subgroups who were on the letter arm had a potential increased risk of a medical contact. The results were similar for the negative binomial results, however for males, primary males, secondary males, and those who had a previous medical contact the odds of having a contact were less for those on the letter arm. This could suggest that males are more likely to respond to the intervention letter or that males have their asthma under more control than females.

The results were similar for the extended endpoint September - December 2013. However, for children who changed from primary to secondary school during the PLEASANT trial their effect estimate suggested a potential decrease in medical contacts in September - December 2013. This could suggest that children who are preparing to go to secondary school for the first time may have taken more precautions compared to other children and responded to the letter. These children may have continued taking their medication throughout the summer so that when they started their new school they were more protected and had less medical contacts. For the negative binomial regression, most of the subgroups showed a potential decrease in medical contacts within September - December 2013 except for females, secondary females and secondary school children. These children had an increase in contacts if they were on the letter arm. This could relate back to the qualitative work (Chapter 5), that older females are more anxious of there asthma, the letter could have caused them to worry more, which led to more contacts.

The results were less consistent for the time interval September 2013 - August 2014. It was found that being on the letter arm could decrease the odds of a medical contacts for most of the subgroups. This is consistent with the original results

(Chapter 4), the intervention had more of an effect in the year following, rather than immediately after the intervention was sent. However, there were some subgroups where the intervention still increased the odds of a medical contact: males, secondary school children, secondary males and secondary females. The results for the negative binomial model were different and it was females, primary females and secondary females who were more likely to have more medical contacts on the intervention. Males are more likely to have at least one contact whereas females are more likely to have multiple contacts.

The last analysis looked at the intervention effect on relevant medical contacts in the various subgroups. The logistic regression results showed that in September 2013 females, secondary school, secondary females and those who changed school were potentially less likely to have a medical contacts on the letter arm compared to those on the no letter arm, the other groups showed an increased odds of contacts. These results were echoed in September - December 2013. September 2013 - August 2014 showed slightly different results. Most groups on the letter arm showed a decreased odds of a medical contact apart from females, males, primary school, primary female, change in school and previous September.

The logistic regression results were not echoed in the negative binomial regression results. The negative binomial results suggested that all subgroups apart from females, primary females and secondary females could have potentially experienced less contacts on the letter arm in September 2013. In general, for the extended endpoints, all subgroups were more likely to have less contacts on the letter arm compared to the no letter arm.

7.6 Interrupted Time Series - Complete Data

This section of the intervention analysis chapter presents the ITS analysis of the complete data set (Method described in Section 7.4.1). This analysis was not done in the original PLEASANT analysis, hence why ITS is being conducted on the full data as well as the subgroups (Section 7.7). ITS analysis takes into account the time nature of the data which was not done in the original PLEASANT analysis as discussed in Section 4.6.1. ITS analysis was conducted on the prescription data, unscheduled medical contacts and all relevant medical contacts. Both single arm and controlled arm ITS were conducted.

For this chapter there are a number of plots showing number of contacts on the (y-axis) against month (x-axis) and the ITS models. Month is labelled 0-25 on the x-axis, where the starting month is August 2012. For the single arm ITS, the graph shows the OLS model for the intervention arm (solid line) and the control arm (dashed line). For the controlled arm there is only one model plotted which is the OLS model for the difference between the control and the intervention. The data points are the intervention arm data before (black) and after (red) the intervention. The red dashed vertical line indicates the month the intervention would have an affect, August for prescriptions and September for medical contacts.

7.6.1 Prescription Analysis

7.6.1.1 Single Arm ITS

This section presents the analysis for the single arm ITS linear OLS model. Figure 7.1 shows that the control arm was lower than the intervention arm in general. The plot also shows that for the intervention arm there was a dip in the number of contacts where a prescription was picked up after the intervention was sent.

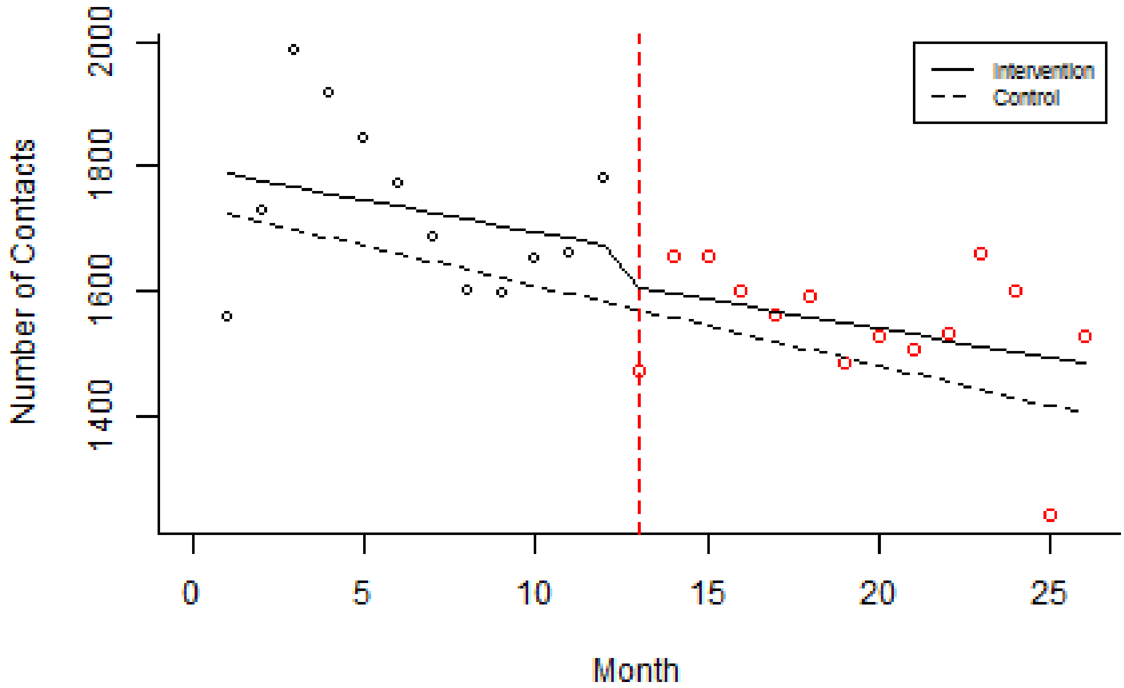


Figure 7.1: Single arm ITS de-seasonalised OLS model for prescription contacts

Table 7.7 presents the OLS model results. The coefficient for time is negative, which suggests a decreasing trend before the intervention was sent. The value for the intervention was -58.868, which suggests a a decrease in the level change immediately after the intervention was sent. Time after the intervention is positive which indicates an increasing trend after the intervention was sent. The F-statistic was 0.207 which was not significant when compared to the null model. There is no evidence to suggest that the alternative model is better at modelling the data compared to the null model, suggesting that the intervention did not have an effect on the number of contacts where a prescription was picked up.

	Dependent variable:
	Number of Contacts
Time	−10.35 (−29.79, 9.08)
Intervention	−58.87 (−240.91, 123.17)
Time after Intervention	0.91 (−23.89, 25.72)
Constant	1,797.55 (1,654.51, 1,940.58)
Observations	26
F-statistic (p-value)	0.207 (0.814)

Table 7.7: Single arm segmented regression analysis for prescription medical contacts

Seasonality

The previous analysis did not take into account the seasonality of the data. To do this, a dummy variable for each month was included in the model. Figure 7.2 shows the seasonal OLS model for the single arm ITS for the intervention and the control. The control arm has fewer contacts in general but the fits are similar in shape.

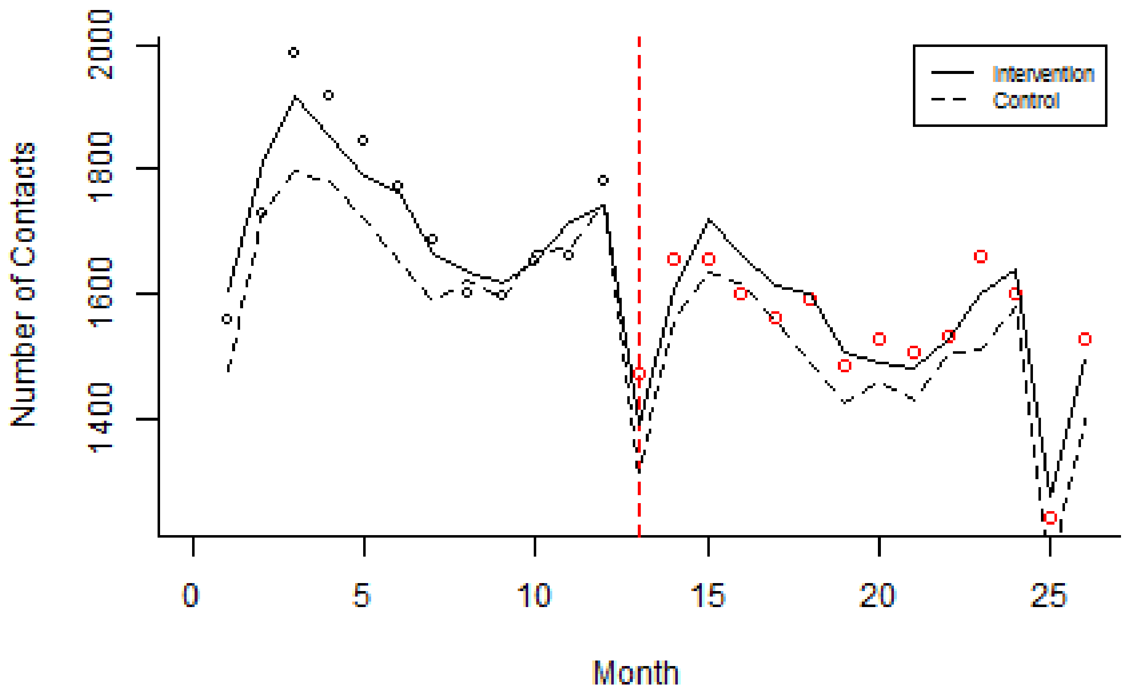


Figure 7.2: Single arm ITS seasonal OLS model for prescription contacts

Table 7.8 presents the results for the seasonal OLS model for the single arm ITS analysis. Time suggested that there was a decreasing the trend before the intervention was sent out. The intervention value was now positive, 9.368, which suggests an increase in the level change for the number of contacts for prescriptions immediately after the intervention was sent. Time after intervention was also positive, which suggests that there was an increasing trend after the intervention was sent. Most months showed a decrease in contacts compared to January apart from June, July, October, November, and December. The F-statistic was 0.743, which was not significant. There is no evidence to suggest that the alternative model with the intervention is better at modelling the data compared to the null model, implying that the intervention did not have an effect.

	Dependent variable:
	Number of Contacts
Time	−19.64 (−36.66, −2.63)
Intervention	9.37 (−150.02, 168.76)
Time after Intervention	10.21 (−6.64, 27.05)
Feb	−81.96 (−224.96, 61.04)
March	−89.42 (−233.84, 54.99)
April	−88.38 (−235.13, 58.37)
May	−32.34 (−182.29, 117.61)
June	49.20 (−104.78, 203.17)
July	94.74 (−64.02, 253.49)
Aug	−257.43 (−390.53, −124.33)
Sept	−30.92 (−163.08, 101.23)
Oct	94.38 (−52.37, 241.13)
Nov	47.92 (−96.49, 192.34)
Dec	6.46 (−136.54, 149.46)
Constant	1,881.91 (1,736.06, 2,027.75)
Observations	26
F-statistic (p-value)	0.743 (0.498)

Table 7.8: Single arm segmented regression analysis for prescription medical contacts adjusting for seasonality

7.6.1.2 Controlled Arm ITS

The previous analysis was on the single arm ITS which does not take into account the control arm. The controlled arm ITS takes into account the control arm to analyse whether the intervention did have an affect or whether it was a just a time trend. Figure 7.3 shows the de-seasonalised OLS model for the controlled arm ITS. The plot shows that after the intervention was sent, there was a decrease in the difference in the number of contacts on the control and intervention. As the difference was calculated as control - intervention, a negative value suggests that there were more contacts on the intervention arm compared to the control arm.

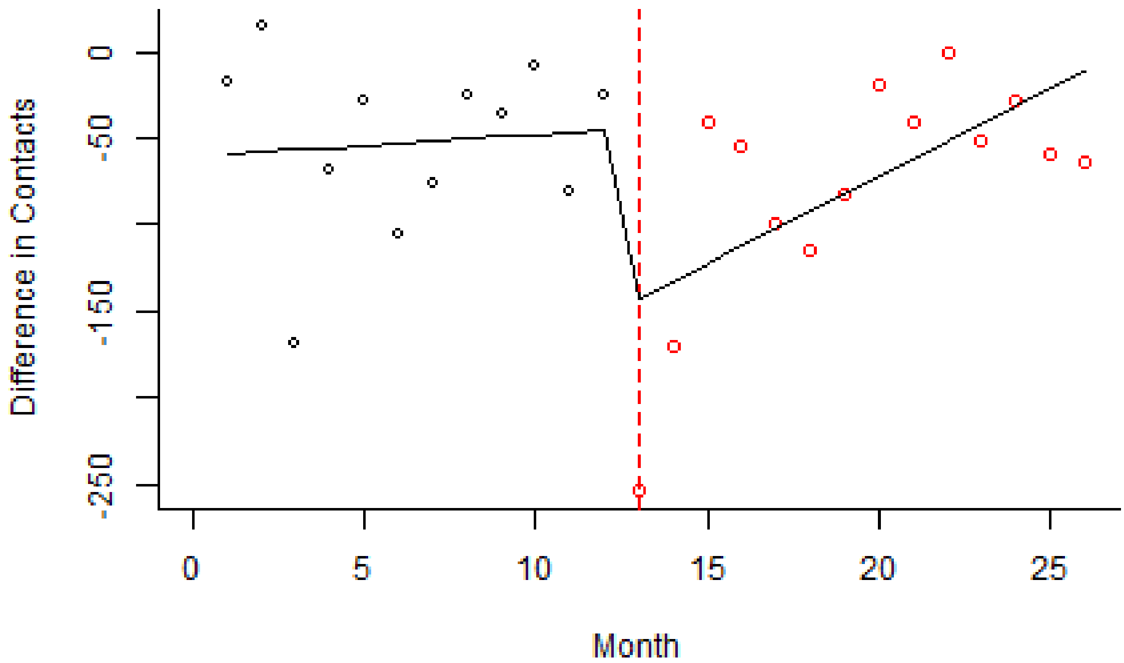


Figure 7.3: Controlled arm ITS de-seasonalised OLS model for prescription contacts

Table 7.9 presents the results for the de-seasonalised OLS controlled arm ITS analysis. Time is positive which suggests that the trend before the intervention increases so the difference between the control and the intervention is getting smaller. The value for the intervention level change is -107.828. This decrease suggests that there was a difference in the level change between the intervention arm and the control arm, with the intervention arm having more contacts picking up prescriptions. The time after intervention value is positive. The value suggests that the difference trend between the control and the intervention is decreasing over time. The F-statistic is 4.833 which is significant. There is evidence to suggest that the alternative model, with the intervention, models the data better than the null model.

	Dependent variable:
	Number of Contacts
Time	1.31 (−7.41, 10.03)
Intervention	−107.83 (−189.52, −26.13)
Time after Intervention	8.81 (−2.32, 19.94)
Constant	−60.94 (−125.13, 3.25)
Observations	26
F-statistic (p-value)	4.833 (0.018)*

Table 7.9: Controlled arm segmented regression analysis for prescription medical contacts

Seasonality

Figure 7.4 shows the seasonal OLS model for the controlled arm ITS model. There is a dip after the intervention which suggests that there were more contacts on the intervention arm compared to the control arm.

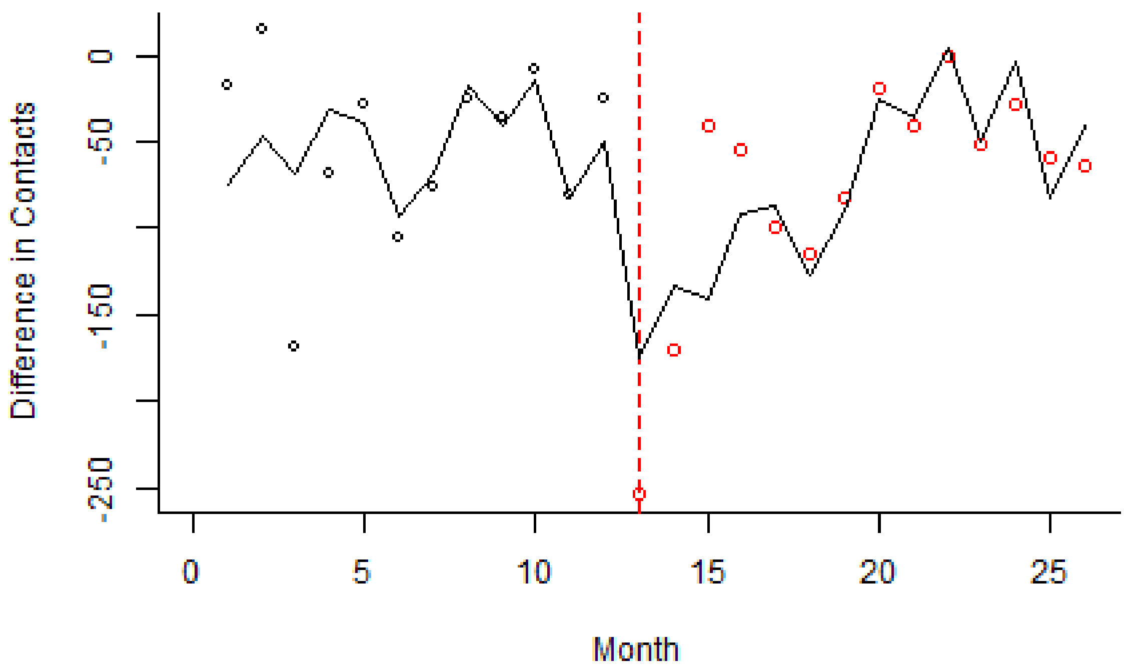


Figure 7.4: Controlled arm ITS seasonal OLS model for prescription contacts

Table 7.10 presents the results for the seasonal OLS controlled arm ITS. Time is negative, this suggests that the trend is decreasing, which means the difference between the control arm and the intervention is getting larger. The intervention value is -46.647. This value implies that there is a difference in the level change between the intervention and control arm, with more on the intervention arm. The time after intervention is positive 13.159. The positive value implies that the trend after the intervention is increasing, so the difference is decreasing. All months have a positive increase compared to January, apart from August. The F-statistic is 2.563, which is not significant. There is no evidence to suggest the alternative model is better at modelling the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	−5.51 (−19.75, 8.73)
Intervention	−46.65 (−180.06, 86.76)
Time after Intervention	13.16 (−0.94, 27.26)
Feb	29.93 (−89.76, 149.62)
March	86.36 (−34.51, 207.24)
April	68.80 (−54.03, 191.62)
May	101.23 (−24.28, 226.74)
June	39.16 (−89.72, 168.03)
July	77.09 (−55.78, 209.96)
Aug	−8.81 (−120.22, 102.59)
Sept	24.93 (−85.69, 135.54)
Oct	8.70 (−114.12, 131.53)
Nov	51.64 (−69.24, 172.51)
Dec	48.07 (−71.62, 167.76)
Constant	−60.52 (−182.59, 61.56)
Observations	26
F-statistic (p-value)	2.563 (0.122)

Table 7.10: Segmented regression analysis for prescription medical contacts adjusting for seasonality

7.6.2 Unscheduled Medical Contacts

7.6.2.1 Single Arm ITS

This section looks at the single arm ITS for unscheduled medical contacts. Unlike the prescriptions, where an increase in contacts was considered good, for unscheduled contacts a decrease in contacts is considered good.

Figure 7.5 shows the de-seasonalised OLS model for the single arm ITS analysis for the intervention and the control. The control arm has more contacts than the intervention arm in general. The intervention model shows that there was a decrease in contacts after the intervention was sent.

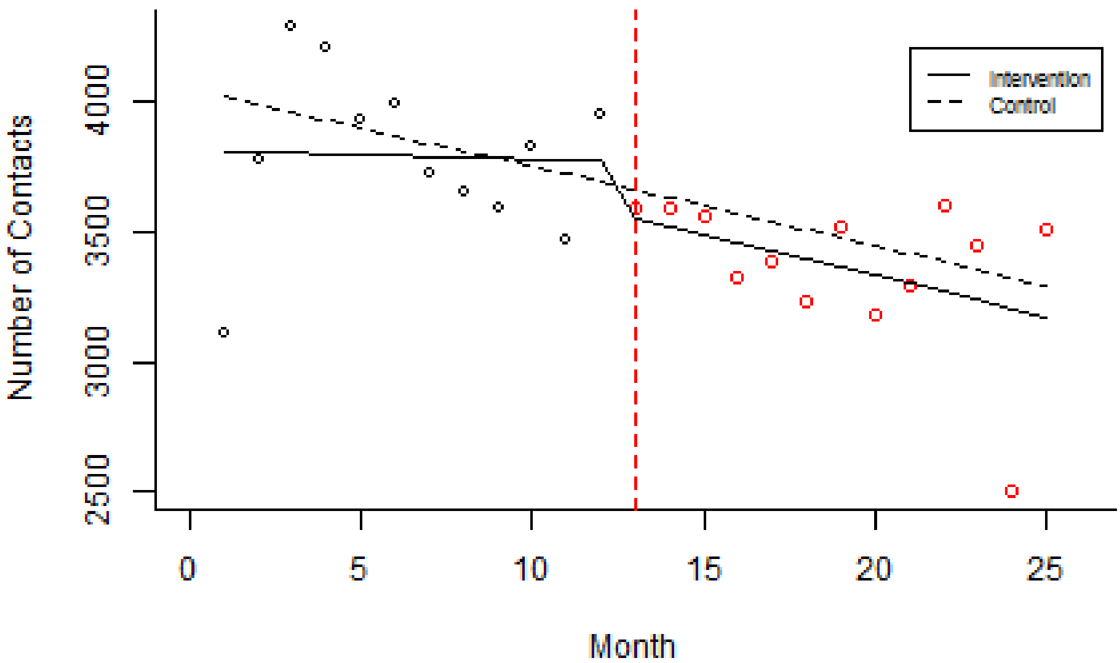


Figure 7.5: Single arm ITS de-seasonalised OLS model for unscheduled medical contacts

Table 7.11 presents the results of the seasonal OSL model for the controlled ITS. Time is negative which suggests the trend before the intervention is decreasing over time, so less contacts. Intervention value is -186.410 which suggests there is a decrease in the level change immediately after the intervention. Time after intervention is also negative which suggests a decrease in trend after the intervention. The F-statistic was 0.622 which is not significant. There is no evidence to suggest that the alternative model is better at modelling the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	−3.41 (−53.86, 47.05)
Intervention	−186.41 (−669.48, 296.66)
Time after Intervention	−28.22 (−95.64, 39.21)
Constant	3,811.47 (3,440.13, 4,182.81)
Observations	25
F-statistic (p-value)	0.622 (0.546)

Table 7.11: Single arm segmented regression analysis for unscheduled medical contacts

Seasonality

Figure 7.6 shows the seasonal OLS model for the single arm ITS analysis. The plot shows that the control arm has more contacts than the intervention arm in general. There is a dip in contacts for both arms at September.

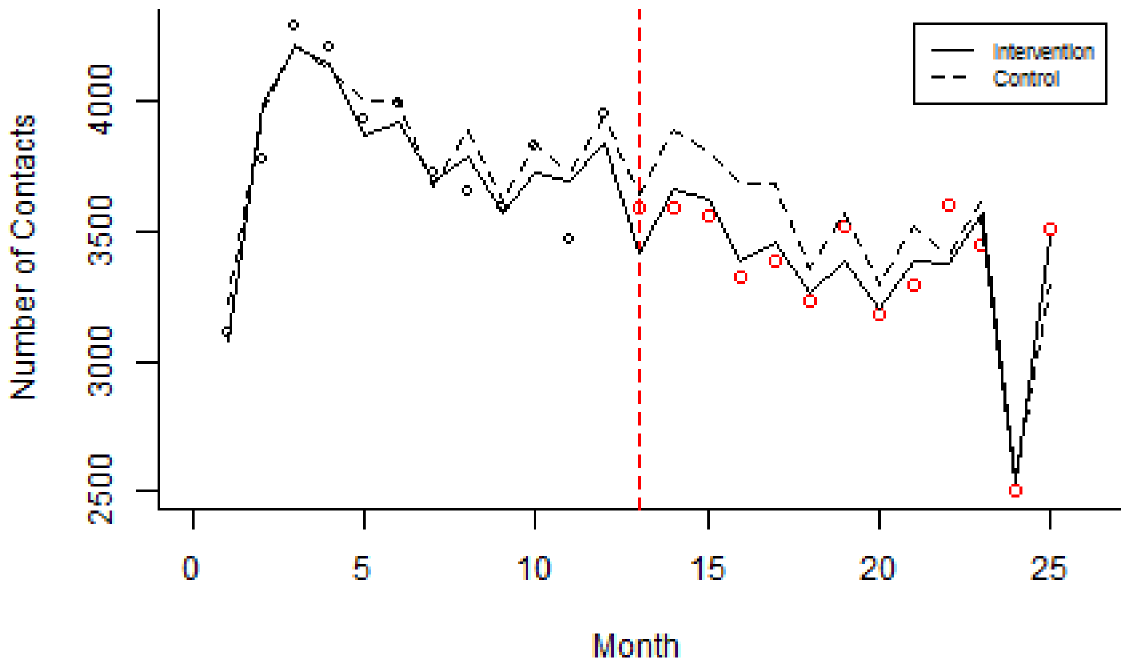


Figure 7.6: Single arm ITS seasonal OLS model for unscheduled medical contacts

Table 7.12 presents the results for the seasonal OLS model for the single arm ITS analysis. Time is negative which suggests a decreasing trend in contacts over time. Intervention is negative which suggests a decreasing level change immediately after the intervention was sent. Time after intervention is positive which suggests an increasing trend in contacts over time after the intervention. Most months have a decrease in contacts compared to January, apart from July, October and November. The F-statistic is 2.919, which is not significant; there is no evidence to suggest that the alternative model is better at modelling the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	−23.56 (−63.67, 16.54)
Intervention	−341.31 (−715.99, 33.38)
Time after Intervention	28.94 (−14.90, 72.79)
Feb	−202.41 (−538.82, 134.01)
March	−89.31 (−429.26, 250.64)
April	−278.22 (−623.98, 67.55)
May	−94.63 (−448.37, 259.12)
June	−111.03 (−474.78, 252.71)
July	61.56 (−314.04, 437.17)
Aug	−960.23 (−1,318.69, −601.77)
Sept	−26.62 (−337.90, 284.65)
Oct	217.72 (−128.05, 563.48)
Nov	174.81 (−165.14, 514.76)
Dec	−69.09 (−405.51, 267.32)
Constant	4,057.29 (3,711.76, 4,402.82)
Observations	25
F-statistic (p-value)	2.919 (0.100)

Table 7.12: Segmented regression analysis for unscheduled medical contacts adjusting for seasonality

7.6.2.2 Controlled Arm ITS

Figure 7.7 shows the de-seasonalised OLS model for the controlled arm ITS analysis. The plot shows an increase in the difference in contacts in September. As the difference was calculated as the control - intervention a positive difference suggests that there were more contacts on the control arm compared to the intervention arm. Therefore an increase in difference suggests a decrease in contacts on the letter arm.

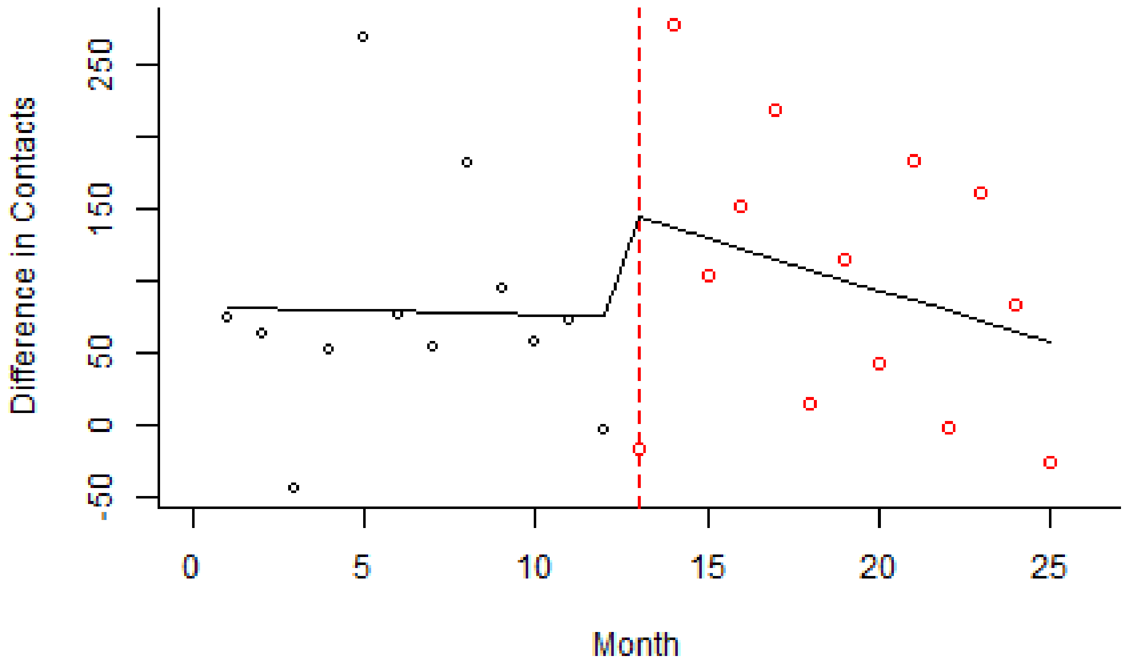


Figure 7.7: Controlled arm ITS de-seasonalised OLS model for unscheduled medical contacts

Table 7.13 presents the results of the de-seasonalised OLS model for the controlled arm ITS analysis. Time is -0.591 which suggests a very slight downward trend (decreasing difference). The intervention has a value of 75.449 which suggests an increase in level change immediately after the intervention was sent. Time after intervention is negative which suggests a downwards (decreasing difference) trend. The F-statistic is 0.761 which is not significant: there is no evidence to suggest that the alternative model is better at modelling the data compared to the null hypothesis.

	Dependent variable:
	Number of Contacts
Time	−0.59 (−15.35, 14.16)
Intervention	75.45 (−65.82, 216.72)
Time after Intervention	−6.57 (−26.29, 13.15)
Constant	82.76 (−25.84, 191.35)
Observations	25
F-statistic (p-value)	0.761 (0.480)

Table 7.13: Segmented regression analysis for unscheduled medical contacts

Seasonality

Figure 7.8 is a plot of the seasonal OLS model for the controlled arm ITS model. It is not clear from the plot the intervention effect, however it appears the difference after the intervention is slightly higher than before the intervention.

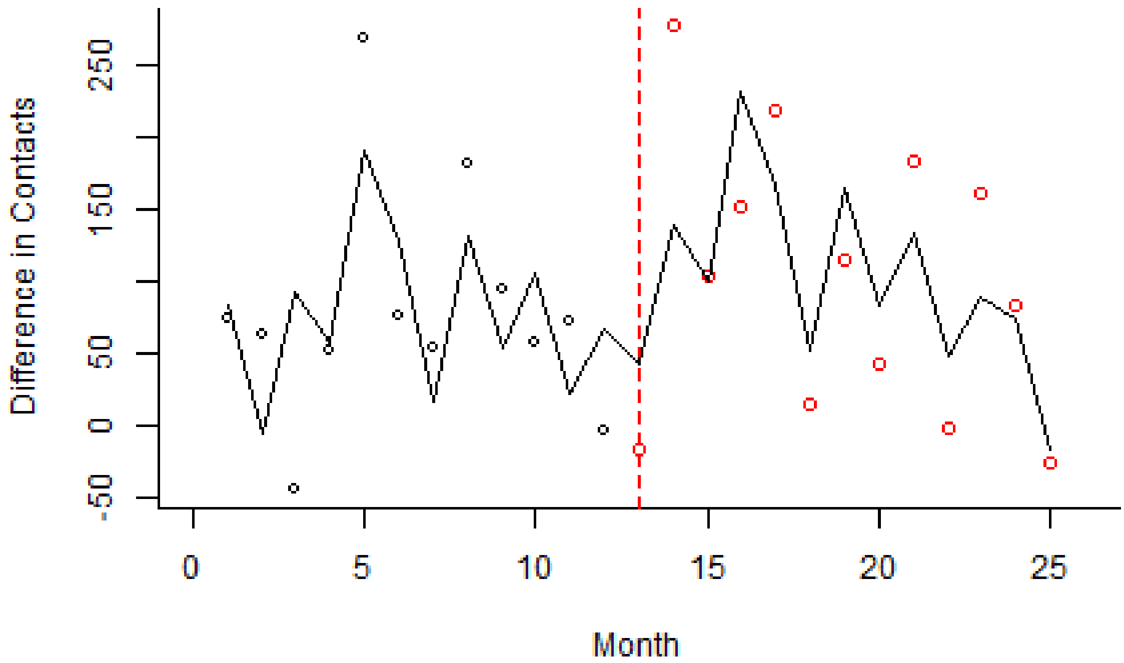


Figure 7.8: Controlled arm ITS seasonal OLS model for unscheduled medical contacts

Table 7.14 presents the results from the seasonal OLS model for the controlled arm ITS model. Time is negative which suggests there is a downwards trend in the difference in contacts before the intervention. Intervention has a value of 78.409, which suggests an increase in level change immediately after the intervention was sent. Time after intervention is negative which suggests a downward trend, a decrease in difference. Most months are negative compared to January, except for March and December.

	Dependent variable:
	Number of Contacts
Time	−2.55 (−25.35, 20.25)
Intervention	78.41 (−134.61, 291.42)
Time after Intervention	−2.45 (−27.37, 22.48)
Feb	−109.23 (−300.48, 82.03)
March	7.55 (−185.72, 200.82)
April	−67.68 (−264.25, 128.90)
May	−12.90 (−214.01, 188.21)
June	−93.63 (−300.42, 113.17)
July	−46.85 (−260.39, 166.68)
Aug	−57.38 (−261.17, 146.41)
Sept	−143.76 (−320.72, 33.21)
Oct	−42.82 (−239.40, 153.75)
Nov	−77.05 (−270.32, 116.22)
Dec	58.73 (−132.53, 249.98)
Constant	144.25 (−52.19, 340.69)
Observations	25
F-statistic (p-value)	0.312 (0.739)

Table 7.14: Segmented regression analysis for unscheduled medical contacts adjusting for seasonality

7.6.3 Any Relevant Medical Contacts

7.6.3.1 Single Arm ITS

This section presents the analysis of the single arm ITS for all relevant medical contacts. Figure 7.9 is a plot of the de-seasonalised OLS model for the single arm ITS analysis. The control arm has a similar number of contacts compared to the intervention arm. The intervention arm model shows an increase in contacts after the intervention was sent.

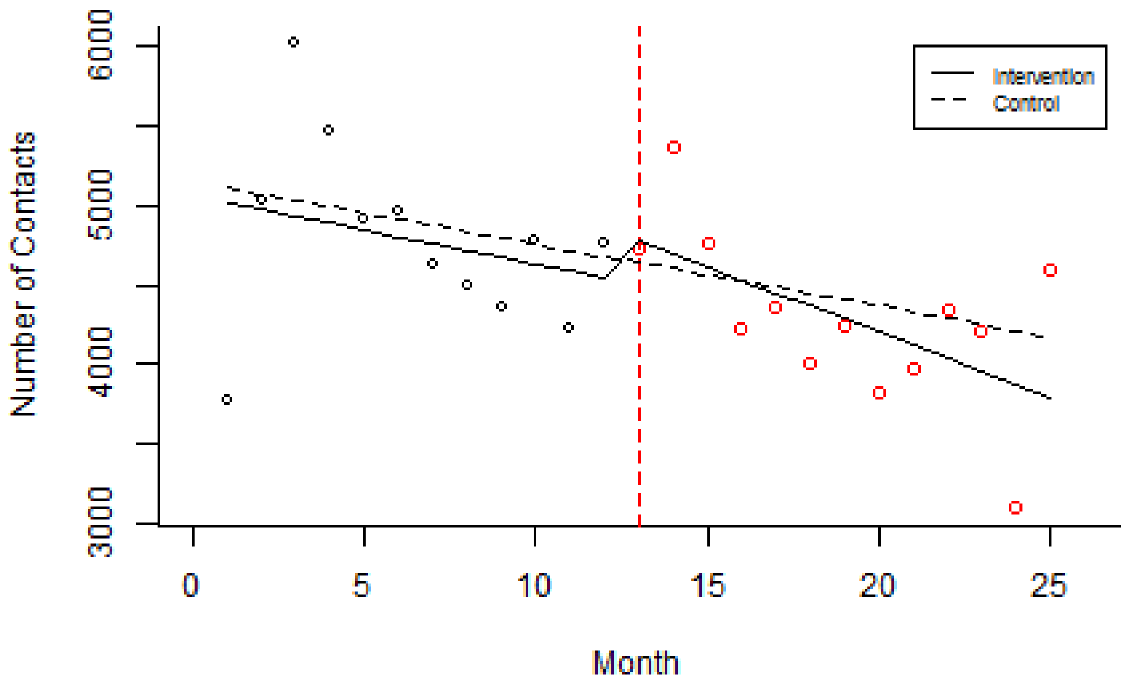


Figure 7.9: Single arm ITS de-seasonalised OLS model for relevant medical contacts

Table 7.15 presents the results for the de-seasonalised OLS model for the single arm ITS analysis. Time is negative which suggests a decrease in contacts over time. Intervention has a value of 312.090 which suggests an increase level change immediately after the intervention was sent. Time after intervention is negative again which suggests the trend is decreasing in contacts after the intervention. The F-statistic is 0.520, which is not significant, there is no evidence to suggest that the alternative model is better at modelling the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	−42.11 (−127.62, 43.41)
Intervention	312.09 (−506.66, 1,130.84)
Time after Intervention	−40.45 (−154.73, 73.83)
Constant	5,057.52 (4,428.14, 5,686.90)
Observations	25
F-statistic (p-value)	0.520 (0.602)

Table 7.15: Segmented regression analysis for all relevant medical contacts

Seasonality

Figure 7.10 is a plot of the seasonal OLS model for the single arm ITS analysis. The plot shows that there were a similar amount of contacts in both arms before the intervention and slightly more in the control after the intervention. It is not clear what effect the intervention had.

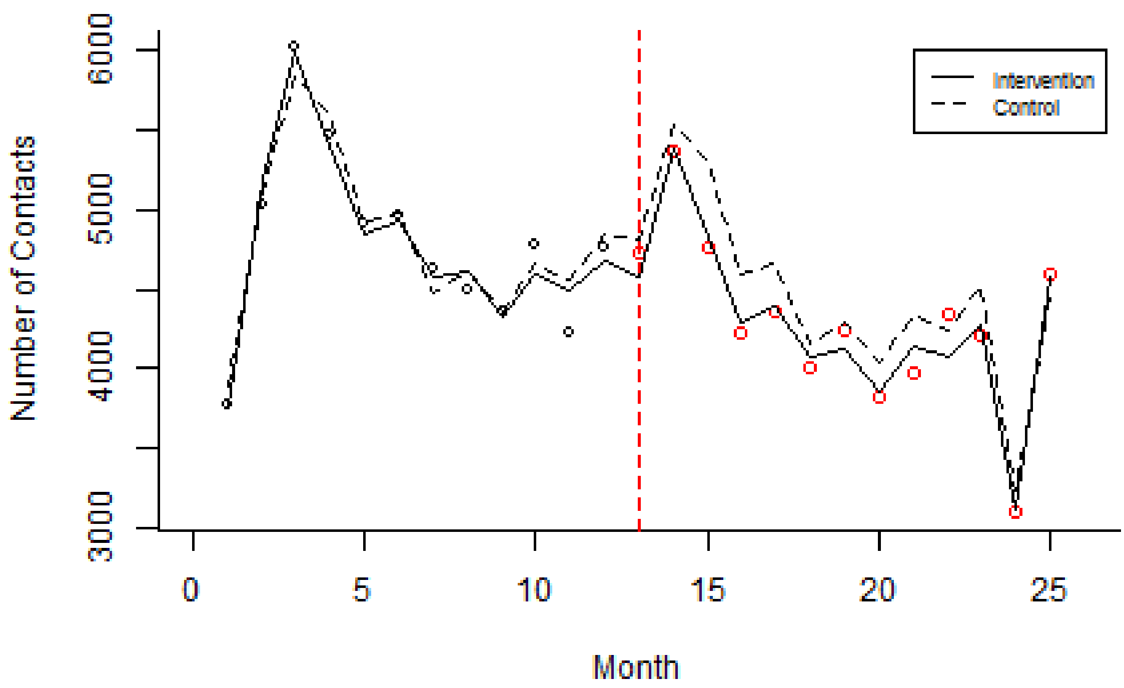


Figure 7.10: Single arm ITS seasonal OLS model for relevant medical contacts

Table 7.16 presents the results for the seasonal OLS model for the single arm ITS analysis. Time is negative which shows a decreasing trend before the intervention. Intervention value is -404.265. This value suggests that there was a decrease level change immediately after the intervention was sent. Time after intervention was positive which suggests an increasing trend after the intervention was sent. Most months are negative compared to January, except for September, October and November. The F-statistic is 2.633 which is not significant, there is no evidence to suggest that the alternative model is a better model for the data compared to the null.

	Dependent variable:
	Number of Contacts
Time	−20.56 (−63.75, 22.62)
Intervention	−404.27 (−807.71, −0.83)
Time after Intervention	19.96 (−27.25, 67.17)
Feb	−325.42 (−687.65, 36.81)
March	−265.33 (−631.37, 100.70)
April	−534.25 (−906.55, −161.96)
May	−242.17 (−623.06, 138.72)
June	−319.57 (−711.24, 72.07)
July	−113.50 (−517.93, 290.92)
Aug	−1,272.80 (−1,658.76, −886.831)
Sept	185.50 (−149.66, 520.66)
Oct	997.75 (625.46, 1,370.05)
Nov	438.83 (72.80, 804.87)
Dec	−99.58 (−461.81, 262.65)
Constant	5,046.71 (4,674.66, 5,418.75)
Observations	25
F-statistic (p-value)	2.633 (0.121)

Table 7.16: Segmented regression analysis for any relevant medical contacts adjusting for seasonality

7.6.3.2 Controlled Arm ITS

Figure 7.11 is a plot of the de-seasonalised OLS model for the controlled arm ITS analysis. The plot shows that the model increases until the intervention is sent and then flattens out after the intervention.

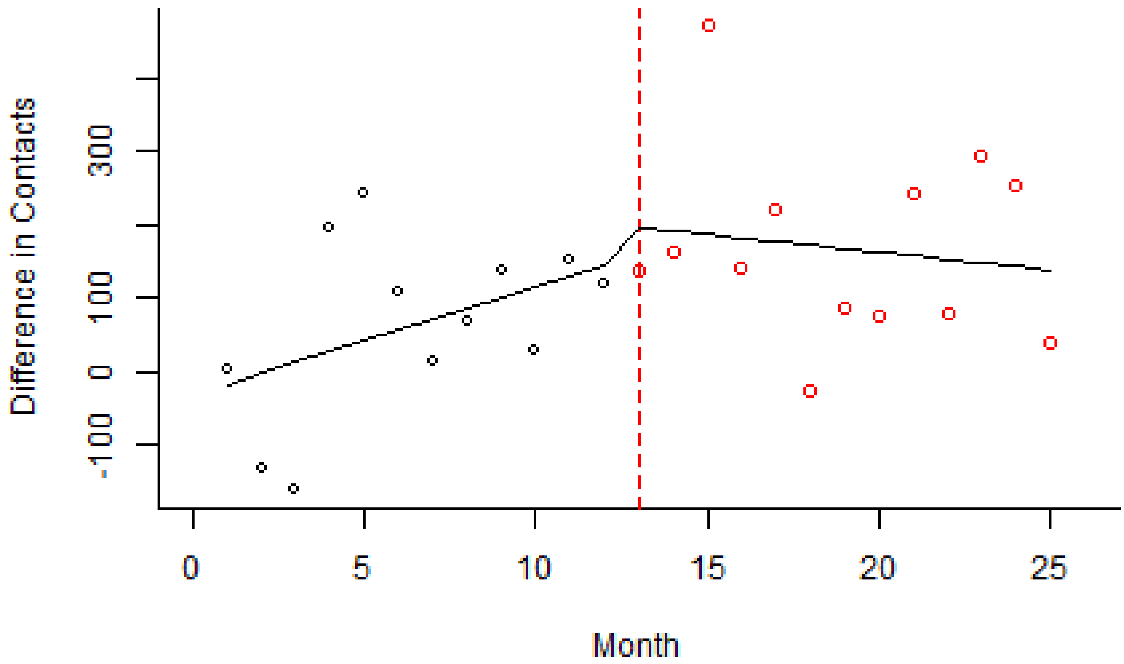


Figure 7.11: Controlled arm ITS de-seasonalised OLS model for relevant medical contacts

Table 7.17 presents the results for the de-seasonalised OLS model for the controlled arm ITS analysis. Time is positive this means the difference between the two arms is increasing. Intervention value is 55.821, which suggests an increase in level change immediately after the intervention was sent, this means there were more contacts on the control arm than the intervention arm. Time after intervention was negative which suggests that the difference is decreasing as time goes on. The F-statistic is 1.147 which is not significant, there is no evidence to suggest that the alternative model is a better model for the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	14.87 (−5.72, 35.47)
Intervention	55.82 (−141.35, 252.99)
Time after Intervention	−19.75 (−47.27, 7.77)
Constant	−32.85 (−184.41, 118.71)
Observations	25
F-statistic (p-value)	1.147 (0.338)

Table 7.17: Segmented regression analysis for any relevant medical contacts

Seasonality

Figure 7.12 is a plot of the seasonal OLS model for the controlled arm ITS analysis. The plot shows, on average, that there was a smaller difference before the intervention compared to after, however it is difficult to see the intervention affect.

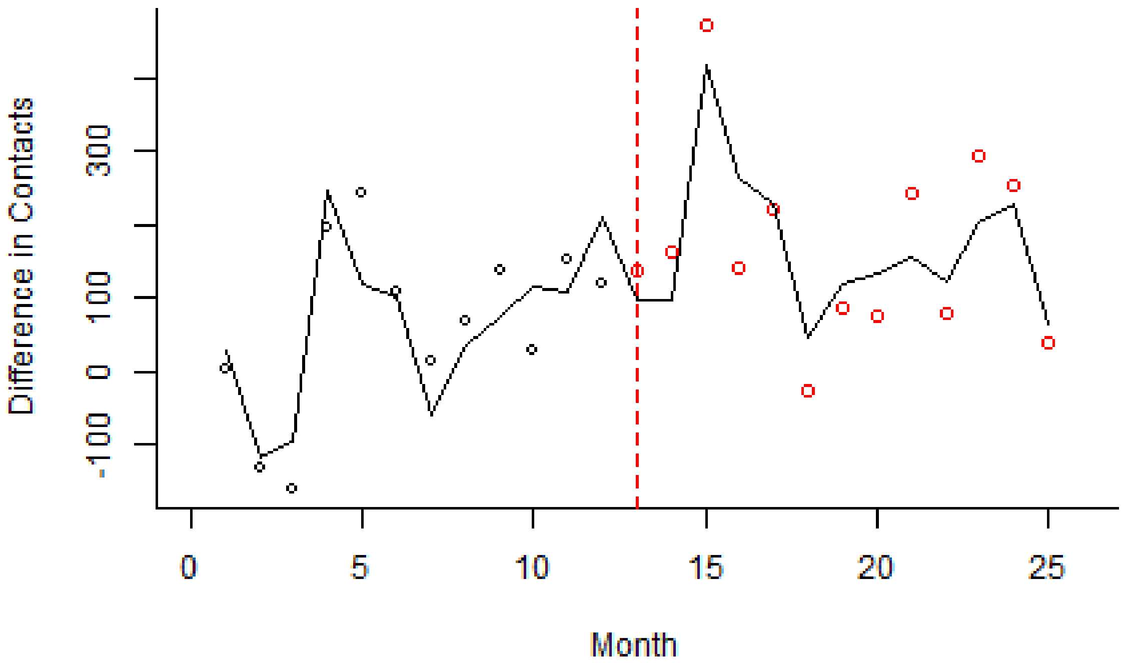


Figure 7.12: Controlled arm ITS seasonal OLS model for relevant medical contacts

Table 7.18 presents the results for the seasonal OLS model for the controlled arm ITS analysis. Time is positive which suggests a positive trend. Intervention has a value of 25.141 which shows an increase level change immediately after the intervention. Time after intervention was negative, which suggests a downward trend after the intervention was sent. Most months were negative compared to January, except for August, November and December. The F-statistic was 1.467, which is not significant, there is no evidence to suggest that the alternative model is a better model for the data compared to the null model.

	Dependent variable:
	Number of Contacts
Time	19.18 (−4.96, 43.32)
Intervention	25.14 (−200.40, 250.68)
Time after Intervention	−22.02 (−48.41, 4.38)
Feb	−179.67 (−382.17, 22.83)
March	−104.34 (−308.97, 100.29)
April	−84.51 (−292.64, 123.62)
May	−62.68 (−275.61, 150.25)
June	−90.35 (−309.30, 128.60)
July	−7.52 (−233.61, 218.57)
Aug	19.88 (−195.89, 235.65)
Sept	−142.31 (−329.68, 45.06)
Oct	−139.99 (−348.12, 68.14)
Nov	183.84 (−20.79, 388.47)
Dec	34.67 (−167.83, 237.17)
Constant	−13.08 (−221.06, 194.91)
Observations	25
F-statistic (p-value)	1.467 (0.276)

Table 7.18: Segmented regression analysis for any relevant medical contacts adjusting for seasonality

7.6.4 Discussion

The analysis in the previous section looked at using interrupted time series on the original PLEASANT data set. The methods used in the original analysis did not take into account time, ITS took this into account. Both single arm and controlled arm analyses were conducted. Each analysis used OLS regression models, with and without seasonality.

The first analysis looked at prescription contacts and whether the intervention had an effect on this. The single arm de-seasonalised model showed that the intervention decreased the number of prescription contacts the children had after the intervention was sent. After taking into account the seasonality of the data, the direction of the intervention effect changed, suggesting more contacts immediately after the intervention. However, the single arm analysis does not take into account the control arm. The controlled arm de-seasonalised model showed a decreased difference in contacts immediately after the intervention was sent. The coefficient for the intervention was negative which means there were more contacts on the intervention arm compared to the control arm. This negative effect was still seen after taking into account seasonality.

The next analysis was on unscheduled medical contacts, unlike the prescription analysis, the intervention aimed to reduce contacts. The de-seasonalised model showed a decrease in contacts immediately following the intervention. The seasonal model showed a larger negative effect. The controlled arm analysis showed a positive increase in the difference in contacts, which means more contacts on the control arm compared to the intervention. After accounting for seasonality, the results were still the same.

For relevant medical contacts, the intervention aimed to decrease unscheduled but potentially increase scheduled contacts as these could be asthma reviews for picking up prescriptions. However, the increase in scheduled contacts would be expected to be seen in August, which was removed in this analysis. Therefore a decrease in relevant medical contacts was considered good. The single arm de-seasonalised model showed that there was an increase in contacts immediately after the intervention was sent. However, after accounting for seasonality, this effect was the opposite. There was a decrease in contacts immediately after the intervention. The controlled arm showed an increase in contacts following the intervention for both the de-seasonalised and the seasonal model.

The results for the single arm and control arm tend to be similar, this also applies to the seasonal and de-seasonalised model. The original PLEASANT results showed that the intervention did have a significant affect on prescriptions but not on other contacts. This increase in prescriptions was seen in both controlled arm models.

The ITS also showed in general that unscheduled and relevant medical contacts were decreased immediately after the intervention was sent for those on the letter arm.

7.7 Interrupted Time Series - Subgroups

This section of the analysis presents the ITS results of the different subgroups. Similarly to the previous section on the complete data, both single arm ITS and controlled arm ITS analysis were conducted on the data for both de-seasonalised and seasonal OLS models.

7.7.1 Prescription Analysis

7.7.1.1 Single Arm ITS

Table 7.19 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) single arm ITS model for prescription contacts. For the prescription analysis, the intervention aimed to increase the number of contacts in August, immediately after the intervention was sent. For the de-seasonalised model the majority of the subgroups showed a decrease in contacts immediately after the intervention, apart from primary school females and those who had a previous September contact who showed an increase in contacts. After adjusting for seasonality, more subgroups showed an increase in contacts. However, male, primary males, secondary males and secondary school children still showed a decrease in prescriptions.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	−4.61 (−14.16, 4.94)	−11.71 (−20.04, −3.39)
	Intervention	−12.60 (−102.03, 76.84)	43.67 (−34.29, 121.63)
	Time after Intervention	2.94 (−9.24, 15.13)	9.10 (0.86, 17.34)
	F-statistic (p-value)	0.159 (0.854)	2.436 (0.133)
Male	Time	−5.74 (−16.28, 4.80)	−7.93 (−17.54, 1.68)
	Intervention	−46.27 (−144.99, 52.45)	−34.30 (−124.31, 55.71)
	Time after Intervention	−2.03 (−15.48, 11.42)	1.11 (−8.41, 10.62)
	F-statistic (p-value)	0.450 (0.644)	0.399 (0.680)
Primary	Time	−9.14 (−19.61, 1.34)	−12.59 (−22.39, −2.78)
	Intervention	−5.55 (−103.65, 92.56)	16.01 (−75.87, 107.88)
	Time after Intervention	1.70 (−11.67, 15.07)	6.00 (−3.71, 15.71)
	F-statistic (p-value)	0.039 (0.962)	0.735 (0.502)
Secondary	Time	−1.22 (−10.80, 8.36)	−7.06 (−15.31, 1.20)
	Intervention	−53.32 (−143.04, 36.40)	−6.64 (−83.99, 70.71)
	Time after Intervention	−0.79 (−13.01, 11.44)	4.20 (−3.97, 12.38)
	F-statistic (p-value)	0.680 (0.517)	0.640 (0.546)
Primary Female	Time	−5.23 (−10.22, −0.24)	−7.66 (−12.29, −3.03)
	Intervention	18.98 (−27.76, 65.73)	36.18 (−7.21, 79.57)
	Time after Intervention	2.23 (−4.14, 8.60)	4.81 (0.23, 9.40)
	F-statistic (p-value)	0.518 (0.603)	2.651 (0.115)
Primary Male	Time	−3.91 (−9.84, 2.02)	−4.92 (−10.90, 1.05)
	Intervention	−24.53 (−80.10, 31.04)	−20.17 (−76.15, 35.80)
	Time after Intervention	−0.53 (−8.10, 7.04)	1.19 (−4.72, 7.12)
	F-statistic (p-value)	0.377 (0.690)	0.462 (0.642)
Secondary Female	Time	0.62 (−4.60, 5.83)	−4.05 (−9.30, 1.20)
	Intervention	−31.58 (−80.39, 17.23)	7.49 (−41.65, 56.62)
	Time after Intervention	0.71 (−5.94, 7.36)	4.30 (−0.91, 9.48)
	F-statistic (p-value)	0.847 (0.442)	1.335 (0.303)
Secondary Male	Time	−1.83 (−6.79, 3.12)	−3.01 (−7.20, 1.18)
	Intervention	−21.74 (−68.16, 24.67)	−14.13 (−53.36, 25.11)
	Time after Intervention	−1.50 (−7.82, 4.82)	−0.08 (−4.23, 4.06)
	F-statistic (p-value)	0.504 (0.611)	0.268 (0.770)
School Change	Time	−0.81 (−2.90, 1.28)	−3.02 (−5.54, −0.49)
	Intervention	−1.04 (−20.61, 18.53)	19.28 (−4.36, 42.91)
	Time after Intervention	−0.89 (−3.55, 1.78)	0.43 (−2.07, 2.92)
	F-statistic (p-value)	0.213 (0.810)	1.294 (0.313)
Previous Sept	Time	−22.39 (−43.36, −1.42)	−33.05 (−60.63, −5.47)
	Intervention	27.13 (−169.31, 223.56)	140.70 (−117.67, 399.06)
	Time after Intervention	14.95 (−11.81, 41.72)	18.36 (−8.95, 45.66)
	F-statistic (p-value)	0.619 (0.547)	1.103 (0.366)

Table 7.19: Single arm ITS segmented regression analysis for prescription medical contacts for subgroups (1) adjusting for Seasonality (2) (Positive good)

7.7.1.2 Controlled Arm ITS

Table 7.20 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) controlled arm ITS model for prescription contacts. For the controlled arm prescription analysis, a negative number shows that there were more contacts on the intervention arm compared to the control. For the de-seasonalised model, all the intervention values are negative, apart for secondary females, which suggests that for most subgroups there were more contacts on the intervention arm immediately after the intervention was sent. For the seasonal model, this was consistent, however males and primary males had a positive value for intervention.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	−0.79 (−5.17, 3.58)	0.71 (−6.42, 7.84)
	Intervention	−34.27 (−75.26, 6.72)	−47.03 (−113.81, 19.76)
	Time after Intervention	2.13 (−3.46, 7.71)	1.03 (−6.03, 8.09)
	F-statistic (p-value)	1.709 (0.204)	1.244 (0.326)
Male	Time	2.11 (−4.46, 8.67)	−6.23 (−14.77, 2.32)
	Intervention	−73.56 (−135.07, −12.05)	0.38 (−79.63, 80.39)
	Time after Intervention	6.68 (−1.70, 15.06)	12.13 (3.67, 20.58)
	F-statistic (p-value)	4.226* (0.028)	4.382* (0.040)
Primary	Time	0.99 (−4.52, 6.49)	−2.68 (−10.62, 5.26)
	Intervention	−65.06 (−116.65, −13.48)	−34.73 (−109.13, 39.67)
	Time after Intervention	5.18 (−1.85, 12.21)	8.05 (0.19, 15.91)
	F-statistic (p-value)	4.352* (0.026)	3.349 (0.073)
Secondary	Time	0.33 (−4.07, 4.72)	−2.83 (−10.28, 4.61)
	Intervention	−42.76 (−83.93, −1.60)	−11.92 (−81.66, 57.83)
	Time after Intervention	3.63 (−1.98, 9.24)	5.11 (−2.26, 12.48)
	F-statistic (p-value)	3.060 (0.067)	1.250 (0.324)
Primary Female	Time	1.51 (−1.04, 4.06)	2.17 (−2.08, 6.42)
	Intervention	−40.26 (−64.13, −16.39)	−45.88 (−85.67, −6.10)
	Time after Intervention	0.06 (−3.19, 3.31)	−0.41 (−4.62, 3.79)
	F-statistic (p-value)	5.495* (0.012)	2.706 (0.111)
Primary Male	Time	−0.52 (−5.16, 4.11)	−4.85 (−9.45, −0.25)
	Intervention	−24.80 (−68.22, 18.62)	11.15 (−31.97, 54.27)
	Time after Intervention	5.12 (−0.80, 11.03)	8.47 (3.91, 13.02)
	F-statistic (p-value)	2.199 (0.135)	6.864* (0.012)
Secondary Female	Time	−2.30 (−5.23, 0.62)	−1.46 (−5.87, 2.97)
	Intervention	5.99 (−21.38, 33.36)	−1.15 (−42.55, 40.26)
	Time after Intervention	2.07 (−1.66, 5.80)	1.45 (−2.92, 5.83)
	F-statistic (p-value)	0.654 (0.530)	0.249 (0.784)
Secondary Male	Time	2.63 (−0.61, 5.87)	−1.38 (−6.39, 3.64)
	Intervention	−48.75 (−79.09, −18.41)	−10.77 (−57.75, 36.21)
	Time after Intervention	1.56 (−2.57, 5.70)	3.66 (−1.31, 8.63)
	F-statistic (p-value)	5.411* (0.012)	1.502 (0.265)
School Change	Time	−0.45 (−2.06, 1.16)	−0.06 (−2.73, 2.60)
	Intervention	−5.02 (−20.13, 10.09)	−8.41 (−33.38, 16.56)
	Time after Intervention	1.61 (−0.45, 3.67)	1.36 (−1.28, 4.00)
	F-statistic (p-value)	1.462 (0.254)	1.047 (0.384)
Previous Sept	Time	0.51 (−5.53, 6.54)	−1.60 (−10.34, 7.13)
	Intervention	−52.30 (−108.81, 4.22)	−33.77 (−115.61, 48.08)
	Time after Intervention	5.65 (−2.05, 13.34)	7.12 (−1.53, 15.77)
	F-statistic (p-value)	2.861 (0.079)	2.270 (0.150)

Table 7.20: Controlled arm ITS segmented regression analysis for prescription medical contacts for subgroups (1) adjusting for Seasonality (2) (Negative good)

7.7.2 Unscheduled Medical Contacts

7.7.2.1 Single Arm ITS

Table 7.21 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) single arm ITS model for unscheduled medical contacts. The de-seasonalised model showed that for most subgroups there was a decrease in unscheduled contacts immediately after the intervention, except for females, primary females and those who had a previous September contact in 2012. After taking into account seasonality, all subgroups apart from previous September contact in 2012 showed a decrease in contacts immediately after the intervention. The effect was largest in males, secondary school children, primary males and secondary males.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	−3.87 (−28.86, 21.13)	−18.16 (−39.63, 3.30)
	Intervention	23.26 (−216.07, 262.58)	−13.55 (−214.10, 186.99)
	Time after Intervention	−6.44 (−39.84, 26.96)	24.25 (0.78, 47.72)
	F-statistic (p-value)	0.090 (0.915)	2.171 (0.165)
Male	Time	0.46 (−26.12, 27.05)	−5.40 (−26.51, 15.70)
	Intervention	−209.67 (−464.18, 44.85)	−327.76 (−524.91, −130.60)
	Time after Intervention	−21.78 (−57.30, 13.75)	4.69 (−18.38, 27.76)
	F-statistic (p-value)	2.025 (0.157)	5.787* (0.021)
Primary	Time	−16.42 (−46.25, 13.41)	−26.11 (−55.45, 3.23)
	Intervention	−47.42 (−333.02, 238.17)	−159.66 (−433.73, 114.40)
	Time after Intervention	−8.06 (−47.92, 31.80)	25.10 (−6.97, 57.17)
	F-statistic (p-value)	0.132 (0.878)	2.198 (0.162)
Secondary	Time	13.01 (−10.78, 36.80)	2.55 (−15.46, 20.55)
	Intervention	−138.99 (−366.76, 88.78)	−181.64 (−349.84, −13.45)
	Time after Intervention	−20.16 (−51.95, 11.63)	3.84 (−15.84, 23.52)
	F-statistic (p-value)	1.487 (0.249)	2.530 (0.129)
Primary Female	Time	−9.20 (−22.81, 4.42)	−15.43 (−29.96, −0.89)
	Intervention	34.31 (−96.03, 164.64)	−1.53 (−137.36, 134.30)
	Time after Intervention	−0.44 (−18.63, 17.75)	15.85 (−0.05, 31.74)
	F-statistic (p-value)	0.134 (0.875)	1.976 (0.189)
Primary Male	Time	−7.22 (−23.93, 9.48)	−10.69 (−26.17, 4.80)
	Intervention	−81.73 (−241.66, 78.20)	−158.14 (−302.80, −13.47)
	Time after Intervention	−7.62 (−29.94, 14.71)	9.26 (−7.67, 26.18)
	F-statistic (p-value)	0.725 (0.496)	1.148 (0.309)
Secondary Female	Time	5.33 (−8.59, 19.24)	−2.74 (−15.70, 10.22)
	Intervention	−11.05 (−144.28, 122.18)	−12.02 (−133.10, 109.06)
	Time after Intervention	−5.99 (−24.59, 12.60)	8.40 (−5.77, 22.57)
	F-statistic (p-value)	0.213 (0.810)	0.757 (0.494)
Secondary Male	Time	7.69 (−4.37, 19.74)	5.28 (−5.66, 16.23)
	Intervention	−127.94 (−243.36, −12.52)	−169.62 (−271.87, −67.37)
	Time after Intervention	−14.16 (−30.27, 1.95)	−4.56 (−16.53, 7.40)
	F-statistic (p-value)	3.844*(0.038)	5.303* (0.027)
School Change	Time	3.17 (−0.97, 7.31)	−0.97 (−5.78, 3.83)
	Intervention	−43.77 (−83.42, −4.12)	−23.74 (−68.65, 21.18)
	Time after Intervention	−6.75* (−12.28, −1.22)	−2.14 (−7.40, 3.12)
	F-statistic (p-value)	5.198* (0.014)	0.733 (0.504)
Previous Sept	Time	−49.79 (−103.50, 3.92)	−71.84 (−137.04, −6.64)
	Intervention	66.53 (−447.70, 580.75)	75.44 (−533.70, 684.58)
	Time after Intervention	25.93 (−45.84, 97.70)	59.34 (−11.94, 130.63)
	F-statistic (p-value)	0.283 (0.756)	1.332 (0.307)

Table 7.21: Single arm ITS segmented regression analysis for unscheduled medical contacts for subgroups (1) adjusting for seasonality (2) (Negative good)

7.7.2.2 Controlled Arm ITS

Table 7.22 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) controlled arm ITS model for unscheduled medical contacts. For the control arm, a positive value for intervention shows that there were more contacts on the control arm compared to the intervention. For the de-seasonalised model most subgroups showed a positive difference between controls and interventions immediately after the intervention was sent, however females and primary females showed a negative difference. The seasonal model showed similar results, however now secondary females also showed a negative difference between the two arms.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	−1.11 (−11.18, 8.96)	3.84 (−11.69, 19.36)
	Intervention	−14.63 (−111.01, 81.76)	−59.03 (−204.05, 85.99)
	Time after Intervention	−4.94 (−18.39, 8.51)	−7.15 (−24.12, 9.82)
	F-statistic (p-value)	0.303 (0.742)	0.562 (0.587)
Male	Time	0.52 (−12.26, 13.29)	−6.39 (−22.81, 10.04)
	Intervention	90.08 (−32.21, 212.36)	137.44 (−15.99, 290.86)
	Time after Intervention	−1.63 (−18.70, 15.44)	4.70 (−13.25, 22.66)
	F-statistic (p-value)	1.060 (0.364)	1.564 (0.257)
Primary	Time	3.46 (−6.80, 13.71)	5.32 (−10.19, 20.83)
	Intervention	55.08 (−43.06, 153.22)	29.77 (−115.09, 174.63)
	Time after Intervention	−9.55 (−23.25, 4.14)	−8.93 (−25.89, 8.02)
	F-statistic (p-value)	1.539 (0.238)	0.708 (0.516)
Secondary	Time	−4.05 (−12.49, 4.40)	−7.87 (−21.21, 5.47)
	Intervention	20.37 (−60.48, 101.22)	48.64 (−75.96, 173.24)
	Time after Intervention	2.99 (−8.30, 14.27)	6.49 (−8.09, 21.07)
	F-statistic (p-value)	0.256 (0.776)	0.575 (0.581)
Primary Female	Time	2.59 (−3.87, 9.04)	6.65 (−0.85, 14.15)
	Intervention	−26.45 (−88.23, 35.33)	−52.57 (−122.65, 17.51)
	Time after Intervention	−5.59 (−14.21, 3.04)	−8.96 (−17.16, −0.76)
	F-statistic (p-value)	1.159 (0.333)	2.915 (0.101)
Primary Male	Time	0.87 (−6.06, 7.79)	−1.33 (−10.74, 8.08)
	Intervention	81.53 (15.22, 147.83)	82.34 (−5.58, 170.25)
	Time after Intervention	−3.97 (−13.22, 5.29)	0.02 (−10.26, 10.31)
	F-statistic (p-value)	3.257 (0.059)	1.736 (0.225)
Secondary Female	Time	−3.70 (−12.57, 5.18)	−2.81 (−16.49, 10.86)
	Intervention	11.82 (−73.18, 96.82)	−6.46 (−134.20, 121.28)
	Time after Intervention	0.65 (−11.22, 12.51)	1.81 (−13.14, 16.76)
	F-statistic (p-value)	0.043 (0.958)	0.038 (0.963)
Secondary Male	Time	−0.30 (−8.99, 8.27)	−5.06 (−16.16, 6.05)
	Intervention	8.55 (−73.96, 91.07)	55.10 (−48.65, 158.85)
	Time after Intervention	2.34 (−9.18, 13.86)	4.68 (−7.46, 16.82)
	F-statistic (p-value)	0.100 (0.905)	0.712 (0.514)
School Change	Time	−4.47 (−8.37, −0.57)	−3.36 (−7.25, 0.54)
	Intervention	39.05 (1.69, 76.41)	20.54 (−15.82, 56.90)
	Time after Intervention	4.48 (−0.74, 9.69)	5.02 (0.77, 9.28)
	F-statistic (p-value)	3.515* (0.048)	2.934 (0.099)
Previous Sept	Time	2.36 (−8.40, 13.12)	−2.62 (−18.99, 13.75)
	Intervention	10.54 (−92.47, 113.55)	62.58 (−90.35, 215.51)
	Time after Intervention	−3.62 (−17.99, 10.76)	−1.88 (−19.77, 16.02)
	F-statistic (p-value)	0.142 (0.869)	0.383 (0.692)

Table 7.22: Controlled arm ITS segmented regression analysis for unscheduled medical contacts for subgroups (1) adjusting for seasonality (2) (Positive good)

7.7.3 Any Relevant Medical Contacts

7.7.3.1 Single Arm ITS

Table 7.23 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) single arm ITS model for relevant medical contacts. For the de-seasonalised model all subgroups apart from school change showed an increase in contacts immediately after the intervention was sent. This was not echoed when seasonality was adjusted for. All subgroups, apart from previous September, showed a decrease in contacts immediately after the intervention was sent.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	−19.50 (−58.16, 19.16)	−18.36 (−43.16, 6.44)
	Intervention	205.36 (−164.78, 575.50)	−51.61 (−283.29, 180.06)
	Time after Intervention	−6.97 (−58.63, 44.70)	26.56 (−0.55, 53.67)
	F-statistic (p-value)	0.626 (0.544)	2.149 (0.167)
Male	Time	−22.61 (−70.63, 25.42)	−2.20 (−23.88, 19.48)
	Intervention	140.21 (−324.02, 604.44)	−346.05 (−545.88, −146.22)
	Time after Intervention	−33.48 (−97.66, 30.69)	−6.60 (−30.31, 17.10)
	F-statistic (p-value)	0.626 (0.544)	5.822* (0.021)
Primary	Time	−39.23 (−85.83, 7.37)	−27.01 (−56.11, 2.10)
	Intervention	232.40 (−213.79, 678.59)	−175.02 (−446.87, 96.85)
	Time after Intervention	−13.29 (−75.57, 48.99)	21.57 (−10.25, 53.38)
	F-statistic (p-value)	0.608 (0.554)	2.031 (0.182)
Secondary	Time	−2.87 (−44.05, 38.30)	6.44 (−15.50, 28.38)
	Intervention	79.69 (−314.56, 473.94)	−229.25 (−434.23, −24.27)
	Time after Intervention	−27.16 (−82.17, 27.87)	−1.61 (−25.59, 22.38)
	F-statistic (p-value)	0.546 (0.587)	2.434 (0.138)
Primary Female	Time	−18.53 (−38.82, 1.76)	−16.63 (−34.04, 0.77)
	Intervention	137.63 (−56.65, 331.91)	−12.43 (−175.03, 150.17)
	Time after Intervention	−0.53 (−27.65, 26.58)	17.06 (−1.97, 36.09)
	F-statistic (p-value)	0.965 0.397	1.651 (0.240)
Primary Male	Time	−20.70 (−47.74, 6.33)	−10.37 (−23.82, 3.07)
	Intervention	94.77 (−164.05, 353.59)	−162.59 (−288.21, −36.97)
	Time after Intervention	−12.76 (−48.88, 23.37)	4.51 (−10.19, 19.21)
	F-statistic (p-value)	0.497 (0.615)	3.776 (0.060)
Secondary Female	Time	−0.97 (−21.34, 19.40)	−1.73 (−15.63, 12.17)
	Intervention	67.73 (−127.30, 262.76)	−39.19 (−169.06, 90.69)
	Time after Intervention	−6.44 (−33.66, 20.79)	9.50 (−5.70, 24.70)
	F-statistic (p-value)	0.339 (0.716)	1.084 (0.375)
Secondary Male	Time	−1.90 (−24.32, 20.51)	8.17 (−4.90, 21.24)
	Intervention	11.96 (−202.65, 226.58)	−190.07 (−312.16, −67.97)
	Time after Intervention	−20.72 (−50.68, 9.23)	−11.11 (−25.40, 3.18)
	F-statistic (p-value)	0.925 (0.412)	5.165* (0.029)
School Change	Time	0.48 (−6.06, 7.02)	0.64 (−3.94, 5.22)
	Intervention	−12.10 (−74.71, 50.51)	−50.04 (−92.83, −7.25)
	Time after Intervention	−7.95 (−16.69, 0.79)	−2.99 (−7.99, 2.02)
	F-statistic (p-value)	1.661 (0.214)	2.935 (0.099)
Previous Sept	Time	−76.11 (−147.10, −5.13)	−74.80 (−145.25, −4.35)
	Intervention	384.08 (−295.58, 1,063.73)	73.82 (−584.33, 731.96)
	Time after Intervention	21.38 (−73.48, 116.24)	56.96 (−20.05, 133.98)
	F-statistic (p-value)	0.711 (0.503)	1.051 (0.385)

Table 7.23: Single arm ITS segmented regression analysis for all relevant medical contacts for subgroups (1) adjusting for seasonality (2) (Negative good)

7.7.3.2 Controlled Arm ITS

Table 7.24 presents the results for the de-seasonalised OLS (1) and the seasonal OLS (2) controlled arm ITS model for relevant medical contacts. The de-seasonalised model had varying results. For females, primary females, secondary males and previous September children, these subgroups showed a negative difference in contacts;

there were more medical contacts on the intervention arm. For the remaining subgroups, there was a positive difference in contact, meaning there were more on the control arm. For the seasonal model the results were similar, however secondary males showed a positive difference and secondary females showed a negative difference.

		Dependent variable:	
		Number of Contacts	
		(1)	(2)
Female	Time	5.90 (−5.61, 17.40)	15.83 (0.12, 31.54)
	Intervention	−4.55 (−114.69, 105.58)	−82.28 (−229.05, 64.50)
	Time after Intervention	−16.20 (−31.57, −0.83)	−22.34 (−39.51, −5.16)
	F-statistic (p-value)	2.137 (0.143)	3.470 (0.072)
Male	Time	8.98 (−9.28, 27.23)	3.35 (−18.28, 24.98)
	Intervention	60.37 (−114.39, 235.13)	107.42 (−94.68, 309.51)
	Time after Intervention	−3.55 (−27.94, 20.84)	0.32 (−23.33, 23.97)
	F-statistic (p-value)	0.270 (0.766)	0.555 (0.591)
Primary	Time	10.22 (−1.41, 21.85)	14.98 (2.89, 27.08)
	Intervention	52.30 (−59.07, 163.66)	13.55 (−99.47, 126.56)
	Time after Intervention	−14.75 (−30.30, 0.79)	−17.17 (−30.39, −3.94)
	F-statistic (p-value)	2.154 (0.141)	3.472 (0.072)
Secondary	Time	4.65 (−6.60, 15.90)	4.20 (−11.41, 19.80)
	Intervention	3.53 (−104.19, 111.23)	11.60 (−134.22, 157.41)
	Time after Intervention	−5.00 (−20.03, 10.03)	−4.85 (−21.91, 12.21)
	F-statistic (p-value)	0.215 (0.809)	0.188 (0.832)
Primary Female	Time	5.88 (−1.98, 13.74)	11.57 (3.32, 19.83)
	Intervention	−22.18 (−97.45, 53.09)	−60.19 (−137.29, 16.92)
	Time after Intervention	−10.10 (−20.61, 0.41)	−14.46 (−23.48, −5.44)
	F-statistic (p-value)	1.942 (0.168)	5.432* (0.025)
Primary Male	Time	4.34 (−3.99, 12.67)	3.41 (−7.36, 14.18)
	Intervention	74.47 (−5.30, 154.25)	73.73 (−26.89, 174.35)
	Time after Intervention	−4.65 (−15.79, 6.48)	−2.71 (−14.48, 9.07)
	F-statistic (p-value)	2.009 (0.159)	1.284 (0.319)
Secondary Female	Time	0.02 (−8.40, 8.43)	4.26 (−8.21, 16.72)
	Intervention	17.63 (−62.92, 98.18)	−22.09 (−138.56, 94.38)
	Time after Intervention	−6.10 (−17.34, 5.14)	−7.88 (−21.51, 5.75)
	F-statistic (p-value)	0.658 (0.529)	0.657 (0.539)
Secondary Male	Time	4.64 (−7.11, 16.38)	−0.06 (−14.51, 14.39)
	Intervention	−14.10 (−126.52, 98.32)	33.69 (−101.29, 168.67)
	Time after Intervention	1.10 (−14.59, 16.79)	3.03 (−12.77, 18.82)
	F-statistic (p-value)	0.040 (0.961)	0.163 (0.852)
School Change	Time	−4.30 (−9.29, 0.68)	−2.38 (−8.60, 3.84)
	Intervention	46.77 (−0.99, 94.53)	22.21 (−35.93, 80.35)
	Time after Intervention	3.56 (−3.12, 10.22)	3.45 (−3.35, 10.25)
	F-statistic (p-value)	2.389 (0.116)	0.665 (0.536)
Previous Sept	Time	11.66 (−2.69, 26.01)	11.67 (−9.15, 32.48)
	Intervention	−62.85 (−200.24, 74.55)	−38.85 (−233.30, 155.59)
	Time after Intervention	−4.39 (−23.56, 14.79)	−7.56 (−30.32, 15.19)
	F-statistic (p-value)	0.502 (0.612)	0.252 (0.782)

Table 7.24: Controlled arm ITS segmented regression analysis for all relevant medical contacts for subgroups (1) adjusting for seasonality (2) (Positive good)

7.7.4 Discussion

This section of the analysis presented results of the ITS analysis for the different at risk subgroups. The purpose of this analysis was to see whether, after taking into account time, the intervention worked on any of the subgroups. If the intervention did not work in any of the subgroups, then an alternative intervention could be targeted at these children.

The first analysis presented was the prescription analysis. The analysis suggested that without adjusting for the control arm children, males, primary males, secondary males and secondary school children were potentially less likely to pick up a prescription in August. After adjusting for the control arm, it was only males and primary male children who were potentially less likely to pick up a prescription. These results suggest that the intervention could have been encouraging children to pick up a prescription in the summer holidays did not work as well in males and primary males compared to the other subgroups. This was not seen in the logistic regression prescription analysis results, Section 7.5.1, where all subgroups were more likely to pick up a prescription on the letter arm. However, logistic regression analysis does not take into account the time nature of the data.

For unscheduled contacts, the first analysis looking at the intervention arm only, found that after adjusting for seasonality the intervention potentially reduced contacts in every subgroups except for those who had an unscheduled contact in 2012 (the previous year). After adjusting for the control arm, the analysis found that females, primary females and secondary females had potentially more contacts in the letter arm after the intervention was sent than the control arm. This is consistent with the negative binomial for the extended endpoint analyses (Section 7.5.2). This could be because these children have uncontrolled asthma with their current medication so are going to have a medical contact regardless of whether they adhere to their medication plan, or the letter could worry the children that it would happen again which causes them to have an asthma attack. The increase in unscheduled contacts could also be due to the coding issues previous discussed in section 4.6.1. The letter caused females to book an appointment to pick up their prescriptions, but as this was patient initiated it was coded as unscheduled.

The results for the relevant medical contacts were similar to those for the unscheduled contacts. After taking into account the control arm, previous September contact in 2012, female, primary female and secondary female children had potentially more contacts on the letter arm. As relevant contacts is both unscheduled and scheduled contacts combined, this could suggest that there was no difference in scheduled contacts for females after the intervention was sent, but the increase in unscheduled contacts is what is different. Whereas, for previous medical contact, this increase in contacts is caused by more scheduled contacts.

7.8 Conclusion

The results of the intervention analysis have provided some indications on who the intervention could have worked for and who the intervention may not have work for. Females were found to be potentially picking up more prescriptions after the intervention was sent, however they were potentially still experiencing more unscheduled medical contacts. Males were potentially not picking up the prescription but they may have had fewer medical contacts. Those who transitioned from primary to secondary school were found to pick up more prescriptions and have less medical contacts. This was also found for primary school children and those who had a previous medical contact in September 2012. However, previous medical contact children had more relevant medical contacts as they are having more scheduled contacts.

These results suggest that females may benefit from an alternative intervention, whereas the others, males, primary school, previous medical contact and those who changed school, may benefit from receiving the original PLEASANT intervention. These results and the results from previous chapters, Chapter 5 and Chapter 6 will be discussed in detail with the relevant literature in the next chapter, Chapter 8.

8. Discussion

8.1 Introduction

The previous chapters have consisted of various analyses which aimed to answer the research aims of this Ph.D. study. Each chapter followed on from the previous, taking the results from the previous chapter into the analyses of the next. This chapter will first describe the aim of the thesis. Secondly, this chapter will discuss the main findings of the Ph.D. study and how these findings compare to the relevant literature. Thirdly, the strengths and limitations of the study are discussed and how this could have impacted on the study. Finally, proposals for further work are given.

8.2 Aim of the Thesis

The overall aim of the thesis was to investigate what factors cause the increase in unscheduled contacts around the start of the new school year. This aim was then broken down into three further questions:

1. What are the factors that influence children with asthma having an unscheduled contact around the start of the new school year?
2. Is it possible to predict which children are more likely to have an unscheduled contact at the start of the new school year?
3. If knowing which children are more likely to have an unscheduled medical contact at the start of the new school year, will the PLEASANT intervention work better in this subpopulation? Or is there a new intervention that could be proposed?

8.2.1 Approach

The study took a mixed methods approach to explore this research aim and these questions. The study used a variety of methods to investigate which children are more likely to have an unscheduled contact after the return to school. The study took an iterative approach, however the simplest way of describing the order of methods is for it to be described as a four stage study, see Figure 8.1.

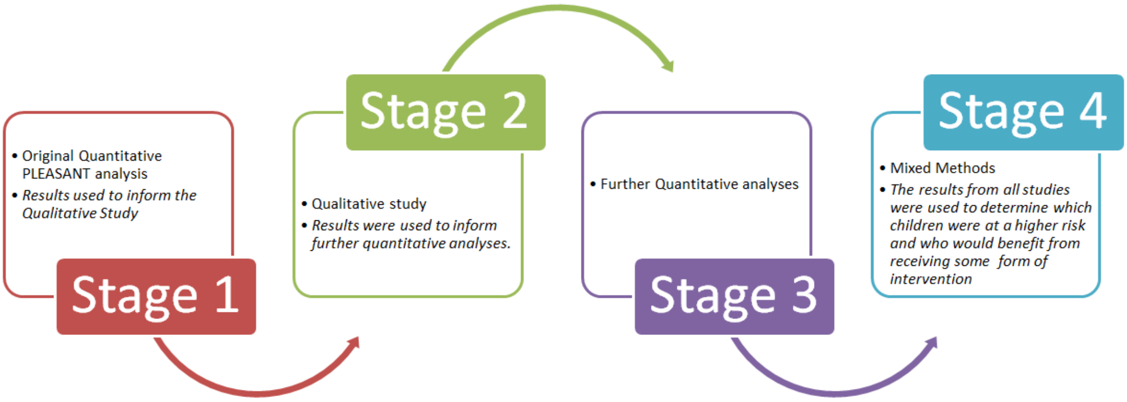


Figure 8.1: Flow diagram of the stages of the project

What are the factors that influence children with asthma having an unscheduled contact around the start of the new school year?

This research question aimed to determine what was causing children with asthma to have unscheduled medical contacts around the start of the new school year and was answered using the initial quantitative analysis and the qualitative study. The first quantitative analysis was used to develop the initial themes and questions for the qualitative study. The qualitative study was then used to find out from the children what they believed was causing the peak after the return to school. This study provided potential factors that influence children with asthma having unscheduled medical contacts around the start of the new school year. The results from the qualitative study can be found in Chapter 5. The results suggest that children who do not exercise over the summer, those who are in the transition from primary to secondary school year, secondary school children and secondary school females were children who were potentially at higher risk of unscheduled medical contacts at the start of the new school year.

Is it possible to predict which children are more likely to have an unscheduled contact at the start of the new school year?

From the qualitative study, those subgroups of children that were at potentially higher risk of having unscheduled contacts at the start of the new school year were identified. These subgroups were explored further using the quantitative data to determine whether they could be more at risk of having an unscheduled medical contact. These results provided an insight into which subgroups were potentially more likely to have a contact after the return to school. These results can be found in Chapter 6. The results from the subgroup analysis suggest that the children potentially most 'at risk' of an unscheduled medical contact were females, primary school children and those who transitioned from primary to secondary school. The analysis also suggested that males and primary school children were potentially most likely to pick up a prescription in the summer holidays.

If knowing which children are more likely to have an unscheduled medical contact at the start of the new school year, will the PLEASANT intervention work better in this sub-population? Or is there a new intervention that could be proposed?

This last question was explored using the results from the preceding questions and tested the original PLEASANT intervention on the various potential 'at risk' subgroups. This analysis made it possible to determine whether the intervention may have worked better for any of the subgroups and, also, which subgroups the intervention may not have worked on. These latter subgroups are those children where it could be beneficial to target a new intervention to reduce the 'after summer' peak in unscheduled contacts. These results can be found in Chapter 7. The results suggested that females may benefit from an alternative intervention whereas primary school children, males, school transition children and those who had a previous medical contact may benefit from continuing to receive the original PLEASANT intervention.

8.3 Key Findings

This section of the discussion describes the main findings from the project and how these finding compare to existing literature. The main findings of this study are:

1. Children with asthma may exercise less during the summer holidays which in turn could be contributing to the peak in unscheduled contacts in September when they return to school and start exercising again.
2. Males and females exhibit different patterns in the type of contact. Consideration of these findings has been used to guide the identification of possible future interventions, these are discussed in the final section.

8.3.1 Exercise levels during the summer holiday period

The main finding from the study is that children with asthma may exercise less during the summer holidays and this could be contributing to the peak in unscheduled contacts in September when they return to school and start exercising again. This is discussed in detail at the end of the qualitative study chapter (Section 5.7.5).

This finding could not be directly tested using the PLEASANT data set as data relating to exercise was not included (see Section 8.4). However, it was thought that reliever inhaler uptake could be used as a potential marker for increased exercise. It was believed that if children are exercising more when they are back at school compared to the summer holidays, then they may need to use their reliever inhaler more, which could lead to an increase in reliever inhaler prescriptions in September. Figure 6.23 in Section 6.5.4 showed the percentage of prescriptions collected by the children each month split by reliever and preventer inhalers. The graphic shows that in each of the three years, there was an increase in reliever inhaler prescriptions compared to preventer inhaler prescriptions during September, suggesting an overall increase in exercise during September.

The logistic regression analysis results provided some evidence to suggest that females were potentially less likely than males to collect their reliever inhaler in August, but more likely to do so in September. This could suggest that females are exercising less than males during the summer holiday period so do not pick up their reliever inhalers and, consequently, are finding they need to use the reliever inhaler more when they go back to school in September. This is consistent with previous studies which have found that females are less active than males (Bailey, 2005; Yiallouros et al., 2015; Lu et al., 2016).

This decrease in exercise amongst children with asthma during the summer holiday period, and its impact, is not something that has been described in previous literature. However, there have been studies on reduced exercise in children with asthma and studies on the impact of the summer holiday on children's health for non-asthmatic children.

Children with asthma have been found to exercise less than other children despite the health benefits that exercising provides (Ram et al., 2000b; Chiang et al., 2006; Glazebrook et al., 2006). There is a culture of over protection for children with asthma which could be contributing to the reduced levels of exercise (Williams et al., 2010). However, even though exercise is a known trigger for asthma, there is evidence to suggest that continued exercise can improve quality of life and exercise capacity for children with asthma (Basaran et al., 2006). An 8-week submaximal exercise study conducted in Turkey found that children with asthma were more likely to increase their exercise capacity and their quality of life compared to those who did not receive the exercise intervention (Basaran et al., 2006). Another study conducted in Norway, piloted an exercise intervention in children with asthma age 10-12 which involved the children exercising twice a week for 6 weeks (Westergren et al., 2016). The study concluded that the children on the exercise intervention felt their asthma, fitness and HRQoL had improved (Westergren et al., 2016). There is also evidence to show that exercise can actually increase asthma control (Lin et al., 2008; Bacon et al., 2015). A study conducted in Canada suggested that continuous exercise throughout the year could be beneficial towards asthma control as they found that people with asthma who exercised the most during the week were 2.5 times more likely to have control over their asthma and those who exercised in the winter were more likely to have control compared to those who only exercised in the summer (Bacon et al., 2015). However, none of these studies looked at the impact of exercise over the summer holidays, in children with asthma.

It is noted that there have been a number of studies that have considered how the summer holidays affect other aspects of children's health. These studies investigated various factors that could cause a change in children's health: diet, weight, physical activity, sleep time, sedentary behaviour, and the characteristics of the child (Cox et al., 2006; Duncan et al., 2007; Baranowski et al., 2014; Staiano et al., 2015; Wang et al., 2015). Nevertheless, the results were not consistent.

The findings from this study and the related literature suggest that there is a potential that children with asthma who discontinue exercising during the summer holidays are at a higher risk of having an unscheduled contact after they return to school. The previous studies have shown that the summer holidays can impact on a child's health and that children with asthma are less active than other children.

8.3.2 Gender and Age Effects

The qualitative study results led to identification of potential subgroups which could be more at risk of a medical contact in September after the return to school. The main subgroup, described in the previous section (8.3.1), was those who exercise less in the summer. The other subgroups were:

- Females,
- Secondary school,
- Those who transitioned from primary school to secondary school.

These subgroups were then analysed further using the PLEASANT dataset to determine if they were at higher risk. However, due to the size of the subgroups the analyses were conducted exploratory due to the reduced power so it was not possible to show conclusively if there were significant effects. Nevertheless, the results do provide potential indications of how the risks relate to these subgroups. The quantitative analysis suggested that these groups were potentially at higher risk, however, it was found that primary school children were more at risk rather than secondary school children.

The analysis provided some evidence that there were differences in contacts relating to gender and school ages of the children. Females were found to have potentially more unscheduled contacts and were found to have less scheduled contacts or pick up fewer prescriptions compared to males. Females were found to be more self-conscious than males about taking their medication. This could suggest that females are more likely to intentionally non-adhere, which could explain the reduction in prescription uptake in females. This was found to be consistent across both age groups (primary and secondary) for females. However, secondary school males showed to have potentially less unscheduled contacts compared to primary school males. This could suggest that for males, asthma symptoms tend to improve as they get older. This is consistent with the literature as it is known the males are more likely to grow out of their childhood asthma compared to females (Almqvist et al., 2008; Tantisira et al., 2008; Arathimos et al., 2017; Laffont et al., 2017).

Not only were there differences relating to gender, but there were also differences relating to age group alone. It has been found that primary school children could be more likely to pick up a prescription but they could be less likely to have a scheduled contact and could be more likely to have an unscheduled contact compared to secondary school children. This age effect was discussed previously in Chapter 3. The study also found that children who were in the year that transitioned from primary to secondary school were potentially more likely to pick up a prescription in August (the summer before starting secondary school) but also potentially more likely to have a contact in September, which was not seen the following year when the children moved up to year 8 (second year of secondary school). This increase in prescriptions during the summer for children in the transition year could be an example of children thinking that they will need to be protected for the challenges changing school could bring on their asthma, so they believe that their medication is a necessity.

There have been few studies on how the school transition affects children with asthma. However, there have been some investigations into how the transition affects other aspects of childrens health. A study in America by Wigfield et al. (1991) looked at children's self-esteem and their perceptions of ability during the transition to Junior High School. The study found that changing schools did impact on children's self-esteem and their perceptions of ability in different school subjects, including maths, English, sport and social activities. The study also found that there were gender differences in the effect of the school transition, with girls reporting lower self-esteem than boys (Wigfield et al., 1991). There are a number of studies that have investigated the effect of the school transition on children's health (Vikram Yadav MRCPsych, 2010; Suldo and Shaunessy-Dedrick, 2013; Zeng et al., 2016), there are also various papers which look at physical activity and the school transition (Cooper et al., 2012; Rutten et al., 2014; Marks et al., 2015) which links back to changes in exercise levels. The study in Australia by Marks et al. (2015) found that physical activity levels declined for those changing from primary to secondary school and sedentary behaviours increased. This change was found to be larger in those who went to a new school compared to those who remained in the same school following the transition (Marks et al., 2015). Rutten et al. (2014) found similar results for the increase in sedentary behaviour, but found that the children took part in different forms of physical activity when they joined secondary school. Finally, a study by Cooper et al. (2012), which was conducted in the UK, looked at whether a change in transport to school was causing the decrease in physical activity when the children changed to secondary school. The study found that those who walked to school for both primary and secondary increased their daily exercise, whereas those who walked to their primary school and changed to either car or bus for secondary school showed a decrease in physical activity. The study also found that those who walked to school did more exercise in the evening compared to those who got the bus or went by car (Cooper et al., 2012).

The results from this study suggest that females are potentially at higher risk of having a medical contact compared to males, as they could be more likely to have unscheduled contacts when they return to school and less likely to have scheduled contacts. Females could also be less likely to pick up a prescription in August before the return to school, but they were shown to potentially pick up more reliever inhalers in September after the return to school. As discussed previously, females are known to be less active than males which could relate back to them doing less exercise during the summer holidays. Also, females were found in the qualitative study to be more self-conscious of taking their medication so may not use their inhaler as much, so do not need to collect new prescriptions as often as males. This could make females more likely to be intentional non-adherers. The original PLEASANT intervention had the potential to work in this subgroup as they were less likely to pick up prescriptions and have more unscheduled contacts when they did not receive the letter.

Another group of children who were found to be potentially at higher risk of an unscheduled contact in September were primary school children. They could potentially have had more unscheduled contacts and less scheduled contacts compared to secondary school children, but could be more likely to pick up a prescription. This could suggest that something else other than lack of adherence is causing the children to have unscheduled contacts in September. Their asthma could be less under control, they could socialise less in the summer holidays with other children compared to secondary school children, or they could be exercising less. The original PLEASANT intervention may not work well on this subgroup as they were already more likely to pick up a prescription compared to the secondary school children.

The last subgroup who were found to be at potentially higher risk were those who transition from primary school to secondary school. The previous studies on this subgroup suggested that physical activity decreases and sedentary behaviour increases when children start secondary school. This suggests that it is not exercise impacting on these children as they are doing less compared to primary school. For these children, it could be the anxiety, stress, self-esteem and self-consciousness that is putting them at potentially higher risk of medical contacts at their new school.

8.3.3 Intervention Analysis/Implications of findings

Following the subgroup analyses, further analysis was conducted on these subgroups to determine whether the intervention potentially had any impact on the groups or not. The previous subgroup analysis concluded that females, primary school children and those transitioning from primary to secondary school were potentially at higher risk of having unscheduled medical contacts after the return to school. Females could be less likely to pick up a prescriptions whereas primary school and transition children could be more likely to pick up a prescription in August 2013. These results suggested that the intervention could be more likely to work in females as they were not picking up their prescriptions. The results from the intervention analysis should be used alongside the results of the qualitative study to determine which groups of children are more likely to be intentional or unintentional non-adherers. Interventions have the potential to work on intentional non-adherers as they are the children who are able to make their own choice about whether they adhere to their medication or not. Interventions can change the patient's view on whether their medication is a necessity (Van Steenis et al., 2014).

The intervention analysis suggested that the intervention may have worked well at increasing prescription uptake in females however females were still potentially having unscheduled medical contacts. This could suggest that females are still not adhering to their medication in spite of picking up their prescriptions. This could relate back to what was found in the qualitative work, females are more self conscious of taking their medication in front of others so are intentionally not adhering to their medication. It could also be related to the amount of exercise females do during the summer holidays, there is evidence to show females do less exercise than males which could be impacting on females when they return back to school regardless of whether they have taken their medication or not. A gender specific intervention could be targeted at female children with asthma, however further work would be required to determine what kind of intervention would work on this population.

The intervention results found that primary school children could still be picking up their prescriptions but they were having less unscheduled contacts after the return to school. The subgroup analysis found that this group of children were potentially at a higher risk of a medical contact. This suggests that that the intervention may have worked on primary school children which could suggest that these children now believe that their medication is a necessity.

The results also suggested that the intervention may have worked on the children in the year that transitioned from primary to secondary school. In the subgroup analysis they were found to be potentially at higher risk of having a medical contact but they were picking up their prescriptions. However, the intervention results found that they could be more likely to pick up their prescriptions and they could be less likely to have an unscheduled medical contact compared to the control arm after the intervention was sent. Again, which could suggest that these children now believe that their medication is a necessity.

The prescription analysis suggested that the intervention may not have caused males, in particular primary school males, to pick up their prescriptions in August after the intervention was sent. However, the unscheduled medical contacts analysis suggests that males could have had less contacts on the letter arm after receiving the intervention. This suggests that the intervention may not have worked as it should have in regards to picking up prescriptions in this population but it may have decrease the number of unscheduled contacts. The results for the male, primary school and school transition children suggest they may benefit from the original intervention being sent out to them each year.

8.4 Strengths and Limitations

Based on the best available knowledge, this is the first study that explores the factors which increase the peak in unscheduled contacts in September for school aged children with asthma using a mixed methods approach. Importantly, it appears to be the first study that has concluded that exercise could be contributing to the peak in September. The project also included a large qualitative study with children with asthma, of various school ages. This provided an opportunity for comparisons between primary and secondary school aged children to be made. One of the strengths of the qualitative study, other than the sample size, was that it was conducted in two parts, before and after summer. This process allowed time to develop emerging themes and explore and validate them thoroughly. Taking an iterative approach which included time for reviewing and analysing the data resulted in a much richer dataset. Alongside a large qualitative study, the project took a mixed methods approach which included using a quantitative dataset which was used to explore further findings from the qualitative study.

There were also a number of limitations in this study. Several have already been discussed at the end of the associated chapters. The limitations discussed in this section briefly highlight those already discussed and then the limitations of the whole study are discussed in detail.

The first limitations discussed in the thesis were those associated with the original PLEASANT analysis (Section 4.6.1). The use of predefined definitions for scheduled and unscheduled contacts may have resulted in contacts potentially being coded incorrectly. For example, the intervention could have caused the children to book an asthma review for their medication, this would have been patient initiated so would have been coded as unscheduled when it was not. This could result in a number of false unscheduled contacts. This could impact on this study, as children influenced by letter influenced to pick up a prescription may be coded as having an unscheduled contact. This could result in a bias in the subgroups that are more likely to have an unscheduled contact.

A number of subgroup analyses were done at reduced power, because of this, and multiple testing issues, the significance of the results were not considered and the direction of the results were explored instead. This is a limitation of the study as it is not possible to determine whether the results were true effects or not. However, this does open up areas for further work; confirmatory studies can be used to investigate these subgroups.

The researcher not having been involved in interviewing before may have impacted on the quality of the data in this study. The interviewer had no previous experience, however, reflecting on this meant they attended a qualitative methods module and conducted practice interviews before the study began. Yet opportunities could have been missed to explore further something a child had said or to question when a child had contradicted themselves. It was challenging, at times, to ask open ended questions, especially given the age of the participants; more simplistic questions were asked. Although this meant there could have been a lack of depth in the interview, it made interactions with the younger participants run smoothly. For there to be less disruption for the school, the interviews were conducted in batches. This maintained good working relationships with the schools. The largest batch was ten interviews. This was challenging for the interviewer as there was limited time to reflect on the answers given and to differentiate between the interviews. For example, keeping track of who had been asked certain questions. This may have also impacted on the analysis of the data.

The children interviewed were recruited from high performing schools through personal contacts, from relatively affluent areas. This means that the results may not be generalisable to the public, and this could also bias the results. As the children were from the least deprived areas, this could suggest that the parents and the schools are more involved in the child's asthma (Wamala et al., 2007; Billimek and August, 2014; Masa et al., 2017). The children may have more help with maintaining their asthma symptoms compared to those in a more deprived area. The children also had more luxury holidays, did more upper-class sports and activities, were able to pay for out-of-school sports and activities and could afford to continue sports over the summer holidays (Collins, 2004). This is not representative of the rest of the population. This is likely to bias what triggers and activities the children associate with making their asthma symptoms worse.

There were also more females than males in the sample, this could be representative of the population as, within the age range of the children, more females develop asthma during adolescence and males can often grow out of their asthma, as discussed previously. However, this could be a limitation of the study as most of the views and themes for the qualitative study would have come from a female perspective. Nevertheless, given the results from the subgroup analyses, females appear to be at a higher risk of having a contact, as compared to males. Therefore, this sample limitation may in fact be a strength of the study as the females may be at higher risk, it was important to get their views on the topic.

There were also limitations of the study as a whole. The main finding from the qualitative study was that some children with asthma may do less exercise during the summer holidays which impacts on their return to school. This could not be validated in the quantitative data as the dataset was fixed and did not contain any information or variables about what exercise the children undertook. Potential markers for exercise were used but this was not ideal. This was a key limitation of the study as it was not possible to validate the qualitative finding in the quantitative data. However, it also opens up and new topic area to study.

The order in which the data collection and analyses were done was another limitation. The qualitative interview study generated a number of potential ideas as to why there is a peak in September; however, the majority of the ideas could not be tested in the dataset, as explained above. If the study had been completed in the reverse order, starting with the full analysis of the quantitative dataset and then used the qualitative study to explored the meaning of the results, this would have fixed what questions were asked in the qualitative interviews and would have most likely not led to the current findings. It is also likely that it would have not answered the research questions, it will have just provided more data for the PLEASANT study. If the study was to be done again, it would be advised to do the qualitative study initially to explore the potential themes and areas and then use the results from that study to determine what quantitative study should be conducted.

8.5 Further Work

There are various further work opportunities following the work from this Ph.D. project. Given the lack of exercise data in the PLEASANT trial, this lends itself to potential further work.

As a starting point, it would be interesting to see how much exercise children with asthma do during the summer holidays compared to the return to school. The study could use pedometers or some form of self-report questionnaire at different times during the summer. This could provide an insight into how much exercise the children do when they are off school. The study could include all school ages and could possibly have a matched control who does not have asthma. Having a matched control would allow for a comparison, to determine if any potential change in exercise amount was seen in all children or in children with asthma only.

Following on from the above suggested research, if there is a decrease in exercise during the summer holidays, then an exercise based intervention could be targeted at children during the summer holidays. A possible intervention could be a few exercise sessions each week, similar to what the children would experience at school in their PE lessons. The intervention would be piloted on a small sample of children to determine the feasibility of the study and whether the study is beneficial for the children. Following a successful pilot study, a full randomised control trial could be implemented. The larger trial would also include collection of data on unscheduled contacts, similar to PLEASANT, to understand whether the exercise intervention had any effect on reducing the number of contacts when the children returned to school.

Other further research opportunities which could be implemented, but require less resources, are sending another letter, similar to the PLEASANT intervention (Original letter in Appendix A), which includes a statement about the impact of exercise and encouraging children to continue exercising during the summer break. The original PLEASANT intervention may not have reduced unscheduled contacts in September as it originally aimed to, however, it was found to be cost effective as the letter intervention was cheap. Alongside the letter being cheap, the study itself was relatively cheap as it used CPRD data. Therefore, adding an addition sentence to the original PLEASANT letter about exercise may be a cheap and simple way of aiming to reduce medical contacts in September. GP's and school teachers also have the influence to remind children and their parents of the importance of exercising and may have the power to encourage them to do so during the summer holidays.

As the subgroup analyses were exploratory, future work could investigate these subgroups further and determine which of the potential 'at risk' subgroups are actually at risk. Following that, the original PLEASANT intervention could be sent to males, primary school children, transition year children and those who had a previous September contact as they may benefit from continually receiving this intervention. As females are those who are still having unscheduled contacts following the intervention, a gender specific letter could be targeted at these children. This would require further work to determine what intervention would benefit female children.

The qualitative study only included the children with asthma, further work could explore the characteristics and beliefs of the parents of the children. This would provide further insight to the children's background and whether the children and parents have contradicting views. Having the parents views has the potential to provide much richer data and deeper understanding.

8.6 Overall Conclusion

The aim of this study was to find what factors influence the peak in unscheduled medical contacts around the start of the new school year using a mixed methods approach. The study was also used to find an alternative intervention that could be targeted at the at risk populations.

There were four sub-populations of children who were potentially more at risk of having unscheduled medical contacts during the start of the new school year, these were:

- Children who do little exercise during the summer holidays,
- Females,
- Primary school children,
- Children who transition from primary to secondary school.

It is thought that children who do not exercise over the summer will struggle when they return to school and start exercising again as this will trigger their asthma. Females could be part of this group of children who do not exercise over the summer or they are not adhering to their medication as they are self conscious of taking it in front of others. Primary school children have not had asthma for long as they are likely to have been recently diagnosed with it, which could suggest their asthma is uncontrolled compared to older children. Finally, the children who were in the transition year were likely to be at risk for various reasons, they are dealing with a big change which could make them anxious, they will be mixing with larger groups of children, they will take part in higher level sports and they will be expected to be much more independent when it comes to managing their asthma medication.

Of these children, those who do not exercise during the summer and females could benefit from an alternative intervention targeted specifically at these children. Those who do not exercise could have an exercise based intervention that would be received during the summer holidays. Females may also benefit from an exercise based intervention. Females (and their parents) may benefit from an education based intervention aimed at increasing asthma control. However, further work and investigations would be required before developing or implementing any of these interventions.

Primary school children and those who transitioned from primary school to secondary school could benefit from receiving the original PLEASANT intervention that year. It was also found that the intervention may have worked at decreasing unscheduled contacts in males even though the intervention did not increase prescriptions, therefore this sub population of children could benefit from receiving the original PLEASANT intervention.

Bibliography

Alexander, D. S., Geryk, L., Arrindell, C., DeWalt, D. A., Weaver, M. A., Sleath, B., and Carpenter, D. M. (2016). Are children with asthma overconfident that they are using their inhalers correctly? *Journal of Asthma*, 53(1):107–112.

Almqvist, C., Worm, M., and Leynaert, B. (2008). Impact of gender on asthma in childhood and adolescence: a ga2len review. *Allergy*, 63(1):47–57.

American Thoracic Society, . (2015). Anatomy and Function of the Normal Lung. http://www.thoracic.org/copd-guidelines/for-patients/anatomy-and-function-of-the-normal-lung.php. Accessed: 20/03/2105.

Anderson, S. and Brannan, J. (2001). Specific problems: exercise-induced asthma. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 471–487. London : W. B. Saunders, 2nd edition.

Arathimos, R., Granell, R., Henderson, J., Relton, C. L., and Tilling, K. (2017). Sex discordance in asthma and wheeze prevalence in two longitudinal cohorts. *PloS One*, 12(4):e0176293.

Asthma UK, . (2014a). Asthma and me. http://www.asthma.org.uk/downloadsAdultDownloads. Accessed: 3/11/2014.

Asthma UK, . (2014b). Triggers. http://www.asthma.org.uk/knowledge-triggers-a-z. Accessed: 27/08/2015.

Asthma UK, . (2015a). Asthma facts and faqs. http://www.asthma.org.uk/asthma-facts-and-statistics. Accessed: 1/9/2015.

Asthma UK, . (2015b). Asthma UK Stratery 2014-17. http://www.asthma.org.uk/recruitment-believe-and-value. Accessed: 2/11/2014.

Austin, P. C. and Steyerberg, E. W. (2015). The number of subjects per variable required in linear regression analyses. *Journal of clinical epidemiology*, 68(6):627–636.

Bacon, S. L., Lemiere, C., Moullec, G., Ninot, G., Pepin, V., and Lavoie, K. L. (2015). Association between patterns of leisure time physical activity and asthma control in adult patients. *BMJ Open Respiratory Research*, 2(1).

Bailey, R. (2005). Evaluating the relationship between physical education, sport and social inclusion. *Educational Review*, 57(1):71–90.

Baranowski, T., O'Connor, T., Johnston, C., Hughes, S., Moreno, J., Chen, T.-A., Meltzer, L., and Baranowski, J. (2014). School Year Versus Summer Differences in Child Weight Gain: A Narrative Review. *Childhood Obesity*, 10(1):18–24.

Barbour, R. (2007). *Doing Focus Groups*. Los Angeles : Sage Publications.

Basaran, S., Guler-Uysal, F., Ergen, N., Seydaoglu, G., Bingol-Karakoç, G., and Ufuk Altintas, D. (2006). Effects of Physical Exercise On Quality Of Life, Exercise Capacity And Pulmonary Function In Children With Asthma. *Journal of Rehabilitation Medicine*, 38(2):130–135.

Bass, P. (2014). Bronchoconstriction- What is Bronchoconstriction? http://asthma.about.com/od/glossary/g/Def$_b$*ronchoconstriction.htm.Accessed* : 13/08/2015.

Bender, B. G. (2001). Psychosocial factors mediating asthma treatment outcomes. In *Naspitz, C. and Szefler, S. and Tinkelman, D. and Warner, J. Textbook of pediatric asthma : an international perspective*, pages 293–309. London : Martin Dunitz,.

Bernal, J. L., Cummins, S., and Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: a tutorial. *International Journal of Epidemiology*, 46(1):348–355.

Bevis, M. and Taylor, B. (1990). What do school teachers know about asthma? *Archives of Disease in Childhood*, 65(6):622–625.

Billimek, J. and August, K. J. (2014). Costs and beliefs: Understanding individual- and neighborhood-level correlates of medication nonadherence among mexican americans with type 2 diabetes. *Health Psychology*, 33(12):1602.

Blaakman, S. W., Cohen, A., Fagnano, M., and Halterman, J. S. (2014). Asthma medication adherence among urban teens: A qualitative analysis of barriers, facilitators and experiences with school-based care. *Journal of Asthma*, 51(5):522–529.

Bousquet, J., Jaffuel, D., Chanez, P., and Michel, F.-B. (2001). Specific problems: food allergy in asthma. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 553–559. London : W. B. Saunders, 2nd edition.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2):77–101.

Bryman, A. (2012). *Social research methods*. Oxford university press.

Burgess, S., Sly, P., and Devadason, S. (2011). Adherence with preventive medication in childhood asthma. *Pulmonary Medicine*, 2011(3):16.

Burney, P. (2000). Epidemiology. In *Clark, T. J. H. and Godfrey, S. and Lee, T.H. and Thomson, N.C. Asthma*, pages 197–224. London : Arnold, 4th edition.

Buston, K. M. and Wood, S. F. (2000). Non-compliance amongst adolescents with asthma: listening to what they tell us about self-management. *Family Practice*, 17(2):134–138.

Butz, A. M., Thompson, R. E., Tsoukleris, M. G., Donithan, M., Hsu, V. D., Mudd, K., Zuckerman, I. H., and Bollinger, M. E. (2008). Seasonal patterns of controller and rescue medication dispensed in underserved children with asthma. *Journal of Asthma*, 45(9):800–806.

Byrne, P. M. and Thomson, N. C. (2001). Preface. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*. London : W. B. Saunders, 2nd edition.

Cameron, A. C. and Trivedi, P. K. (1986). Econometric models based on count data. comparisons and applications of some estimators and tests. *Journal of applied econometrics*, 1(1):29–53.

Cameron, A. C. and Trivedi, P. K. (1998). *Basic Count Regression*, page 5995. Econometric Society Monographs. Cambridge University Press.

Cameron, A. C. and Trivedi, P. K. (2013). *Regression analysis of count data*, volume 53. Cambridge university press.

Campbell, E. (1969). Physical signs of diffuse airways obstruction and lung distension. *Thorax*, 24(1):1–3.

Campbell, M. J. and Walters, S. J. (2014). *How to design, analyse and report cluster randomised trials in medicine and health related research*. John Wiley & Sons.

Carlsen, K. C. L., Roll, S., Carlsen, K.-H., Mowinckel, P., Wijga, A. H., Brunekreef, B., Torrent, M., Roberts, G., Arshad, S. H., Kull, I., et al. (2012). Does pet ownership in infancy lead to asthma or allergy at school age? pooled analysis of individual participant data from 11 european birth cohorts. *PloS one*, 7(8):e43214.

Carlsen, K.-H. (2001). Exercised-induced asthma in children and adolescents and its relationship to sport. In *Naspitz, C. and Szefler, S. and Tinkelman, D. and*

Warner, J. Textbook of pediatric asthma : an international perspective, pages 211–223. London : Martin Dunitz,.

Carlsen, K.-H. (2012). Sports in extreme conditions: the impact of exercise in cold temperatures on asthma and bronchial hyper-responsiveness in athletes. *British Journal of Sports Medicine*, 46(11):796–799.

Cates, C. J., Oleszczuk, M., Stovold, E., and Wieland, L. S. (2012). Safety of regular formoterol or salmeterol in children with asthma: an overview of cochrane reviews. *The Cochrane Library*.

Chapman, S. C., Barnes, N., Barnes, M., Wilkinson, A., Hartley, J., Piddock, C., Weinman, J., and Horne, R. (2015). Changing adherence-related beliefs about ics maintenance treatment for asthma: feasibility study of an intervention delivered by asthma nurse specialists. *BMJ open*, 5(6):e007354.

Chiang, L.-C., Huang, J.-L., and Fu, L.-S. (2006). Physical activity and physical self-concept: comparison between children with and without asthma. *Journal of Advanced Nursing*, 54(6):653–662.

Chung, K. (2001). Specific problems: difficult, therapy-resistant asthma. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 559–577. London : W. B. Saunders, 2nd edition.

Clark, T. (1998). *Practical management of asthma*. London : Martin Dunitz, 1998, London, 3rd ed. edition.

Clifford, S., Barber, N., and Horne, R. (2008). Understanding different beliefs held by adherers, unintentional nonadherers, and intentional nonadherers: application of the necessity–concerns framework. *Journal of psychosomatic research*, 64(1):41–46.

Cohen, H. A., Blau, H., Hoshen, M., Batat, E., and Balicer, R. D. (2014). Seasonality of asthma: a retrospective population study. *Pediatrics*, 133(4):923–932.

Colice, G. L. (2004). Categorizing asthma severity: an overview of national guidelines. *Clinical Medicine & Research*, 2(3):155–163.

Collins, M. (2004). Sport, physical activity and social exclusion. *Journal of Sports Sciences*, 22(8):727–740.

Cooper, A. R., Jago, R., Southward, E. F., and Page, A. S. (2012). Active travel and physical activity across the school transition: the peach project. *Medicine and Science in Sports and Exercise*, 44(10):1890–1897.

Copay, A. G., Subach, B. R., Glassman, S. D., Polly, D. W., and Schuler, T. C. (2007). Understanding the minimum clinically important difference: a review of concepts and methods. *The Spine Journal*, 7(5):541–546.

Cox, M., Schofield, G., Greasley, N., and Kolt, G. (2006). Pedometer steps in primary school-aged children: A comparison of school-based and out-of-school activity. *Journal of Science and Medicine in Sport*, 9(1-2):91–97.

CPRD (2015). Welcome to the clinical practice research datalink. http://www.cprd.com/intro.asp. Accessed: 27/08/2015.

Creswell, J. W. (1994). Research design: Qualitative & quantitative approaches.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Crombie, I. K. and Davies, H. (1996). *Research in health care: design, conduct and interpretation of health services research*. John Wiley & Sons.

Cukier, A. (2010). Perception of asthma symptoms. *Jornal Brasileiro de Pneumologia*, 36(5):523–524.

Cypcar, D. and Lemanske, R. F. (1994). Asthma and exercise. *Clinics in Chest Medicine*, 15(2):351–68.

Dahlén, B., Zetterström, O., and Dahlén, S.-E. (2001). Specific problems: asthma induced by asperin and other non-steroidal anti-inflammatory drugs. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 453–463. London : W. B. Saunders, 2nd edition.

De Simoni, A., Horne, R., Fleming, L., Bush, A., and Griffiths, C. (2017). What do adolescents with asthma really think about adherence to inhalers? insights from a qualitative analysis of a uk online forum. *BMJ open*, 7(6):e015245.

Desai, M. and Oppenheimer, J. J. (2011). Medication adherence in the asthmatic child and adolescent. *Current Allergy and Asthma Reports*, 11(6):454–464.

Dijkman, B., Kooistra, B., and Bhandari, M. (2009). How to work with a subgroup analysis. *Canadian Journal of Surgery*, 52(6):515.

Dobson, A. J. and Barnett, A. (2008). *An introduction to generalized linear models*. CRC press.

Driessen, J. M., van der Palen, J., van Aalderen, W. M., de Jongh, F. H., and Thio, B. J. (2012). Inspiratory airflow limitation after exercise challenge in cold air in asthmatic children. *Respiratory medicine*, 106(10):1362–1368.

Dudeney, J., Sharpe, L., Jaffe, A., Jones, E. B., and Hunt, C. (2017). Anxiety in youth with asthma: A meta-analysis. *Pediatric Pulmonology*, 52(9):1121–1129.

Duncan, M. J., Al-Nakeeb, Y., Woodfield, L., and Lyons, M. (2007). Pedometer determined physical activity levels in primary school children from central England. *Preventive Medicine*, 44(5):416–420.

Eijkemans, M., Mommers, M., Jos, M. T., Thijs, C., Prins, M. H., et al. (2012). Physical activity and asthma: a systematic review and meta-analysis. *PLoS One*, 7(12):e50775.

Eldridge, S. and Kerry, S. (2012). *A practical guide to cluster randomised trials in health services research*, volume 120. John Wiley & Sons.

Farmer, T., Robinson, K., Elliott, S. J., and Eyles, J. (2006). Developing and implementing a triangulation protocol for qualitative health research. *Qualitative Health Research*, 16(3):377–394.

Fereday, J. and Muir-Cochrane, E. (2008). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5(1):80–92.

Fiese, B. H. and Wamboldt, F. S. (2000). Family routines, rituals, and asthma management: A proposal for family-based strategies to increase treatment adherence. *Families, Systems, & Health*, 18(4):405.

Fiese, B. H., Wamboldt, F. S., and Anbar, R. D. (2005). Family asthma management routines: connections to medical adherence and quality of life. *The Journal of Pediatrics*, 146(2):171–176.

Fleming, D., Cross, K., Sunderland, R., and Ross, A. (2000). Comparison of the seasonal patterns of asthma identified in general practitioner episodes, hospital admissions, and deaths. *Thorax*, 55(8):662–665.

Flynn, T. N., Whitley, E., and Peters, T. J. (2002). Recruitment strategies in a cluster randomized trial–cost implications. *Statistics in Medicine*, 21(3):397–405.

Fretheim, A., Soumerai, S. B., Zhang, F., Oxman, A. D., and Ross-Degnan, D. (2013). Interrupted time-series analysis yielded an effect estimate concordant with the cluster-randomized controlled trial result. *Journal of Clinical Epidemiology*, 66(8):883–887.

Fretheim, A., Zhang, F., Ross-Degnan, D., Oxman, A. D., Cheyne, H., Foy, R., Goodacre, S., Herrin, J., Kerse, N., McKinlay, R. J., et al. (2015). A reanalysis of cluster randomized trials showed interrupted time-series studies were valuable in health system evaluation. *Journal of Clinical Epidemiology*, 68(3):324–333.

Fu, L., Freishtat, R. J., Gordish-Dressman, H., Teach, S. J., Resca, L., Hoffman, E. P., and Wang, Z. (2014). Natural progression of childhood asthma symptoms and strong influence of sex and puberty. *Annals of the American Thoracic Society*, 11(6):939–944.

Fuhrman, C., Dubus, J.-C., Marguet, C., Delacourt, C., Thumerelle, C., de Blic, J., and Delmas, M.-C. (2011). Hospitalizations for asthma in children are linked to undertreatment and insufficient asthma education. *Journal of Asthma*, 48(6):565–571.

Fulton, L. V., Mendez, F. A., Bastian, N. D., and Musal, R. M. (2012). Confusion between odds and probability, a pandemic? *Journal of Statistics Education*, 20(3):1–15.

Gergen, P. J., Mitchell, H., Lynn, H., et al. (2002). Understanding the seasonal pattern of childhood asthma: results from the national cooperative inner-city asthma study (ncicas). *The Journal of Pediatrics*, 141(5):631–636.

Gibson, J. E. (2012). Interviews and focus groups with children: Methods that match children's developing competencies. *Journal of Family Theory & Review*, 4(2):148–159.

Gibson, P., Henry, R., Vimpani, G., and Halliday, J. (1995). Asthma knowledge, attitudes, and quality of life in adolescents. *Archives of Disease in Childhood*, 73(4):321–326.

Glazebrook, C., McPherson, A. C., Macdonald, I. A., Swift, J. A., Ramsay, C., Newbould, R., and Smyth, A. (2006). Asthma as a Barrier to Children's Physical Activity: Implications for Body Mass Index and Mental Health. *Pediatrics*, 118(6).

Global Initiative for Asthma, . (2015a). Global strategy for asthma management and prevention. *NIH Publication*.

Global Initiative for Asthma, . (2015b). Global strategy for asthma management and prevention (online appendix). *NIH Publication*.

Godden, D. J., Ross, S., Abdalla, M., McMurray, D., Douglas, A., Oldman, D., Friend, J., Legge, J. S., and Douglas, J. (1994). Outcome of wheeze in childhood. symptoms and pulmonary function 25 years later. *American Journal of Respiratory and Critical Care Medicine*, 149(1):106–112.

Godfrey, S. (2000). Childhood asthma. In *Clark, T. J. H. and Godfrey, S. and Lee, T.H. and Thomson, N.C. Asthma*, pages 381–426. London : Arnold, 4th edition.

Goodman, A., Guell, C., Panter, J., Jones, N. R., and Ogilvie, D. (2012). Healthy travel and the socio-economic structure of car commuting in cambridge, uk: a mixed-methods analysis. *Social Science & Medicine*, 74(12):1929–1938.

Gordon, K., Smith, F., and Dhillon, S. (2007). Effective chronic disease management: patients perspectives on medication-related problems. *Patient education and counseling*, 65(3):407–415.

Grech, V. E., Balzan, M. V., and Distefano, S. (2004). Paediatric wheezy admissions at and around school holiday periods. *Malta Medical Journal*, 16(1):23–26.

Green, J. and Thorogood, N. (2014). *Qualitative methods for health research*. Sage Publications.

Greene, S. and Hogan, D. (2005). *Researching children's experience: Approaches and methods (Chapter 16)*. Sage Publications.

Guest, G., Bunce, A., and Johnson, L. (2006). How many interviews are enough? an experiment with data saturation and variability. *Field Methods*, 18(1):59–82.

Hammersley, M. and Atkinson, P. (2007). *Ethnography: Principles in practice*. Routledge.

Han, Y.-Y., Lee, Y.-L., and Guo, Y. L. (2009). Indoor environmental risk factors and seasonal variation of childhood asthma. *Pediatric Allergy and Immunology*, 20(8):748–756.

Harju, T., Keistinen, T., Tuuponen, T., and Kivelä, S.-L. (1997). Seasonal variation in childhood asthma hospitalisations in finland, 1972–1992. *European Journal of Pediatrics*, 156(6):436–439.

Hausman, J. A., Hall, B. H., and Griliches, Z. (1984). Econometric models for count data with an application to the patents-r&d relationship.

Hayes, R. and Moulton, L. (2009). *Cluster randomised trials*. Chapman & Hall/CRC.

Health, U. D. and Human Services, . (2004). The health consequences of smoking: a report of the surgeon general. *Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health*, 62.

Heary, C. and Hennessy, E. (2006). Focus groups versus individual interviews with children: A comparison of data. *The Irish Journal of Psychology*, 27(1-2):58–68.

Herrett, E., Gallagher, A. M., Bhaskaran, K., Forbes, H., Mathur, R., van Staa, T., and Smeeth, L. (2015). Data resource profile: clinical practice research datalink (cprd). *International journal of epidemiology*, 44(3):827–836.

Hilbe, J. M. (2011). *Negative binomial regression*. Cambridge University Press.

Ho, P. M., Bryson, C. L., and Rumsfeld, J. S. (2009). Medication adherence: its importance in cardiovascular outcomes. *Circulation*, 119(23):3028–3035.

Holgate, S. T. (2006). *Asthma*. Abingdon : Health, 2006, Abingdon, 2nd ed. / stephen t. holgate, jo douglass. edition.

Horne, R., Chapman, S. C., Parham, R., Freemantle, N., Forbes, A., and Cooper, V. (2013). Understanding patients adherence-related beliefs about medicines prescribed for long-term conditions: a meta-analytic review of the necessity-concerns framework. *PloS one*, 8(12):e80633.

Horne, R. and Weinman, J. (2002). Self-regulation and self-management in asthma: exploring the role of illness perceptions and treatment beliefs in explaining non-adherence to preventer medication. *Psychology and Health*, 17(1):17–32.

Horne, R., Weinman, J., and Hankins, M. (1999). The beliefs about medicines questionnaire: the development and evaluation of a new method for assessing the cognitive representation of medication. *Psychology and health*, 14(1):1–24.

Horspool, M. J., Julious, S. A., Boote, J., Bradburn, M. J., Cooper, C. L., Davis, S., Elphick, H., Norman, P., Smithson, W. H., et al. (2013). Preventing and lessening exacerbations of asthma in school-age children associated with a new term (pleasant): study protocol for a cluster randomised control trial. *Trials*, 14(1):297.

Hugg, T. T., Jaakkola, M. S., Ruotsalainen, R., Pushkarev, V., and Jaakkola, J. J. (2008). Exposure to animals and the risk of allergic asthma: a population-based cross-sectional study in finnish and russian children. *Environmental Health*, 7(1):28.

Hughes, D. (2014). Childhood asthma and exercise. *Paediatrics & Child Health*, 19(9):467–468.

Jafer, A. T., Mahmood, A. A., Fatah, M. A., and Jasim, M. A. (1991). Guidelines for the diagnosis and management of asthma.

Jago, R., Searle, A., Henderson, A. J., and Turner, K. M. (2017). Designing a physical activity intervention for children with asthma: a qualitative study of the views of healthcare professionals, parents and children with asthma. *BMJ Open*, 7(3):e014020.

Janssens, T., Verleden, G., De Peuter, S., Van Diest, I., and Van den Bergh, O. (2009). Inaccurate perception of asthma symptoms: a cognitive–affective framework and implications for asthma treatment. *Clinical Psychology Review*, 29(4):317–327.

Johnston, N. and Sears, M. (2006). Asthma exacerbations· 1: epidemiology. *Thorax*, 61(8):722–728.

Johnston, N. W., Johnston, S. L., Duncan, J. M., Greene, J. M., Kebadze, T., Keith, P. K., Roy, M., Waserman, S., and Sears, M. R. (2005). The september epidemic of asthma exacerbations in children: a search for etiology. *Journal of Allergy and Clinical Immunology*, 115(1):132–138.

Julious, S., Campbell, M., Bianchi, S., and Murray-Thomas, T. (2011). Seasonality of medical contacts in school-aged children with asthma: association with school holidays. *Public Health*, 125(11):769–776.

Julious, S., Osman, L., and Jiwa, M. (2007). Increases in asthma hospital admissions associated with the end of the summer vacation for school-age children with asthma in two cities from england and scotland. *Public Health*, 121(6):482–484.

Julious, S. A., Horspool, M. J., Davis, S., Bradburn, M., Norman, P., Shephard, N., Cooper, C. L., Smithson, W. H., Boote, J., Elphick, H., et al. (2016). Pleasant: Preventing and lessening exacerbations of asthma in school-age children associated with a new term-a cluster randomised controlled trial and economic evaluation.

Julious, S. A., Horspool, M. J., Davis, S., Franklin, M., Smithson, W. H., Norman, P., Simpson, R. M., Elphick, H., Bortolami, O., and Cooper, C. (2018). Open-label, cluster randomised controlled trial and economic evaluation of a brief letter from a gp on unscheduled medical contacts associated with the start of the school year: the pleasant trial. *BMJ open*, 8(4):e017367.

Kanabar, D. (2010). *ABC of asthma (Asthma in Children)*. Chichester, West Sussex, UK ; Hoboken, NJ : Wiley-Blackwell : BMJ Books, 2010, Chichester, West Sussex, UK ; Hoboken, NJ, 6th ed. edition.

Kane, R., Wellings, K., Free, C., and Goodrich, J. (2000). Uses of routine data sets in the evaluation of health promotion interventions: opportunities and limitations. *Health Education*, 100(1):33–41.

Kao, C.-C., Dah-Chin, Y., Ou, L.-S., and Jing-Long, H. (2001). Time trends and seasonal variations in hospital admissions for childhood asthma in taiwan from 1990 to 1998. *Asian Pacific Journal of Allergy and Immunology*, 19(2):63.

Keene, O. N., Jones, M. R., Lane, P. W., and Anderson, J. (2007). Analysis of exacerbation rates in asthma and chronic obstructive pulmonary disease: example from the tristan study. *Pharmaceutical Statistics*, 6(2):89–97.

Khot, A., Evans, N., and Lenney, W. (1983). Seasonal trends in childhood asthma in south east england. *BMJ*, 287(6401):1257–1258.

Kimbell-Dunn, M., Pearce, N., and Beasley, R. (2000). Seasonal variation in asthma hospitalizations and death rates in new zealand. *Respirology*, 5(3):241–246.

Kit, B. K., Simon, A. E., Ogden, C. L., and Akinbami, L. J. (2012). Trends in preventive asthma medication use among children and adolescents, 1988–2008. *Pediatrics*, 129(1):62–69.

Kleinbaum, D., Kupper, L., Nizam, A., and Rosenberg, E. (2013). *Applied regression analysis and other multivariable methods*. Cengage Learning.

Kleinbaum, D. G. (1994). Introduction to logistic regression. In *Logistic Regression*, pages 1–38. Springer.

Kremelberg, D. (2010). *Practical Statistics: A Quick and Easy Guide to IBM® SPSS® Statistics, STATA, and Other Statistical Software*. Sage Publications.

Kvale, S. (1996). *InterViews: An Introduction to Qualitative Research Interviewing*. Sage Publications.

Laffont, S., Blanquart, E., and Guéry, J.-C. (2017). Sex differences in asthma: A key role of androgen-signaling in group 2 innate lymphoid cells. *Frontiers in Immunology*, 8:1–7.

Lai, C., Beasley, R., Crane, J., Foliaki, S., Shah, J., and Weiland, S. (2009). Global variation in the prevalence and severity of asthma symptoms: Phase three of the international study of asthma and allergies in childhood (isaac). *Thorax*.

Le Souëf, P. N. (2001). Lung function and development. In *Naspitz, C. and Szefler, S. and Tinkelman, D. and Warner, J. Textbook of pediatric asthma : an international perspective*, pages 1–19. London : Martin Dunitz,.

Lecomte, J. (2002). Asthma and exercise. *Revue medicale de Bruxelles*, 23(4):A206–A2 10.

Lehane, E. and McCarthy, G. (2007). Intentional and unintentional medication non-adherence: a comprehensive framework for clinical research and practice? a discussion paper. *International journal of nursing studies*, 44(8):1468–1477.

Lehrer, P. M., Isenberg, S., and Hochron, S. M. (1993). Asthma and emotion: a review. *Journal of Asthma*, 30(1):5–21.

Leickly, F. E., Wade, S. L., Crain, E., Kruszon-Moran, D., Wright, E. C., and Evans, R. (1998). Self-reported adherence, management behavior, and barriers to care after an emergency department visit by inner city children with asthma. *Pediatrics*, 101(5):e8.

Levy, M., Andrews, R., Buckingham, R., Evans, H., Francis, C., Houston, R., Lowe, D., Nasser, S., Paton, J., Puri, N., et al. (2014). *Why asthma still kills: The national review of asthma deaths (NRAD).* Royal College of Physcians.

Lin, H.-L., Wang, S.-Y., Chen, W.-Y., and Chen, C.-H. (2008). Exercise Behavior in Asthmatic Children: Effects of a Summer Camp Fitness Program in Taiwan. *The Kaohsiung Journal of Medical Sciences*, 24(6):297–305.

Lipkovich, I., Dmitrienko, A., Muysers, C., and Ratitch, B. (2018). Multiplicity issues in exploratory subgroup analysis. *Journal of biopharmaceutical statistics*, 28(1):63–81.

Loh, L.-C. and Teh, P.-N. (2009). Perception of breathlessness by a 3-minute respiratory exerciser test predicts asthma exacerbations: a prospective cohort study. *Journal of Asthma*, 46(6):529–534.

Lowry, K. P., Dudley, T. K., Oddone, E. Z., and Bosworth, H. B. (2005). Intentional and unintentional nonadherence to antihypertensive medication. *Annals of Pharmacotherapy*, 39(7-8):1198–1203.

Lu, K. D., Billimek, J., Bar-Yoseph, R., Radom-Aizik, S., Cooper, D. M., and Anton-Culver, H. (2016). Sex Differences in the Relationship between Fitness and Obesity on Risk for Asthma in Adolescents. *The Journal of Pediatrics*, 176:36–42.

Marefati, H., Vizvari, E., Esmaeilizadeh, M., and Boskabady, M. H. (2016). The effect of climatic conditions on exercise-induced bronchoconstriction in 10–12 year old students. *Journal of Bodywork and Movement Therapies*, 20(3):549–553.

Marks, D. F. and Yardley, L. (2004). *Research methods for clinical and health psychology (Chapter 4).* Sage Publications.

Marks, J., Barnett, L. M., Strugnell, C., and Allender, S. (2015). Changing from primary to secondary school highlights opportunities for school environment interventions aiming to increase physical activity and reduce sedentary behaviour: a longitudinal cohort study. *International Journal of Behavioral Nutrition and Physical Activity*, 12(1):59.

Masa, R., Chowa, G., and Nyirenda, V. (2017). Barriers and facilitators of antiretroviral therapy adherence in rural eastern province, zambia: the role of household economic status. *African Journal of AIDS Research*, 16(2):91–99.

Mash, B. R., Bheekie, A., and Jones, P. (2001). Inhaled versus oral steroids for adults with chronic asthma. *The Cochrane Library.*

Masoli, M., Fabian, D., Holt, S., and Beasley, R. (2004). The global burden of asthma: Executive summary of GINA dissemination committee report. *Allergy.*

May, T. and Perry, B. (2010). *Social Research and Reflexivity.* Sage Publications.

McConnell, W. D. and Holgate, S. T. (2000). The definition of asthma: its relationship to other chronic obstructive lung diseases. In *Clark, T. J. H. and Godfrey, S. and Lee, T.H. and Thomson, N.C. Asthma*, pages 1–32. London : Arnold, 4th edition.

McCullagh, P. and Nelder, J. A. (1989). *Generalized linear models*, volume 37. CRC press.

McDowall, D. (1980). *Interrupted time series analysis*, volume 21. Sage Publications.

McFadden, E. and Gilbert, I. A. (1994). Exercise-Induced Asthma. *New England Journal of Medicine*, 330(19):1362–1367.

Medjo, B., Atanaskovic-Markovic, M., Nikolic, D., Spasojevic-Dimitrijeva, B., Ivanovski, P., and Djukic, S. (2013). Association between pet-keeping and asthma in school children. *Pediatrics International*, 55(2):133–137.

Milgrom, H., Bender, B., Ackerson, L., Bowrya, P., Smith, B., and Rand, C. (1996). Noncompliance and treatment failure in children with asthma. *Journal of Allergy and Clinical Immunology*, 98(6):1051–1057.

Mirabelli, M. C., Hsu, J., and Gower, W. A. (2016). Comorbidities of asthma in us children. *Respiratory medicine*, 116:34–40.

Moran-Ellis, J., Alexander, V. D., Cronin, A., Dickinson, M., Fielding, J., Sleney, J., and Thomas, H. (2006). Triangulation and integration: processes, claims and implications. *Qualitative Research*, 6(1):45–59.

Morton, R. W., Everard, M. L., and Elphick, H. E. (2014). Adherence in childhood asthma: the elephant in the room. *Archives of Disease in Childhood*, 99(10):949–953.

Naimi, D. R., Freedman, T. G., Ginsburg, K. R., Bogen, D., Rand, C. S., and Apter, A. J. (2009). Adolescents and asthma: why bother with our meds? *Journal of Allergy and Clinical Immunology*, 123(6):1335–1341.

Naspitz, C. K., Szefler, S. J., Tinkelman, D. G., and Warner, J. O. (2001). *Textbook of pediatric asthma : an international perspective (Foreword).* London : Martin Dunitz, c2001, London.

Nelder, J. A. and Baker, R. J. (1972). *Generalized linear models.* Wiley Online Library.

NHS (2014a). Asthma. http://www.nhs.uk/conditions/asthma/Pages/Introduction.aspx. Accessed: 31/10/2014.

NHS (2014b). Asthma - Symptoms. http://www.nhs.uk/Conditions/Asthma/Pages/Symptoms.aspx. Accessed: 31/10/2014.

NICE (2009). Medicines adherence: involving patients in decisions about prescribed medicines and supporting adherence (cg76).

Nistal-Nuño, B. (2017). Segmented regression analysis of interrupted time series data to assess outcomes of a south american road traffic alcohol policy change. *Public Health*, 150:51–59.

Nocon, A. (1991). Social and emotional impact of childhood asthma. *Archives of Disease in Childhood*, 66(4):458.

O'Cathain, A., Murphy, E., Nicholl, J., et al. (2010). Three techniques for integrating data in mixed methods studies. *BMJ*, 341.

O'Cathain, A. and Thomas, K. (2006). *Qualitative research in health care (Chapter 9).* John Wiley & Sons.

Paton, J. (2001). Management of chronic asthma in children. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 339–399. London : W. B. Saunders, 2nd edition.

Patton, M. Q. (1990). *Qualitative evaluation and research methods* . SAGE Publications, inc.

Peláez, S., Lamontagne, A. J., Collin, J., Gauthier, A., Grad, R. M., Blais, L., Lavoie, K. L., Bacon, S. L., Ernst, P., Guay, H., et al. (2015). Patients perspective of barriers and facilitators to taking long-term controller medication for asthma: a novel taxonomy. *BMC Pulmonary Medicine*, 15(1):42.

Penza-Clyve, S. M., Mansell, C., and McQuaid, E. L. (2004). Why don't children take their asthma medications? a qualitative analysis of children's perspectives on adherence. *Journal of Asthma*, 41(2):189–197.

Ram, F. S., Robinson, S. M., and Black, P. N. (2000a). Effects of physical training in asthma: a systematic review. *British Journal of Sports Medicine*, 34(3):162–7.

Ram, F. S., Robinson, S. M., and Black, P. N. (2000b). Effects of physical training in asthma: a systematic review. *British Journal of Sports Medicine*, 34(3):162–167.

Rand, C. S. (2005). Non-adherence with asthma therapy: more than just forgetting. *The Journal of Pediatrics*, 146(2):157–159.

Rees, J. (2010). *ABC of asthma (Asthma in Adults).* Chichester, West Sussex, UK ; Hoboken, NJ : Wiley-Blackwell : BMJ Books, 2010, Chichester, West Sussex, UK ; Hoboken, NJ, 6th ed. edition.

Rhee, H., Belyea, M. J., and Brasch, J. (2010). Family support and asthma outcomes in adolescents: barriers to adherence as a mediator. *Journal of Adolescent Health*, 47(5):472–478.

Rossman, G. B. and Wilson, B. L. (1985). Numbers and words combining quantitative and qualitative methods in a single large-scale evaluation study. *Evaluation Review*, 9(5):627–643.

Rothman, K. J. (2012). *Epidemiology: an introduction.* Oxford University Press.

Ruffin, R., Southcott, A. M., and Adams, R. (2001). Specific problems: psychological factors. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 515–521. London : W. B. Saunders, 2nd edition.

Rutten, C., Boen, F., and Seghers, J. (2014). Changes in physical activity and sedentary behavior during the transition from elementary to secondary school. *Journal of Physical Activity and Health*, 11(8):1607–1613.

Samet, J. M., Wiesch, D. G., and Ahmed, I. H. (2001). Pediatric asthma: epidemiology and natural history. In *Naspitz, C. and Szefler, S. and Tinkelman, D. and Warner, J. Textbook of pediatric asthma : an international perspective*, pages 35–67. London : Martin Dunitz,.

Sandelowski, M. (1991). Telling stories: Narrative approaches in qualitative research. *Journal of Nursing Scholarship*, 23(3):161–166.

Sears, M. (2001). Natural history. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 19–27. London : W. B. Saunders, 2nd edition.

Sears, M. R. (1998). Epidemiology. In *Barnes, P. Rodger, I. and Thomson, Neil. Asthma : basic mechanisms and clinical management*, pages 1–35. San Diego, Calif. ; London : Academic, 3rd edition.

Sears, M. R. and Johnston, N. W. (2007). Understanding the september asthma epidemic. *Journal of Allergy and Clinical Immunology*, 120(3):526–529.

Seys, S. F., Daenen, M., Dilissen, E., Van Thienen, R., Bullens, D. M., Hespel, P., and Dupont, L. J. (2013). Effects of high altitude and cold air exposure on airway inflammation in patients with asthma. *Thorax*, 68(10):906913.

SIGN-153 (2016). British guideline on the management of asthma. *Thorax*.

Silverman, D. (2006). *Interpreting qualitative data: Methods for analyzing talk, text and interaction*. Sage Publications.

Silverman, D. (2013). *Doing qualitative research: A practical handbook*. Sage Publications Limited.

Silverman, R. A., Stevenson, L., and Hastings, H. M. (2003). Age-related seasonal patterns of emergency department visits for acute asthma in an urban environment. *Annals of Emergency Medicine*, 42(4):577–586.

Smith, J. A. (2015). *Qualitative psychology: A practical guide to research methods*. Sage Publications.

Spahn, J. D. and Covar, R. (2008). Clinical assessment of asthma progression in children and adults. *Journal of Allergy and Clinical Immunology*, 121(3):548–557.

Staiano, A., Broyles, S., and Katzmarzyk, P. (2015). School Term vs. School Holiday: Associations with Children's Physical Activity, Screen-Time, Diet and Sleep. *International Journal of Environmental Research and Public Health*, 12(8):8861–8870.

Stevens, K. J. (2008). *The development of a preference based paediatric health related quality of life measure for use in economic evaluation*. PhD thesis, University of Sheffield.

Storr, J. and Lenney, W. (1989). School holidays and admissions with asthma. *Archives of Disease in Childhood*, 64(1):103–107.

Strachan, D. P., Butland, B. K., and Anderson, H. R. (1996). Incidence and prognosis of asthma and wheezing illness from early childhood to age 33 in a national british cohort. *BMJ*, 312(7040):1195–1199.

Suldo, S. M. and Shaunessy-Dedrick, E. (2013). Changes in stress and psychological adjustment during the transition to high school among freshmen in an accelerated curriculum. *Journal of Advanced Academics*, 24(3):195–218.

Szumilas, M. (2010). Explaining odds ratios. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 19(3):227.

Tantisira, K. G., Colvin, R., Tonascia, J., Strunk, R. C., Weiss, S. T., and Fuhlbrigge, A. L. (2008). Airway responsiveness in mild to moderate childhood asthma: sex influences on the natural history. *American Journal of Respiratory and Critical Care Medicine*, 178(4):325–331.

Teddlie, C. and Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage Publications Inc.

Thomas, M. and Bruton, A. (2014). Breathing exercises for asthma. *Breathe*, 10(4):312–322.

Thomas, M., McKinley, R. K., Mellor, S., Watkin, G., Holloway, E., Scullion, J., Shaw, D. E., Wardlaw, A., Price, D., and Pavord, I. (2009). Breathing exercises for asthma: a randomised controlled trial. *Thorax*, 64(1):55–61.

Thomson, N. (2001). Triggers of asthma. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 43–53. London : W. B. Saunders, 2nd edition.

Van Steenis, M., Driesenaar, J., Bensing, J., Van Hulten, R., Souverein, P., Van Dijk, L., De Smet, P., and Van Dulmen, A. (2014). Relationship between medication beliefs, self-reported and refill adherence, and symptoms in patients with asthma using inhaled corticosteroids. *Patient preference and adherence*, 8:83.

Vazquez, K., Sandler, J., Interian, A., and Feldman, J. M. (2017). Emotionally triggered asthma and its relationship to panic disorder, ataques de nervios, and asthma-related death of a loved one in latino adults. *Journal of Psychosomatic Research*, 93:76–82.

Vikram Yadav MRCPsych, M. (2010). Secondary school transition: does mentoring help'at-risk'children? *Community Practitioner*, 83(4):24.

Wagner, A. K., Soumerai, S. B., Zhang, F., and Ross-Degnan, D. (2002). Segmented regression analysis of interrupted time series studies in medication use research. *Journal of Clinical Pharmacy and Therapeutics*, 27(4):299–309.

Walters, E. H., Gibson, P. G., Lasserson, T. J., and Walters, J. A. (2007). Long-acting beta2-agonists for chronic asthma in adults and children where background therapy contains varied or no inhaled corticosteroid. *The Cochrane Library*.

Wamala, S., Merlo, J., Bostrom, G., Hogstedt, C., and Agren, G. (2007). Socioeconomic disadvantage and primary non-adherence with medication in sweden. *International Journal for Quality in Health Care*, 19(3):134–140.

Wang, R., Lagakos, S. W., Ware, J. H., Hunter, D. J., and Drazen, J. M. (2007). Statistics in medicinereporting of subgroup analyses in clinical trials. *New England Journal of Medicine*, 357(21):2189–2194.

Wang, Y. C., Vine, S., Hsiao, A., Rundle, A., and Goldsmith, J. (2015). Weight-Related Behaviors When Children Are in School Versus on Summer Breaks: Does Income Matter? *Journal of School Health*, 85(7):458–466.

Warner, J. O., Naspitz, C. K., and Rizzo, M. C. (2001). Management of chronic asthma in children between 5 and 18 years of age. In *Naspitz, C. and Szefler, S. and Tinkelman, D. and Warner, J. Textbook of pediatric asthma : an international perspective*, pages 149–189. London : Martin Dunitz,.

Weiss, K. B. (1990). Seasonal trends in us asthma hospitalizations and mortality. *Jama*, 263(17):2323–2328.

Westergren, T., Fegran, L., Nilsen, T., Haraldstad, K., Kittang, O. B., and Berntsen, S. (2016). Active play exercise intervention in children with asthma: a pilot study. *BMJ Open*, 6(1):e009721.

WHO (2014). Epidemiology. http://www.who.int/topics/epidemiology/en/. Accessed: 13/08/2015.

Wigfield, A., Eccles, J. S., Mac Iver, D., Reuman, D. A., and Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology*, 27(4):552.

Wilkinson, S., Joffe, H., and Yardley, L. (2004). Qualitative data collection: interviews and focus groups. In *Marks, David F and Yardley, Lucy Research methods for clinical and health psychology*, pages 39–56. London : Sage Publications.

Williams, B., Hoskins, G., Pow, J., Neville, R., Mukhopadhyay, S., and Coyle, J. (2010). Low exercise among children with asthma: a culture of over protection? a qualitative study of experiences and beliefs. *British Journal of General Practice*, 60(577):e319–e326.

Wood, B. L., Lim, J., Miller, B. D., Cheah, P. A., Simmens, S., Stern, T., Waxmonsky, J., and Ballow, M. (2006). Family emotional climate, depression, emotional triggering of asthma, and disease severity in pediatric asthma: Examination of pathways of effect. *Journal of Pediatric Psychology*, 32(5):542–551.

Woolcock, A., Keena, V., and Peat, J. (2001). Definition, classification, epidemiology and risk factors. In *O'Byrne, Paul. and Thomson, Neil. Manual of asthma management*, pages 3–19. London : W. B. Saunders, 2nd edition.

Xirasagar, S., Lin, H.-C., and Liu, T.-C. (2006). Seasonality in pediatric asthma admissions: the role of climate and environmental factors. *European Journal of Pediatrics*, 165(11):747–752.

Xu, D., Wang, Y., Chen, Z., Li, S., Cheng, Y., Zhang, L., and Zhao, L. (2016). Prevalence and risk factors for asthma among children aged 0–14 years in hangzhou: a cross-sectional survey. *Respiratory research*, 17(1):122.

Yeh, K.-W., Chang, C.-J., and Huang, J.-L. (2011). The association of seasonal variations of asthma hospitalization with air pollution among children in taiwan. *Asian Pacific Journal of Allergy and Immunology*, 29:34–41.

Yiallouros, P. K., Economou, M., Kolokotroni, O., Savva, S. C., Gavatha, M., Ioannou, P., Karpathios, T., and Middleton, N. (2015). Gender differences in objectively assessed physical activity in asthmatic and non-asthmatic children. *Pediatric Pulmonology*, 50(4):317–326.

Zeng, D., Thomsen, M. R., Nayga, R. M., and Rouse, H. L. (2016). Middle school transition and body weight outcomes: Evidence from arkansas public schoolchildren. *Economics & Human Biology*, 21:64–74.

A. PLEASANT

List of the secondary endpoints used in the PLEASANT study:

N^{O}.	Endpoint	Time	Type	Contact
1	Proportion of patients who had a medical contact	Sept-Dec 13	Relevant	Unscheduled
2	Total number of medical contacts per patient	Sept 13 & Sept-Dec 13	Relevant	Unscheduled & Scheduled
3	Proportion of patients who had a medical contact	Sept 13 & Sept-Dec 13	Relevant	Unscheduled or Scheduled
4	Time to first medical contact	Sept 13 & Sept-Dec 13	First Relevant	Unscheduled
5	Time to first medical contact	Sept 13 & Sept-Dec 13	First Relevant	Unscheduled or scheduled
6	Proportion of patients who had a medical contact	Sept 13 & Sept-Dec 13	Respiratory	Unscheduled or Scheduled
7	The total number of medical contacts per patient	Sept 13 & Sept-Dec 13	Respiratory	Unscheduled
8	Time to first medical contact	Sept 13 & Sept-Dec 13	Respiratory	Unscheduled
9	Number of Prescriptions per patient	August 13	-	-
10	Number of prescriptions after the intervention	Sept 13-Aug 14	-	-
11	Proportion of patients who have a asthma review	August 13	Asthma Review	Scheduled
12	Proportion of patients after the intervention	Sept 13-Aug 14	Asthma Review	Scheduled

Table of the secondary endpoints in the PLEASANT study

GP letterhead

< Address line 1>
< Address line 2>
< Address line 3>
< Address line 4>

<Insert Date>

Dear Parent

Please read this important letter regarding your child's asthma

It is really important that your child continues to take their asthma medication during the summer holidays. Returning to school is a time when asthma can get worse and make children and young people with asthma poorly. This may be due to contact with infections at the start of the new school year.

To reduce the chances of getting poorly when they return to school, your child should continue to take their asthma medication as prescribed by their GP or practice nurse. If your child has stopped taking their medication over the summer holidays it is important to start it again as soon as possible. If they are short of medication, or you are not sure of the proper dose, please get in touch with the practice.

Yours sincerely

<Name of Doctor>

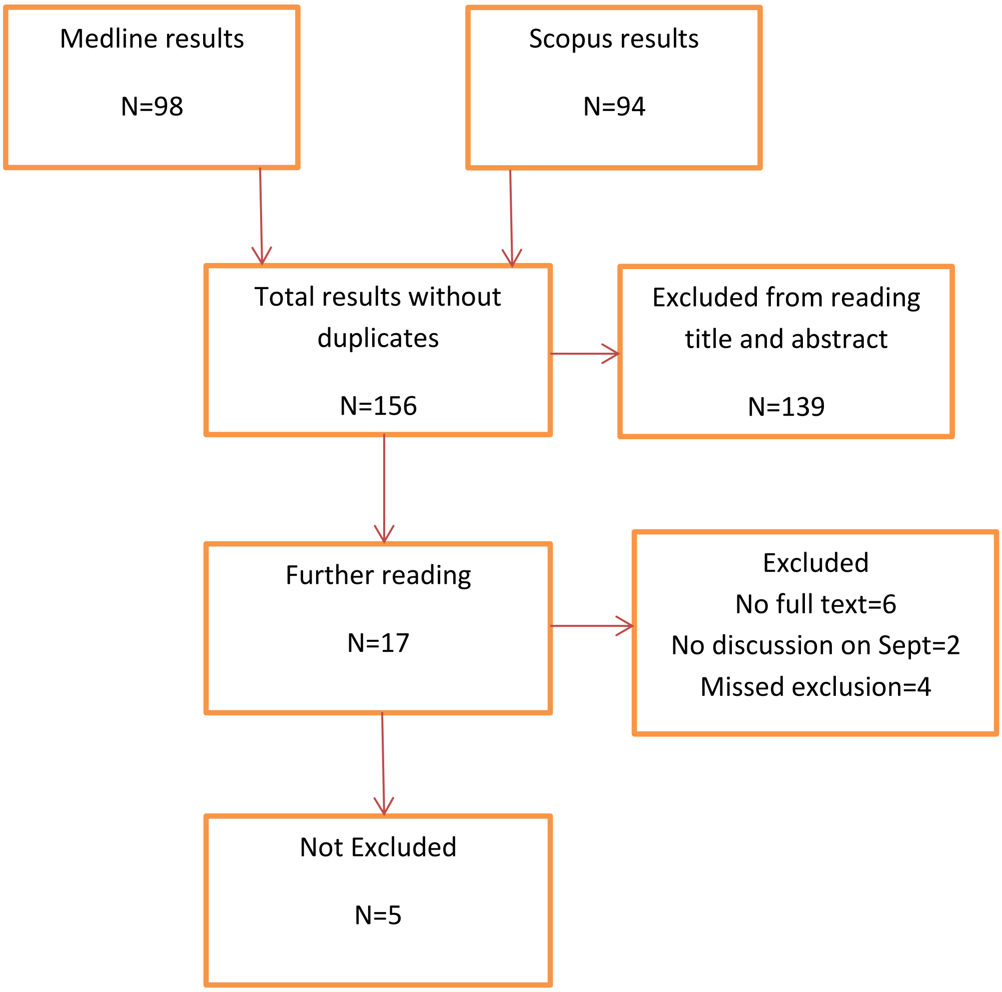
B. Search Terms

Medline (Pubmed)

	Search Terms [Accessed 08/11/15]	**Results**
1	pediat*[Title/Abstract] OR child*[Title/Abstract] OR adolescent[Title/Abstract] OR adolescents[Title/Abstract] OR teen*[Title/Abstract] OR Boys[Title/Abstract] OR Girls[Title/Abstract] OR Minors[Title/Abstract] OR Pupils[Title/Abstract] OR School[Title/Abstract] OR Youngsters[Title/Abstract] OR young People[Title/Abstract] OR Youths[Title/Abstract] OR school age*[Title/Abstract] OR school-age*[Title/Abstract] OR 5-16 year* old*[Title/Abstract] OR child[Mesh] OR adolescent[Mesh]	2560935
2	asthma[Title/Abstract] OR asthma*[Title/Abstract] OR antiasthma*[Title/Abstract] OR anti-asthma*[Title/Abstract] OR respiratory[Title/Abstract] OR wheez* [Title/Abstract] OR bronco*[Title/Abstract] OR respiratory airway*[Title/Abstract] OR asthma[Mesh]	468948
3	Unscheduled medical contact[Title/Abstract] OR Medical contacts[Title/Abstract] OR hospitali*[Title/Abstract] OR admission[Title/Abstract] OR GP[Title/Abstract]	310879
4	England[Title/Abstract] OR English[Title/Abstract] OR Wales[Title/Abstract] OR Welsh[Title/Abstract] OR Britain[Title/Abstract] OR British[Title/Abstract]	164452
5	Factor*[Title/Abstract] OR predict*[Title/Abstract] OR Time Series[Title/Abstract] OR Logistic Regression[Title/Abstract]	3400819
6	1 AND 2 AND 3 AND 4 AND 5	98

Scopus

	Search Terms [Accessed 08/11/15]	**Results**
1	TITLE-ABS (pediat*) OR TITLE-ABS (child*) OR TITLE-ABS (adolescent) OR TITLE-ABS (adolescents) OR TITLE-ABS (teen*) OR TITLE-ABS (boys) OR TITLE-ABS (girls) OR TITLE-ABS (minors) OR TITLE-ABS (pupils) OR TITLE-ABS (school) OR TITLE-ABS (youngsters) OR TITLE-ABS (young people) OR TITLE-ABS (youths) OR TITLE-ABS (school age*) OR TITLE-ABS (school-age*) OR TITLE-ABS (5-16 year* old*)	2619462
2	TITLE-ABS (asthma) OR TITLE-ABS (asthma*) OR TITLE-ABS (antiasthma*) OR TITLE-ABS (anti-asthma*) OR TITLE-ABS (respiratory) OR TITLE-ABS (wheez*) OR TITLE-ABS (bronco*) OR TITLE-ABS (respiratory airway*)	561107
3	TITLE-ABS (unscheduled medical contact) OR TITLE-ABS (medical contacts) OR TITLE-ABS (hospitali*) OR TITLE-ABS (admission) OR TITLE-ABS(GP)	448256
4	TITLE-ABS (england) OR TITLE-ABS (english) OR TITLE-ABS (wales) OR TITLE-ABS (welsh) OR TITLE-ABS (Britain) OR TITLE-ABS (British)	672470
5	TITLE-ABS (factor*) OR TITLE-ABS (predict*) OR TITLE-ABS (Time Series) OR TITLE-ABS (Logistic Regression)	7167941
6	1 AND 2 AND 3 AND 4 AND 5	94


Medline results
N=98
Scopus results
N=94
Total results without duplicates
N=156
Excluded from reading title and abstract
N=139
Further reading
N=17
Excluded
No full text=6
No discussion on Sept=2
Missed exclusion=4
Not Excluded
N=5

C. Ethics Approval

The following ethics approval letter have been included:

- Secondary Data Analysis Ethics.
- Qualitative Study Ethics.

The University Of Sheffield.

School Of Health And Related Research.

Ellie Nicolson
Ethics Committee Administrator

Regent Court
30 Regent Street
Sheffield S1 4DA

Telephone: +44 (0) 114 222 2965
Fax: +44 (0) 114 272 4095 (non confidential)
Email: e.l.nicolson@sheffield.ac.uk

07 August 2015

ScHARR

Dear Rebecca,

An investigation of the factors which influence children with asthma having asthma exacerbations around the start of the new school year

I am pleased to inform you your supervisor has reviewed your project and classed it as 'low risk' so you can proceed with your research. The research must be conducted within the requirements of the hosting/employing organisation or the organisation where the research is being undertaken.

I have received a copy of your student declaration together with your Supervisor's confirmation for research that does not involve human participants and that you will be undertaking research which involves analysis of already existing data ('secondary data').

Yours sincerely

E. Nicolson

Ellie Nicolson
On behalf of the ScHARR Research Ethics Committee

Copy:

Downloaded: 10/05/2016
Approved: 10/05/2016

Rebecca Simpson
Registration number: 140132696
School of Health and Related Research
Programme: N/A

Dear Rebecca

PROJECT TITLE: An Investigation of the Factors which Influence Children with Asthma Having Asthma ExacerbationsThroughout the Year
APPLICATION: Reference Number 008174

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 10/05/2016 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 008174 (dated 09/05/2016).
- Participant information sheet 1016813 version 2 (03/05/2016).
- Participant information sheet 1016812 version 2 (03/05/2016).
- Participant information sheet 1016811 version 2 (03/05/2016).
- Participant consent form 1016814 version 2 (03/05/2016).

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since written approval will be required.

Yours sincerely

Jennifer Burr
Ethics Administrator
School of Health and Related Research

D. Topic Guides

The following topic guides are provided:

- Secondary school before summer topic guide.
- Secondary school after summer topic guide.

Topic Guide for Interviews with Children with Asthma (Secondary before summer)

Aim:

Want to get an understanding of what it is like to asthma from a child's point of view.
Want to know what they think can cause their or others asthma to get worse.
Want to know if there are times when they or others don't take their medication and why that is.

Ice Breakers:

- How are you today?
- What have you been doing today at school? Etc.

Introductions:

Introduce yourself
Describe the project
For my project I have information about children visiting their doctors. Sometimes it was for asthma, sometimes it was not. I am interested in the times when the appointment was for asthma. Sometimes it can be for a routine appointment, meaning you go to the doctors because you have run out of medicine. Or the appointment can be because your asthma is making you feel more unwell than normal. I am talking to you because I want to know what it is like to have asthma and what you think can make your asthma better or worse. There are no right or wrong answers; I just want to hear from someone with asthma what they think. I will use this information to try to explain what makes people with asthma more poorly.
Go through the information sheet and answer any questions they have
Read through the information sheet with the young person and allow them to ask questions, and make sure they understand what everything means.
Ask for verbal consent – <u>talk about audio recording.</u>
You then need to sign their previously signed consent form.
Do you understand what you are here to do? Are you still happy to take part? Are you happy for me to audio record the interview? This means I'll use this device (show device) to record our interview and when I go back to work I will write up what we said. When I do that I will change your name so no one will know it was you.

<u>Questions</u>

Starter/background:

- Tell me a little bit about yourself?
- How old are you?
- What year are you in?
- What do you like doing? Favourite hobby/pet/sport/activity?
- Been on any holidays recently?

Remind the children that they have asthma and you don't so <u>they are the expert</u>. They can help you understand what it is like to have asthma.

- How long have you had asthma?
  Or when did your asthma start? How old?
- How many people do you know with asthma?
- What kind of sports/activities do you like to do?
- How much sport/exercise/activities do you do? (after-school clubs?)

Asthma affecting their life (*Seasons*):

- Tell me about your daily routine, from getting up in the morning to going to bed?
  -Do you take your asthma medicines?
  -When do you take your asthma medicines?
- Tell me what is it like having asthma? Describe to me what it is like having asthma?
- Does your asthma stop you from doing what you want to do?
- Can you do the same things as your friends and family?
- Does your asthma affect your day?
  Probes- At home/school/friends/spare time/sleeping/weekends/sport
- How is your asthma today?
- How has it been recently?
- Do you notice anything different about your asthma when you are at school?
- Do you notice anything different about your asthma when you are on holiday? (School holidays and away)
- What kinds of things make your asthma better?
- What kinds of things make your asthma worse?
- What times of year does your asthma have an impact? (PROMPT – leading question)

Medications:

- Which out of these pictures of asthma medication do you take?
- What is it like taking your asthma medicines?
- When do you take your asthma medications?
- Does taking your medication stop you from doing anything?
- Are there any times when you don't take your medication?
- Do you forget to take your medication?
- Do you take it yourself?
- How often do you take your asthma medicines?
- How often do you see your doctor because of your asthma?
- Have you ever been to hospital because of your asthma? – How did that make you feel?
- How often do you get new asthma medicines?

End:

- Is there anything that you think is important about being a young person with asthma that we haven't covered?
- Do you have any questions for me?

After interview:

Thank them for their time.
Give them amazon voucher.

<u>Topic Guide for Interviews with Children with Asthma (Secondary after summer)</u>

Aim:

Want to get an understanding of what it is like to asthma from a child's point of view.
Want to know what they think can cause their or others asthma to get worse.
Want to know if there are times when they or others don't take their medication and why that is.

Ice Breakers:

- How are you today?
- What have you been doing today at school? Etc.

Introductions:

<u>Start recorder now</u>

Introduce yourself
Describe the project
For my project I have information about children visiting their doctors for asthma. I am interested in the times when the appointment was for asthma. Sometimes it can be for a routine appointment, meaning you go to the doctors because you have run out of medicine. Or the appointment can be because your asthma is making you feel more unwell than normal. I am talking to you because I want to know what it is like to have asthma and what you think can make your asthma better or worse. I also want to know about your asthma medicines. There are no right or wrong answers; I just want to hear from someone with asthma what they think. I will use this information to try to explain what makes people with asthma more poorly.

Remind the children that they have asthma and you don't so <u>they are the expert</u>. They can help you understand what it is like to have asthma.
Go through the information sheet and answer any questions they have
Read through the information sheet with the young person and allow them to ask questions, and make sure they understand what everything means.
Ask for verbal consent – <u>talk about audio recording.</u>
You then need to sign their previously signed consent form.
Do you understand what you are here to do? Are you still happy to take part? Are you happy for me to audio record the interview? This means I'll use this device (show device) to record our interview and when I go back to work I will write up what we said. When I do that I will change your name so no one will know it was you.

Icebreaker task: Ask the pupil to choose or pick a name they would like to be referred to as when I write up the transcript.

<u>Questions</u>

Starter/background:

- How old are you?
- What year are you in?

- What have you been doing today at school?
- How is your asthma today?
- How has it been recently?
  If not good, what where the symptoms, how did they feel unwell?
- Do you remember when your asthma started? When was it?
- Do any of your family have asthma?
- Tell me what is it like having asthma? Describe to me what it is like having asthma?

Factors:

- What kinds of things make your asthma better?
- What kinds of things make your asthma worse?
  Pets/asthma/dust/pollen/cold weather/ wet weather/unwell

<u>Sports</u>

- What do you like doing? Favourite hobby/sport/activity?
- What kind of sports/activities do you like to do?
- How much sport/exercise/activities do you do? (after-school clubs?)
- How active would you say you were?
- How does the asthma affect your sport?
- Has it ever stopped you from doing sport?
- How does it make you feel?

<u>Holidays</u>

- Been on any holidays recently?
- What was the last holiday you went on?
- Are you going on any holidays?
- How is your asthma when you are on holiday?
- Do you notice anything different about your asthma when you are away on holiday?
-

<u>Pets/Allergies</u>

- Do you have any pets?
- Do you have any other allergies?
- Hay fever? When do you get hay fever?
- Weather?
-

Routine:

- Do you notice anything different about your asthma when you are at school?
- Do you notice anything different about your asthma when you are on holiday? (School holidays and away)

- Tell me about your daily routine, from getting up in the morning to going to bed?
  -Do you take your asthma medicines?
  -When do you take your asthma medicines?
- Does your asthma affect your day?
  Probes- At home/school/friends/spare time/sleeping/weekends/sport
- How often does your asthma make you feel unwell in a year?
- What times of year does your asthma have an impact? (PROMPT – leading question)
- If there was a good time to have asthma, what time of the year would it be?

Summer Holiday/Return to School

- How was your summer holiday?
- Tell me what you did in the summer holidays?
- Did you go away anywhere during the summer break?
- When you were at home in the summer holidays, can you tell me what your usual day was?
- Did you do any sport/activities during the summer holidays?
- How was your asthma during the summer?
- Did you take your medication during the summer break?
- Was there any time that you didn't take your medication?
- How has returning back to school been?
- How has your asthma been now you are back at school?
- Have you noticed anything different about your asthma from when you were at home during the break to now when you are back at school?
-

Medications:

- Which out of these pictures of asthma medication do you take?
- When do you take your asthma medications?
- How often do you take your asthma medication?
- Does taking your medication stop you from doing anything?
- Are there any times when you don't take your medication?
- Do you take your medication when you are on holiday?
- What is the longest you have been without taking your medication?
- Do you forget to take your medication?
  If they don't take their medication, ask why?
- Some other children have told me that they sometimes forget to take their medication?
- Do you sometimes forget/need reminding by your parents?
- Do you take it yourself?
- How often do you take your asthma medicines?
- How often do you see your doctor because of your asthma?
- Have you ever been to hospital because of your asthma? – How did that make you feel?
- When did you go to the hospital?
- How often do you get new asthma medicines?

End:

- Is there anything that you think is important about being a child with asthma that we haven't covered?
- Do you have any questions for me?

After interview:

Thank them for their time.
Give them amazon voucher.