

Understanding the Presentation and Management of Functional Neurological Disorders

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctorate in Clinical Psychology

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Declaration

I, the author, confirm the contents of this thesis are my own work and that I am aware of the University of Sheffield guidance on unfair means (www.sheffield.ac.uk/new-students/ unfairmeans). This thesis is submitted in partial fulfilment of the requirements for the degree of Doctorate in Clinical Psychology. This work has not been submitted for any other degree or to any other institution. No funding has been received for this thesis. No conflicts of interests stated. For any enquiries about data or code sharing, please contact kmorgan5@sheffield.ac.uk or m.simmonds-buckley@sheffield.ac.uk.

Structure and Word Count

Section One: Literature Review

Excluding references and tables:	7,673
Including references and tables:	16,157

Section Two: Empirical Study

Excluding references and tables:	7,349
Including references and tables:	11,071

Total

Excluding references and tables:	15,022
Including references and tables:	27,228

Lay Summary

Functional Neurological Disorder (FND) is an umbrella diagnosis for a number of neurological difficulties that are associated with changes in how the brain processes information, but do not have the same observable changes as other neurological conditions. Increasing awareness of FND within health care settings has led to a drive to develop an understanding of the disorder and effective treatments. Patients with FND often experience a range of physical and psychological symptoms, which can lead to very different presentations across individuals. It is therefore important to develop ways to understand how FND can present differently. Additionally, due to the range of symptoms, it is recommended that treatment include a range of relevant professionals often described as a multimodal intervention.

Multimodal interventions can be complicated due to having multiple parts delivered by different professionals. Section one of this report explores how multimodal interventions are currently delivered and described, including participant characteristics and outcome measures used. A search was completed to identify research exploring multimodal interventions. Twenty-five studies were identified as suitable to be included in the review. Studies varied markedly in the level of reporting of interventions and mostly had a medium-low risk of bias. Inconsistent reporting means that it is difficult for researchers and clinicians to gather a balanced picture of existing interventions. This means that it can be challenging to implement interventions in practice and make decisions about care provision. Outcomes measures utilised across studies could be categorised into quality of life, psychological distress, FND symptoms, physical symptoms, functioning, non-standardised measures, engagement, adverse experiences, and other which correspond with areas of known difficulty for individuals with FND. Studies generally

reported participant age, gender, diagnoses (and how they were given); however, ethnicity and nationality were less regularly reported. Future research should aim to give more consistent reports of interventions and patient demographics to enable health care professionals to implement effective treatment.

Section two of this report aims to build on the current understanding of FND by using data gathered from individuals with FND to identify and label subgroups in a way that is useful for patients and health care professionals. A further aim was to identify whether demographic characteristics could predict which subgroup someone might belong to. Pre-existing data from an NHS FND psychotherapy service were analysed. The analysis found five subgroups based on their self-ratings on outcome measures of distress and functioning. These subgroups were then labelled based on their severity of distress and functioning. Age and employment were found to predict which subgroup an individual might belong to, but only for some subgroups. This study was the first to use data of this size to identify subgroups. Future research should aim to replicate these results and begin to identify whether some treatments are more effective than others for different subgroups.

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Section One: Literature Review

A Scoping Review of Psychologically-informed Multimodal Interventions for Functional Neurological Disorder

Abstract

Objectives: Functional Neurological Disorder (FND) is a complex disorder with current guidelines recommending multimodal treatments. This study aims to review: 1. How multimodal interventions are described in the literature using the TIDieR (Template for Intervention Description and Replication) checklist, with a quality assessment, 2. Patient demographics, diagnoses and how these are given, 3. Outcomes measurement of multimodal interventions.

Methods: Systematic database searches were completed on Medline, PsychInfo and Scopus in February 2025 and grey literature searches were completed in March 2025. Study characteristics were adult samples, investigating multimodal interventions that were not case studies. The quality assessment used three different critical appraisal tools for case series, randomised controlled trials and grey literature.

Results: Twenty-five studies were included. Studies demonstrated marked inconsistency in reporting on TIDieR checklist. Participant age (mean age in 30s and 40s), gender (female preponderance) and diagnoses (range of FND presentations) was consistently reported across studies. Ethnicity and nationality were consistently not reported. Outcome measurement mapped onto core symptoms and wider health issues associated with FND difficulties (such as psychological distress and quality of life). Studies were mainly categorised as medium-low risk of bias.

Conclusions: On the whole, interventions were in line with existing knowledge of FND and available treatments, with the inclusion of psychological components. Outcome reporting was well mapped onto relevant areas of health for FND patients. However, reporting varied widely and studies lacked elements of methodological robustness. Future research should address limitations highlighted in the quality

assessment and improve the consistency of reporting for multimodal interventions. Strengths and limitations of this review are discussed.

Keywords: Functional Neurological Disorder, FND, Conversion Disorder, Multimodal, Multidisciplinary

Practitioner Points

- Multimodal interventions most commonly consist of medical, psychological, physiotherapy, occupational therapy and speech and language therapy professionals.
- Reporting on intervention procedures is particularly inconsistent in the literature.
- Outcome measurement for multimodal interventions measures core symptoms and wider factors associated with FND, such as psychological distress and quality of life.
- Future research should aim to report interventions and patient demographics more consistently using more standardised approaches, as well as begin to use more robust methodological processes.

Introduction

Functional Neurological Disorder (FND) is a neurological disorder characterised by neurological symptoms without the same underlying observable pathology as other neurological conditions (National Institute of Neurological Disorders and Stroke, n.d.; American Psychiatric Association, 2013). Prevalence of FND is reported to be between 4-12 people per 100,000 and accounts for approximately 5-10 percent of new neurology consultations (Hirtz et al., 2007; Bennett et al., 2021). FND is an umbrella term encapsulating several clinical presentations: functional dissociative seizures, functional movement disorders (FMD), functional tics, functional tremor/parkinsonism (American Psychological Association, 2013). Historically, a range of alternative terms and perspectives (e.g., hysteria, conversion, psychogenic, pseudo) have been used to describe the same condition however these have been retired based on research advances allowing for more precise and less pejorative nomenclature.

The number of distinct clinical manifestations demonstrates high heterogeneity across individuals, particularly in symptom severity and persistence, duration and onset of illness, symptom type and overlap, and symptom location (Mavroudis et al., 2024). FND is associated with poorer health-related quality of life (HRQoL) compared to healthy controls (Vechetová et al., 2018) and a negative relationship between fatigue (an associated symptom of FND) and HRQoL. Disability and social outcomes are also commonly affected where factors such as employment rates are lower than healthy controls (Jennum et al., 2019) as well as high physical and psychiatric co-morbidity (Williams et al., 2022; Butler et al., 2020). Evidence also shows increased system-level costs for people with FND in terms of high health care utilisation (O'Mahony et al., 2023; Seneviratne et al., 2019).

Additionally, individuals with FND commonly receive incorrect diagnoses (Walzl et al., 2021), which can lead to harm from delayed evidence-based treatment but also the psychological harm of identifying with a diagnosis that is later changed (Solomon & Klein, 2013).

Complexity of FND

Understanding FND is complex. Firstly, research has demonstrated high symptom heterogeneity, including fatigue, cognitive symptoms, psychopathology (Butler et al., 2021), and various manifestations including sensory symptoms, limb weakness and non-epileptic seizures (Ahmad & Ahmad, 2016). FND charities have also highlighted complexity and heterogeneity, listing 16 symptoms of FND and 11 associated symptoms (Neurosymptoms.org, n.d.). Secondly, although various clinical manifestations show some distinct features, there also tends to be similarities in aetiology and pathophysiology. For example, Hallett et al., (2022) discussed how individuals may be assigned a distinct diagnosis of functional seizures or functional movement disorder (FMD), with distinct presentations but can overlap in risk factors and associated brain networking.

The context of these distinct subtypes bridges the divide between neurology and psychiatry. Recent historical perspectives have conceptualised FND as a psychological response to trauma and have been treated by psychiatry (Raynor & Baslet, 2021). However, as understanding grows about the underlying neurobiological mechanisms and psychological difficulties no longer being a prerequisite for diagnosis, neurologists are often the most appropriate medical professionals to work with FND patients (Hallett et al., 2022). Multi-professional involvement is nuanced due to the complexity of symptomology and requires a considered individualised approach (Aybek & Perez, 2022).

Treatment of FND

Medication is not recommended for management of FND symptoms and depending on the specific presentation, the frontline treatment is considered to be a combination of psychological and physical therapy (Epsay et al., 2018; National Institute of Neurological Disorders and Stroke, n.d.). Due to the range of physical, occupational and psychological difficulties individuals with FND experience, the consensus among researchers and clinicians is that a multidisciplinary (MDT) approach is the most appropriate (Hallett et al., 2022; British Psychological Society, 2024). Research has shown that, prior to direct interventions, psychoeducation around the diagnosis of FND is a potentially therapeutic step in care (La France et al., 2016). After diagnosis, there are a range of methods utilised with individuals with FND. Psychological professionals are often involved in treatment approaches, and research has investigated a range of models. Firstly, systematic reviews of Cognitive Behaviour Therapy (CBT) approaches have demonstrated improvement across a range of outcomes but studies generally lack long-term follow-up and high-quality trial data (Gutkin et al., 2021). A study that did include follow-up found improvements were no longer statistically significant at follow-up (Sharpe et al., 2011). CBT plus standard medical care (SMC) has demonstrated superiority over SMC alone for symptom reduction (Goldstein et al., 2010). However, in a large randomised controlled trial, Goldstein et al. (2020) found no difference in seizure frequency between CBT plus SMC and SMC alone. A recent scoping review also demonstrated mixed findings around the effectiveness of CBT (Varley et al., 2023). Other psychological approaches to treating FND include Acceptance and Commitment Therapy (Graham et al., 2018), mindfulness-based therapy (Baslet et al., 2020) and psychodynamic psychotherapy (Gutkin et al., 2021).

Often, psychological assessments and interventions are administered alongside other disciplines, particularly where there is a motor presentation (Czarnecki, et al., 2012). A small number of studies investigating MDT interventions demonstrated improvements in patient-reported health ratings and symptom severity, regardless of medication use or previous intervention history (Elliot & Elmalem, 2021). Importantly, there is evidence that improvements in somatic symptoms, depression, anxiety and functioning are sustained at 6-month follow-up (Petrochilos et al., 2020). Inpatient services consisting of neuropsychiatry, psychology, physiotherapy, occupational therapy and speech and language therapy have also demonstrated significant improvements for individuals with functional motor disorder (McCormack et al., 2014). In a systematic review, Aybek and Perez (2022) gave an overview of the existing evidence for treatment and management of FND, including multimodal rehabilitative settings. They draw conclusions that “early treatment should be informed by the biopsychosocial model” and “many patients benefit from a multidisciplinary approach that incorporates neuropsychiatric and rehabilitation perspectives”.

Current Multimodal Approaches

Although the emerging evidence suggests multimodal interventions benefit individuals with FND (Aybek & Perez, 2022; McCormack et al., 2014), treatment approaches are complex because multimodal interventions (interventions consisting of more than one professional approach) can adopt different methods. For example, an intervention could be multidisciplinary, interdisciplinary or transdisciplinary (Choi & Pak, 2006) depending on how each discipline's interventions integrate. The distinction in integration approach is often not made in the literature or clinically, and a large proportion of the wider literature on the management of FND, recommends

MDT treatment. An additional complexity is that recommendations draw on research that investigates each intervention separately (Keatley & Molton, 2022; Saxena & Yogarajah, 2023). It has not been investigated empirically how the intersection of integrated professional involvement impacts the effects of interventions being administered separately.

Despite the consensus for multimodal interventions and growing consideration of complex treatment approaches, the National Institute for Health and Care Excellence (NICE) has stated “adults diagnosed with a functional neurological disorder are supported to manage symptoms that are a part of the disorder in non-specialist care.” This guidance is in the context of research findings that professionals often do not feel skilled enough to treat FND (de Liège et al., 2022). This lack of clarity is also reflected in how interventions are investigated and presented. Large reviews of existing treatments give clear overviews of the outcomes from MDT treatment, but fail to adequately outline what the interventions actually constitute. For example, Aybek and Perez’s (2022) review refers to “rehabilitation treatment” and outlines the professionals involved in treatment, but rarely gives more details (Aybek Perez, 2022). Similarly, Sireci et al. (2024) completed a scoping review of therapeutic interventions for FND, of which multimodal interventions were included. However, this was not a systematic search aimed at collecting purely MDT interventions and did not use an established guideline for extracting and collating data. Additionally, studies sometimes detail single discipline treatment which occur within an MDT context, but fail to refer to this in the literature (Gutkin et al., 2021). MDTs often treat each patient slightly differently, with differing quantities of each profession's input, which is necessary when working with high levels of heterogeneity (McCormack et al., 2014). Without

the reporting of adaptation and tailoring, there is a barrier to implementation in practice. This creates a gap between research and clinical practice, whereby professionals and services cannot directly implement the interventions indicated in the evidence base due to the lack of detail and clarity.

With this in mind, the current study aims to review the current literature investigating psychologically-informed multimodal interventions to undertake a formal narrative synthesis of:

1. How psychologically-informed multimodal interventions are described in the literature using the TIDieR (Template for Intervention Description and Replication) checklist as a framework, with an assessment of methodological robustness of the included studies.
2. Patient groups (age, gender, ethnicity), diagnoses and how these are given,
3. Outcomes reported to assess multimodal interventions. This will be broken down into categories (such as psychological outcomes, physical outcomes, engagement/dropout, functioning, quality of life and other).

Methods

This report has been prepared in accordance with PRISMA (2020) guidance (Page et al., 2021; see Appendix A for full checklist) and pre-registered with the Open Science Framework (https://doi.org/10.17605/OSF.IO/4YS8A) where the review protocol can be accessed.

Eligibility Criteria

The inclusion and exclusion criteria used to determine eligibility for studies included in the review followed the “PICO” (Participants, Intervention, Comparator, Outcome) framework and are detailed in Table 1.

Table 1

Showing inclusion and exclusion criteria

PICO component	Inclusion criteria	Exclusion criteria
Participants	Adults with a diagnosis of FND	Paediatric samples [a]
Intervention	Any multimodal intervention consisting of psychology plus 1 or more other disciplines [b]	Intervention only included neurology and one other discipline. [c]
Comparator	With or without control or comparator group	
Outcome	Any	Any outcome that means the study is not assessing multimodal interventions
Publication language	Published in English Language	Not published in English
Study types and design	RCTs, cohort studies, comparator studies, qualitative studies	Case studies [d]

RCT = Randomised Controlled Trial, [a] Paediatric neurology is a different specialism to adult neurology in terms of developmental stage, treatment recommendations and outcomes. Therefore the decision was taken to only focus on adult samples.
[b] Discipline = any health and social care professional and alternative therapy practitioners, e.g. music therapy, support workers. Psychology must be a component of the intervention due to this being considered first line treatment. This is defined as involvement from a psychological professional or a psychological component delivered by another trained professional that goes beyond basic psychoeducation delivered as part of diagnosis.

[c] After diagnosis, input from neurology is limited (involving annual reviews with no active interventions delivered). Therefore, for any studies of neurology plus another discipline, the lead reviewer established whether there was active involvement from neurology. If there is not, the article will be excluded.
[d] Case studies were excluded because case studies are unlikely to be representative of a service provided.

Information Sources

Three databases were searched; Medline, PsycInfo and Scopus. The grey literature was also searched for any other relevant information using Opengrey.eu archives, ProQuest for dissertations and theses and FNDaction and FND Hope conference archives. Forward and backwards citation searching was also completed. Medline, PsycInfo and Scopus were searched on 3rd February 2025. ProQuest, and grey literature were searched on 17th February 2025, and forwards and backwards citation chasing was completed on 22nd March 2025. See Appendix B for the full search strategy.

Search Strategy

Databases were searched using the following search terms: Multimodal interventions OR multidisciplinary OR MDT OR interdisciplinary OR transdisciplinary OR “joint working” OR combined treatment AND “Functional neurological disorders” OR FND OR “Functional movement disorders” OR “functional motor disorder” OR FMD OR “non-epileptic seizures” OR “Non-epileptic attack disorder” OR NEAD OR “functional seizures” OR “psychogenic seizures” OR “dissociative seizures” OR “functional tics” OR “functional tremo*” OR “conversion disorder”. Search terms were checked for associated subject headings, and if appropriate, terms were searched as both a keyword and a subject heading. The search strategy was validated by identifying three studies that were eligible for inclusion and identifying them in the search results. The search strategy structure was informed by the “PICO”

framework. There were no date limits placed on the search to facilitate inclusion of all relevant research.

Selection Process

Studies were screened according to identified eligibility criteria by the lead reviewer. A researcher outside the research team independently screened a sample of 20% of studies for eligibility at title/abstract screening and full text screening. There was a percentage agreement of 89% between raters at title and abstract screening. Disagreements regarding inclusion were discussed at the title and abstract screening to clarify any issues before completing full-text screening. The percentage agreement between raters at full text screening was 63.6%, and 100% agreement was reached through discussion of the papers alongside eligibility criteria. During the screening process, the reviewers used Zotero (Zotero et al., 2023) for reference management and Excel (Microsoft Corporation, 2018) for data management. Eight correspondence authors were contacted where the lead reviewer was unable to access articles for full-text screening, two authors replied, one authors correspondence address no longer existed and five did not respond.

Data Extraction and Synthesis Methods

To ensure inclusion of any relevant research, any research design was eligible for inclusion (apart from case studies). Together the research team discussed papers that were more complex to establish eligibility. For example, papers that were presenting the development of a multimodal treatment pathway but not empirically testing the intervention. This decision was determined, primarily by the aim of the current study but also by considering the clinical utility of the inclusion and exclusion of studies. Data was extracted by the lead reviewer only, using several methods. Firstly, to satisfy the main aim of reviewing how multimodal interventions

are described in the existing literature, data was extracted using the TIDieR checklist (Hoffmann et al., 2014; see Appendix C). The TIDieR checklist is a 12-item guideline for reporting interventions following the framework of “name, why, what (materials), what (procedure), who provided, how, where, when and how much, tailoring, modifications, how well (planned), how well (actual)”. It was used to review how multimodal interventions are described in the literature. Excel was used to gather extracted data and was formatted in line with the TIDieR checklist (Hoffman et al., 2014) alongside data gathered around outcome measures and participant characteristics. Information for each item was condensed as much as possible from each study. If the information was missing, it was simply noted as “no details”. Data from the 12 items were then collapsed down into groups for the narrative write up: 1. Naming and “Why”, 2. What (Materials), What (Procedure) and Who Provided, 3. When and How Much 4. Tailoring, Modifications & “How Well”. Once descriptive information was compiled, synthesis around missing information and interpretation of the different reporting methods for each section of the TIDieR checklist was completed.

Secondly, to review and summarise patients, setting, conditions, and how diagnoses were given, the lead review manually extracted this data. Lastly, to review what outcomes are measured, the lead reviewer manually extracted outcomes reported and grouped these in the following categories: psychological outcomes, physical outcomes, engagement, functioning, quality of life, and other. Missing data was identified and is reported in the results section of this report. An interpretation of how outcome measurement mapped onto elements of the interventions was made. All data were then synthesised narratively for each aim of the review through

tabulation of the extracted data along with a narrative synthesis of common themes and reporting processes across studies.

Risk of Bias Assessment

Study Risk of Bias

Risk of bias (RoB) was assessed by the lead reviewer. Case series studies were assessed using the Joanne Briggs Institute Case Series Checklist (Munn et al., 2020), randomised controlled trials (RCT) were assessed using the CASP RCT checklist (Critical Appraisal Skills Programme, 2024), and reports of service development were assessment using the AACODS (Authority, Accuracy, Context, Objectivity, Date, Significance) (Tyndall, 2010). Risk of Bias assessments were amended post hoc and consequently no second-rater assessment and agreement analysis has been completed. There is no established procedure for categorising level of risk on the chosen tools. Therefore, low, medium and high risk categories were established based on the number of “yes” answers on the measure which indicate strengths of the papers. Due to the differing number of questions across appraisal tools, categories varied slightly. See Appendix D for checklist and Appendix E for the full risk of bias summary and corresponding risk categories included as notes on each table.

Reporting Bias

Measures were taken to avoid reporting biases by Cochrane handbook guidance (Sterne et al., 2008). Firstly, searches were untaken in the grey literature and unpublished dissertations and theses repositories to combat publication bias. FND charities’ websites were searched for any relevant research material, including conference abstracts or posters. Forward and backwards citation chasing was completed. Both screening stages included a sample of independent review, and any

disputes were discussed with the wider research team where necessary. In order to include all studies relevant to the aim of the review, studies with high risk of bias were not excluded and any research design was included.

Changes from Pre-registration

There were several changes from the pre-registration for the project. Firstly, it was registered as a systematic review but due to the aims of the study, this has been reframed as a scoping review. Secondly, the decision was made to exclude case studies due to this not being reflective of wider service and treatment provision. Thirdly, having a psychological component to the intervention was included as an inclusion criteria due to this being considered the first line treatment.

Results

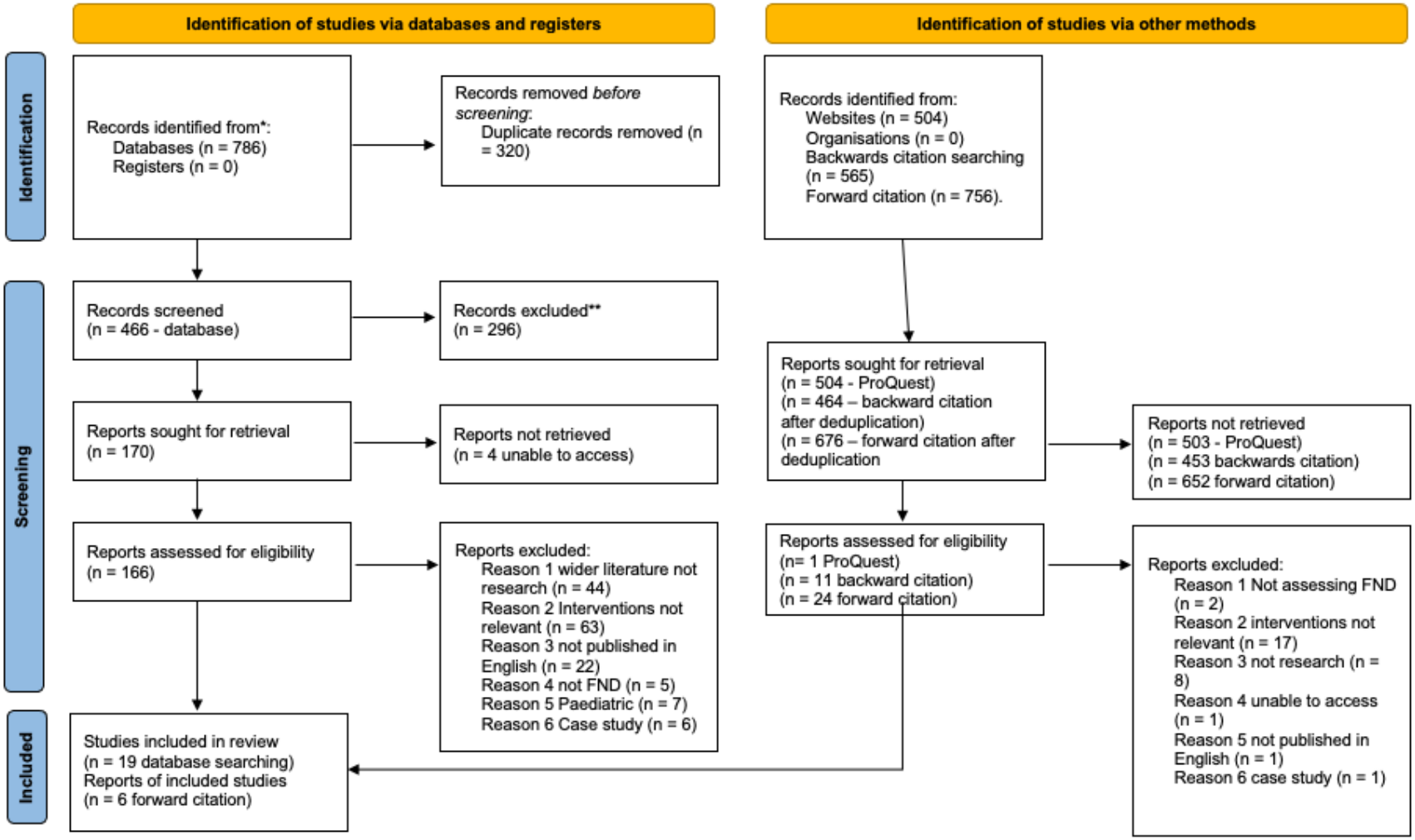
The database search strategy returned 468 unique titles and abstracts. At full-text screening, one hundred and sixty-five studies were assessed for eligibility. Common reasons for exclusion were: studies were not assessing FND, only assessing single-discipline interventions, constituted wider literature as opposed to research or were unable to access the paper. Reasons for exclusion were collapsed into six main categories: wider literature not research, interventions not relevant, not published in English, not FND, Paediatric sample, and case studies. Nineteen articles were identified as eligible for inclusion in the final review. Forward and backwards citation, and ProQuest searches identified 1644, six of which were eligible for inclusion. Consequently, k = 25 were included in the final sample for the scoping review. Figure 1 shows the PRISMA flow diagram detailing study selection processes.

Risk of Bias

Studies were mainly categorised as medium risk (k = 12) and low risk (k = 10) with only 3 categorised as high risk. For case series studies a consistent issue for risk of bias was not using reliable and valid methods for measuring conditions as well as not having consecutive or complete inclusion of cases. This was a consistent problem across low, medium and high risk categorisation. A strength for case series reports was consistent reporting of demographic and clinical participant information. This strength is particularly important with a population with high levels of heterogeneity for clinicians applying findings to their own clinical population. For randomised controlled trials patterns for risk of bias are hard to identify due to only having two RCTs. Nonetheless, neither paper had full blinding procedures that included participants, investigators and assessors and neither paper had a cost-effective analyses. This is important when thinking about a potential use of the research being determining cost-effectiveness in service planning and commissioning. For reports of service development, all studies came from a reputable source with authors who would be considered experts in the field and had established coverage for the article. However, a consistent issue was not having a clearly stated aim which makes assessing quality of methodology reporting difficult to establish and not having a clear date or period of time that the articles covered. For categorisation for each study, please see Table 2.

Figure 1

PRISMA flow diagram for study selection



*Automation tools were used to deduplicate all but one study from the database and register searches. Deduplication was mainly done by hand for the citation chasing studies, as automation tools were not able to identify duplicates.

Study and Patient Characteristics

There were (k = 18) case series studies, (k = 2) randomised controlled trials and (k = 5) reports of service development. Studies were conducted across a number of countries: New Zealand (k = 2), England (k = 9), Spain (k = 1), USA (k = 6), Italy (k = 1), Canada (k = 2), Germany (k = 2), Switzerland (k = 2). There was a range of study samples. Sample sizes ranged from n = 13 to n = 193, four studies did not include sample sizes and were instead focused on intervention models or pathways of care. Study participants varied in terms of presentation. There were samples of mixed presentations (k = 5), functional motor disorder or functional movement disorder (k = 12), functional neurological disorder (k = 5), non-epileptic seizures (k = 1) and motor conversion disorder (k = 1), with one study not detailing patient group. The studies reported: a mean age within the 40s (k = 16) or 30s (k = 1), frequencies across age brackets (k = 2) or did not report age (k = 6). In terms of gender, studies reported a female preponderance or did not report (k = 5). Most studies did not report ethnicity (k = 20), those that did, reported mostly white samples (k = 5). Studies varied in reporting of how diagnoses were given depending on whether diagnoses were established prior to referral, and the framework used for diagnosis. Several studies did not report how diagnoses were given (k = 8). See table 2 for a summary of sample size, age, diagnosis, gender, ethnicity and how diagnosis were given for each study.

Table 2

Summary of sample size, age, diagnosis, gender, ethnicity, how diagnoses were given for each study and risk categorisation

Paper	Sample size	Mean age in years	Diagnosis	Gender (% female)	Ethnicity	How diagnoses were given	Risk of Bias	Country	Design
Richardson et al. (2018)	12	41.2	FND 7 = weakness/reduced mobility, 3 with tremor, 2 non-epileptic seizures, 2 = mixed symptomology	50%	N/A	Unclear	Medium	New Zealand	Case series
Macías-García et al. (2024)	20 in MDT group (40 overall)	43.5	FMD	80%	majority white European	Used phenotype-based Espay and Lang (2015) criteria	Low	Spain	Randomised controlled trial
Polich et al. (2022)	18	N/A	Motor FND	N/A	N/A	Motor FND diagnosis given by neurologist on medical ward at affiliated hospital	Medium	USA	Report of service development
Cope et al. (2021)	193 patients (plus 153 relatives)	18-25 = 32, 26-35 = 40, 36-45 = 42, 46-55 = 46, 56-65 = 22, 66+ = 10	Functional neurological disorder	78.8%	Majority White British	N/A	Medium	England	Case series
Schmidt et al. (2021)	31	47	Functional Movement Disorder	54.4%	N/A	N/A	Medium	Germany	Case series
Jiménez et al. (2029)	49	42.53	FND diagnoses (25 PNES, 6 FMD, 18 unspecified FND)	63.7%	71.4% Caucasian	Diagnosis given previously	High	USA	Case series
Stanton et al. (2023)	N/A	N/A	One functional seizures group, one general FND group	N/A	N/A	N/A	High	England	Report of service development
Finzel et al. (2024)	N/A	N/A	Dissociative seizures	N/A	N/A	Diagnosis confirmed prior to admission through vEEG monitoring	Low	Germany	Report of service development
Saifee et al. (2012)	26	47	Functional motor symptoms (FMS) and FMD	58%	N/A	already diagnosed on admission	Medium	England	Case series
Schneider et al. (2024)	30 (27 acute, 3	43.6	Motor FND	70%	N/A	Diagnosis given upon admission based on DSM 5 criteria	Low	Switzerland	Case series

Paper	Sample size	Mean age in years	Diagnosis	Gender (% female)	Ethnicity	How diagnoses were given	Risk of Bias	Country	Design
	FND relapse)								
Jacob et al. (2018)a	32	49.1	FMD	75%	N/A	Movement disorder specialist diagnosed/confirmed diagnosis using Fahn and Williams criteria	Low	USA	Case series
Jacob et al. (2018)b	34	47.9	FMD	80%	N/A	N/A	Medium	USA	Case series
Hebert et al. (2021)	17	N/A	FMD	80%	N/A	Diagnosed by movement disorders physician and confirmed by panel (using history and protocolised video). Fahn-Williams criteria	Low	USA	Case series
Faul et al. (2020)	14	48.4	FMD	85.7%	N/A	Diagnosis given at movement disorder clinic using Epsay and Lang (2015) criteria	Low	USA	Case series
Petrochilos et al. (2020)	78	42.6	FND	76.9%	N/A	N/A	Medium	England	Case series
Palmer et al. (2023)	13	42	Motor FND	64%	10 NZ European, 1 NZ Māori, 1 Cook Island Māori, 1 Other	N/A	Medium	New Zealand	Case series
Guy et al. (2024)	50	44.69	FND	84%	N/A	Diagnosis made by neurologist or neuropsychiatrist (in line with DSM-5 criteria)	Low	England	Case series
McCormack et al. (2014)	33	40.8	motor conversion disorder	78.8%	N/A	Diagnosis according to ICD-10 criteria for motor conversion disorder	Low	England	Case series
Saunders et al. (2024)	52	40	severe functional neurological disorder	65.4%	N/A	N/A	Medium	England	Case series
Dallocchio et al. (2016)	CBT alone 11, CBT + APA 10	CBT alone = 34.7, CBT +APA = 33.7	FMD	CBT alone 81%, CBT + APA 60%	N/A	Diagnosed elsewhere but engaged in discussion at start of program	High	Italy	Randomised controlled trial
Russell et al. (2022)	N/A	N/A	N/A	N/A	N/A	N/A	Medium	England	Report of service development

Paper	Sample size	Mean age in years	Diagnosis	Gender (% female)	Ethnicity	How diagnoses were given	Risk of Bias	Country	Design
Bailey et al. (2024)	61	18-25 = 14, 26-35 = 12, 36-45 = 10, 46-55 = 14, 56-65 = 7, 66+ = 4	Functional seizures and general FND	72.1%	68.9% White British, 9.8% other White background, 1.6% Asian Pakistani, 1.6% Asian Bangledeshi, 6.6% Black African, 4.9% Back Caribbean, 6.6% White and Black Caribbean	N/A	Medium	England	Case series
Bhatt et al. (2024)	48	48.5	FMD	70%	N/A	Neurologist at hospital movement disorders clinic	Medium	Canada	Case series
Barbey et al. (2022)	N/A	N/A	Any FND symptoms	N/A	N/A	Neurologist assess and give diagnosis based on positive signs and exclusion of alternative neuro diagnosis.	Low	Switzerland	Report of service development
Townsend et al. (2024)	18	49.8	Functional neurological disorder	67%	N/A	Referring neurologist diagnosed FND	Low	Canada	Case series

FMD = Functional Movement Disorder, PNES = Psychogenic non-epileptic seizures, vEEG = Video electroencephalogram, APA = adjunctive physical activity.

Review of Multimodal Interventions

In this section, the descriptions of MDT interventions are synthesised using the TIDieR checklist. Please refer to Table 3 and 4 for MDT interventions for each study.

Naming and "Why"?

Naming of interventions varied. Studies named interventions according to; the disciplines that were utilised such as "combined CBT and APA"; clinical setting, such as "acute inpatient rehabilitation"; their approach such as "Integrated rehabilitation"; and established protocolised names, such as "MoRe". Many studies used a variety of these components in their naming, such as "Individualised outpatient MDT".

Studies utilised different rationales for MDT interventions. Five studies identified the underlying mechanisms implicated in FND as a target for intervention. For example, using a cognitive approach due to the involvement of belief systems in the maintenance of FND. Fifteen studies provided evidence of intervention outcome in FND, such as combined CBT and physical activity have shown positive outcomes for symptom severity. For these studies, the rationale was implicitly provided through the introduction, it would have been helpful if it had been more explicitly stated. Three studies gave a specific rationale for each component of the intervention, explicitly detailing the exact discipline-specific techniques. Only three studies did not give a clear rationale.

Naming and rationale for interventions is complex due to the depth of understanding required to make conceptual sense of the components identified in naming. Where studies talk about "integrated", "interdisciplinary" "multidisciplinary" or "individualised" approaches, this is rarely operationalised effectively to create a shared understanding with the reader about what this entails practically. Although

there is existing literature that aims to provide a framework for understanding the nuanced differences and similarities in these approaches (Choi & Pak, 2006), the use of these in the studies included in this review is limited.

What (Materials), What (Procedure) and Who Provided

Finzel et al. (2024) was the only study that explicitly addressed the issue of materials. All other studies described processes where the reader could assume which materials were used but were not explicitly stated, such as in video recordings of symptoms. The nature of multimodal interventions means that it is not possible to explicitly list every single material used by each discipline and therefore the reader is expected to use their own expertise and knowledge if they were to attempt replication.

Procedures had the most pronounced variation in reporting. Studies generally reported referral procedure, admission process, labelling the different professional involvement and discharge processes. However, the reporting of the delivery of active intervention components is much more complex and studies took various approaches. Some studies simply label the professional disciplines involved (such as Jiménez et al., 2019), whilst others detail all elements of each discipline's intervention. For example, reporting the various retraining techniques used in Physiotherapy (PT) interventions, specific Cognitive and Behavioural strategies as part of CBT and the vocational exercises as part of an Occupational Therapy (OT) intervention. Another approach was to spend less time exploring the specific techniques and instead focus on the theoretical stance. For example, Stanton et al. (2023) describe using a "whole person" approach, demonstrating "joint-working across the mind/body divide". These different approaches to procedure reporting demonstrate different levels of working with individuals with FND; the higher-level

theoretical approach, followed by more practical details on professional involvement, followed by a detailed description of individual elements of each discipline's intervention. All elements are important, but offer different things to the reader. Lastly, four studies reported delivering "MoRe", an intensive multimodal approach which focuses on supporting individuals to relearn normal movement using motor retraining principles (hence the name "MoRe") together with breathing and relaxation exercises. This is one of the few protocolised MDT approaches and interestingly studies that used this approach did not report any details of tailoring interventions. However, Jimenez et al. (2019) reported using the Interdisciplinary chronic pain rehabilitation programme (iCPRP), which is a somewhat protocolised approach with distinct features (see Table 4) . Jimenez et al. (2019) reported the features that are present in this approach and also reported customisation in with PT and OT sessions.

Differences in the standard of reporting for intervention procedures are likely to cause challenges for applying a study's findings to clinical practice. Reporting disparity also makes it difficult to ascertain whether and how interventions are comparable to each other. For example, if two studies included a CBT component, the two interventions may not include the same CBT elements, techniques or exercises.

Who provided the intervention was reported by all but one study (Dallocchio et al., 2016). For the studies that did report who provided the intervention, the details of which professionals were involved are listed in Table 4. Medical input was part of 21 of studies and was provided by a range of specialities: unspecified, Neurologist, Anaesthetist, Physiatrist, Psychiatrist, Neuropsychiatrist. Twenty-one studies had a PT within the MDT. Twenty-one studies had a psychological professional in the

MDT; either a psychologist, neuropsychologist, counsellor or psychotherapist. Fourteen studies had an OT within the MDT. All studies delivered a psychological element, and in studies where there was no psychological professional, either these elements were delivered by other members of the MDT, or the studies provided limited details about which professionals were involved. Eight studies had a Speech and Language Therapist (SLT) within the MDT. Four studies had nursing as part of the MDT. Three studies had social workers within the MDT. Two studies had an expert by experience within the MDT. Two studies detailed additional components, such as leisure activities in inpatient settings or complementary therapies such as music therapy.

Only three studies reported additional training in FND specifically. Reporting of professional involvement in itself, implicitly indicates some level of training; if a Neurologist is in the MDT, they have had medical training. As most interventions were delivered in a neurological or inpatient setting, the team will have expertise in working with neurological conditions. However, this is not directly reported, and is important when professional training across countries is not always the same. Specific expertise in working with FND likely comes from on-the-job experience and learning from more experienced colleagues. In addition, no study discusses the years of practical experience working in the field which would be a valuable way to capture some of this information. Please see Table 3 for professional involvement.

Table 3

Professional involvement in interventions

Study	Medic	Psychological Professional	Physiotherapist	Occupational Therapist	Speech and Language Therapist	Expert by Experience	Complementary therapist	Nursing	Social Services/ Workers

Richardson et al. (2018)	X	X	X	X						
Macías-García et al. (2024)	X	X	X							
Polich et al. (2022)	X	X	X	X	X				X	
Cope et al. (2021)	X	X	X			X				
Schmidt et al. (2021)	X	X	X	X	X		X	X		
Jiménez et al. (2029)	X	X	X	X				X		
Stanton et al. (2023)	X	X	X			X				
Finzel et al. (2024)	X	X					X	X	X	
Saifee et al. (2012)	X	X	X	X				X		
Schneider et al. (2024)	X									
Jacob et al. (2018)a	X		X	X	X				X	
Jacob et al. (2018)b	X									
Hebert et al. (2021)	X	X	X	X	X					
Faul et al. (2020)	X	X	X	X	X					
Petrochilos et al. (2020)	X	X	X	X						
Palmer et al. (2023)	X	X	X							
Guy et al. (2024)	X	X	X							
McCormack et al. (2014)	X	X	X	X	X					
Saunders et al. (2024)		X	X	X						
Dallocchio et al. (2016)										
Russell et al. (2022)		X	X	X	X					
Bailey et al. (2024)	X	X	X			X				
Bhatt et al. (2024)	X		X					X		

Barbey et al. (2022)	X	X	X	X				X
Townsend et al. (2024)		X	X	X	X			

When and How Much?

Generally, studies detailed a mixed mode of individual and group work. (Macías-García et al., 2024; Schmidt et al., 2021; Jiménez et al., 2019; Finzel et al., 2024; Petrochilos et al., 2020; Dallocchio et al., 2016). Three studies reported only group interventions (Cope et al., 2021; Stanton et al., 2023; Bailey et al., 2024). Fifteen studies did not provide any detail on whether interventions were delivered in an individual or group format (Richardson et al., 2018; Polich et al., 2022; Saifee et al., 2012; Schneider et al., 2024; Jacob et al., 2018; Jacob et al., 2018; Hebert et al., 2021; Faul et al., 2020; Palmer et al., 2023; Guy et al., 2024; McCormack et al., 2014; Russell et al., 2022; Bhatt et al., 2024; Barbey et al., 2022; Townsend et al., 2024). Saunders et al., (2024) reported individual work only, although group elements could have been included due to being in an inpatient setting, but this is not explicitly stated.

Interventions were delivered across several clinical settings. Ten studies took place in an inpatient setting (Richardson et al., 2018; Polich et al., 2022; Schmidt et al., 2021; Finzel et al., 2024; Saifee et al., 2012; Schneider et al., 2024; Jacob et al., 2018; Hebert et al., 2021; McCormack et al., 2014; Saunders et al., 2024). Given the number of studies taking place in an inpatient setting, it is reasonable to assume that there are components of group and one-to-one contact with staff and other service users which are valuable elements of treatment but are not directly measured. Eight studies reported interventions in an outpatient setting, also referred to as ambulatory, clinic and community (Macías-García et al., 2024; Petrochilos et al., 2020; Guy et al.,

2024; Bhatt et al., 2024; Townsend et al., 2024; Jacob et al., 2018; Palmer et al., 2023; Russell et al., 2022). Two studies reported interventions delivered online (Stanton et al., 2023; Bailey et al., 2024). Barbey et al., (2022) described a mixed intervention that was generally delivered in an inpatient setting, but if appropriate, could be delivered in a community setting. Three studies either did not provide details or were unclear on setting (Jiménez et al., 2019; Dallocchio et al., 2016; Faul et al., 2020). Terminology of setting descriptions makes interpretation of the intervention more difficult. For example, the terms ambulatory and outpatient are sometimes used interchangeably but can be used to refer to different settings. This makes it difficult for clinicians to make well-informed decisions about implementing the evidence base in their own clinical practice.

Schedule, dose and duration were reported in varying amounts of detail, particularly duration of stay (if inpatient), duration of individual discipline sessions, dose (or intensity) of these sessions throughout the intervention or per week. To some extent the schedule, dose and duration is determined by external factors. For example, the number of sessions per week with rehabilitation therapies is perhaps determined by funding organisations. Duration and number of sessions in psychotherapy can in part be due to therapeutic modality. It would be beneficial for this to be explicitly considered within studies. Russell et al., (2022) is the only study that provided no information. Specific details for schedule, dose and duration are provided for each study in Table 4.

Tailoring, Modifications & "How Well"

Eighteen studies detail some of the ways that interventions were tailored to individuals. Studies varied in the amount of detail included; for example, most studies simply state that the interventions were tailored, whereas some describe the

tailoring process of individual elements of the intervention. The lack of explicit reporting of the tailoring of interventions is perhaps due to the scope of publication guidelines. By nature, multimodal interventions are tailored depending on the individual's needs for each discipline. Clinically, this is a complex process and would not be feasible to report every adaptation to interventions. In addition, there is no definitive threshold for authors to identify which tailoring processes are most salient and salient features will be different for each patient. Please see Table 4 for full details. Seven studies did not include any information about the tailoring of interventions (Cope et al., 2021; Schneider et al., 2024; Jacob et al., 2018; Jacob et al., 2018; Hebert et al., 2021; Faul et al., 2020; Bailey et al., 2024).

Only two studies reported on modifications made during the study. Palmer et al., (2023) reported that initially, there was a psychiatrist as part of the MDT, but due to other commitments, they could no longer be part of the service. Saunders et al., (2024) reported that a PT outcome measure was introduced for patients who could not complete the original PT outcome measures. This is perhaps reflective of the fact that multimodal interventions are flexible in nature and often do not follow a manualised approach meaning modifications in the intervention are a fundamental element of the treatment approach. Nonetheless, if this is the case, it is important to acknowledge. No study reported planned or actual fidelity or modification assessment.

Table 4

Information extracted from each study according to the TIDieR checklist

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
Richardson et al. (2018)	Nocebo hypothesis CBT	Involvement of belief systems in FND presentations	No details	Medical: evidence impossibility of structural change. Psychology: gathered case history, developed formulation, encouraged new narrative. PT [a]: cycle of increasing movement, using distraction, providing video recording of improvement. Cycle repeated with increasingly complex tasks. OT [b]: support return to activities performed prior to symptoms.	Medic, Psychologist, PT and OT. No further details.	No details of interventions modes. Follow up done predominantly by phone.	Inpatient setting. No further details.	Estimated 2-4 hours per day, 5 days a week. 24-hour nursing support. No further details.	1 patient seen as an outpatient with 3 hours of input.	No details
Macías-García et al. (2024)	Combined PT and CBT	Positive results for CBT and specialised PT shown to significantly improve symptoms	No details	Neurologist: assigned to treatment and revealed to the team, completed follow-up motor assessment (blinded neurologist). Neuropsychology: baseline assessment. Patient attended weekly CBT group in outpatient clinic and 12 ambulatory PT session.	Neurologist, "experienced" Clinical Psychologist, PT trained in neuro and FMD PT.	Group CBT, individual PT	Outpatient CBT and ambulatory PT	4 weekly 1-hour CBT, 12 1-hour individualised PT.	PT individualised, no further details	No details
Polich et al. (2022)	Acute inpatient rehabilitation	Existing evidence for rehabilitation interventions. 2 week stay based on average LOS[d], fixed end point decided through discussion with experts.	No details	Admission: motor FND diagnosis by neurology, confirmed all diagnostic testing, patient affirmed openness to diagnosis, intervention, 2 week stay and meets criteria for rehab. Neurology: confirm diagnosis, PE [e], treatment plan, medical management. Psychology: biopsychosocial assessment and formulation, 2 x weekly, FND focused psychotherapy Nursing: PE, encourage and facilitate engagement in rehabilitation interventions. PT, OT, SLT [f]: develop and implement approach to goals, self-management strategies,	Neurologist, Psychology, PT, OT, SLT, nursing. Training from team: provided to referring hospitals, department wide by PT, OT and SLT, lead therapist also act as coach/supervisor. Training for team: lectures, journal articles, FND education websites given to each discipline,	Not directly addressed but assuming in person due to inpatient stay.	Inpatient hospital, no details on ward/specialty	3 hours per day of PT, OT and SLT, 5-6 day per week. Minimum of twice weekly CBT sessions.	Following elements could be individualised: LOS, ancillary services, social work, family involvement, psychiatry, removal of equipment, and discharge planning. Psychological interventions adapted to individual need depending on readiness for	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
				communication with team (PT - mobility training, OT – self-care, ADLs[g], SLT – speech/voice, language, swallowing, cognition). Family involvement encouraged. Additional services: therapeutic recreation, music therapy, aquatic therapy	interprofessional FND symposiums				change, engagement, self-awareness, symptom presentation and strengths.	
Cope et al. (2021)	MDT Education Session	Communication of diagnosis has been shown to be therapeutic but can lead to mixed messages about diagnosis when explanation is from multiple professionals separately	No details	Neurologist: covered assessment, diagnosis, types of FND and labels. Neuropsychiatrist: covered aetiology, common predisposing, precipitating, perpetuating factors, neuropsychiatric assessment and treatment. Clinical psychologist: covered aspects of psychological treatment such as CBT, used two case examples. PT: covered how PT can help improve function and reduce disability. Previous patient: covered their experiences of treatment. Q&A session at the end.	Neurologist, Neuropsychiatrist, Clinical Psychologist, neuro-PT, previous patient.	Group delivery	UK NHS team, held in lecture theatre.	1 hour 45-minute duration.	No details	No details
Schmidt et al. (2021)	Multimodal inpatient treatment	Preliminary evidence for multimodal treatment for FND	No details	Referral into team from Neurologist/GP. Team was integrated through weekly meetings/briefings, emphasis on coordination of therapy. Psychotherapy: CBT and narrative trauma interventions. PT: enhanced body awareness, motor retraining. “Other therapy involvement followed principles of PT”.	Neurologist, Psychotherapist, PT, SLT, OT, Music Therapist, Nurses. Leading clinician was Neurologist, Psychiatrist and Psychotherapist.	Individual and group, no further details.	Inpatient setting, no further details.	Mean LOS 21 days.10-15 individual and group session per week from different disciplines (2-3 psychotherapeutic, 3-4 individual physiotherapy), session duration ranged from 20-60 minutes.	Psychotherapy: imagery reprocessing and rescripting used when needed. Follow up time scale individualised, varying involvement of different disciplines depending on individual need.	No details.
Jiménez et al. (2019)	Interdisciplinary chronic pain	iCPR contains involvement	No details	Medication management (detoxification of opioids),	Typically staffed with Psychiatry,	Individual and group	No details	3-4 weeks, all day Monday-Friday	Standardised approach with	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
	rehabilitation programme (iCPR)	from disciplines shown to be effective for FND		psychotherapy, education, biofeedback, relaxation, physical and occupational therapy. No further details.	Psychologist, Counsellor, PT, OT and Nurses	psychotherapy. No further details			some customisation in PT/OT, no further details	
Stanton et al. (2023)	FND education group	Evidence that group education was linked to improved coping mechanisms and sometimes symptom reduction	No details	Referral from Neurologist by email. On arrival, complete questionnaire, given broad aims Utilised mind-body approach. Neurologist: introduction to FND. Service user: share their story as a talk or a video. PT: covered PT for FND. Break. Psychology: self-management and CBT. Neuropsychiatrist: predisposing, precipitating and perpetuating factors, heterogeneity. Q&A to the panel. Make recommendations to referrers to have follow up after workshop.	Neurologist, Neuropsychiatrist, PT, Clinical Psychologist or Psychotherapist and service user. No further details	Group session (approx.15 service users per group with carer, relative or friend), delivered online since COVID.	Online	Duration 2 hours	Group dynamics managed depending on specific dynamics, for example if group had dominating members.	No details
Finzel et al. (2024)	Inpatient treatment on psychotherapy wards of epilepsy centres	Admission procedure: important opportunity to share parts of experience that have not been able to share before, Psychotherapy: indicated for diagnostic issues that cannot be managed in outpatient psychotherapy.	Rooms with video surveillance and hand held cameras, medical diagnostic tools, EEG, staff that made up the interdisciplinary team	Initially confirm diagnosis, discuss goal of inpatient stay. Admission: in-depth medical history, therapy and nursing contact gives information about procedures during seizures, patient assigned to therapies. Psychotherapy: space for clients judgements, PE, development of disease model, behaviour therapy, DBT, work during seizure event, cognitive work, ACT, trauma approaches. Complementary approaches: OT, PT, nursing.	Physicians, Psychologists with psychotherapeutic training, social services, specialist Nursing, “complementary treatment staff” (no details on training or expertise of these staff)	Individual and group work, no further details. Goal of inpatient stay discussed on phone or in outpatient clinic.	Inpatient epilepsy wards	Average LOS 6-8 weeks, some cases up to 12 weeks.	Video recording of seizures may be repeated for some patients. Treatment as a whole is tailored depending on need and presentation	No details
Saifee et al. (2012)	MDT inpatient programme	Rationale for CBT – cognitive factors are important in the way symptoms are produced and therefore	No details	Referrals from Neurologist. Assessment clinic: meet with MDT, discuss diagnosis, treatment rationale and programme. Common components of intervention: PT (distraction and error based	Neurology (consultant, 2 x trainee), Neuropsychiatry (consultant, 2 x trainee), Nursing, CBT practitioners	No details	Neuropsychiatry ward of national hospital	Standard LOS was 4 weeks, therapy 5 days of the week.	Common components are tailored to individual depending on goals. Early discharge if	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
		need to be part of treatment		learning), OT, CBT (coping strategies, changing illness beliefs), mental health Nursing staff, Neuropsychiatry assessment, Neurology input	(unclear if therapist or Psychologist), PT, OT.				goals met, attribution of symptoms to trauma done on individual basis and not standardised practice.	
Schneider et al. (2024)	Inpatient rehabilitation	Indication in research for rehabilitation for FND	No details	PE, support therapy, identification of perpetuating factors. Minimum of one psychiatry assessment to manage comorbid psychiatric difficulties. PT, OT, Psychotherapy	Experienced Psychiatrist, no professionals identified for other elements of intervention.	No details	Inpatient neuro rehabilitation	Two daily sessions of PT, one daily session of OT (30-45 minute duration) on five days a week, 1 x weekly psychotherapy	No details	No details
Jacob et al. (2018)a	MoRe[h] for FND	MDT indicated as most appropriate for severely affected FMD patients	No details	Prior to admission: assessed by movement disorder specialist, PT and Psychologist. Intervention: based on principles of relearning normal movement. Begins with establishing movement in affected body region, use of breathing and relaxation imagery. Mental practice training used during first therapy session of the day and encouraged to do it independently in the morning. PT, OT, SLT and psychotherapy every day.	Neurologist, Physiatrist, PT, SLT, OT, social worker.	No details	Inpatient setting	3 hours per day of PT, OT and SLT. 1 hour per day of psychotherapy. Intervention lasts 1 week.	No details	No details
Jacob et al. (2018)b	MDT Clinic	MDT interventions have demonstrated improvements in other neuro conditions	No details	Patient attends clinic for half a day and sees each specialist for an hour. Team then has a meeting and neurologist will share treatment recommendations with patient. Clinic aim is to ascertain suitability for MoRe programme.	Neurologist, no other disciplines specified	No details	Clinic setting, no further details	Half a day once a month for 3 patients. Patient sees each specialist for one hour.	No details	No details
Hebert et al. (2021)	MDT inpatient rehabilitation	No clear information	No details	Referred after diagnosis. Admission: seen by Psychiatrist, Physiatrist, Neurologist,	Neurologist, Psychiatrist, Physiatrist,	No details	Inpatient setting	Mean LOS was 7.5 days	No details	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
				Psychologist, PT, OT, SLT. PT: MoRe principles adapted (relearning movement, identifying triggers for abnormal movement). Physiatrist: supervised treatment. Neurologist: reinforced diagnosis, administered assessment scales, 12 month re-evaluation. Psychiatrist: treatment of psychiatric illness. Clinical Psychologist: diagnostic interview, identifying problems, introducing CBT, providing continuing therapy recommendations after discharge.	Psychologist, PT, OT, SLT				
Faul et al. (2020)	Inpatient rehabilitation	Promising results in literature for rehabilitation with FND	No details	MoRe delivered. MDT intervention overseen by Physiatrist with daily involvement from PT, OT, SLT and Psychologist delivering CBT.	Physiatrist, Psychologist, PT, OT, SLT	No details	Rehabilitation institute/clinic	3 hours daily of PT, OT and SLT. 1 hour daily of CBT.	No details	No details
Petrochilos et al. (2020)	Individualised outpatient MDT	Complex FND patients are often referred to MDT clinics	No details	Referred by Neurologists and GPs. Patient attended triage clinic to assess suitability then progressed to intervention. Neuropsychiatry: assessment and 2x progress meetings. CBT: personalised formulation, awareness of emotions and triggers, behavioural interventions between sessions. PT: motor retraining. OT: fatigue, pain and anxiety management, improving routine, confidence and independence, grading ADLS, accessing community). Group education session, goal setting session and family session	Neurpsychiatry, CBT therapist, PT, OT	Face-to-face, group and individual.	Run through National hospital of neurology and neurosurgery, location of intervention varied (outpatient clinic, inpatient stay or outpatient CBT only). Run in outpatient clinic area with access to gym and kitchen facilities.	5 week intervention. 2 days per week. 9 x CBT, 9x PT, 9 x OT, 3 x neuropsychiatry. CBT formulation was delivered on day 1 and group education session with family members administered on day 2.	location varied depending on individual need, individual themes or difficulties were explored in CBT.	No details
Palmer et al. (2023)	Integrated MDT clinic	Unmet need for FND treatment	No details	Referrals came from Neurologist. First session	Senior Neurology registrar, PT and	No details	FND treatment clinic	45 minute session fortnightly for a	Explanation of FND tailor	Psychiatry initially

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
		and best evidence is in multi day inpatient intensive program		patients gave their history and understanding of FND then explanation given to patient and goals set. First symptoms addressed were motor symptoms using attention-distraction exercises and video feedback. Psychology and Psychiatry: identifying thought-patterns and anxiety, teaching distraction, sensory grounding and mindfulness and administering graded desensitisation and CBT for insomnia. Fatigue addressed multimodally	Clinical Psychologist. Psychiatry initially attended but stopped. No professionals had experience in FND.			maximum of 6 sessions	depending on patients own understanding	attended clinic but stopped due to other commitments.
Guy et al. (2024)	Functional Integrated Neurological Programme (FiND)	intervention to address broad range of FND issues and also be individualised	No details	Referrals from consultants, GPs and mental health teams. Diagnosis confirmed by Neurologist or Neuropsychiatrist, assessed for suitability for CBT and PT. CBT: formulation, diary keeping, anxiety work, behvaioural experiments, grounding, attention training, goal directed activities). PT: retraining movement, normalising sensory experience, distraction, graded exercise and pacing. Self-management: gradually implementing skills from therapy sessions. Group based PE, alumni session and friends/family session.	Neurologist or Neuropsychiatrist, CBT therapist, PT.	3 patients attended at a time but no details on whether interventions delivered in group format.	Outpatient clinic with access to gyms and kitchens.	2 days per week over 8 weeks. 16 x CBT, 16 x PT, 16 x self-management, group-based PE, PT workshop, mindfulness workshop.	CBT formulation tailored to each individual	No details
McCormack et al. (2014)	Specialist inpatient treatment	Unclear	No details	Psychiatrist liaises with other medics to confirm diagnosis. Admission: history taking, treat medical and psychiatric comorbidity. Psychology: CBT (PE, CBT techniques, relapse prevention). PT: stretches, massage, posture, stability, balance, strength, relearning	Neuropsychiatrist, Psychologist, PT, OT, SLT	No details	Inpatient neuropsychiatry unit	2 x weekly PT	PT adapted for relevant disability , SLT delivered on case-by-case basis.	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
				control. OT: assess baseline activities and build new skills, explore patient role and routine. MDT discharge plan.						
Saunders et al. (2024)	Inpatient management of severe FND	Unclear	No details	Initial stages: formulation PE, therapeutic relationship building, personalised treatment timetable developed. Psychology: CBT, dynamic/interpersonal concepts incorporated. OT: activity planning and management, relaxation, confidence building, like skills. PT: retraining movement, attentional strategies, education and exercise. Leisure activity and community meetings on ward	Clinical Psychology, OT, PT.	Individual therapy, assuming group elements such as activities on the ward.	Inpatient neurology	Mean LOS was 19.4 weeks (skewed due to 3 long stay patients).	Therapy timetables are personalised, including individual therapy sessions, regular medical review, goal setting meetings, activity groups, and if needed social work input.	Retrospective change to PT measure using functional mobility scale due to patients being unable to complete all physio measures
Dallocchio et al. (2016)	CBT with APA[i]	preliminary evidence the CBT and APA is helpful for FMD	No details	Formulation based approach. CBT: identifying somatic misinterpretations, thoughts and beliefs, low mood, anxiety, developing alternative hypotheses about bodily sensations, distraction techniques, motor strategies (tapping with unaffected area). APA: structured low-moderate intensity walking.	No detail	APA: group or individual at county track. No detail on CBT.	No details	CBT + APA: 60 min sessions twice a week. CBT alone: 90 min session once a week, control: standard medical care (no further details. Both treatments = 12 weeks	Formulation based issues raised during sessions were addressed	No details
Russell et al. (2022)	Integrated FND pathway (Exeter model)	Develop a pathway that can break down barriers to treatment for conditions that fall through the gaps.	No details	Neurology: diagnosis and explanation of nervous system, identify and manage new symptoms, provide second opinion or review. OT: meaningful activity (graded exposure, fatigue/symptom management, vocational rehab, using aids/splints). PT: explore impact of movement on symptoms, encourage activity, manage posture, identify positive signs of FND.	Community Neuropsychology, Neurology, rehabilitation specialities (OT, PT, SLT).	No details	Community setting	No details	Delivering of different disciplines intervention depending on patient need. Complex cases discussed at MDT meetings. Psychological therapy approach tailored to	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
				Psychiatric liaison: identify comorbid mental health problems. Psychology: neuropsychological testing, biopsychosocial assessment, formulation, intensive short term dynamic psychotherapy, EMDR, ACT, CFT, CAT. SLT: communication, swallowing, coughing.					individual need.	
Bailey et al. (2024)	MDT group education	Implications of illness beliefs in FND, and no research investigating role of illness beliefs in MDT group education sessions	No details	Intervention components taken from Cope et al., and Stanton et al., and therefore full description not given.	Neurologist, Neuropsychiatrist, Psychologist, PT and expert by experience	Group session (approximately 50 patients plus carers or family members), previously fun face-to-face but now online	Online	1 hour 45-minute duration	No details	No details
Bhatt et al. (2024)	Integrated model of care	Rationale given for each individual component and skill of the intervention	No details	Assessment session: education, triage for rehabilitation and assessment for eligibility. Case discussed in team meeting for treatment plan (IT[j] or PT alone). IT: administered by Neurologist, Psychiatrist and PT simultaneously. Intervention: nervous system reset, introduction to skills at home, self-regulation, mastery of skills at home, relapse prevention and self-management. In IT emphasis on mind-body connection and understanding bi-directional relationship.	Neurologist, Psychiatrist, mental health Nurse, PT	Online and in person	Outpatient setting	6 sessions, 2 virtual session, therapy duration 3 months delivered bi-weekly. Visit duration 45 minutes.	Therapeutic content was individualised using patient goals as framework	No details
Barbey et al. (2022)	MDT outpatient and inpatient programme	Rationale given for each individual component and skill of the intervention	No details recording equipment	Referrals from internal departments or primary care. Neurology: initial and follow-up for confirmation/diagnose FND given with metaphor of software and hardware. Whole team develops treatment plan. PT:	Neurologist, internists, Anaesthetists, Psychiatrist, PT, OT, Psychologist, Social Workers. Junior	No details.	Some care given internally but for patients with milder symptoms or living further away	Communication of diagnosis (1 hour visit), psychotherapy (at beginning seen every 2-3 weeks with subsequent	Individual care plan developed involvement of SLT PT, OT and psychotherapy. Inpatient	No details

Paper	TIDieR 1 - brief name	TIDieR 2 - rational for intervention	TIDieR 3 - materials	TIDieR 4 - procedures	TIDieR 5 - expertise, background, training	TIDieR 6 - modes of delivery	TIDieR 7 - where did intervention occur	TIDieR 8 - when & how much	TIDieR 9 - tailoring	TIDieR 10 [c] - modifications during study
				stretching exercises, myorelacing approaches for comorbid muscular pain, body awareness, supplemented relaxation for sensory deficits. SLT: speech therapy, breath and swallowing. OT: prevent activity avoidance, managing daily life. Psychotherapy: CBT and symptom-oriented psychotherapy	Neurologists undergo training and supervised sessions with senior Neurologist with training in FND. Team delivers training to network for FND.		interdisciplinary care is organised externally.	intervals of 4-8 weeks, no definitive number of sessions, 6-12 months of treatment). If needed patient can have intensive 3-week inpatient treatment program	therapy vs outpatient therapy, where needed patient assisted to find external therapist for longer term work after intervention has finished	
Townsend et al. (2024)	Brief MDT outpatient treatment	MDT treatment demonstrates lasting outcome, further rationale for each element of intervention given.	No details	Referrals from diagnosing Neurologist. Intervention based on BeST programme, MoRe programme and 5-day programme from UK. Triage with either psychology or PT. PT: intake phone interview (rapport building and PE). Psychology: intake appointment covering history taking, precipitating or perpetutating factors, inform MDT individualised care. Treatment: 5 consecuative days of 1 hour sessions with PT, 4 days of SLT, 3 days of OT, one counselling appointment. Follow up review with Psychology, group education.	Psychologist, PT, OT, SLT, peer supported training, peer networking with other FND programmes.	In person and over the phone, individual therapy and group sessions	Ambulatory neurology clinic	5 day MDT, one hour of PT on five days, four days of SLT, three days of OT if needed.	Described as individualised care but no details on tailoring of intervention elements	No details

[a] Physiotherapy, [b] Occupational therapy, [c] Item 11-12 on treatment fidelity/adherence were not reported in any study and therefore are not included in the table. [d] Length of stay, [e]Psychoeducation, [f]Speech and Language Therapy. [g]Activities of daily living. [h] Motor Retraining intervention (protocol for MDT treatment from Mayo clinic). [I] Adjunctive physical activity. [j] Integrated therapy

Outcome Measures

Studies varied in the types of outcome measures used but there was generally consistent reporting across studies. Some studies opted to gather only one outcome measure such as the Clinical Global Impression (CGI) scale or Functional Independence Measure (FIM), whereas other studies had several primary and secondary outcome measures. For studies undertaken as part of routine clinical practice, outcome measurement is likely determined by the standard approaches of the service, which can vary across services. In the current synthesis, outcome measures were broken down into categories, please see Table 5 for full details of outcome measure reporting. Six studies utilised Quality of Life measures. Sixteen studies utilised measures of psychological distress. Six studies utilised measures of FND symptoms. Jiménez et al., (2019) also measured more general physical symptoms associated with FND by using the pain disability index. Eleven studies utilised measures of functioning. Six studies utilised non-standardised measures such as neuro-imaging. Two studies utilised measures of adverse experiences. Only Bailey et al. (2024) measured engagement. Five studies utilised measures that were categorised as “Other”. Three studies did not report outcome measures (Stanton et al., 2023; Russell et al., 2022; Barbey et al., 2022). Outcome measures reported largely reflect the difficulties associated with FND, including FND core and associated symptoms and the wider impact on wellbeing and functioning. Outcome measurement was associated with professional involvement, for example, the use of the “timed up and go test” was utilised when there was physiotherapy involvement. The use of non-standardised measures is perhaps reflective of the need to be innovative in capturing change in complex and heterogeneous presentations, as well as the aims of the study. For example, Faul et al. (2020) aim to investigate the effect

of multi-modal interventions on neural activity and therefore, used a non-standardised outcome measure in neuro-imaging and task completion. Only Macías-García et al. (2024) and Petrochilos et al. (2020) included a health economic evaluation in their analysis.

Table 5

Outcome measure employed by studies in the scoping review sample

Paper	Outcome measures	Category of measures
Richardson et al. (2018)	Functional Independence Measure (FIM) administered at admission and discharge.	Measure of functioning
Macías-García et al. (2024)*	EQ-5D-5L, 36 item short form (SF-36), Clinical Global Impressions (CGI).	quality of life, psychological distress
Polich et al. (2022)	Inpatient rehabilitation facility patient assessment instrument (IRF-PAI), SF-36, PHQ 15, GAD 7, PHQ 9, perceived change in clinical status. Videotaping of patient's functional status	other. Quality of life. psychological distress non-standardised measures
Cope et al. (2021)	EQ5D5L, FND symptoms, relatives asked to report relationship to the patient, views on diagnosis	Quality of life, non-standardised measures
Schmidt et al. (2021)	CGI, Functional Movement Disorder Rating Scale, Psychogenic Movement Disorder Rating Scale.	psychological distress measures of FND symptoms
Jiménez et al. (2019)	Depression, anxiety and stress scale (DASS), pain disability index (PDI), timed up and go test, stair climbing test, 6 min walk test	psychological distress physical symptoms functioning
Stanton et al. (2023)	N/A	N/A
Finzel et al. (2024)	Fragebogen zu Dissoziation (FDS): questionnaire on dissociation DSS: Dissociation Tension Scale AMDP-Module on dissociation and conversion, Symptom checklist, Post traumatic Symptom Scale-10, International Trauma Questionnaire, Impact of Event Scale – revised form, Childhood Trauma Questionnaire, Post traumatic Stress Diagnostic Scale, PTSD checklist for DSM-5, Beck Anxiety Inventory, Generalized Anxiety Disorder Scale 7, Beck Depression Inventory Revision, Patient Health Questionnaire-9, Assessment of DSM-IV Personality Disorders Questionnaire, Borderline Symptom List, Borderline Personality Inventory	Psychological distress
Saifee et al. (2012)	Work and Social Adjustment Scale (WSAS), Illness Perception Questionnaire (IPQ), VAS scales to assess impact of symptoms	Functioning measures non-standardised measures Other
Schneider et al. (2024)	Functional independence measure scale	Measure of functioning
Jacob et al. (2018)a	CGI, Sheehan Disability Scale, Health Related Quality of Life Scale (HRQoLS), health care visits, BDI, Primary Care PTSD Screen, Sexual and Physical Abuse Screen questionnaire, Linear Analogue Self-Assessment of overall wellbeing	psychological distress scale, functioning quality of life non-standardised measures psychological distress measures of adverse experiences quality of life

Paper	Outcome measures	Category of measures
	(LASA), body vigilance scale, emotional response questionnaire, short health anxiety inventory, Psychogenic movement disorder rating scale.	other FND Symptoms
Jacob et al. (2018)b	beck's depression inventory, adverse childhood experience questionnaire, primary care PTSD screen	psychological distress measure of adverse experiences
Hebert et al. (2021)	CGI. Motor assessment scale, functional gait assessment, berg balance scale, timed up and go test, function in sitting test, FIM. depression and somatic symptom scale, GAD 7, PHQ 9, PCL 5	psychological distress Functioning FND symptoms
Faul et al. (2020)	psychogenic movement disorder rating scale, clinical global impression scale, state-trait anxiety inventory, PHQ9, GAD 7, Becks depression inventory, neuro imaging, scanning paradigm during emotional go/no go task	psychological distress FND symptoms psychological distress non-standardised measures
Petrochilos et al. (2020)*	Health of the nation outcome scales (HoNOS), PHQ9, GAD 7, Rosenberg self-esteem, social phobia inventory, EQ5D5L, Canadian occupational performance measure, WSAS, CGI	psychological distress quality of life functioning
Palmer et al. (2023)	short form 36, WSAS, CGI	health related quality of life functioning psychological distress
Guy et al. (2024)	Beck anxiety inventory, Beck depression inventory, WSAS. 10 meter walk test, timed up and go test, Berg balance scale.	psychological distress functioning
McCormack et al. (2014)	Duration of illness, LOS, comorbidities, history of abuse, history as carer/care professional, employment, mobility, ADLs. Modified Rankin Scale	Non-standardised measures functioning
Saunders et al. (2024)	CGI, Beck depression inventory, Spielberger trait anxiety inventory, EQ5D5L, EQVAS, Cambridge depersonalisation scale, revised illness perception questionnaire, berg balance scale, 10m walk test, timed up and go, Functional Mobility scale	psychological distress quality of life Other functioning
Dallocchio et al. (2016)	Psychogenic movement disorder rating scale, Hamilton depression scale, beck depression inventory, PHQ 15	FND symptoms psychological distress
Russell et al. (2022)	N/A	N/A
Bailey et al. (2024)	Self-reported symptoms, Revised Illness Perceptions Questionnaire, Scale for Stigma in Chronic Illness, Chronic illness anticipated stigma scale, patient health engagement scale, hospital anxiety and depression scale (HADS).	Other Engagement psychological distress
Bhatt et al. (2024)	Simplified functional movement disorders rating scale, CGI	FND symptoms psychological distress
Barbey et al. (2022)	N/A	N/A
Townsend et al. (2024)	anxiety and depression subscales from Battery for Health Improvement, EQ5D5L, Canadian Occupational Performance Measure, timed up and go.	Psychological distress Quality of Life Functioning

*Included a health economic evaluation. EQ-5D-5L = EuroQol - 5 dimensions – 5 levels. PHQ = Patient Health Question, GAD = General Anxiety Disorder, CGI = Clinical Global Impressions scale

Discussion

Clinical guidelines currently recommend multimodal interventions for working with FND (British Psychological Society, 2024; Neilson et al., 2015; Nicholson et al., 2020; National Neurosciences Advisory Group, 2023), but the rationale for this is often drawn from literature that investigates single-discipline interventions (Keatley & Molton, 2022; Saxena & Yogarajah, 2023). To our knowledge, this is the first review of psychologically-informed multimodal interventions for FND. The review summarised a total of 25 studies, detailing a range of interventions involving over 18 different disciplines, employing outcome measures from 9 different categories. The studies varied markedly in terms of reporting patient characteristics, interventions and outcomes and whilst guidelines describe MDT interventions as effective, with the majority were categorised as medium risk.

Risk of Bias

The quality assessment in this review highlighted that the majority of the extant literature is medium-low risk of bias. However, it is important to consider that although case series and reports of service development were largely categorised as medium-low of the respective appraisal tools, they have limitations in terms of generalisability, selection bias and absence of a control group. Methods used are likely to reflect the fact that multimodal interventions are difficult to study in their entirety due to the number of different dimensions to the intervention and the potential impact of the intersection of having a number of interventions delivered jointly. Researchers have attempted to present MDT in a useful way by describing treatment pathways which is clinically valuable but means that effectiveness of interventions is still not investigated in robust ways.

Patient and Study Characteristics

The fact that studies most consistently reported gender, age, diagnosis and how diagnosis was given demonstrates that these characteristics are being considered as part of understanding FND and applying interventions. The sample characteristics were also largely in line with known predictors of FND such as preponderance of females and the mean age of participants in studies was predominantly 40s (Butler et al., 2020). In terms of diagnoses, studies often used samples of specific sub-diagnoses (such as functional seizures or FMD). This demonstrates the efforts made to understand differing presentations and begin to target treatments for different clinical characteristics (Myers et al., 2021). Different labels were also used to refer to the same symptom presentation, for example, non-epileptic seizures and functional seizures. This likely reflects the change in terminology over time (Raynor & Baslet, 2021). It is important to note that ethnicity and nationality are not reported in 20 of the 25 studies included. There were no obvious trends in the studies that reported ethnicity and nationality. Reporting on the ethnicity and nationality of the samples is an important step in beginning to think more deeply about the impact of demographic factors and for clinicians to apply the research clinically to the populations they are working with. The lack of reporting perhaps suggests that currently ethnicity and nationality in relation to a diagnosis of FND is not being adequately considered.

Intervention Reporting

All studies reported which disciplines were involved, but varied in the reporting of additional training. All studies involved a psychological component of treatment, typically CBT, either delivered by a psychological professional or other professional. This is in line with Epsay et al.'s (2018) review that demonstrated psychological treatment, particularly CBT is considered the "treatment of choice" for

FND. Another consistent feature of interventions was physiotherapy, occupational therapy and speech and language therapy. Again, this is reflective of current consensus guidelines for rehabilitation therapies as a key part of MDT interventions (Neilson et al., 2015; Nicholson et al., 2020). Some studies had social work involvement, to support finances, work and participation in wider life activities. This perhaps shows a consideration of the detrimental impact FND can have on individuals' wider wellbeing (Jennum et al., 2019). However, it does make investigating multimodal interventions even more difficult because the relationship between core symptoms, associated symptoms and wider impact is complex.

Interestingly, studies rarely reported any additional training for working with individuals with FND. In the UK, this could reflect several processes. Firstly, there are limited dedicated treatment pathways for FND, meaning patients are treated in existing provisions such as psychiatric or neurological settings where teams do not have specialist training. Secondly, current UK NICE guidance (n.d, 2021) states that specialist teams are not needed to manage FND. These system-level processes are in juxtaposition with literature detailing professionals' views that they do not feel skilled enough to work with FND (de Liège et al., 2022). Of the studies that did not report additional expertise, only one study directly stated that there was no specialist training, other studies neglected to comment on any additional training and expertise. This can make drawing on the existing evidence base for understanding expertise of FND teams difficult.

Studies more consistently reported the clinical settings. Studies mostly took place across inpatient and outpatient services. Interestingly, mode of delivery as either group or individual was not consistently reported but the clinical settings have important implications for mode of delivery. For example, one study reported only

group level interventions but care was delivered in an inpatient setting. This means that at least some interactions between staff and service users would happen on a 1:1 basis (or vice versa where therapy is delivered on a 1:1 basis but there are community elements to being on a ward). These elements can all contribute towards change and recovery and are not currently being explicitly reported. This, may reflect how difficult it is to study and report on multidisciplinary interventions. More importantly, this could also reflect that the additional components of MDT interventions are not being considered as part of the active intervention.

Lastly, modifications and fidelity assessments were consistently not reported in the literature. The lack of modification reporting, perhaps, reflects the nature of flexibility and responsiveness in MDT interventions and the practice-based nature of much of the available research. However, if this is the case, it is important to be reported on. The lack of fidelity assessment could be largely due to the lack of manualised protocols for MDT interventions, which would suggest that the reporting templates available for intervention studies (such as the TIDieR checklist used here) are not necessarily appropriate for MDT interventions. However, studies that did use a more manualised approach, such as the “MoRe” programme, did not report any fidelity or adherence assessments which would have been beneficial for transparent reporting and more robust quality assessments to take place.

Outcomes

Studies reported a range of outcome measures, which for the purposes of this review, were broken down into nine categories: quality of life, psychological distress, FND symptoms, physical symptoms, functioning, non-standardised measures, engagement, adverse experiences, and other. Outcomes employed were generally established, validated measures, and where non-standardised methods of

measurement were used, they were integrated with validated measures. This was a strength of the current evidence base. In addition, it is clear from the categories of outcome measures that existing research is assessing outcomes that are relevant to issues associated with FND such as psychological distress (Williams et al., 2022; Butler et al., 2020) and quality of life (Vechetová et al., 2018). Studies generally balance measurement of relevant domains with a limited set of measures. This is in line with current recommendations from Pick et al. (2020) to have a limited set of measures to be able to establish whether MDT interventions are effective in meaningful ways for FND patients and different interventions can be compared. Generally, studies did not include health economic evaluations of the MDT interventions, making it difficult for key stakeholders and decision-makers to know if the interventions are good value for money. Understanding the costs and benefits of these studies is crucial for ensuring MDT interventions are accessible, especially given that the nature of MDT interventions is resource and time-intensive.

Strengths and Limitations

There were several strengths to the current study. Firstly, a broad and exhaustive search strategy was developed and utilised. The search strategy was inclusive of current and older clinical terms to increase the likelihood of capturing relevant research. Peer-reviewed database searches, grey literature searching and citation chasing were completed to mitigate publication bias. These methods have consequently meant that a range of studies have been included. Secondly, further steps to reduce bias in the review included using a second rater at title and abstract screening and full text screening. This increases the reliability of findings. Although reliability could have been increased if a second rating were done on all title abstracts and full texts as opposed to a 20% sample.

Thirdly, an established RoB assessments were utilised based on study design. These were established measures that reviewed several domains of research bias. This was an amended approach that took place post hoc and therefore did not include a second rater. Having a second rater would increase the robustness of the assessments and therefore the conclusions drawn.

Clinical and Research Implications

The main aim of this review was to give a narrative synthesis of how multimodal interventions are described in the literature. The review establishes clear areas of consistency and inconsistency in the reporting of MDT interventions. Future research should aim to build on this review in several ways. Firstly, it would be beneficial to review existing literature to establish the effectiveness of the interventions described here. Secondly, future research should continue consistent reporting of professional involvement and reporting key elements of the intervention and aim to improve inconsistent reporting of training and expertise, including thinking about wider elements of the intervention that are not always considered “active ingredients” and begin to use more robust methodology to address issues relating to risk of bias. Lastly, future research would benefit from developing an appropriate, fit-for-purpose reporting guideline specific to multimodal interventions and including health economic evaluations.

This review has several key clinical implications. Firstly, as healthcare providers are beginning to address the disparity in dedicated service provision for individuals with FND, this review enables providers to identify the key, most commonly involved healthcare professions. Secondly, the studies that did report specialist training such as peer support networks and symposiums, give important information to healthcare professionals currently working with FND about ways to

upskill and connect with experienced colleagues in the field. Lastly, the consistent reporting of outcome measurement can facilitate the embedding of appropriate outcome measurement in clinical settings. This could help clinicians demonstrate the impact of the work they are doing with individuals with FND and think about important targets for treatment.

Conclusions

This review found that the evidence base for multimodal interventions for FND is currently highly variable in terms of reporting of intervention procedures, expertise, modes of delivery and tailoring. This could be linked to the complexity of interventions and the scope of publication requirements. Studies more consistently report outcome measurement of core and associated symptoms of FND and measurement of the wider impact of the condition. The results provide a synthesis of multimodal interventions to facilitate clinical implementation of FND treatments. Future research should focus on more consistent reporting of multimodal interventions through the development of reporting guidelines and research that more clearly details the expertise of the professionals involved and include health economic evaluations. In turn, this would hopefully continue to improve the limited evidence base and support the development of dedicated FND treatment pathways.

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Appendices

Appendix	Title	Page
A	PRISMA Checklist	63
B	Full Search Strategy	65
C	TIDieR Checklist	67
D	JBI Quasi-experimental Appraisal Tool	68
E	Summary Risk of Bias	73

Appendix A. PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	viii
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 4-8
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 9
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 9-10
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 10
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 11
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 11-12
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 12-13
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 12-13
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 12-13
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 14
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 12-13
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 12-13
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 13
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 14
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 13-14

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 17
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	No citations included
Study characteristics	17	Cite each included study and present its characteristics.	Page 19-21
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 16 and 19-21
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 15-41
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Page 15-41
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 15-41
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 42-46
	23b	Discuss any limitations of the evidence included in the review.	Page 42-46
	23c	Discuss any limitations of the review processes used.	Page 46-46
	23d	Discuss implications of the results for practice, policy, and future research.	Page 47-48
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 9
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 9
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page ii
Competing interests	26	Declare any competing interests of review authors.	Page ii
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page ii

Appendix B. Full Search Strategy

Search Terms

"Multimodal interventions" OR multidisciplinary OR MDT OR interdisciplinary OR transdisciplinary OR "joint working" OR "combined treatment"

AND

"Functional neurological disorders" OR FND OR "Functional movement disorders" OR "functional motor disorder" OR FMD OR "non-epileptic seizures" OR "Non-epileptic attack disorder" OR NEAD OR "functional seizures" OR "psychogenic seizures" OR "dissociative seizures" OR "functional tics" OR "functional tremo*" OR "conversion disorder"

Databases

PSYCINFO, MEDLINE, Scopus

Grey literature searches

Opengrey.eu (archived) and ProQuest (advanced search for interventions AND functional neurological disorder for theses and dissertation and conference papers_ for dissertations and theses and organisations websites (FNDaction FNDHope conference archives)

Additional Techniques

Forward and backward citation searching

Search and citation software

Reference management - Zotero Takats, S., Stillman, D., Cheslack-Postava, F., Bagdonas, M., Jellinek, A., Najdek, T., Petrov, D., Rentka, M., & Venčkauskas, A. (2023). Zotero (6.0.26) [Windows 10]. Corporation for Digital Scholarship. https://www.zotero.org/

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Appendix C. TIDieR Checklist

Item No	Item
Brief name	
1	Provide the name or a phrase that describes the intervention
Why	
2	Describe any rationale, theory, or goal of the elements essential to the intervention
What	
3	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (such as online appendix, URL)
4	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities
Who provided	
5	For each category of intervention provider (such as psychologist, nursing assistant), describe their expertise, background, and any specific training given
How	
6	Describe the modes of delivery (such as face to face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group
Where	
7	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features
When and How Much	
8	Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity, or dose
Tailoring	
9	If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how
Modifications	
10*	If the intervention was modified during the course of the study, describe the changes (what, why, when, and how)
How well	
11	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them
12*	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned

Appendix D.

Figure D1

JBI Checklist for Case Series

	Yes	No	Unclear	Not applicable
• Were there clear criteria for inclusion in the case series?	☐	☐	☐	☐
• Was the condition measured in a standard, reliable way for all participants included in the case series?	☐	☐	☐	☐
• Were valid methods used for identification of the condition for all participants included in the case series?	☐	☐	☐	☐
• Did the case series have consecutive inclusion of participants?	☐	☐	☐	☐
• Did the case series have complete inclusion of participants?	☐	☐	☐	☐
• Was there clear reporting of the demographics of the participants in the study?	☐	☐	☐	☐
• Was there clear reporting of clinical information of the participants?	☐	☐	☐	☐
• Were the outcomes or follow up results of cases clearly reported?	☐	☐	☐	☐
• Was there clear reporting of the presenting site(s)/clinic(s) demographic information?	☐	☐	☐	☐
• Was statistical analysis appropriate?	☐	☐	☐	☐

Figure D2

CASP RCT Checklist

Section A Is the basic study design valid for a randomised controlled trial?

1. Did the study address a clearly formulated research question?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
Was the study designed to assess the outcomes of an intervention?
Is the research question 'formulated' in terms of:
- *Population studied*
- *Intervention given*
- *Comparator chosen*
- *Outcomes measured?*

2. Was the assignment of participants to interventions randomised?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *How was randomisation carried out? Was the method appropriate?*
- *Was randomisation sufficient to eliminate systematic bias?*
- *Was the allocation sequence concealed from investigators and participants?*

3. Were all participants who entered the study accounted for at its conclusion?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Were losses to follow-up and exclusions after randomisation accounted for?*
- *Were participants analysed in the study groups to which they were randomised (intention-to-treat analysis)?*
- *Was the study stopped early? If so, what was the reason?*

Section B Was the study methodologically sound?

4. (a) Were the participants 'blind' to intervention they were given?	☐ Yes ☐ No ☐ Can't Tell
(b) Were the investigators 'blind' to the intervention they were giving to participants?	☐ Yes ☐ No ☐ Can't Tell
(c) Were the people assessing/analysing outcome/s 'blinded'?	☐ Yes ☐ No ☐ Can't Tell
5. Were the study groups similar at the start of the randomised controlled trial?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Were the baseline characteristics of each study group (e.g. age, sex, socio-economic group) clearly set out?*
- *Were there any differences between the study groups that could affect the outcome/s?*

6. Apart from the experimental intervention, did each study group receive the same level of care (that is, were they treated equally)?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Was there a clearly defined study protocol?*
- *If any additional interventions were given (e.g. tests or treatments), were they similar between the study groups?*
- *Were the follow-up intervals the same for each study group?*

Section C: What are the results?

7. Were the effects of intervention reported comprehensively?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Was a power calculation undertaken?*
- *What outcomes were measured, and were they clearly specified?*
- *How were the results expressed? For binary outcomes, were relative and absolute effects reported?*
- *Were the results reported for each outcome in each study group at each follow-up interval?*
- *Was there any missing or incomplete data?*
- *Was there differential drop-out between the study groups that could affect the results?*
- *Were potential sources of bias identified?*
- *Which statistical tests were used?*
- *Were p values reported?*

8. Was the precision of the estimate of the intervention or treatment effect reported?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Were confidence intervals (CIs) reported?*

9. Do the benefits of the experimental intervention outweigh the harms and costs?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *What was the size of the intervention or treatment effect?*
- *Were harms or unintended effects reported for each study group?*
- *Was a cost-effectiveness analysis undertaken? (Cost-effectiveness analysis allows a comparison to be made between different interventions used in the care of the same condition or problem.)*

Section D: Will the results help locally?

10. Can the results be applied to your local population/in your context?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *Are the study participants similar to the people in your care?*
- *Would any differences between your population and the study participants alter the outcomes reported in the study?*
- *Are the outcomes important to your population?*
- *Are there any outcomes you would have wanted information on that have not been studied or reported?*
- *Are there any limitations of the study that would affect your decision?*

11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?	☐ Yes ☐ No ☐ Can't Tell

CONSIDER:
- *What resources are needed to introduce this intervention taking into account time, finances, and skills development or training needs?*
- *Are you able to disinvest resources in one or more existing interventions in order to be able to re-invest in the new intervention?*

		☐	☐	☐	☐
Result 3		☐	☐	☐	☐
Outcome 6		**Yes**	**No**	**Unclear**	**N/A**
Result 1		☐	☐	☐	☐
Result 2		☐	☐	☐	☐

Figure D3

AACODS Checklist for Grey Literature

AACODS		YES	NO	?
Authority	Identifying who is responsible for the intellectual content. **Individual author:** • Associated with a reputable organisation? • Professional qualifications or considerable experience? • Produced/published other work (grey/black) in the field? • Recognised expert, identified in other sources? • Cited by others? (use Google Scholar as a quick check) • Higher degree student under "expert" supervision? **Organisation or group**: • Is the organisation reputable? (e.g. W.H.O) • Is the organisation an authority in the field? **In all cases:** • Does the item have a detailed reference list or bibliography?			
Accuracy	• Does the item have a clearly stated aim or brief? • Is so, is this met? • Does it have a stated methodology? • If so, is it adhered to? • Has it been peer-reviewed? • Has it been edited by a reputable authority? • Supported by authoritative, documented references or credible sources? • Is it representative of work in the field? • If No, is it a valid counterbalance? • Is any data collection explicit and appropriate for the research? • If item is secondary material (e.g. a policy brief of a technical report) refer to • the original. Is it an accurate, unbiased interpretation or analysis?			
Coverage	All items have parameters which define their content coverage. These limits might mean that a work refers to a particular population group, or that it excluded certain types of publication. A report could be designed to answer a particular question, or be based on statistics from a particular survey. • Are any limits clearly stated?			
Objectivity	It is important to identify bias, particularly if it is unstated or unacknowledged. • Opinion, expert or otherwise, is still opinion: is the author's standpoint clear? • Does the work seem to be balanced in presentation?			
Date	For the item to inform your research, it needs to have a date that confirms relevance • Does the item have a clearly stated date related to content? No easily discernible date is a strong concern. • If no date is given, but can be closely ascertained, is there a valid reason for its absence? • Check the bibliography: have key contemporary material been included?			
Significance	This is a value judgment of the item, in the context of the relevant research area • Is the item meaningful? (this incorporates feasibility, utility and relevance) • Does it add context? • Does it enrich or add something unique to the research? • Does it strengthen or refute a current position? • Would the research area be lesser without it? • Is it integral, representative, typical? • Does it have impact? (in the sense of influencing the work or behaviour of others)			

Appendix E. Full Risk of Bias Summary

Table E1

Case Series Risk of Bias Assessment Summary

Study	Clear inclusion criteria	Reliable condition measurement	Valid condition measurement	Consecutive inclusion	Complete inclusion	Participant demographics	Participant clinical information	Outcomes and follow-up	Site information	Appropriate anlayses	Rating
Richardson et al. (2018)	NC	Y	NC	Y	Y	Y	Y	Y	NC	N/A	Medium
Cope et al. (2021)	Y	Y	NC	NC	NC	Y	Y	Y	NC	Y	Medium
Schmidt et al. (2021)	Y	Y	NC	N	N	Y	Y	Y	Y	Y	Medium
Jimenez et al. (2019)	N	N	NC	NC	NC	Y	Y	Y	N	Y	High
Saifee et al. (2012)	Y	NC	NC	Y	N	Y	Y	Y	Y	Y	Medium
Schneider et al. (2024)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Low
Jacob et al. (2018)a	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Low
Jacob et al. (2018)b	NC	NC	NC	Y	Y	Y	Y	N/A	Y	N/A	Medium

Hebert et al. (2021)	Y	Y	Y	NC	NC	Y	Y	Y	Y	Y	Low
Faul et al. (2020)	Y	Y	Y	NC	N	Y	Y	Y	Y	Y	Low
Petrochilos et al. (2020)	NC	NC	NC	N	N	Y	Y	Y	Y	Y	Medium
Palmer et al. (2023)	NC	NC	NC	N	N	Y	Y	Y	Y	Y	Medium
Guy et al. (2024)	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Low
McCormack et al. (2014)	NC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Low
Saunders et al. (2024)	NC	NC	NC	Y	N	Y	Y	Y	Y	Y	Medium
Bailey et al. (2024)	Y	NC	NC	NC	N	Y	Y	Y	N	Y	Medium
Bhatt et al. (2024)	Y	Y	Y	N	N	Y	Y	NC	Y	Y	Medium
Townsend et al. (2024)	Y	NC	NC	Y	Y	Y	Y	Y	Y	Y	Low

Note. Y = yes, N = no, NC = not clear, N/A = not applicable, 0-4 yes = high risk, 5-7 yes = medium risk, 8-10 yes = low risk

Table E2

Report of Service Development Risk of Bias Summary

Study	Authority	Accuracy	Coverage	Objectivity	Date	Significance	Rating
Polich et al. (2022)	Y	Y	Y	N	N	Y	Medium
Stanton et al. (2023)	Y	NC	N	NC	N	NC	High
Finzel et al. (2024)	Y	Y	Y	Y	Y	Y	Low
Russell et al. (2022)	Y	NC	Y	Y	N	Y	Medium
Barbey et al. (2022)	Y	Y	Y	Y	N	Y	Low

Y = yes, N = no, NC = not clear. 0-2 yes = high risk, 3-4 yes = medium risk, 5-6 yes = low risk

Table E3

Randomised Controlled Trials Risk of Bias Assessment Summary

Study	Research Question	Randomisation	All participant accounted for	Participant blinding	Investigator blinding	Assessor blinding	Group similarity	Equal care	Comprehensive effect reporting	Precision of estimated effect reported	Benefits vs costs	Local application	Provide greater value	Rating
Macías-García et al. (2024)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	NC	Y	Y	Low
Dallocchio et al. (2016)	Y	Y	N	NC	NC	Y	Y	NC	NC	N	NC	Y	NC	High

Y = yes, N = no, NC = not clear, 0-5 yes = high risk, 6-9 yes = medium risk, 10-13= low risk.

Section Two: Empirical Study

A Latent Profile Analysis of Routine Data to Investigate Subgroups of Functional Neurological Disorder in a Secondary Care Specialist Neurology Psychotherapy Service

Abstract

Objectives: Functional Neurological Disorder (FND) is a complex and heterogeneous condition. To better understand FND, this study aimed to: 1. identify subgroups in FND based on scores on nine psychosocial measures, 2. visualise, interpret and assign labels to the subgroups, 3. classify cases to subgroups, 4. investigate demographic features associated with subgroups.

Methods: The current study used data collected as part of routine practice in a specialist neurology psychotherapy service for N=469 patients between March 2020 and January 2022. A latent profile (LPA) analysis was used to identify and visualise subgroups and included a post-hoc sensitivity analysis to validate the model. This was followed by a multinomial logistic regression to identify demographic features that predicted subgroup membership.

Results: The LPA identified and visualised five subgroups, which were assigned descriptive labels based on distress and functional impairment; 1. Moderately distressed with moderate functional impairment, 2. Mild distress with mild functional impairment, 3. Severely distressed with severe functional impairment, 4. Mild-moderately distressed with moderate functional impairment, 5. Moderate-severely distressed with moderate functional impairment. Unemployment significantly predicted group membership for profiles 1 and 3 compared to profile 5. Age significantly predicted group membership for profiles 1 and 2 compared to profile 5.

Conclusions: These results indicated that individuals with FND can be grouped into five profiles and that grouping is predicted by age and employment status for some profiles. Clinically, this can help understand FND presentations and provides a foundation for future research to investigate group characteristics and begin investigating targeted treatments. Strengths and limitations are discussed.

Keywords: *Functional Neurological Disorder, FND, Conversion Disorder, Latent Profile Analysis*

Practitioner Points

- Individuals with FND can be grouped into five profiles based on dimensions of distress and functional impairment.
- The two most distressed and functionally impaired groups, profiles 3 and 5, score particularly highly on measures of PTSD symptoms and unmitigated communion.
- Age and unemployment predicted group membership for some profiles.
- Future research should aim to replicate these results, further investigate the role of PTSD symptoms and unmitigated communion in FND and further investigate demographic predictors of group membership.

Introduction

What Is Functional Neurological Disorder?

Functional Neurological Disorder (FND) is a neurological condition characterised by neurological symptoms associated with changes in how brain networks process information, but without any underlying structural pathology (National Institute of Neurological Disorders and Stroke, n.d.; American Psychiatric Association, 2013). FND is considered an umbrella diagnosis, encapsulating several clinical manifestations (e.g., functional dissociative seizures, functional movement disorders (FMD), functional tics, functional tremor/parkinsonism etc.). FND is associated with a poorer health-related quality of life (HRQoL) (Vechetová et al., 2018; Gelauff et al., 2018), lower employment rates (Jennum et al., 2019) and higher rates of physical and psychiatric co-morbidity (Williams et al., 2022; Butler et al., 2020). FND also has high economic costs, particularly in terms of costs associated with high health care utilisation (O'Mahony et al., 2023; Seneviratne et al., 2019).

Complexity And Heterogeneity Of FND

In the largest survey of FND patients conducted to date (N = 1162), Butler et al. (2021) demonstrated that FND has markedly high symptom heterogeneity. Participants reported experiencing high rates of core FND symptoms (mean = 10), including: altered bodily sensations (79.2%), loss of balance (76.7%), difficulty walking (75.8%), muscle jerking (65.6%), difficulties talking (64.8%), muscle spasms (64.9%), tremors (60.7%), seizures (50.6%), vision problems (45.5%), paralysis (42.3%), trouble swallowing (41.1.%), hearing problems (37.5%), memory problems (80.3%). Butler et al. (2021) also demonstrated the complexity of FND due to high rates of associated symptoms that can cause significant disability; fatigue (92.8%), headache (70.1%), bladder symptoms (45.5%) and bowel symptoms (38.6%). The

most common manifestations of FND include sensory symptoms, limb weakness and non-epileptic seizures (Ahmad & Ahmad, 2016).

In addition to high levels of symptom complexity, research has found high inter- and intra-individual heterogeneity. Heterogeneity may exist at different levels, such as within-person, between persons, between conditions, and in terms of rates of co-morbidity. Bahous et al. (2024) found that patients can vary in seizure presentation, such as affected anatomical area, movements and duration. They also found that individuals can vary in the consistency of seizure presentation across time, with some individuals having highly consistent seizure presentations over time and others having low consistency in presentation. Kerr et al. (2021) has also demonstrated higher work disability, delay to diagnosis and comorbidities with age of presentation.

Historically, here have been many attempts to theoretically explain the development of FND (e.g., spiritual, religious understanding, reproductive systems, hysteria, conversion, dissociation) (Raynor & Baslet, 2021); however, these models fail to adequately explain observed heterogeneity in symptom presentations and timing of onset. In routine practice, clinicians anecdotally report differing subtypes of FND such as subtypes based on traumatic experiences, however, this notion is only just beginning to be evidenced empirically (Hingray et al., 2022). Research has shown that individuals with traumatic histories show earlier onset and greater delay from onset to diagnosis (Selkirk et al., 2008) as well as having increased symptom severity and decreased overall physical health scores (Paredes-Echeverri et al., 2022).

Extant Literature Exploring FND Subtypes

Current classifications of FND within the International Classification of Diseases (ICD-10) (World Health Organisation, 1993) and Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) (American Psychiatric Association, 2013) are based on the predominant neurological symptoms (e.g., seizures, tics, weakness). This fails to account for presentations with multiple symptoms or a range of psychosocial factors associated, which may have a discriminative use for subtyping. Increased understanding regarding FND classification has important clinical implications as different variants, with different underlying mechanisms, may require different treatment approaches.

Researchers are now beginning to explore ways to classify FND presentations clinically, often by investigating clusters or profiles within data from FND populations. Pun et al., (2020) used clustering methods to identify psychological profiles in an FND sample of clinical outcome data (N=288). Severe psychological diagnoses, childhood trauma, and other neurological diagnoses were more likely for individuals with dissociation as the primary symptom compared to those with primary motor symptoms. Although this provides initial evidence of psychological classifications, the study did not use any standardised or validated measures and there are limitations of the statistical methods (ANOVA). These limitations could be overcome by using more sophisticated statistical methods but would require a larger sample size. Other research has clustered FND presentations based on sensory profiles using standardised tools and found FND to be characterised by tendencies for low registration, sensory sensitivity, and sensation avoiding (Ranford et al., 2020). More recently, investigating phenotypes in FMD found episodic FMD was associated with hyperkinetic movements, hyperarousal, anxiety and trauma history, whereas

constant FMD with weakness, gait disorders, activity avoidance and low self-agency (Gilmour et al., 2023).

Data-Driven Approaches Exploring Subgroups

Although previous research has taken a step towards a wider understanding of FND, sample sizes do not facilitate more complex diagnoses that assess differences across subgroup membership and studies with larger samples often do not use standardised measures (Pun et al., 2020). Much of the existing research also only tends to attempt grouping based on single dimensions, such as sensory processing (Ranford et al., 2020), which does not account for the range of complexity highlighted above. It is also clear from research in other complex diagnoses that classifications based on theory often lack diagnostic accuracy, and unitary diagnostic labels do not adequately characterise a heterogeneous population. For example, Simmonds-Buckley et al. (2021) found that patients with depression could be characterised into 14 subgroups, which in turn demonstrated differential response rates to treatment. These types of clustering analyses typically require a large sample size (approximately over N=500), which is scarce in FND research due to the rarity of the condition (less than 1 in 2000). Accessing routine data from specialist tertiary care services is one potential method to establish larger datasets for exploring subtypes in FND populations.

Clinical Implications

Clinical reports and emerging research suggest there are particular patterns of presentations in the context of a highly heterogeneous population. However, empirical datasets are small and have not applied sufficiently powered data-driven methods. The current study aims to use empirically sound data-driven methods to identify whether subtypes of FND using psychological variables exist. This has

implications for understanding the condition, care provision, training for health professionals, and developing more targeted interventions. This would also provide a platform for future research investigating the effectiveness of different treatment models.

Aims and Hypotheses

The objective of this study was to investigate and identify symptom profiles of people with FND using latent profile analysis applied to a large routine outcome dataset from a specialist FND secondary care service. The aims of the study were to:

1. Identify symptom profiles (i.e., subtypes) of FND presentations based on intake scores on a battery of standardised measures of symptoms and functioning administered at referral into the service.
2. Visualise and interpret symptom profiles to assign descriptive labels for the identified subgroups of FND.
3. Classify cases according to their identified symptom profile to establish distinct subgroups and their prevalence.
4. Investigate which clinical and demographic features are associated with different FND subgroups.

Due to limited prior research, this was an exploratory analysis applying data-driven methods to identify latent clustering, therefore, no a priori constructs based on theoretical or clinical assumptions were applied. The only confirmatory hypothesis was that empirically derived subgroups of FND based on different symptom profiles would be identified. There were no expectations about the number of subtypes, the latent symptom groupings, or their prevalence.

Method

The study is reported according to the REportingof studies Conducted using Observational Routinely-collected health Data (RECORD) guidelines (Benchimol et al., 2015). Please see Appendix A for the full checklist. The study received Health Research Authority approval (24/HRA/4738), secondary ethical approval from the University of Sheffield ethics department (057847) and was pre-registered through the Open Science Framework (https://doi.org/10.17605/OSF.IO/3BCDS). Please see Appendix B for ethical approval documentation.

Design and Data Sources

This study comprised a secondary analysis of routine data from a specialist neurology psychotherapy service treating patients with FND, using latent profile analysis to identify latent subgroups of FND based on a range of self-report variables. Baseline data collected from N=469 patients before starting treatment between March 2020 and January 2022 were accessed for the study. To our knowledge, this is one of the largest datasets available in the existing literature in FND populations using data driven methods. As previously stated, the approach was exploratory due to the limited nature of the extant literature.

Setting

Data was collected from patients referred to a team of psychotherapists working in the Department of Neurology at the Royal Hallamshire Hospital, Sheffield, United Kingdom. Referrals to psychotherapy were made by Consultant Neurologists serving a regional population of 1.39 million people. Sheffield's Neurology Psychotherapy service was set up by Sheffield Teaching Hospitals to provide specialist treatment for individuals with FND, whose needs are often not met by other existing

psychotherapy services. The service consists of specialist psychotherapists with training and a special interest in FND.

Participants and Sample Selection

Participant data was collected as part of routine patient care within the psychotherapy service. As part of the clinical consent process, patients gave consent for anonymised data to be used for evaluation purposes. Participants were assessed for eligibility to access the service using referral criteria. Neurologists were encouraged to refer all patients diagnosed with FND and willing to access psychotherapy with the following exceptions:

- Patients with serious ongoing psychiatric problems
- Patients who are currently suicidal or who have had a suicide attempt in the last year
- Patients who are currently receiving psychotherapy elsewhere
- Patients who have already had two episodes of treatment from the service
- Patients who are currently dependent on alcohol or opiate drugs

Referrals for these patients were rejected because they initially required intervention from other treatment providers. Participants' data was included in the final sample if they had either complete data, or sufficient missing data to complete data imputation (see information on data preparation). See Table 1 for sample characteristics and the STROBE flowchart in Appendix C for selection of the final sample.

Table 1

Demographic and clinical characteristics of the sample.

Characteristics	Descriptives
Age mean (SD)	41.22 (14.85)
Gender (n)	97 male / 364 female
Relationship status (n)	120 in a relationship / 341 not in a relationship
Employment (n)	58 employed / 403 unemployed
Education (n)	70 university education / 359 school education
Ethnicity (n)	35 minoritised background / 426 non-minoritised background
Nationality (n)	438 British/Irish / 23 Other nationality
Baseline GAD-7: mean (SD)	14.04 (6.08)
Baseline EQVAS: mean (SD)	44.13 (21.30)
Baseline EQ index: mean (SD)	0.45 (0.24)
Baseline PHQ-9: mean (SD)	17.31 (6.84)
Baseline PHQ-15: mean (SD)	16.96 (6.16)
Baseline WSAS: mean (SD)	25.51 (10.16)
Baseline EASE: mean (SD)	127.67 (18.10)
Baseline PCL-5: mean (SD)	64.54 (21.75)
Baseline UCS: mean (SD)	32.31 (6.48)

Note: GAD = Generalised Anxiety Disorder Questionnaire, EQVAS = EuroQol Visual Analogue Scale, EQ index = EuroQol index score, PHQ = Patient Health Questionnaire, WSAS = Work and Social Adjustment Scale, EASE = self-Efficacy Assertiveness, Social support, self-awareness and hElpful questionnaire, PCL = PTSD Checklist, UCS = Unmitigated Communion Scale, SD = Standard Deviation. The only cases with enough missing data to be removed (n = 8) were missing across all variables.

Sample Size Calculation

There is a building consensus for sample size and power calculations in latent variable modelling and more specifically latent profile analysis (LPA). In previous behavioural research using LPA, the median sample size is 494 (Spurk et

al., 2020). There are recommendations made from Monte Carlo simulations that a sample size of approximately 500 will give enough statistical power to select the optimal number of profiles specified by the model (Tein et al., 2013), although this will have to be considered alongside other factors (number of indicators and profiles within the model). Guidance on sample size recommendations for using the bootstrap likelihood ratio test (BLRT) to empirically select the appropriate number of profile classes based on different numbers of classes and estimated effect sizes of interclass differences was provided by Dziak et al., (2014). Using the comparison tables provided, to achieve 80% power to detect a moderate effect size in interclass differences when determining the number of underlying profile classes, a model with nine indicator variables would require a sample size of N=393. Eligible data was available for N = 461 (n=8 cases were excluded due to missing data) and therefore sufficiently powered to detect latent profiles of FND using nine indicator variables (outlined below).

Procedure and Measures

Patients in the service completed several measures at the baseline assessment. The measures completed were chosen by the service because of their perceived clinical relevance to FND (see Appendix D for measures). Reliability and validity statistics for measures were gathered in as much detail as possible, however due to the inconsistency in the psychometric testing across measures, some psychometric properties cannot be reported for all measures.

Demographic Information

Demographic information included age, gender, marital status, employment, education, ethnicity and nationality.

Service Usage

Service usage was assessed by measuring access to GP surgery (telephone appointments, home appointments, nurse appointments), Accident & Emergency attendance, NHS direct, health visitor, day hospital services, outpatient clinics, psychology, NHS physiotherapy, other physiotherapy, mental health professionals, health therapists and other. This is because individuals with FND have been found to frequently attend health services (O'Mahony et al., 2023; Seneviratne et al., 2019).

The Self-Efficacy Assertiveness, Social support, Self-awareness and Helpful Questionnaire (EASE)

The EASE is a patient-reported outcome measure assessing psychotherapy-related change in patients with seizure disorders. The 40-item measure explores self-awareness, social support, assertiveness, general and event-related self-efficacy and helpful thinking, with a higher score indicating higher self-efficacy. It has been found to have good internal consistency with Conbach's α of around 0.92 and good content validity (Michaelis et al., 2019). There is ongoing research looking to validate the measure for an FND population.

Patient Health Questionnaire 9 (PHQ- 9)

The PHQ-9 is an assessment tool to measure the experience of depressive symptoms. It is a standard measure for depression in healthcare settings (Kroenke et al., 2010). Internal reliability has been found at Cronbach's α of around 0.86 (Kroenke, Spitzer and Williams, 2001). Scores of 5, 10, and 15 represent cut-off points for mild, moderate, and severe depression. It has now been validated with an FND population (Lopez et al., 2021).

Patient Health Questionnaire 15 (PHQ-15)

PHQ-15 is an assessment tool to identify patients in a primary care setting who are at risk of developing somatoform symptoms. It is not a diagnostic tool but helps identify the presence of risk factors. It has been found to have construct validity when intercorrelated with SF-12 and PHQ-9 (Kocolevant et al., 2013), and internal reliability was found with Cronbach's α of 0.80 (Kroenke et al., 2002). Scores of 5, 10 and 15 represent cut-off points for low, medium and high somatic symptom severity.

Generalised Anxiety Disorder 7 (GAD-7)

GAD-7 is an assessment tool for generalised anxiety disorder. The questionnaire is found to have excellent internal consistency (Cronbach α = .92) good test-retest reliability (Spitzer et al., 2006), and increasing scores on the scale are associated with higher functional impairment (Spitzer et al., 2006). This tool has been validated with an FND population (Goldstein et al., 2023).

EQ-5D-3L

EQ-5D-3L is a tool designed by the EuroQoL organisation to measure quality of life (EuroQol.org, n.d.). EQ-5D-3L is the 3-level version of the EuroQoL measure. It has five dimensions consisting of mobility, self-care, usual activities, pain/discomfort and anxiety/depression and rates on a 3-point scale (no problems, some problems, extreme problems). The 3 levels of response have no arithmetic value and therefore an index score is derived by attaching values to each level of each health state and then deducting these from 1 (EuroQol Research Foundation, 2023). Value sets have been obtained for the general population in the UK and are used as part of the analysis (Devlin et al., 2017). It has been validated across health populations and demonstrated low inconsistency (5.4%) (Yfantopoulos &

Chantzaras, 2017) and found to have good validity. However, as with all measures of quality of life (QoL) it is yet to be validated in an FND population.

Work and Social Adjustment Scale (WSAS)

WSAS is a 5-item self-report measure where the patient rates the impact of their difficulties from their perspective where a higher score indicates more difficulty. The scale has good internal reliability with a Cronbach's α from 0.7 to 0.94, and good test-retest reliability (0.73). The scores on this measure have been found to be sensitive to differences in disorder severity and to treatment-related change (Mundt et al., 2002).

Unmitigated Communion Scale (UCS)

UCS is a scale that assesses an individual's focus on others and concern for others over their own distress or needs where a higher score indicates higher levels of unmitigated communion. This scale has been found to have acceptable internal consistency and high test-retest reliability (Fritz & Helgeson, 1998).

PTSD Checklist 5 (PCL-5)

PCL-5 is a 20-item self-report measure of the DSM-IV symptoms of Post-Traumatic Stress Disorder (PTSD) where a high score indicates higher levels of PTSD symptoms. This scale has been found to have high internal reliability with a Cronbach's α of 0.94, test-retest reliability and convergent (rs = .74 to .85) and discriminant validity (rs - .31 to .60) (Blevins et al., 2015).

Analysis

Data Preparation.

Prior to analysis, ethnicity and nationality variables were collapsed into high-level ethnic groups using NHS Mapping and SNOMED codes for more granular classification (NHS Digital, 2020). Missing data was handled in a two-stage process.

First, small amounts of missing single-item data was imputed using the mean score for each individual on that measure before computing total scores for inclusion in the model (termed profile indicators). Second, missing outcome measure totals were then imputed using the R package, missForest (Stekhoven & Buhlmann, 2012). MissForest is a non-parametric imputation approach that uses a Random Forest decision tree approach to impute missing values based on the remaining available data. It has been shown to be reliable and robust when there is less than 40-50% missing data and typically outperforms other missing data approaches (Stekhoven & Buhlmann, 2012). Data of n=8 participants who had more than 50% missing on variables were removed. There were large amounts of missing data for the service usage variable, which meant that it was not possible to include in the analysis.

There is no standardised scoring procedure or established scoring consensus in the existing literature for the UCS, therefore a summed total score was calculated for within-sample comparison. The EASE also does not have a standardised scoring system, therefore total scores were calculated in line with scoring processes suggested by Adewusi et al., (2023). The EQ-5D-3L was recoded and an index score computed according to the UK value sets as per the manual (Delvin et al., 2017; EuroQol Research Foundation, 2023) alongside the EQ-5D-3L single item visual analogue scale subjective health rating (termed EQVAS). Subsequently, z-standardised scale scores for the indicator variables (measure totals) were calculated for use in LPA to aid interpretation across indicator variables. The scores of the EQ index, EQVAS and EASE scores (measures where a higher score indicated less impairment) were inverted to ensure all measures could be interpreted in the same direction (higher score = greater impairment, lower score = less

impairment). The analysis was conducted in four stages to map onto the corresponding aims.

Aim 1: Identify Symptom Profiles

The first stage of the analysis employed exploratory LPA using *Jamovi* software (The jamovi project, 2023), an open-source software package which operates as a graphical user interface for the R programming environment (R Core Team, 2023). LPA is a latent variable modelling approach that assumes there is heterogeneity in the sample, meaning hidden subgroups of individuals who have similar symptom profiles on observed continuous measures can be identified (Collins & Lanza, 2013). LPA is therefore a method of reducing many variables to a small number of subgroups that have different configurations or patterns of the measured variables. The benefit of using LPA compared with traditional non-latent methods is that individuals are classified based on the probability estimated by the model itself and variables can be nominal or ordinal (Spurk et al., 2020). Individuals are allocated to a subgroup profile based on probabilities of membership estimated by the model.

The analysis was undertaken using guidelines specified by Spurk et al. (2020). First, the distribution of the nine indicator variables was inspected using histograms and indicators of normality to determine the appropriate model estimator to be used. Second, LPA models were fitted to the data using an increasing number of class solutions (starting with a 2-class solution). Model specification can allow for different combinations of equal, varying and zero-fixed variances and covariances. The more parameters that are allowed to vary (i.e. have to be estimated), the more complex the model becomes. To balance parsimony with the best fit of the data, two model specifications were tested for each class solution to evaluate different variations in variances and covariances; Model 1 specified equal variances with

covariances fixed to zero, and Model 2 specified varying variances with covariances fixed to zero. As is recommended, multiple statistical fit indices were compared to select the final model identified as having the optimal number of classes following Wickrama et al.'s (2016) recommendations outlined below:

1. Smallest Bayesian Information Criterion (BIC) value
2. Statistically significant Bootstrapped Likelihood Ratio Test (BLRT) indicating models with an increasing number of classes provided a statistically better fit of the data
3. Entropy values (confidence in individuals' membership classification) higher than 0.8
4. Smallest class size has at least 5% membership of the sample to maintain usefulness of classes
5. Classes with meaningful interpretations.

Model fitting with additional classes stopped when the additional class model did not significantly improve the fit according to these criteria.

Aim 2: Visualise Symptom Profiles and Assign Descriptive Labels

After the selection of the optimal model, latent profile classifications were visualised using a profile plot to display the symptom profiles and how the configuration of the indicator variables differed between subgroups. This plot was used to support the assignment of descriptive labels to each subgroup. Latent profiles were conceptualised by the research team depending on the features of the profiles. This in part was shaped by the positionality and bias of the research team, who were white, psychological professionals with a specialist professional interest in FND. In order to consider how this contributes to the conceptualisation of profiles, profiles were discussed in research supervision to reflect on epistemological stances and

pre-conceived knowledge and attitudes. In order to contextualise findings, normative sample mean, standard deviation and Z scores are reported. For the UCS, the normative mean was taken from Helgeson et al. (2015) which was an item-level mean and multiplied by nine to scale up to a total score (methodology taken from Scott-Bridge et al., 2025). For the WSAS, authors could not find a normative score, therefore instead the comparison is made between the current sample and a depression sample. A separate software was used to enable visualisation of the profiles across all nine indicators using means and standard deviations.

Aim 3: Classify Cases

The class probabilities of the selected model were used to classify all cases in the dataset into the most similar subgroup to their symptom profiles and report the proportion of cases in each subgroup.

Aim 4: Investigate Demographic Features

Finally, multinomial logistic regression analysis was conducted to investigate whether participant demographic characteristics (gender, marital status, employment status, education, ethnicity, nationality and age) were associated with subgroup classification (outcome variable).

Post-Hoc Sensitivity Analysis

The EASE and the UCS indicators have high clinical utility but are not as robustly tested in a research setting and lack a standardised scoring process and less reliable psychometrics. Therefore, to ensure robustness of the model, a sensitivity analysis was run, including a repeated set of LPA analyses but without the EASE and UCS.

Results

Aim 1: Identify Symptom Profiles

Nested models of up to 7 classes were tested, before fit metrics indicated model fit was deteriorating (see Table 1). Taking into consideration Wickrama et al.'s (2016) recommendations and the law of parsimony, the 5-class model 2 (varying variances with zero-fixed co-variances) was shown to have the best fit based on having the lowest BIC (9964.44), an entropy value of above 0.8 (0.87) and BLTR that was significantly better for the 5-class model 2. The percentage of participants in each subgroup was also assessed to ensure that there is more than 5 percent of the sample in each group (increasing the likelihood of a meaningful grouping). In the 5-class model 2, the smallest subgroup consisted of 7.8% of the sample and the largest subgroup consisted of 29.5% of the sample.

Table 2

Fit metric indices for each nested model 1 (equal variance, zero-fixed covariance) and 2 (varying variances, zero-fixed covariances) up to seven classes (optimal model in bold).

Model	Classes	BIC	Entropy	n_min	n_max	BLRT_p
1	1	11875.74	1.00	1.00	1.00	
1	2	10616.71	0.89	0.42	0.58	0.01
1	3	10264.41	0.90	0.14	0.46	0.01
1	4	10165.44	0.86	0.12	0.43	0.01
1	5	10106.18	0.82	0.10	0.28	0.01
1	6	10112.15	0.83	0.04	0.31	0.01
1	7	10066.58	0.86	0.04	0.33	0.01
2	1	11875.74	1.00	1.00	1.00	
2	2	10488.92	0.91	0.48	0.52	0.01
2	3	10227.57	0.85	0.26	0.45	0.01
2	4	10054.98	0.87	0.14	0.37	0.01
2	**5**	**9964.44**	**0.87**	**0.08**	**0.30**	**0.01**
2	6	10016.28	0.86	0.08	0.28	0.01
2	7	10049.49	0.85	0.03	0.25	0.01

Sensitivity Analysis

The model did not provide a better statistical fit without these measures. For statistical indices of the alternative model, see Appendix E. Therefore, the model with the EASE and UCS was selected as the optimal model for the next analysis steps.

Aim 2 & 3: Profile Descriptions

Profile descriptions were assigned to each of the 5 classes in the optimal model to aid interpretation. The nine indicators were conceptualised in terms of "distress" (GAD, PHQ15, PHQ9, PCL) and "functioning" (WSAS, UCS, EASE, EQVAS, EQ index). When interpreting the results, it is important to consider that they are interpreted in the context of the sample. For example, a subgroup described as "mild distress" is considered mild in the context of the rest of the sample. Please see Table 3 for the comparison to normative samples. Please see Figure 1 for a visualisation of the Z standardised scores for each subgroup across all nine indicators and Figure 2 for a visualisation of the raw means and standard deviations for each profile.

Figure 1

Visualisation of each subgroup across all nine indicators using Z-standardised scores (reversed scale for EQVAS, EQ index and EASE).

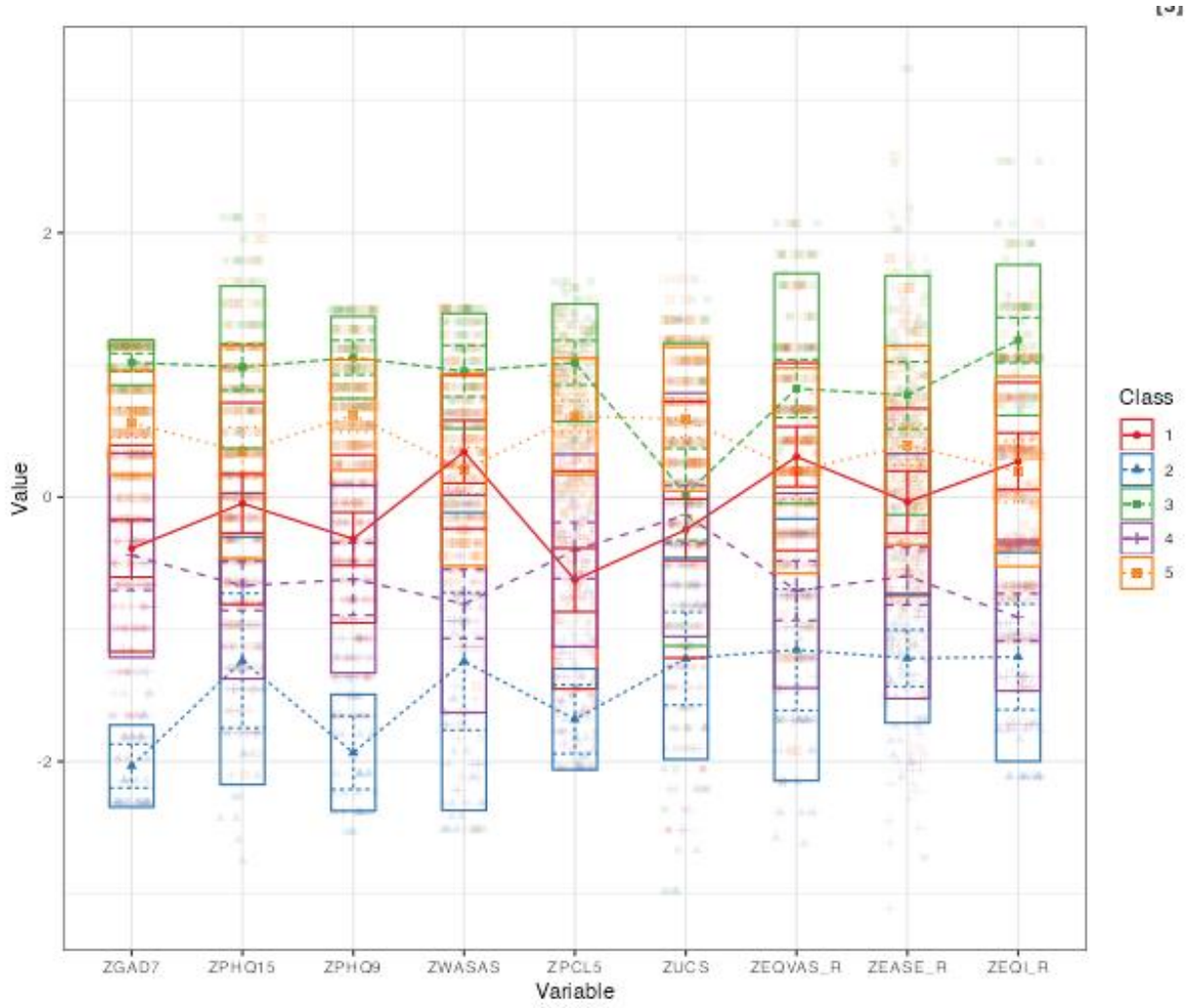


Figure 2

Plots of means and standard deviations for each profile.

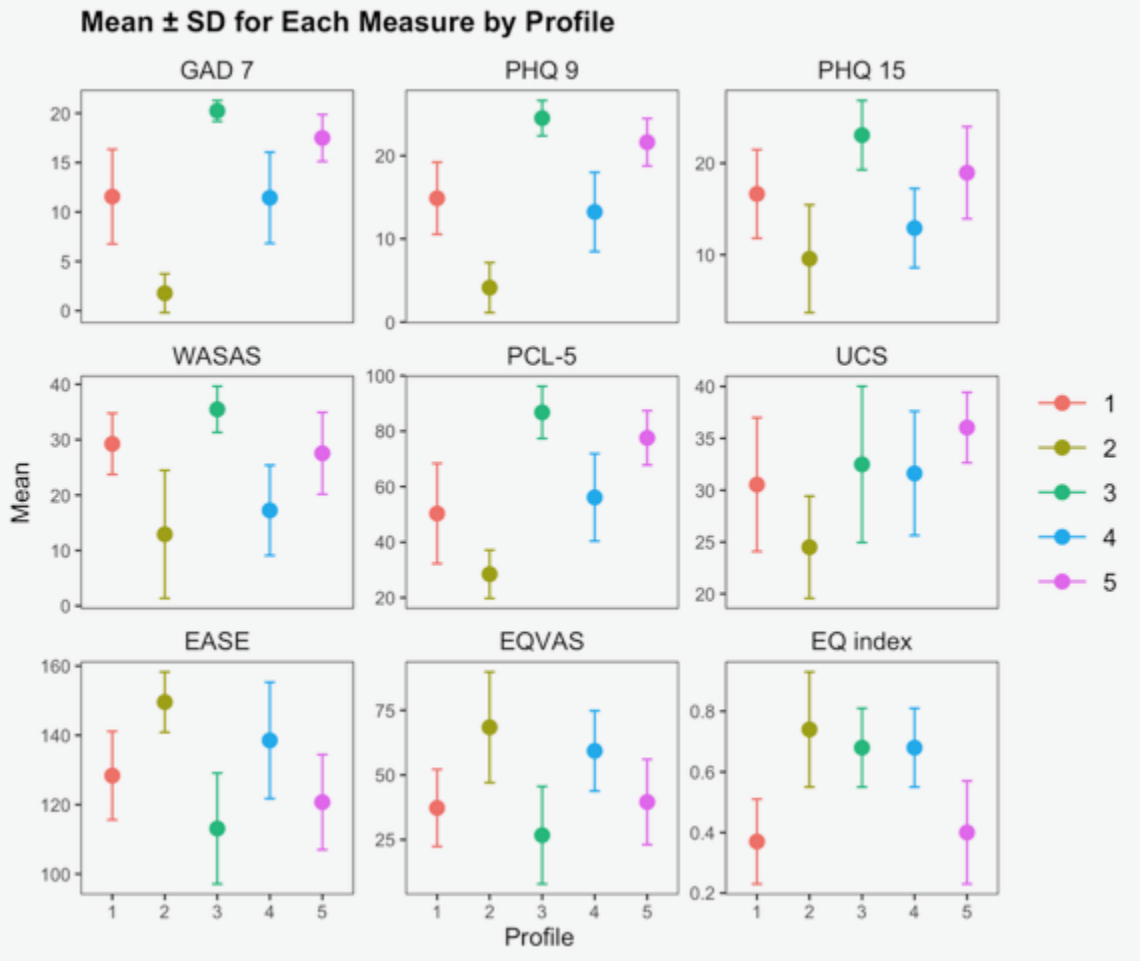


Table 3

Means, standard deviation, normative means and standard deviations, Z-scores clinical thresholds for each profile on each indicator.

Profile	Measure	Mean	SD	Normative mean (SD)	Z-scores	Clinical threshold
1	GAD 7	11.56	4.794	2.95 (3.41)[a]	2.52	Moderate anxiety[i]
	PHQ 15	16.65	4.84	3.8 (4.1) [b]	3.13	Severe symptom severity[b]
	PHQ 9	14.88	4.33	3.2 (3.8)[c]	3.07	Moderate depression[c]
	WSAS	29.24	5.53	18.55 (10.17) [d]	1.05	Severe[j]

	PCL 5	50.33	18.05	29.7 (17.7) [e]	1.17	Within clinical range[e] (symptomatic PTSD range) [k]
	UCS	30.54	6.46	29.25 (5.31) [f]	0.24	N/A
	EQVAS	37.27	14.89	78.3 (20.4) [g]	-2.01	N/A
	EQ index	0.37	0.14	0.92 (0.17) [h]	-3.24	N/A
	EASE	128.38	12.75	N/A		N/A
2	GAD 7	1.78	1.96	2.95 (3.41)	-0.34	Mild anxiety
	PHQ 15	9.58	5.88	3.8 (4.1)	1.41	Moderate symptom severity
	PHQ 9	4.14	3.00	3.2 (3.8)	0.25	Mild depression
	WSAS	12.92	11.55	18.55 (10.17)	-0.55	Significant functional impairment, less severe clinical psychopathology
	PCL 5	28.47	8.7	29.7 (17.7)	-0.07	Below clinical threshold
	UCS	24.5	4.93	29.25 (5.31)	-0.89	N/A
	EQVAS	68.44	21.39	78.3 (20.4)	-0.48	N/A
	EQ index	0.74	.19	0.92 (0.17)	-1.06	N/A
	EASE	149.58	8.7	N/A		N/A
3	GAD 7	20.23	1.05	2.95 (3.41)	5.07	Severe anxiety
	PHQ 15	23.06	3.78	3.8 (4.1)	4.70	Severe
	PHQ 9	24.51	2.12	3.2 (3.8)	5.01	Severe depression
	WSAS	35.48	4.17	18.55 (10.17)	1.66	Moderately severe

	PCL 5	86.78	9.43	29.7 (17.7)	3.22	Within clinical range (symptomatic PTSD)
	UCS	32.49	7.54	29.25 (5.31)	0.61	N/A
	EQVAS	26.74	18.85	78.3 (20.4)	-2.53	N/A
	EQ index	0.68	0.13	0.92 (0.17)	-1.41	N/A
	EASE	113.11	15.99	N/A		N/A
4	GAD 7	11.44	4.61	2.95 (3.41)	2.48	Moderate anxiety
	PHQ 15	12.92	4.32	3.8 (4.1)	2.22	Moderate
	PHQ 9	13.24	4.76	3.2 (3.8)	2.64	Moderate depression
	WSAS	17.24	8.14	18.55 (10.17)	-0.13	Significant functional impairment, less severe clinical psychopathology
	PCL-5	56.13	15.77	29.7 (17.7)	1.49	Within clinical range (symptomatic PTSD)
	UCS	31.62	5.99	29.25 (5.31)	0.45	N/A
	EQVAS	59.32	15.51	78.3 (20.4)	-0.93	N/A
	EQ index	0.68	0.13	0.92 (0.17)	-1.41	N/A
	EASE	138.53	16.78	N/A		N/A
5	GAD 7	17.49	2.37	2.95 (3.41)	4.26	Severe anxiety
	PHQ 15	18.96	5.03	3.8 (4.1)	3.70	Severe
	PHQ 9	21.62	2.85	3.2 (3.8)	4.85	Severe depression
	WSAS	27.54	7.38	18.55 (10.17)	0.88	Moderately severe

PCL-5	77.58	9.79	29.7 (17.7)	2.71	Within clinical range (symptomatic PTSD)
UCS	36.04	3.4	29.25 (5.31)	1.28	N/A
EQVAS	39.57	16.46	78.3 (20.4)	-1.90	N/A
EQ index	0.40	0.17	0.92 (0.17)	-3.06	N/A
EASE	120.72	13.72	N/A		N/A

[a]Löwe et al. (2008) [b]Kocalevent et al. (2013) [c]Maric & Mahic (2023) [d] Heissel et al. (2021), [e]Ashbaugh et al. (2016) [f] Helgeson et al. (2015) [g] Janssen et al. (2021), [h] Devlin et al. (2018), [i]Sapra et al. (2020), [j]Mundt et al. (2002), [k]Gray et al. (2020).

Profile 1

The first subgroup was the third smallest group (n = 91, 19.7%). This was conceptualised as moderately distressed with moderate functional impairment. This means participants in this group scored within the moderate range on self-rated measures of anxiety and depression, the severe range on somatoform risk and within the clinical range on symptoms of PTSD. Participants in this group scored within the severe range on the WSAS and -2.01 standard deviations (SD) lower than normative samples EQVAS, -3.24 SD lower on the EQ index, 0.24 SD higher on UCS. However, as shown in Figure 1, profile one's scores on functional measures are plotted around the average z-standardised score for the sample.

Profile 2

The second subgroup was the smallest group (n = 36, 7.8%). This was conceptualised as mild distress with mild functional impairment. This means participants in this group scored within the mild range on self-rated measures of anxiety and depression, moderately on somatoform risk and below the clinical range

on symptoms of PTSD. Participants in this group scored within the “significant functional impairment, less clinical psychopathology” range on the WSAS, -0.48 SDs below normative samples on the EQVAS, -1.06 SD below normative samples on the EQ index, -0.89 SDs lower on the UCS. However, as shown in Figure 1, profile two scored between 1 and 2 z-standardised scores below the average on the sample on all measures.

Profile 3

The third subgroup was the second smallest group (n = 81, 17.6%). This was conceptualised as severely distressed with severe functional impairment. This means participants in this group scored within the severe range on self-rated measures of anxiety, depression, and somatoform risk and within the clinical range on symptoms of PTSD. Participants in this group scored within the “moderately severe” range on the WSAS and -2.53 SDs below normative sample on the EQVAS, -1.41 SDs below on the EQ index, 0.61 SDs higher on the UCS. On Figure 1, it is clear that profile three self-rated as the most distressed and functionally impaired of all subgroups, scoring between 1 z-standardised scores above the average of the sample on all measures apart from scoring average on the UCS.

Profile 4

The fourth subgroup was the second largest group (n = 117, 25.4%). This was conceptualised as mild-moderately distressed with moderate functional impairment. This means participants in this group scored within the moderate range on self-rated measures of anxiety, depression, and somatoform risk and within the clinical range on symptoms of PTSD. Participants in this group scored within the “Significant functional impairment, less severe clinical psychopathology” range on the WSAS, -

0.93 SDs below normative samples EQVAS, -1.41 SDs below normative samples on the EQ index, and 0.45 SDs higher on the UCS. On Figure 1, it is clear that profile four's Z-standardised scores are below the average of the sample on all measures apart from scoring average on the UCS and PCL.

Profile 5

The fifth subgroup was the largest group (n = 136, 29.5%). This was conceptualised as moderate-severely distressed with moderate functional impairment. This means participants in this group scored within the severe range on self-rated measures of anxiety, depression, and somatoform risk and within the clinical range on symptoms of PTSD. Participants in this group scored within the "moderate-severe" range on the WSAS, -1.9 SDs below the normative sample on the EQVAS, -3.06 SDs below on the EQ index, 1.28 SDs higher on the UCS. On Figure 1, it is clear that profile five's Z-standardised scores are above the average of the sample, however they do not score as highly as profile three, apart from on UCS.

Aim 4: Demographic Characteristics and Profile Membership

A multinomial regression using the largest profile (class 5) as the reference category indicated the predictor variable model was a significantly better-fit than intercept only (x^2 = 51.95, df = 28, *p = 004*). Goodness of fit tests suggested good fit of the data indicated by the Pearson chi-squared (x^2 = 1038.89, df = 980, *p = .094*), and by the deviance statistic (x^2 = 857.09, df = 980, *p = .998*). Overall, the likelihood ratio tests found age (x^2 = 14.418, df = 4, *p = .006*) and employment (x^2 = 24.960, df = 4, *p < .001*) were significant predictors of profile membership. All the other variables were not significant predictors overall (*p* > .05).

Table 4 presents the coefficients for predictor association with each profile membership (1-4) compared to profile 5. In profile 1, employment status (B = 1.562, p = .015) and age (B = 0.035, p < .001) was statistically associated with group membership. Relative to profile 5, profile 1 participants were on average 7 years older and were more likely to be unemployed. In profile 2, age significantly predicted group membership (B = 0.036, p = *.018*). Relative to profile 5, participants in profile 2 were on average 6 years older. In profile 3, employment status significantly predicted group membership (B = 1.507, p = *.019*). No other covariates were statistically associated with class membership. Please see Table 4 for statistical indices from regression analysis and Table 5 for each demographic variable per subgroup.

Table 4

Inferential statistics for the multinomial logistic regression with class as the dependent variable and age, gender, relationship status, education, employment status, ethnicity and nationality as the covariates

Class [a]	Covariates	B	Standard Error	Sig.
1 vs 5	Intercept	-5.741	2.00	.004
	Gender	0.097	0.374	.796
	Relationship status	-.158	0.345	.648
	Employment status	**1.562**	**0.643**	**.015**
	Education	0.399	0.407	.327
	Ethnicity	0.36	0.617	.953
	Nationality	0.234	0.759	.095
	Age	**0.035**	**0.10**	**< .001**
2 vs 5	Intercept	1.137	2.532	.653
	Gender	-0.866	0.448	.053
	Relationship status	-0.481	0.473	.309
	Employment status	-.682	0.503	.175
	Education	0.101	0.574	.861
	Ethnicity	-0.757	1.171	.518
	Nationality	0.131	1.245	.916
	Age	**0.036**	**0.015**	**.018**
3 vs 5	Intercept	-4.063	2.075	.050
	Gender	-.208	0.369	.573
	Relationship status	0.007	0.354	.983
	Employment status	**1.507**	**0.644**	**.019**

	Education	0.281	0.424	.507
	Ethnicity	0.437	0.580	.450
	Nationality	-0.673	0.911	.460
	Age	.019	0.11	.080
4 vs 5	Intercept	0.844	1.598	.508
	Gender	-0.094	0.336	.780
	Relationship status	-0.169	0.314	.591
	Employment status	-0.06	0.39	.875
	Education	-0.391	0.351	.265
	Ethnicity	0.315	0.544	.563
	Nationality	-0.209	0.744	.779
	Age	0.014	0.010	.154

[a]Reference category is class 5

Table 5

Sample demographics for each profile

	N	Mean age	Gender	Marital status [a]	Employment [b]	Education [c]	Ethnicity [d]	Nationality [e]
Profile 1	91	45.0	M = 18 F = 73	1 = 23 2 = 68	1 = 3 2 = 88	1 = 13 2 = 74	1 = 85 2 = 6	1 = 86 2 = 5

Profile 2	36	43.9	M = 12 F = 24	1 = 11 2 = 25	1 = 9 2 = 27	1 = 5 2 = 26	1 = 35 2 = 1	1 = 34 2 = 2
Profile 3	81	42.4	M = 18 F = 63	1 = 19 2 = 62	1 = 3 2 = 78	1 = 11 2 = 65	1 = 74 2 = 7	1 = 78 2 = 3
Profile 4	117	40.6	M = 26 F = 91	1 = 32 2 = 85	1 = 23 2 = 94	1 = 22 2 = 87	1 = 105 2 = 12	1 = 111 2 = 6
Profile 5	136	37.8	M = 23 F = 113	1 = 35 2 = 101	1 = 20 2 = 116	1 = 19 2 = 107	1 = 127 2 = 9	1 = 129 2 = 7

[a] 1 = in a relationship, 2 = not in a relationship. [b] 1 = employed, 2 = not employed. [c] 1 = university educated, 2 = school educated. [d] 1 = non-minoritised background, 2 = minoritized background. [e] 1 = British/Irish, 2 = Other nationality

Discussion

This study employed an exploratory data-driven approach to identifying subgroups in an FND population based on psychological indicators. To our knowledge, this is the first study to employ data-driven methods for identifying subgroups of FND based on psychological and functional variables. This has previously not been possible. Firstly, because previous studies did not have large enough datasets for more sophisticated statistical methods (Pun et al., 2020). Secondly, previous studies have aimed to identify symptom profiles based on single dimensions such as sensory processing (Ranford et al., 2020). The results of this study have identified subgroups in an FND population based on psychological indicators and an association between employment and age and group membership.

Identifying Subgroups

The results of this study suggest that subgroups exist within the FND population based on psychological variables. This exploratory latent profile analysis identified five subgroups:

1. Moderately distressed with moderate functional impairment (19.7%)
2. Mild distress with mild functional impairment (7.8%)
3. Severely distressed with severe functional impairment (17.6 %)
4. Mild-moderately distressed with moderate functional impairment (25.4%)
5. Moderate-severely distressed with moderate functional impairment (29.5%).

It is important to reiterate the labels assigned to subgroups, as mild, moderate or severe are relative to the sample itself, as opposed to clinical thresholds or normative samples. Although it is statistically possible to categorise the sample into five subgroups, it could be possible that these subgroups are more akin to a continuum. Profile 2 is the least distressed and functionally impaired, followed by profile 4 with more distress and similar functioning, followed by profile 1 with increased distress again but the similar functioning, followed by profile 5 with increased distress and somewhat similar functioning (particularly on work and social adjustment and quality of life ratings), followed lastly by profile 3 with the highest level of distress and lowest level of functioning. Interestingly, on the profile continuum, participants across profiles 1, 4 and 5 reported increasing levels of distress with similar levels of functional impairment.

PCL-5 scores across profiles were high. With the exception of profile 2, all profiles had a mean score that fell within the clinical range (score of 31-33 or above; Ashbaugh et al., 2016), indicating the experience of PTSD symptoms (score of 50 or above; Gray et al., 2020). Profile 2 was the smallest subgroup, therefore, only 7.8%

of the sample did not fall within the clinical range. It is important to note that the dichotomous cut offs of above or below clinical thresholds do not adequately reflect the variation in this sample. Across the four profiles that could be categorised as above the clinical threshold, profile 1 is 1.17 standard deviations above the normative mean, profile 4 is 1.49 standard deviations above the normative mean, profile 5 is 2.71 standard deviations above the normative mean and profile 3 is 3.22 standard deviations above the normative mean. Profile 3 and 5 are also considerably higher than profile 1 and 4. The implication of PTSD symptoms in FND presentations in this study is in line with existing research, which found three subtypes, categorised by type of traumatic experiences and associated with variations in FND presentations (Hingray et al., 2022).

In addition to high PCL scores, profiles 3 and 5 also have the highest scores of unmitigated communion across profiles, and constitute 47.1% of the overall sample. Profile 3 had the highest scores on eight of the nine indicators, including the highest PCL score and the second highest UCS score, whereas profile 5 had a slightly lower PCL score but the highest UCS score in the sample. Ratings of unmitigated communion (process of focusing on the needs of others, and excluding needs of the self) being highest in the most highly distressed and functionally impaired suggests that unmitigated communion and PTSD symptoms are important factors when thinking about mechanisms underlying the development and maintenance of FND symptoms and the relationship between distress, impairment and FND symptoms.

Identifying Demographics Associated with Group Membership

The investigation of associations between demographic factors and group membership found that only employment status and age were associated with group

membership. One could argue that differences in employment may be linked to distress and impairment as factors that would impact someone's ability to engage in employment. However, profile 1 and profile 3 are categorised as below and above profile 5 on ratings of distress and functional impairment, but compared to profile 5, profile 1 and 3 are more likely to be unemployed which suggests that more complex processes explain this relationship.

In terms of age, profile 1 participants were on average 7 years older compared to participants in profile 5. In profile 2, participants were on average 6 years older. Differences in age between subgroups are complex to understand. Profile 1 is below profile 5 in ratings of distress and functional impairment and is the third highest ratings of distress and impairment overall, and profile 2 is the lowest scoring profile on ratings of distress and impairment. One could argue that the duration from onset to diagnosis could impact age at the point of data collection, although this is beyond the scope of the current study. There was a clear preponderance of females in the sample, with at least twice as many females as males in each subgroup. However, gender was not highlighted as a predictor of group membership.

Strengths and Limitations

The current study has several strengths and limitations. Firstly, a sophisticated, robust data-driven approach was employed, enabling identification of subgroups in FND. This is partly due to having a large sample size which has not been available in previous research. Data-driven approaches make it possible to understand more about the differences in profiles compared to less sophisticated methods like ANOVAs that only identify a difference but do not identify

characteristics of differences. On the other hand, best practice in LPA would be to split the dataset and run the analysis separately on the two samples to validate the model. This would have required a dataset twice the size of the one used in this study for enough statistical power. This means that it was not possible to internally validate the model identified and could be improved in future research with larger sample sizes. Secondly, a robust method of imputation using a two-stage process of item-level imputation followed by the missForest approach to calculate missing data at a total score level and although a robust imputation method was undertaken, imputing missing data does introduce the potential for bias and threaten validity. The multinomial logistic regression has a potential lack of power due to the sample size of the smaller subgroups. This means that the results detailing characteristics associated with group membership could be impacted and should be interpreted with caution.

A notable limitation of the study is the lack of standardised processes for scoring the UCS and the EASE. This meant that it was not possible to make direct comparisons between normative data and the current sample. Although these measures do not have as much established empirical testing as other measures used in the model, they have high clinical utility. The EASE was developed following qualitative interviews with patients in Germany and provides a valuable patient voice to standardised measures. To provide rationale for inclusion in the model, an alternative model excluding the UCS and EASE demonstrated no better statistical fit than the current model and therefore, the decision was made to include the measures.

A complex step in the current research was naming and conceptualising each subgroup. This required naming the subgroups based on the domains and concepts

measured in the data collected. The research team discussed various ways this could be done and decided that the most accessible way would be to collapse the indicator variables down into distress and functional impairment. This approach has clinical utility as interventions for FND often target distress and functioning, whilst also simplifying the profiles without being overly reductionist. However, the approach has limitations because on the domains of distress and functioning, measures do not sit entirely in one domain or the other. For example, some items on the UCS are addressing distress, whilst some items are addressing some form of functioning. Using language to conceptualise subgroups is an inherently limited process, in that language does not always adequately reflect the complexity of experience and is inherently biased.

One final limitation to consider is the representativeness of the sample. The sample was of FND patients accessing a psychological therapy service, which potentially biases the sample to individuals with FND who require psychological support, compared to individuals with FND who decide not to access psychological support, have very mild symptoms or spontaneously recover. In addition, the service referral criteria (detailed in the methods section of this report) mean that individuals who have severe psychiatric difficulties, substance misuse difficulties, learning difficulties and homelessness are likely to be underrepresented in the sample. In addition, the sample consisted of a range of FND presentations, and the analysis did not investigate any specific clinical characteristics in each subgroup, such as whether functional seizures are more represented in some subgroups than others. This would be a useful step in future research.

Clinical and Research Implications

The primary implication from the current study is a deeper understanding of the FND population. The identification of subgroups will allow more individualised and tailored treatment that is aligned with the distress and functional impairment profiles. Recognition of profiles can help apply existing knowledge about prognosis and treatment of varying levels of severity of distress and functional impairment such as identifying the appropriate intensity of intervention. Additionally, using the domains of distress and functioning as a framework, services can begin to plan ways to mobilise resources within treatment pathways depending on profile presentation and need. In the UK NHS context, there is a scarcity of formalised or dedicated treatment pathways for FND, which means that FND is often treated within existing neurology, rehabilitation or psychological therapy pathways. It is therefore even more important to be able to accurately identify distress and functioning profiles to best utilise limited resources. Understanding subgroups may help plan care for individuals who might be disadvantaged in terms of access. For example, profile 2 may require support from services but are unlikely to meet criteria for services such as NHS Talking Therapies.

The results of this study have important implications for future research. Firstly, the identification of subgroups provides a foundation for future research to replicate these results, perhaps with larger datasets that would allow for internal validation of the model that was not possible in the current study. Secondly, future research can begin to investigate targeted treatments for different subgroups based on their distress and functional impairment profile. For example, investigating whether current treatment approaches demonstrate differing efficacy for someone who is severely distressed and functionally impaired compared to someone who is mildly distressed with mild functional impairment. Future research can also further

investigate the differences in characteristics associated with subgroup membership. For example, the relationship between employment and profile membership. It would also be valuable for future research to investigate PTSD symptoms and unmitigated communion and the mechanisms of their involvement in FND development and maintenance. Lastly, it would also likely be useful to think about whether different subgroups have different healthcare utilisation in order to think about providing and mobilising available resources in a more targeted way.

Conclusion

This study has found that individuals with FND can be grouped into five subgroups based on nine self-report psychosocial indicator variables, and that employment status and age can predict subgroup membership to some extent. These results have clinical utility for supporting the understanding of FND in terms of distress and functioning, as well as supporting service planning and provision for FND treatment. Future research should aim to replicate these findings with larger datasets, begin to research the most efficacious treatments for each subgroup and explore the relationship between UCS, PCL, other psychosocial indicators and FND presentation. The findings of this study should be considered with caution due to limitations around representativeness of the sample, lack of standardised scoring for two measures, and the complexity of conceptualising and naming subgroups.

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Appendices

Appendix	Title	Page
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Appendix A. RECORD Checklist

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	A) Page 77 b) Page 78-79	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	1. Page 77-79 2. Page 77-79 3. N/A
Introduction					

Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 79-83		
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 83		
Methods					
Study Design	4	Present key elements of study design early in the paper	Page 84		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 84-85		

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	Page 85 - 86	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	6.1 N/A 6.2 N/A 6.3 N/A

Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Page 87-90	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 87-90
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 87-90		

Bias	9	Describe any efforts to address potential sources of bias	Page 91		
Study size	10	Explain how the study size was arrived at	Page 87		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Page 91-94		

Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	Page 91-94		

Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1 Page 84-5 12.2 Page 91-94

Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	12.3N/A
Results					

Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	a) Page 84 b) N/A c) Page 139	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	13.1 Page 85 and Page 139

Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	A and b)Page 86, 100 and 106 c) N/A		

Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures	Page 86, 100 and 106		

Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Page 95-107		

Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Page 95-107		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Page 106-114		

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 106-114	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 106-114

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 106-114		
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 106-114		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page ii		

Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Page ii

Appendix B. Ethical Documentation





Downloaded: 25/04/2024
Approved: 22/11/2023

Katherine Morgan
Registration number: 220237974
Psychology
Programme: Doctorate in Clinical Psychology

Dear Katherine

PROJECT TITLE: A latent profile analysis of routine data to investigate subgroups of Functional Neurological Disorder in a secondary care specialist neurology psychotherapy service.
APPLICATION: Reference Number 057847

This letter confirms that you have signed a University Research Ethics Committee-approved self-declaration to confirm that your research will involve only existing research, clinical or other data that has been robustly anonymised. You have judged it to be unlikely that this project would cause offence to those who originally provided the data, should they become aware of it.

As such, on behalf of the University Research Ethics Committee, I can confirm that your project can go ahead on the basis of this self-declaration.

If during the course of the project you need to deviate significantly from the above-approved documentation please inform me since full ethical review may be required.

Yours sincerely

Department Of Psychology Research Ethics Committee
Departmental Ethics Administrator

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

NHS
Health Research Authority

Mrs Katherine Morgan
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Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

11 December 2024

Dear Mrs Morgan

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**A latent profile analysis of routine data to investigate subgroups of Functional Neurological Disorder in a secondary care specialist neurology psychotherapy service.**
IRAS project ID:	**343173**
Protocol number:	**N/A**
REC reference:	**24/HRA/4738**
Sponsor	**University of Sheffield**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report

(including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The *"After HRA Approval – guidance for sponsors and investigators"* document on the HRA website gives detailed guidance on reporting expectations for studies with HRA and HCRW Approval, including:

- Registration of Research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **343173**. Please quote this on all correspondence.

Yours sincerely,
Rachel Katzenellenbogen
Approvals Specialist

List of Documents

The final document set assessed and approved by HRA and HCRW Approval is listed below.

Document	*Version*	*Date*
IRAS Application Form [IRAS_Form_04122024]		04 December 2024
Research protocol or project proposal [Protocol]		
Summary CV for Chief Investigator (CI) [CI CV]		19 August 2024
Summary CV for supervisor (student research) [Supervisor CV]		19 August 2024
Validated questionnaire [Validated measures information]		

IRAS project ID	343173

Information to support study set up

The below provides all parties with information to support the arranging and confirming of capacity and capability with participating NHS organisations in England and Wales. This is intended to be an accurate reflection of the study at the time of issue of this letter.

Types of participating NHS organisation	Expectations related to confirmation of capacity and capability	Agreement to be used	Funding arrangements	Oversight expectations	HR Good Practice Resource Pack expectations
This is a non-commercial single site study taking place in the NHS where that single NHS organisation's partner University is the study sponsor therefore there is only one site type.	This is a single site study sponsored by that single NHS organisation's partner University. You should work with the sponsor/JRO R&D office to make arrangements to set up the study. The sponsor/JRO R&D office will confirm to you when the study can start following issue of HRA and HCRW Approval.	This is a non-commercial single site study taking place in the NHS where that single NHS organisation's partner University is the study sponsor. Therefore no study agreements are required.	Study funding arrangements are detailed in A65 of the IRAS form.	A Principal Investigator should be appointed at participating NHS organisations of this type.	Where an external individual will be conducting any of the research activities that will be undertaken at this site type then they would be expected to hold a Letter of Access if they undertake the activities at the site. This should be issued be on the basis of a Research Passport (if university employed) or an NHS to NHS confirmation of pre-engagement checks letter (if NHS employed).

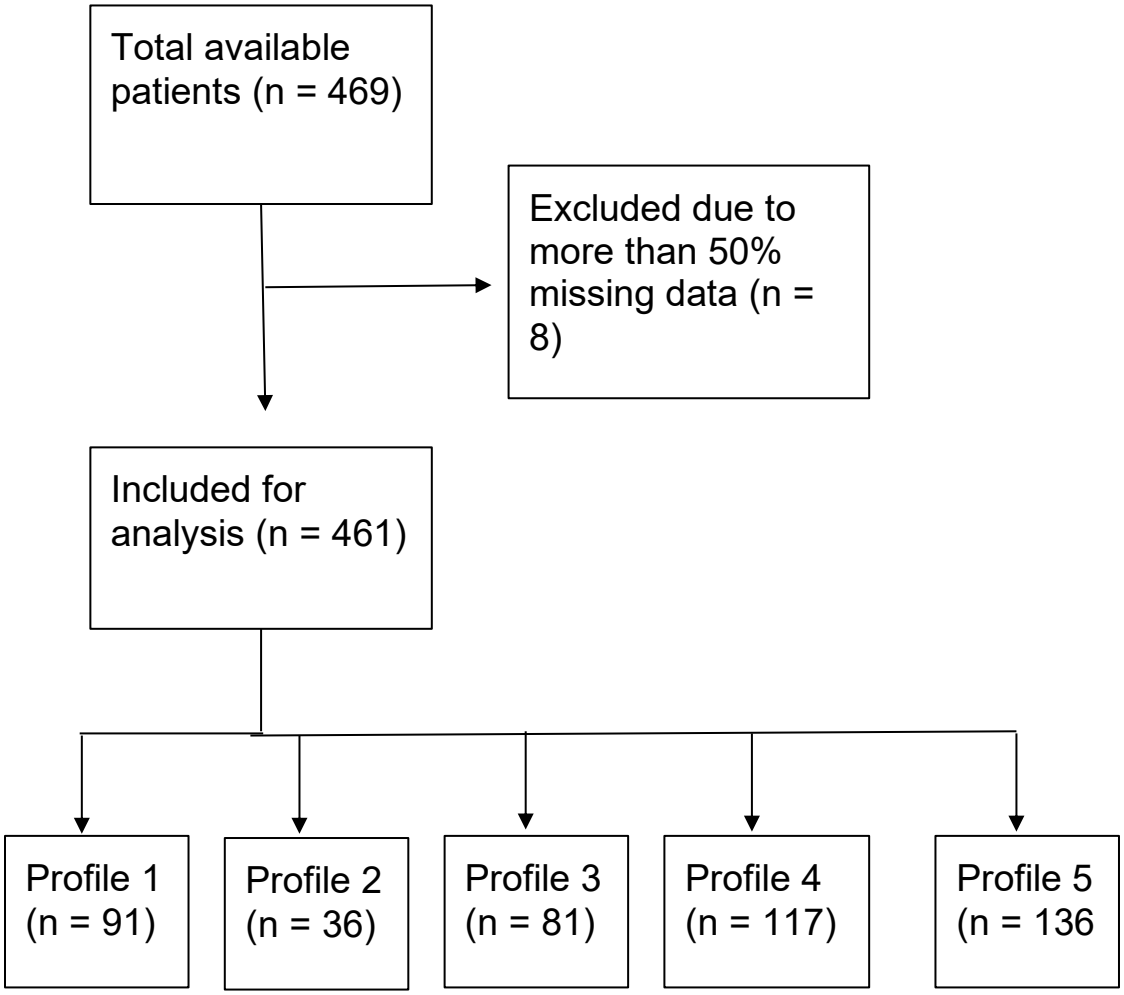
Other information to aid study set-up and delivery

This details any other information that may be helpful to sponsors and participating NHS organisations in England and Wales in study set-up.
The applicant has indicated they do not intend to apply for inclusion on the NIHR CRN Portfolio.

Appendix C. STROBE Diagram

Figure C1

STROBE diagram showing patient flow through the study



Appendix D. Outcome Measures

Figure D1

Blank version of the PHQ-9.

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Figure D2

Blank version of the PHQ-15.

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Figure D3

Blank version of the GAD-7.

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Figure D4

Blank version of the EQ-5D-3L.

Figure D5

Blank version of the WSAS.

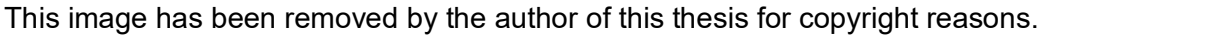


Figure D6

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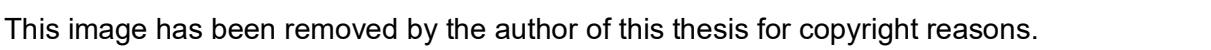


Figure D7

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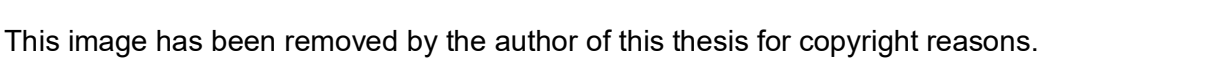


Figure D8

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Appendix E. Statistical Indices for Alternative Model

Table E1

Statistical indices for the alternative model run for the sensitivity analysis.

Model Design			Statistics					
Class	Variance	Covariance	BIC	BLRT value	BLRT *p*	Entropy	n_min	n_max
2	equal	zero	8152.47154	1133.2849	0.0099	0.87857	0.41	0.58
2	varying	zero	8000.90218	1327.78805	0.0099	0.89776	0.46	0.53
3	equal	zero	7829.56988	371.96885	0.0099	0.87757	0.14	0.46
3	varying	zero	7742.05252	350.85064	0.0099	0.86644	0.17	0.46
4	equal	zero	7716.57386	162.0632	0.0099	0.84768	0.11	0.42
4	varying	zero	7634.72575	199.32774	0.0099	0.84263	0.14	0.33
5	equal	zero	7671.79614	93.8449	0.0099	0.80767	0.11	0.3
5	varying	zero	N/A could not be estimated.					

Note. BIC = Bayesian Intake Criterion, BLRT = Bootstrapped Likelihood Ration Test, n_min = size of the smallest group, n_max = size of the largest group.