JUDO : HISTORICAL, STATISTICAL AND SCIENTIFIC APPRAISAL

by

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A thesis submitted for the degree
of Doctor of Philosophy

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NOVEMBER 1994

精力善用

自他共栄

Maximum Efficient Use of Energy of Mind and Body
Mutual Welfare and Benefit

Jigoro Kano

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ACKNOWLEDGEMENTS

Firstly, I am indebted to Dr E A Trowbridge for more than three years of advice, support, encouragement and enthusiasm. This thesis would never have been completed without his input.

I would like to thank the Department of Medical Physics and Clinical Engineering at the University of Sheffield for the use of the equipment and facilities mentioned in this thesis.

I also wish to express my gratitude to Mr N Roach, Dr C Crofts, Dr R Davey, Mr T Lea and Mr N Sato for their guidance and support during this work.

I must also thank Mr A Miller for helping with my English construction.

I am also grateful to the staff of the Department of Physical Education in Tokai University for experiment assistance, and the all Japan Judo Federation, together with the British Judo Federation, their chairman Mr G.Kerr and Mr N.Somas who helped me obtain the video and statistical information that were necessary for this thesis.

I must also send out thanks to all the willing and unwilling poor souls who offered to be my subjects during the experiment phase of my thesis.

Finally, thanks to all other people who have helped me, especially my family who have provided financial and moral support throughout.

DECLARATION

The material presented in this thesis is entirely original. No part of this thesis has been submitted for any other degree or qualification.

The experiments were designed, and the theoretical concepts developed, in collaboration with Dr E A Trowbridge. The execution of the experimental work and theoretical details are the sole responsibility of the author.

The thesis format satisfies British Standard 4821: 1972; "Recommendations for the Presentation of Theses".

SUMMARY OF THE THESIS

This thesis presents the sport of Judo from historical, statistical and scientific perspectives.

Modern Judo introduced in 1882 by Professor Jigoro Kano, used the combat element of Jujitsu, stressing the importance of mental and physical preparation. Judo rules evolved with changes in the scoring categories and style of Judo suit. Gradually Judo spread from Japan, and the International Judo Federation was created in 1951, initially consisting of only 12 countries, increasing to 157 in 1992.

Statistical analysis of the 1991 World Championships and 1992 Olympic Games showed significant differences in scoring patterns between standing and groundwork techniques for male and female competitors. Groundwork techniques consistently resulted in Ippon. Uchi-Mata and Seoi-Nage were the most successful standing techniques, whilst Osae-Waza was the most successful groundwork technique for both genders. Based on these observations strength programmes to improve Uchi-Mata and Seoi-Nage were developed. A statistical comparison of the two championships indicated that all subgroups of competitors, except male non-medallists displayed the same scoring patterns. Judo can be considered as a multiple activity sport, where flurries of activity are interspersed with periods of recovery. Video analysis of the World Championship and Olympic Games showed that the average activity to recovery ratio was about 1.9:1. Exercise intensity was studied by measuring cardiorespiratory and metabolic responses to Judo practice and competition. The intensity of exercise, based on blood lactate concentration, during competition was higher than the intensity of exercise during practice. To supplement Judo practice a specifically designed rowing exercise was prescribed. An interval programme was based on the average activity-to-rest ratio determined from the video analysis. Blood lactate concentration was higher, and

heart rate lower, for rowing compared to Judo practice. Rowing with short intervals of high intensity separated by short recoveries appears to be a good whole body exercise for conditioning the power endurance component of Judo. Further research is required to confirm this preliminary observation.

CHAPTER 1
GENERAL INTRODUCTION

Judo was created by Professor Jigoro Kano in 1882. The sport has grown enormously since its inception in the 19th century. The International Judo Federation was founded in 1951 and by 1992 it had 157 members. Men's Judo was first included in the 1964 Olympic Games. Women's Judo had to wait until 1992 before it was accepted as an Olympic event. Judo can now be considered as a prominent sport throughout the world. However, Judo's development is slightly different from other sports which have emerged from games played during recreation.

Judo's origin is from the battle fields of the Samurai. Initially Judo gained a reputation through its mysterious eastern background, especially on the disciplinary and educational side. It is clear from research in this area that the acceptance of Judo as a competitive sport is relatively recent. In addition, in-depth studies have been hampered by the physical nature of the sport which makes data collection difficult. It is for these reasons that this thesis has been written.

The presence of two major competitions in 1991 and 1992 at the same geographical location in Barcelona Spain provided an opportunity to gather significant quantities of data about Judo performance at the highest level. This thesis has been designed to give a flavour of Judo history before addressing both statistical and video analysis of the World Championships and Olympic Games. The results obtained from these competitions were used to identify strength conditioning programmes for the most successful techniques at World level. In addition, an endurance conditioning programme based on real data obtained at the highest level was constructed. These constructs have been complemented by scientific data observed, during practice and competition from world and national class Judo players both in the U.K and Japan.

First, the historical development of the sport of Judo is provided in Chapter 2. Second, in order to study the patterns and tendencies of competitions at the highest level, the results of the 1991 World Championships and 1992 Olympic Games are analysed in Chapter 3 and Chapter 4. The next chapter displays and analyses the most successful techniques from these championships, also the specific training methods for these techniques are identified.

In Chapter 6 and Chapter 7, the video recordings of each final in each weight category at the 1991 World Championships and 1992 Olympic Games are analysed. In particular these chapters provide an assessment of how the winners achieved their success. In Chapter 8, the 1991 World Championships and 1992 Olympic Games are compared. This approach was thought to be relevant because these championships were held at the same geographical location (elements such as climate, food and atmosphere the same), and took place within a year of each other.

Finally, although previous chapters indicate that Judo is a sport in which periods of whole body activity are separated by intervals of recovery, they give no information about the intensity of this exercise. Chapter 9 presents data on the blood lactate concentration obtained from different sites at rest and during exercise. Both the ear-lobe and fingertip are attractive options for blood sampling after Judo competition and during conditioning, but there is no consensus opinion on the agreement of the lactate concentrations obtained from these sites. Chapter 9 goes some way to help this debate. Recognising the lack of authentic data on the intensity of exercise during Judo practice and competition Chapter 10 concentrates on the physiological assessment of Judo players, by measuring heart rate during, and blood lactate concentration after practice and competition. The aim and objectives of this thesis were :

* To provide the reader with a historical development of Judo.

* To collect and analyse data obtained from the 1991 Judo World Championships and 1992 Olympic Games.
* To draw conclusions from this analysis that might improve the conditioning programmes used by elite Judo competitors.
* To obtain scientific data related to the intensity of exercise experienced by Judo players, both during practice and competition, and apply the findings pragmatically during preparation for competition.

CHAPTER 2

THE HISTORY AND EVOLUTION OF WORLD JUDO

2.1 INTRODUCTION

This chapter provides a brief historical development of the sport of Judo. The first section follows the evolution of the sport from the hand to hand fighting employed by Japanese knights (BUSHI) in the middle ages. Section 2.3 explains how the rules of Judo have developed in the last hundred years. The next section considers the transformation in the clothing worn by competitors from the cloak-like HAKAMA to the modern Judo suit. Section 2.5 describes the techniques used in Judo. The final section gives a brief synopsis of the spread of Judo from Japan to other countries in the world and the emergence of the International Judo Federation.

2.2 HISTORICAL DEVELOPMENT OF JUDO

The KODOKAN Judo introduced by Professor Jigoro Kano in 1882 is the forerunner of the sport of Judo that provides competition today. Many European sports have developed from play and recreation. In contrast, Judo through Jujitsu, developed from the method of fighting during military battles. During the Japanese civil wars between different warlords (12th ~ 17th century), there existed a social class system. The classes were structured as follows, at the top were the lords, next were the knights or military followers who supported the warlords. Next in the social hierarchy were the farmers followed by manual workers and finally shopkeepers. In Japan during the middle ages, the men who acted as knights to the lords were known as 'BUSHI'. The main function of the BUSHI was fighting to protect the land owned by the lord and to acquire new territories and property. The traditional martial arts practiced by the Bushi were known as Bujitsu ('Bu' meaning BUSHI, 'Jitsu' meaning Arts). Jujitsu is also one of the martial arts which was practiced within Bujitsu, as were, the arts of swordmanship, archery and spear fighting. Some BUSHI were masters in more than one martial art.

There was a certain pattern of warfare at that time. A battle would begin from a distance, mainly using arrows fired by archers, then the fighting would develop into hand to hand combat. In most cases, the result of the battle would depend upon this close contact fighting. Later, as the feudal era developed, the distinctions between the different classes became more pronounced. As a result the morals of BUSHI-DO developed, (The meaning of the word BUSHI-DO depicts the BUSHI's moral and spiritual behavior. The word is a combination of BUSHI and 'DO' meaning literally, 'way'(1)), and became widespread amongst the BUSHI. According to this code the way victory was achieved became more important than the actual victory itself. The true BUSHI took pride in the way that they conducted themselves in battle. In fact, during the 16th century, several categories of vanquishing an opponent appeared. The order was as follows :

1) without weapons
2) with sword
3) with spear
4) with bow and arrow
5) with guns

At this time, in most battles, the opportunities for hand to hand combat were great. Therefore, techniques which could be used in warfare such as throws, method of holding down, striking, strangle and joint holds were developed. These methods of warfare had their origin in the grappling techniques associated with SUMO. Unlike the SUMO of today, one may think of the SUMO at this time as a form of wrestling (including groundwork). SUMO was therefore a form of martial art without the use of weapons, where more often than not superior strength dominated the eventual outcome.(2)

In the 17th century, JUJITSU was developed in order to defeat the enemy. This was achieved by holding the opponent and sometimes killing him without weapons or by just using a small weapon such as a dagger. Jujitsu became indispensable to the BUSHI, and several different schools developed. However, KATA became the main part of training and practice for Jujitsu. KATA means 'form' and is pre-arranged to provide practice of attack and defence in a way which is unlikely to cause injury. This was because Jujitsu had many dangerous techniques such as ATEMI-WAZA, which involved the striking of the opponent's vital areas with punches and kicks. For safety reasons these techniques could only be practiced in the form of KATA. In the case of matches between different schools, rather than practicing technique the bouts were often bloodthirsty and dangerous and resulted in the death of some competitors. As a result of different schools developing their own special techniques, bouts would be organized between different schools. Each school boasted superiority in the development of their techniques.

In the 19th century, Jujitsu lost its popularity. There were mainly two reasons for this. Firstly, the type of warfare changed. Introduction of guns, mainly from the west, lessened the opportunities for hand to hand combat. Secondly from the beginning of the 17th century to the end of the 19th century in Japan, there were hardly any wars. In fact, the BUSHI class went into decline. However, as a result of the disintegration of the BUSHI class, the art of Jujitsu, which only up until then had been available to the BUSHI, now started to spread throughout the nation to all social classes. Jujitsu came under the control of the police instead of the BUSHI class. [Actually, policemen have to learn Judo or Kendo (swordsmanship) even now]. By the end of the 19th century, Jujitsu was performed in small clubs, at public demonstrations, and was also taught to policemen. There were also a lot of influences from western cultures at this time, and gymnastics attracted more attention than Bujitsu (Japanese traditional martial arts).

During this period, Jigoro Kano learned Jujitsu (TENGINSHIYOU-RYU and KITOU-RYU). The ability to defeat a larger person with the use of Jujitsu, attracted the young Kano to this form of martial art. Ignoring his father's opposition, he began to study Jujitsu at the age of 18. Then in 1882, he opened his Judo school (the way of Jujitsu) in Tokyo which was called KODOKAN. KODOKAN means the place where one is taught the way (Literally, 'KO' means to give a lecture, 'DO' means the way and 'KAN' means mansion/castle). Kano's Judo was completely different from the former Jujitsu with respect to the quality of ideas and techniques. The teaching of Judo was aimed at developing both mental and physical education through culture. Jujitsu had, however, descended from Bujitsu which was learned through Bushido. For Judo, the training style was changed. Originally the form of practice had been mainly KATA. As mentioned earlier this form of training was less physical and dangerous than Jujitsu. However, through Judo this type of preparation for competition was changed to RANDORI. Unlike KATA, this method of training is not pre-arranged. The Judo players developed their techniques through free practice. The techniques which were used could be employed with safety. Training in this way is very similar to competition Judo. At present this is the main method for improving Judo.

In 1882 KODOKAN Judo was still only one school amongst many other schools of Jujitsu. In 1885, for the first time the KODOKAN Judo school took part in a competition which was organised by the police board, and the KODOKAN Judo school won overwhelmingly against all the other schools. These victories continued for several years. The reason for these successes was because the other Jujitsu and Judo schools did not develop their style to suit competition in the same way as the KODOKAN school. As a result of this continued superiority in competition, the KODOKAN Judo school was given the responsibility for teaching Judo to the police. Hence the number of students of KODOKAN Judo increased. In addition, Judo teachers from KODOKAN were sent to some universities, the navy schools and some high schools.

In 1892 a national organization called BUTOKUKAI was created to promote Bujitsu and spirit of the teaching. Under the classification of Jujitsu, the KODOKAN and many other Jujitsu schools became members of this organization(3)(4). Eventually in 1895, BUTOKUKAI amalgamated all of the Judo clubs and schools in the country into one federation. Competitions between schools were organised more frequently, and as a result contest rules became necessary. These were first introduced in 1899. At this time the chairman of BUTOKUKAI was Professor Kano. He created the rules for competition based on his KODOKAN Judo. For this reason KODOKAN Judo became even more widespread.(4)(5)(6)(7)

2.3 HISTORY OF THE RULES OF JUDO

To the untrained eye Judo appears to be simply rough fighting. However, the real nature of Judo is completely different from its appearance. There is the spirit of friendship, cooperation and peace in the background of Judo. Hence, in general the rules were designed to produce a common method of fighting in the form of play with order. The basis of the rules are shown below,

1, To ensure all competition is fair.

2, To maintain the safety of participants.

3, To bring interest into matches or games.

In Judo, these rules also encourage other factors such as,

a), the use of physical fitness.

b), the encouragement of a higher standard of technique and tactics.

c), the reduction of the advantage of strength by introducing weight categories.

The rules which were introduced in 1899 form the basis of modern competitive Judo.

2.3.1 Judo Rules Introduced in 1899

1, A contest consists of Standing and Groundwork techniques.

2, Standing techniques involve both throwing and sacrifice techniques, and Groundwork techniques involve SHIME-WAZA (strangle), OSAE-WAZA (hold down), and KANSETSU-WAZA (joint technique).

3, A match is decided by IPPON and the contest is decided by the best of three competitions (the first to win two competitions is the victor).

4, If the decision is not made within a certain amount of time, then the contest is called a HIKIWAKE (draw).

5, If an IPPON (full point) is scored, the referee must express this by shouting out 'IPPON'.

6, When during a contest, a technique is used and the result is not quite worth an IPPON, the referee can call out the score of 'WAZA-ARI'. If during the contest another WAZA-ARI is scored, this would result in IPPON. The referee can then call out the score of AWASETE IPPON. However, if the competitor who has had WAZA-ARI scored against him throws his opponent for IPPON, he then becomes the winner.

7, There are three conditions required to score an IPPON by a Standing technique.

(a) One must throw someone or counter the opponent. In contrast, if the opponent falls down, this is not an IPPON.

(b) One must throw the opponent on his back clearly. However, as it is difficult to throw clearly with some techniques, an IPPON would depend on the referee's judgement.

(c) A throw must have power and dynamism.

8, If the opponent is thrown, and manages to twist out of the throw landing on his front, then this is not an IPPON.

9, If the opponent is thrown on his back, but then twists onto his front, this is still regarded as an IPPON.

10, In the case of Standing techniques, if the person being thrown makes the throwing technique very difficult, by not letting go of an opponent's hand, or by hanging on to the opponent's body, arms or neck, then the referee must allow for this in his judgement of the final throw.

11, In the case of Groundwork techniques, the contest is decided when the competitor taps either his or her opponent's body or the mat more than twice, or he shouts out 'MAITTA' (his submission). However, the referee can decide whether or not to stop the fight by his own judgement.

13, In the case of KANSETSU-WAZA (joint technique), it is illegal to use these techniques on the wrists, ankles and fingers.[3][4][8][9][10][11]

Since 1899 these rules have been revised at regular intervals with the intention, at all times, of improving the art of competitive Judo. Some of the major aspects that have benefited from these revisions are ;

1, Improvements in techniques.

2, The removal of observed dangers in the sport.

3, Defining more clearly the winner and loser.

4, Introduction of equality by specifying different weight categories.

5, Introduction of a time allowance for treatment of injury.

6, Judo has become more sport orientated.

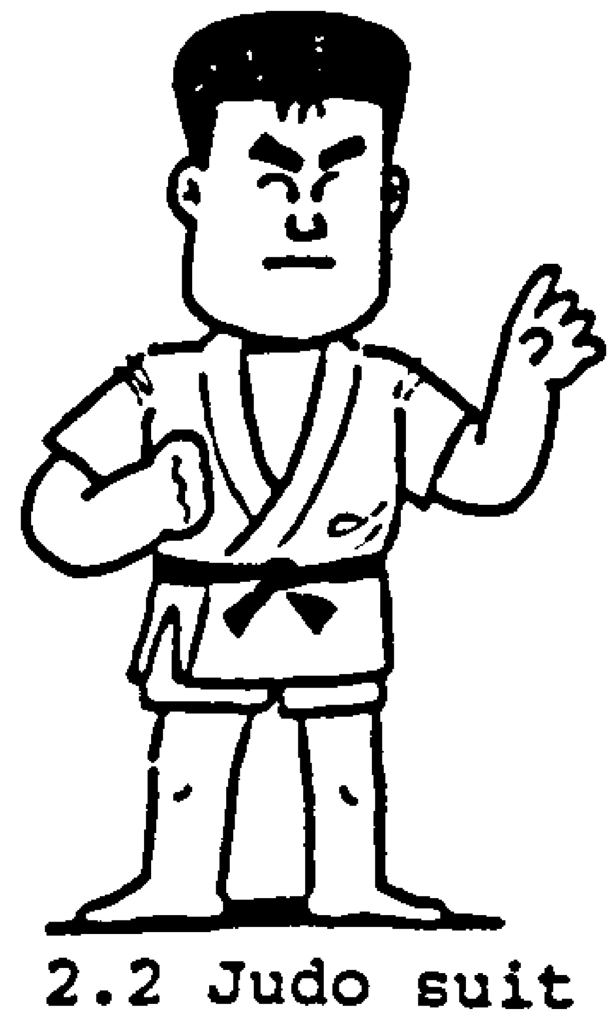
With these revisions the modern rules of Judo competition have developed.[3][4][5][7][8][9][10]

2.4 HISTORY OF THE JUDO SUIT

Jujitsu and Judo originated from fighting during military battles. At this time no form of suit or jacket was worn. Most soldiers used swords, spears and also they wore armour. When students learned Jujitsu and Judo, they wore HAKAMA (Figure 2.1)(1). This was the same attire as used by the practitioners of swordsmanship (Kendo). The HAKAMA was very long, and it covered the ankles completely. As a result opponents were unable to identify the direction of movement of the feet, the position of the weight, the bend or extension of the knees and the kick movement. These features were all very important for Judo. In the 19th century, Jujitsu and Judo were separated away from swordsmanship. Unlike the free practice of Judo today (RANDORI), the main element of Jujitsu training at that time, was in the form of KATA (regulated movement of throwing and striking). Therefore, the best way to judge a student's development depended upon his ability to correctly reproduce his techniques in the KATA form. The HAKAMA gave trouble when students tried to learn Jujitsu and Judo, because they could not see the feet move.

(Figure 2.1 Judo suit 1)

For this reason they wore MOMOHIKI. Instead of HAKAMA these garments were like modern thermal underwear. At the end of the 19th century, RANDORI (free practice) became more popular. This meant that throwing techniques and groundwork techniques were mainly practiced. The KODOKAN Judo school used the Judo suit which had short sleeves and also had a short hem (Figure 2.2)(1). This enabled the Judo players to grasp each other, and as a consequence reduced the fighting distance between the competitors. Techniques that do

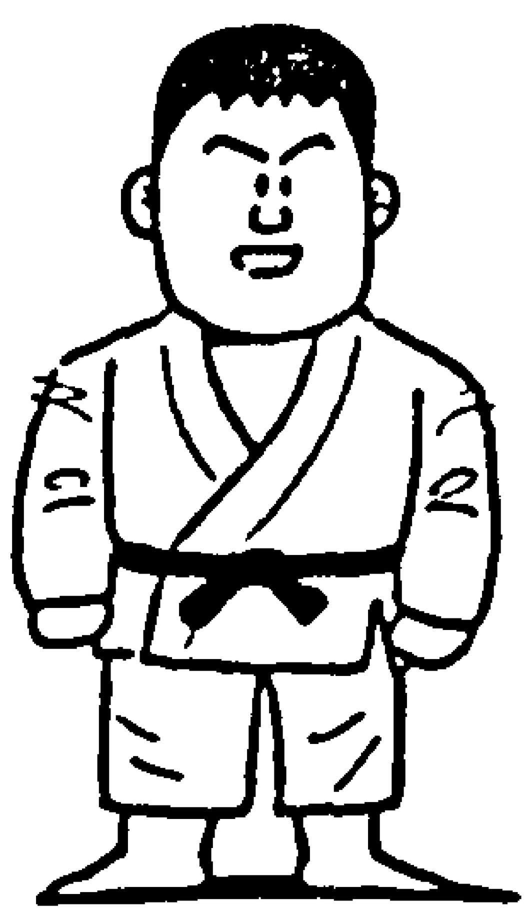


(Figure 2.2 Judo suit 2)

not need a large amount of space such as YAMAARASHI (It is an old style of technique which is like the HARAI-GOSHI of today. It's literal meaning is 'Mountain Storm') were more commonly used. Due to this style of suit having no sleeves, the person would grip the collar and at the seam of the shoulder. This kind of judo suit became popular with the increasing interest in Judo. However, after the 19th century, complaints about the style of the suit arose. The reasons for these complaints were ;

1) It was easy to cause injury at the knee and the elbow because of the absence of sleeves and trousers.
2) Because of the closeness of combat, if one had a secure grip on both lapels of the suit and only concentrated on defence, it became very difficult for both attacker or defender to practice his skills.
3) It did not look elegant.

Eventually, the Judo suit which can be seen in Figure 2.3[1] was developed. It was created through a mixture of the western suit and the original judo suit. The sleeves had to cover at least 1/3 of the arms and trousers had to be 10cm lower than the knee. (In the modern Judo suit of today, the sleeves must be 5cm from the wrist, and the bottom of the trousers, should be 5cm from the ankles)[5]. As a result of the change in style of the suit, especially the length of the sleeves, different techniques emerged. The introduction of the new Judo suit and its longer sleeves enabled participants to hold behind the elbow and at the wrist, where as before only the collar and the seam of the shoulders were gripped. These changes in the site of gripping increased the distance between the fighters. As a result a freedom in the range of movement developed, and consequently the importance of breaking the opponents balance became greater, this enabled throws such as UCHI-MATA and SEOI-NAGE to evolve. Techniques such as these


(Figure 2.3 Judo suit 3)

have become the most successful techniques at the top-level competitions of today (see Chapter 3 and 4).[3][12][13]

Finally, one must consider that the Judo suit is not like the uniform worn by a football team, but a practical accessary in the art of Judo. It is not worn to distinguish the different teams as in soccer. All Judo suits are the same. In the same way, all footballs are the same in the game of soccer and must conform to the same air pressure. A Judo contest is decided by the ability of the opponent and not by the suit that he wears. However, the Judo suit plays an important part in Judo skill and technique. For example, suppose A is stronger than B. If they clasp each other's hand and then they pull each other, B will definitely lose his balance, because A is stronger than B. However, if there is a slack 1m rope between their hands, then it is not so clear who is going to win. A pulls on the rope, he may be off balance before B is forced into this state, a technique has to be developed so that the opponent's strength can be used to advantage. The loose fitting Judo suit with its specially designed weave acts like a slack rope attaching the Judo player to his opponent. An experienced competitor develops a 'feel' for his opponent's strength through the response of his Judo suit to the pull of an opponent.

2.5 TECHNIQUES OF JUDO

Judo techniques can be separated into three different categories. These are :

1, Standing techniques.

2, Groundwork techniques.

3, Striking techniques.

2.5.1 Standing Techniques

The way that standing techniques are recognised are through GOKYO NO WAZA[14]: (see below)

1) Hand techniques
2) Hip techniques
3) Leg techniques
4) Sacrifice techniques
5) Side Sacrifice techniques

There are 65 kinds of standing techniques

2.5.1.1 GOKYO NO WAZA

GOKYO NO WAZA means five [hand, hip, leg, sacrifice and side sacrifice] teaching techniques, J.Kano created them in 1895, and they were revised in 1920.[14][15]

Table 2.1 GOKYO NO WAZA

1) Hand techniques	2) Hip techniques	3) Leg techniques
KATA-GURUNA	HANE-GOSHI	ASHI-GURUMA
OBI-OTOSHI	HARAI-GOSHI	DEASHI-BARAI
SEOI-NAGE	KOSHI-GURUMA	HARAI-TSURIKOMI-ASHI
SEOI-OTOSHI	OH-GOSHI	HIZA-GURUMA
SUKUI-NAGE	TSURI-GOSHI	KOSOTO-GAKE
SUMI-OTOSHI	TSURIKOMI-GOSHI	KOSOTO-GARI
TAI-OTOSHI	UKI-GOSHI	KOUCH-GARI
UKI-OTOSHI	USHIRO-GOSHI	OH-GURUMA
YAMA-ARASHI	UTSURI-GOSHI	OHSOTO-GARI
		OHSOTO-GURUMA
		OHSOTO-OTOSHI
		OHUCHI-GARI
		OKURIASHI-BARAI
		SASAE-TSURIKOMI-ASHI
		UCHI-MATA

4) Sacrifice techniques	5) Side Sacrifice techniques
HIKIKOMI-GAESHI	DAKI-WAKARE
SUMI-GAESHI	HANE-MAKIMOMI
TAWARA-GAESHI	SOTO-MAKIKOMI
TOMOE-NAGE	TANI-OTOSHI
URA-NAGE	UCHI-MAKIKOMI
	UKI-WAZA
	YOKO-GAKE
	YOKO-GURUMA
	YOKO-OTOSHI
	YOKO-WAKARE

2.5.1.2 In addition to GOKYO NO WAZA

With the development of Judo, other techniques were introduced in addition to GOKYO NO WAZA(14) (GOKYO NO WAZA were created in 1895 and revised in 1920 by the KODOKAN)

TABLE 2.2 In addition to GOKYO NO WAZA

1) Hand techniques	2) Hip techniques	3) Leg techniques
KIBISU-GAESHI	DAKI-AGE	HANE-GOSHI-GAESHI
KUCHIKI-TAOSHI		HARAI-GOSHI-GAESHI
MOROTE-GARI		KOUCHI-GAESHI
UCHI-MATA-SUKASHI		OHSOTO-GAESHI
		OHUCH-GAESHI
		TSUBAME-GAESHI
		UCHI-MATA-GAESHI

5) Side Sacrifice technique
KANI-BASAMI
KAWAZU-GAKE
HARAI-MAKIKOMI
OHSOTO-MAKIKOMI
UCHI-MATA-MAKIKOMI

* There is no extra Sacrifice techniques.

2.5.2 Groundwork Techniques

Groundwork techniques have been divided into three different sub-categories[15]:

1) Osae-Waza (hold down techniques)
2) Shime-Waza (strangle techniques)
3) Kansetsu-Waza (arm-lock techniques)

There are 26 kinds of these different techniques.
They can be described in the following way :

Table 2.3 Groundwork Techniques

1) Osae-Waza	2) Shime-Waza	3) Kansetsu-Waza
KAMI-SHIHO-GATAME	GYAKU-JUJI-JIME	HARA-GATAME
KATA-GATAME	HADAKA-JIME	HIZA-GATAME
KESA-GATAME	KATAHA-JIME	JUJI-GATAME
KUZURE-KAMI-SHIHO-GATAME	KATA-JUJI-JIME	UDE-GARAMI
KUZURE-KESA-GATAME	NAMI-JUJI-JIME	UDE-GATAME,
KUZURE-YOKO-SHIHO-GATAME	OKURI-ERI-JIME	WAKI-GATAME
MAKURA-KESA-GATAME	RYOUTE-JIME	
TATE-SHIHO-GATAME	SANKAKU-JIME	
USHIRO-KESA-GATAME	SODE-GURUMA-JIME	
YOKO-SHIHO-GATAME	TSUKOMI-JIME	

2.5.3 Striking Techniques

These techniques are not allowed in the sport of modern Judo, and are now only practiced during Kata[15].
KEN-ATE (2 techniques), HGI-ATE, HIZA-ATE, SHITOU-ATE, SHOTOU-ATE, SHU-ATE, SHUTOU-ATE, SOKUTOU-ATE.

2.6 INTRODUCTION OF JUDO TO OTHER COUNTRIES

Shortly after 1890, Judo was introduced to the west and other countries. The main reason for this, was the character and international approach of Jigoro Kano. Jigoro Kano himself and then his students went abroad to teach Judo. In 1899, Yukio Tani was the first Japanese teacher of Judo in the U.K.(16) Through the influence of Japanese instructors, many overseas Judo clubs, such as the Budokwai in London, were formed. The Budokwai was formed early in 1918 and instruction was undertaken by Master Gunji Koizumi, a student of Professor Kano. He was also assisted by other Japanese experts including Professor Kano himself.

As well as the knowledge of Judo which was being spread by the travelling Jigoro Kano, the KODOKAN also welcomed foreign visiters to receive tuition at their club. They began to develop and exchange techniques and ideology between Japan and the rest of the world.(3)(4)

However, besides the introduction of Judo to other countries through Professor Kano himself, there are several other factors which have influenced foreigners to take up Judo. According to a survey by the KODOKAN taken in 1955 these are

a) as a form of sport
b) mystery of the East
c) self-defence.

Factors a) and c) are still common reasons why people start Judo even now.(13)(16)(17)(18)

An earlier French national team coach, K.Murakami(19), has suggested that due to there being similarities between the thinking of BUSHIDO and the idea of CHIVALRY, Judo was accepted as a form of educational sport and not as a barbaric, dangerous activity. Also, one must not neglect the fact that certain countries already had their own form of martial art. For example, in the former Soviet Union, there is Sombo and Chitaoba, in Mongolia, this martial art is called Mongol-Sumo and in Korea, Shirum. Many of these grappling forms of martial arts have formed a base from which the transition to Judo has been made smoothly. This can be exemplified when one looks at recent results at major competitions. The Montreal Olympic Judo champions in 1976, Novikov and Nebuzolov, were both Sombo champions. The 1989 World Judo silver medallist, Odovogin was originally a Mongol-Sumo wrestler. Finally, Ha the Los Angeles Olympic -95kg champion was also a strong Shirum wrestler.

A Judo federation at a world level emerged in 1951. Twelve countries formed the International Judo Federation (I.J.F). These original countries were Great Britain, France, Italy, Belgium, Germany, Switzerland, Austria, Holland, Luxembourg, Cuba, Canada and Japan. By 1992, the I.J.F consisted of 157 countries. The first men's world Judo championship took place in Tokyo in 1956 where 31 contestants representing 21 countries competed. In 1991 the 17th world Judo championship took place in Barcelona. Judo became an official Olympic event at the 1964 Tokyo Olympic games. The introduction of weight classes was a significant event in the development of a more sport oriented Judo.(5) The changing history of men's weight categorization is as follows,

1956 World Championships at Tokyo
~ **Open**
1961 World Championships at France
1964 Olympic Games in Tokyo
~ **-68kg, -80kg, +80kg and Open**
1965 World Championships at Brazil
1967 World Championships at the U.S.A
~ **-63kg, -70kg, -80kg, -93kg, +93kg and Open**
1976 Olympic Games in Montreal
1979 World Championships at France
~ **-60kg, -65kg, -71kg, -78kg, -86kg, -95kg, +95kg and Open**

The sport of women's Judo arrived approximately 20 years after men's Judo. One can say that such development was

more evident in Europe than in Japan. The main reason was that during this time, the social status of women in Europe in comparison to that of Japan, developed at a more rapid rate. This enabled European women to participate with men in Judo at an earlier stage. In contrast, the Judo women of Japan concentrated their training on self-defence and Kata (pre-arranged movements) and very light Randori (free practise). The participation of women in contests in Japan was not allowed. Also at this time, culturally it was strongly believed, more so in Japan than in Europe, that Judo was a man's sport.
In 1974, the first women's Oceanic Judo championships were organised. In 1975, the first women's European Judo championships and in 1977 the first Pan American women's Judo championships were organised. However, the first female Japanese Judo championships were not held until 1978. The first world Judo championships for women took place in 1980 in New York where 149 competitors represented 27 countries. The 2nd women's world Judo championships was held in Paris in 1982. All the champions in all weight categories of both of these World championships were European players. The weight categories were as follows, -48kg, -52kg, -56kg, -61kg, -66kg, -72kg, +72kg and Open. The same system applies today. Women's Judo was a demonstration event at 1988 Seoul Olympic Games. In 1992 at the Barcelona Olympic Games, it became an official event.(5) Together with the development of Judo, the improvement in the strength and quality of Judo players of many different countries has become evident. In the 1992 Barcelona Olympic Games, eight different countries for women and nine different countries for men were represented in each final of the seven weight categories.

2.7 SUMMARY

* In 1882, modern Judo was introduced by Professor Jigoro Kano.
* Judo developed from Jujitsu, a method of military fighting.
* Kano took certain aspects of Jujitsu and developed the elements of combat. At the same time, he stressed the importance of both mental and physical education.
* Kano introduced new practice methods into Judo, called 'Randori'.
* The original scoring categories in Judo were only Ippon and Waza-ari. These two scores have been extended to include Yuko and Koka.
* Changes in the style of the Judo suit led to new techniques.
* Rules of Judo evolved with all these changes.
* The spread of Judo from Japan to the west was a direct result of the international approach of Professor Kano.
* The International Judo Federation was created in 1951, originally it consisted of 12 countries. This number has increased to 157 in 1992.
* For the first time in the 1992 Olympic Games, Judo was an official event for both men and women. Players from eight different countries for women and nine different countries for men competed for gold medals in the finals.

CHAPTER 3

A STATISTICAL ANALYSIS OF THE RESULTS OF THE WORLD JUDO CHAMPIONSHIPS HELD IN BARCELONA 1991

3.1 INTRODUCTION

In 1991 the top performers in Judo gathered together in Barcelona, Spain to contest the World Judo Championships. Both male and female competitors in different weight categories took part. It was the 17th World Championships for men and 7th World Championships for women. The Japanese Judo Federation obtained a comprehensive set of results from these championships. This chapter is an analysis of these results.

First of all, the statistical techniques used in the analysis are discussed and then the data are partitioned into different subsets in an attempt to identify any underlying pattern that might exist. The distribution of contest times, during the entire competition, in each weight category for both males and females is studied in section 3.3. The length of the Judo contest is designated as 5 minutes for men and 4 minutes for women but a winning fall often finishes the contest before these time limits are reached.

The next section displays the scores that occurred in each contest for the entire competition. The scores are separated into 7 different categories and the competitors are grouped by gender and weight. Of particular interest was the number of Ippon scored in each weight category and for the different genders.

In section 3.5, the competitors are grouped into medallists and non-medallists and the scores obtained by males and females in these two different groups are compared. In the next section, the competitors are separated into female and male competitors and the scores obtained by the medallists and non-medallists in these two groups are compared.

In section 3.7, the competitors are separated into female medallists and non-medallists and male medallists and non-medallists and the scores obtained from standing and groundwork techniques are compared. Section 3.8 considers the scores obtained in the different weight categories for both males and females. Finally, all the scoring techniques for both standing and groundwork techniques are evaluated and ranked to find the most successful techniques used by the world's best Judo competitors. In particular, those techniques which are most successful in producing Ippon are identified. The overall results of the chapter are discussed, in the context of World Judo, and key points arising from the analysis are identified.

3.2 STATISTICAL TECHNIQUES

This chapter has been constructed to investigate the statistical evidence arising from the results of the Judo World Championships in Barcelona in 1991.

Judo competition is separated into different categories both by gender (male and female) and by weight. In addition, the competitors can be grouped into the successful medallists within these categories and the unsuccessful non-medallists. The techniques used during Judo competition can also be separated into the two categories of standing and groundwork techniques. The four major scores (in order of importance) that can be obtained during competition are Ippon, Waza-ari, Yuko and Koka. In some cases the bout is decided on penalties or the judges' decisions. The different groups described above and the four different score categories suggest that the majority of the results can be analysed by two-way classification into a contingency table.

By using this type of analysis it is possible to evaluate whether the number of scores obtained in each category is different from what would be expected on the basis of chance when the competitors are grouped in different ways (for example, into medallists and non-medallists). This type of distribution-free statistics makes no assumption about the distribution of scores with regard to the Gaussian nature or the homogeneity of variance between the two groups being compared. The Chi-square (X^2) technique provides a statistical test of the significance between the observed and expected data.

To assist in the visualisation of the data, the results are also expressed as bar charts, pie-charts and dot diagrams. Throughout this chapter statistical significance will always be assigned at the 5% level, unless otherwise stated.

ABBREVIATIONS USED IN THE TEXT FOR TECHNIQUES

The following abbreviations for Judo technique have been used.

Standingwork technique

DAB : Deashi-Barai (forward foot sweep)
HRG : Harai-Goshi (hip sweep)
HRM : Harai-Makikomi (hip sweep wrap-around)
KAD : Kata-Ashi-Dori (one leg catching)
KGU : Kata-Guruna (shoulder whirl)
KTA : Kuchiki-Taoshi (dead-tree drop)
KSG : Kosoto-Gari (small outside clip)
KSK : Kosoto-Gake (small outside hook)
KUG : Kouchi-Gari (small inside clip)
KUM : Kouchi-Makikomi (small inside clip wrap-around)
MGA : Morote-Gari (Two-arm clip)
OAB : Okuri-Ashi-Barai (assist foot sweep)
OGA : Osoto-Gaeshi (big outside clip counter)
OGO : Ogoshi (hip roll)
OSG : Osoto-Gari (big outside clip)
OUC : Ouchi-Gaeshi (big inside clip counter)
OUG : Ouchi-Gari (big inside clip)
SKG : Sode-Tsurikomi-Goshi (hip throw with a rising sleeve pull)
SN : Seoi-Nage (back-carry throw)
SOT : Sumi-Otoshi (corner drop)
STA : Sasae-Tsurikomi-Ashi (lifting-pull throw with supporting foot)
SUG : Sumi-Gaeshi (corner reversal)
SUK : Sukui-Nage (scoop throw)
TKG : Tsurikomi-Goshi (lift-pull hip throw)
TN : Tomoe-Nage (round throw)
TNO : Tani-Otoshi (valley drop)
TO : Tai-Otoshi (body drop)
UM : Uchi-Mata (thigh throw)
UNA : Uranage (inside-out throw)
UWA : Uki-Waza (floating technique)

Groundwork technique

HKG : Hon-Kesa-Gatame (scarf hold)
JG : Juji-Gatame (cross arm bar)
KKS : Kuzure-Kami-Shiho-Gatame (modified upper four-corner hold)
KSH : Kami-Shiho-Gatame (upper four-corner hold)
KYS : Kuzure-Yoko-Shiho-Gatame (modified side four-corner hold)
OEJ : Okuri-Eri-Jime (sliding lapel choke)
TSG : Tate-Shiho-Gatame (vertical four-corner hold)
UKG : Ushiro-Kesa-Gatame (back scarf hold)
YSG : Yoko-Shiho-Gatame (side four-corner hold)

3.3 DISTRIBUTION OF CONTEST TIMES

The full time duration of a Judo contest is 4 minutes for females and 5 minutes for males in all weight categories, but not all contests run their full duration. If Ippon is scored the competition ends. Table 3.1 gives the number of contests in each weight category for female competitors, the number of the contests that went the full duration and the average time of competition in that weight category.

Table 3.1 The number of contests for female competitors

Women	Number of Contests	Number of Contests Full duration	Average Time of Competition	Percentage of Contests full duration
-48kg	39	25	3:21	64.1%
-52kg	37	17	2:48	45.9%
-56kg	36	19	2:58	52.8%
-61kg	46	28	3:00	60.7%
-66kg	36	22	3:19	61.1%
-72kg	30	17	3:20	56.7%
+72kg	31	20	3:14	64.5%
Open	28	10	2:18	35.7%

The distribution of contest times in each weight category are displayed in Figure 3.1 for female competitors.

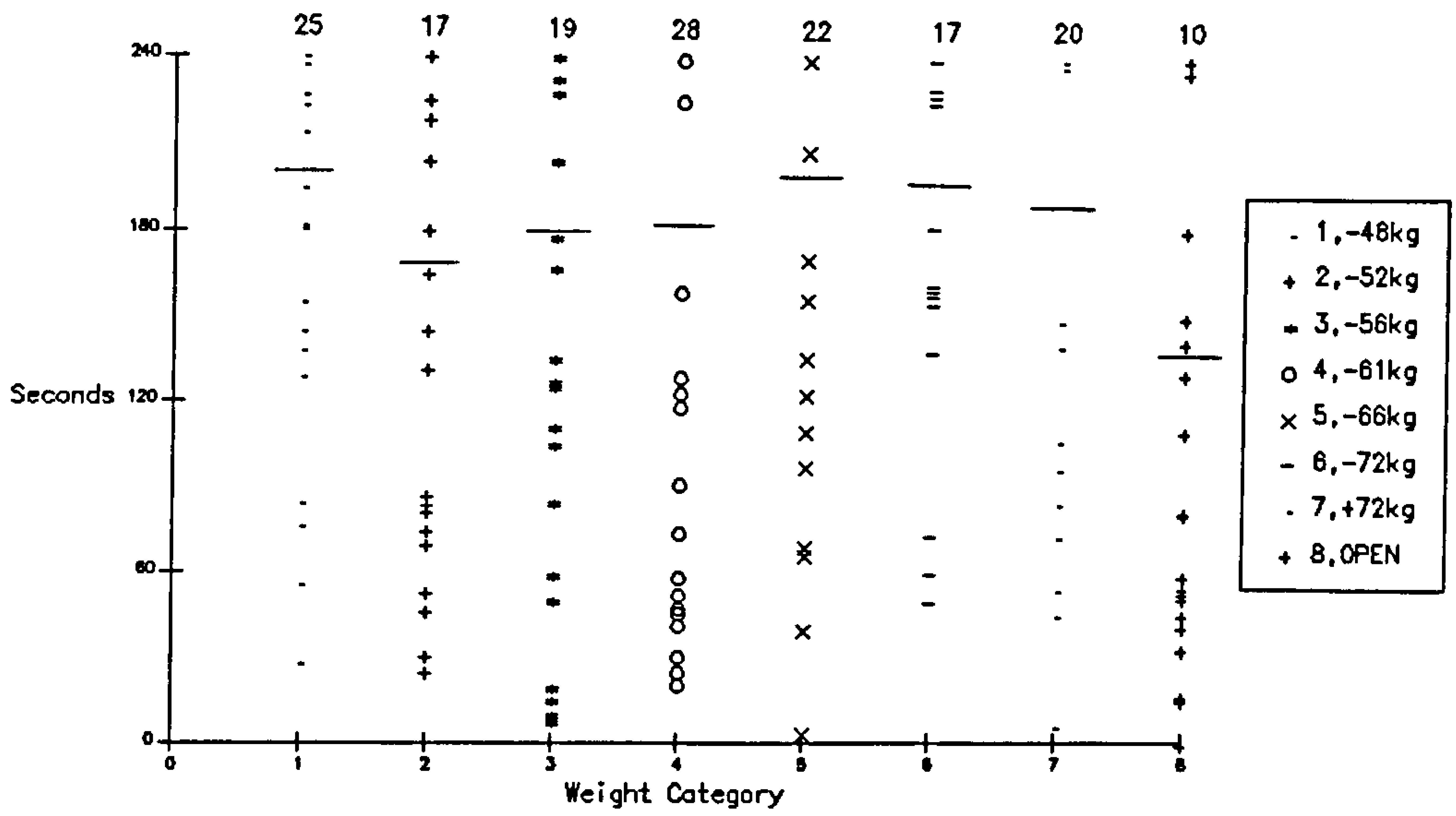


Figure 3.1 Illustration of contest time for all female competitors. The number of contests in which the competitors fought the full 4 minutes is shown at the head of each column.

A similar table 3.2 has been constructed for male competitors

Table 3.2 The number of contests for male competitors

Men	Number of Contests	Number of Contests Full duration	Average Time of Competition	Percentage of Contests full duration
-60kg	50	21	3:12	42.0%
-65kg	50	33	3:59	66.0%
-71kg	50	21	3:06	42.0%
-78kg	48	21	3:11	43.8%
-86kg	43	15	3:13	34.9%
-95kg	43	15	3:29	34.9%
+95kg	31	10	3:06	32.3%
Open	33	9	3:17	27.3%

For the male competitors the percentage of contests that lasted the full 5 minutes was much higher in the lighter weight categories compared with the heavier weight categories. This trend was not observed with the female competitors.

A similar figure, Figure 3.2 displays the distribution of contest times for the male competitors.

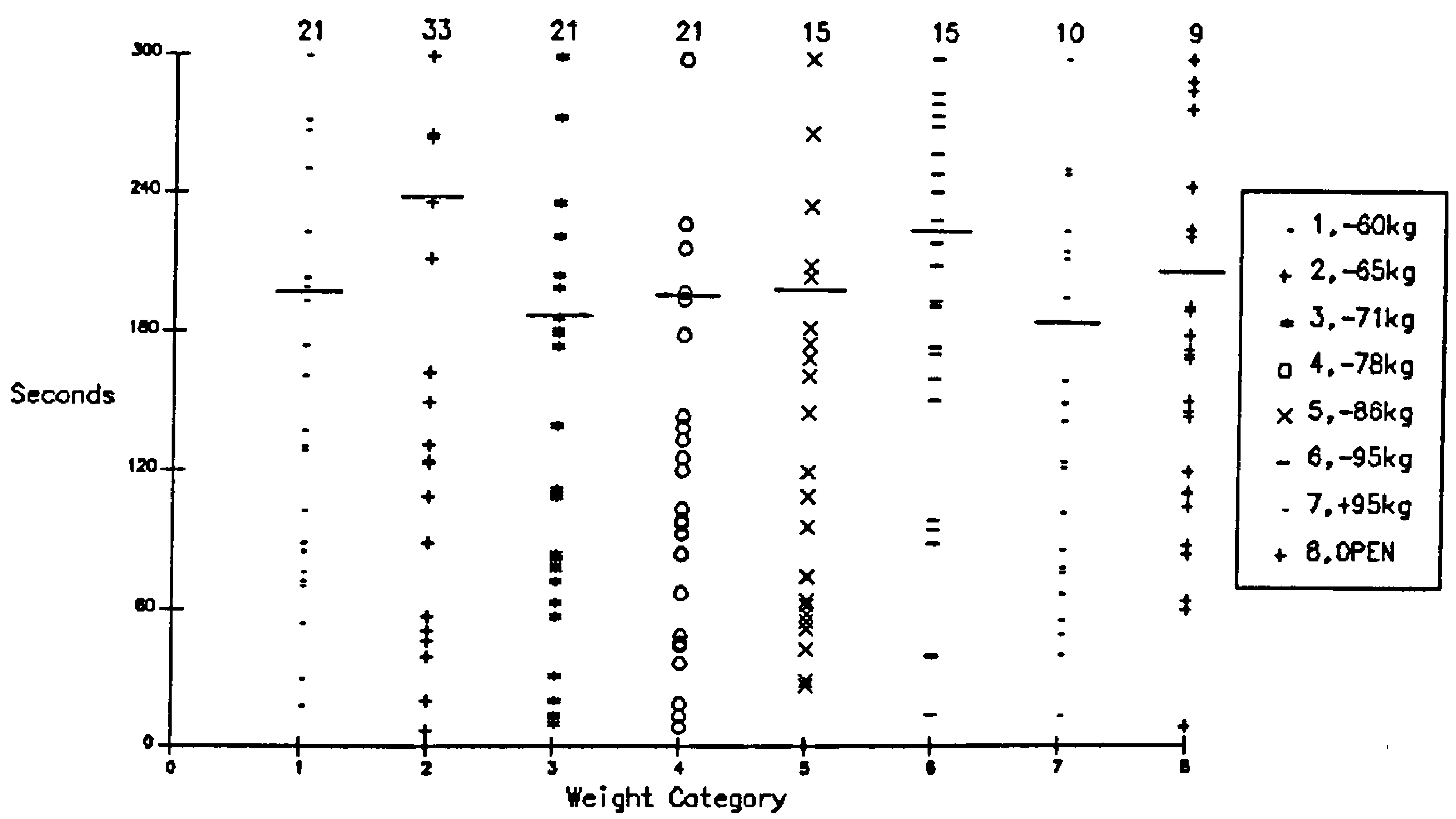


Figure 3.2 Illustration of contest time for all male competitors. The number of contests in which the competitors fought the full 5 minutes is shown at the head of each column.

3.4 CHARACTERISATION OF THE SCORES IN EACH CONTEST

In this section all of the data were partitioned between the male and female competitors. The scores that occurred in each contest were divided into seven different categories

1 Ippon
2 Waza-ari
3 Yuko
4 Koka
5 Penalty
6 Judges' Decision
7 any other score

For ease of visualising the data, male and female contests were sub-divided further into a group of light weight categories (male: -60kg, -65kg, -71kg, -78kg ; female: -48kg, -52kg, -56kg, -61kg) and a group of heavy weight categories (male: -86kg, -95kg, +95kg and Open ; female: -66kg, -72kg, +72kg and Open). In all, 631 contests were analysed.

Figure 3.3 shows the distribution of scores for the female light weight categories. The numbers on the horizontal axis refer to the score categories defined above. Ippon represented the highest percentage of scores in all categories with the -52kg weight category scoring over 50% Ippon, while the -48kg category scored 33% Ippon.

A significant percentage of the contests required a Judges' decision with over 20% of the contests in the -61kg category being decided this way. No more than 10% of the contests were decided by Waza-ari in all these light weight categories. Yuko was scored in over 20% of contests in the -61kg weight category.

Figure 3.4 shows the distribution of scores for the female heavy weight categories. It is of some interest that over 60% of contests were decided by Ippon in the Open weight category, while the Ippon percentage was less than 40% in all other heavy weight categories. Again a significant number of contests were decided by the Judges. Waza-ari was scored in less than 6% of contests in all categories.

Yuko was scored in over 20% of contests in all heavy weight categories except the Open event.

A similar picture emerged for the male competitors. However significantly more Ippon were scored in these contests especially for the heavy weight categories. Figure 3.5 shows the distribution of scores for the male light weight categories. Ippon was scored in over 50% of the contests in all weight categories, except for the -65kg class, in which only 34% of contests were concluded by Ippon. It may be of some significance that this weight class had a relatively high percentage of Yuko scored, which approached 30%. Again the judges' decisions was required in a number of contests, especially in the -71kg weight category where the judges' decided over 15% of the contests.

Figure 3.6 shows the distribution of scores for the male heavy weight categories. A striking feature of this display is the high percentage of Ippon scored in all heavy weight categories, ranging from 60% in the -95kg category to 70% in the Open weight category. These are very high percentages for the scoring of Ippon.

As a consequence the percentages for the other scoring categories were relatively low. Only the Open weight category showed a Waza-ari score of almost 20%. The judges were only called on to make a decision in over 10% of contests in the +95kg weight category. Both Yuko and Koka had percentage values of less than 10% in all the heavy weight categories.

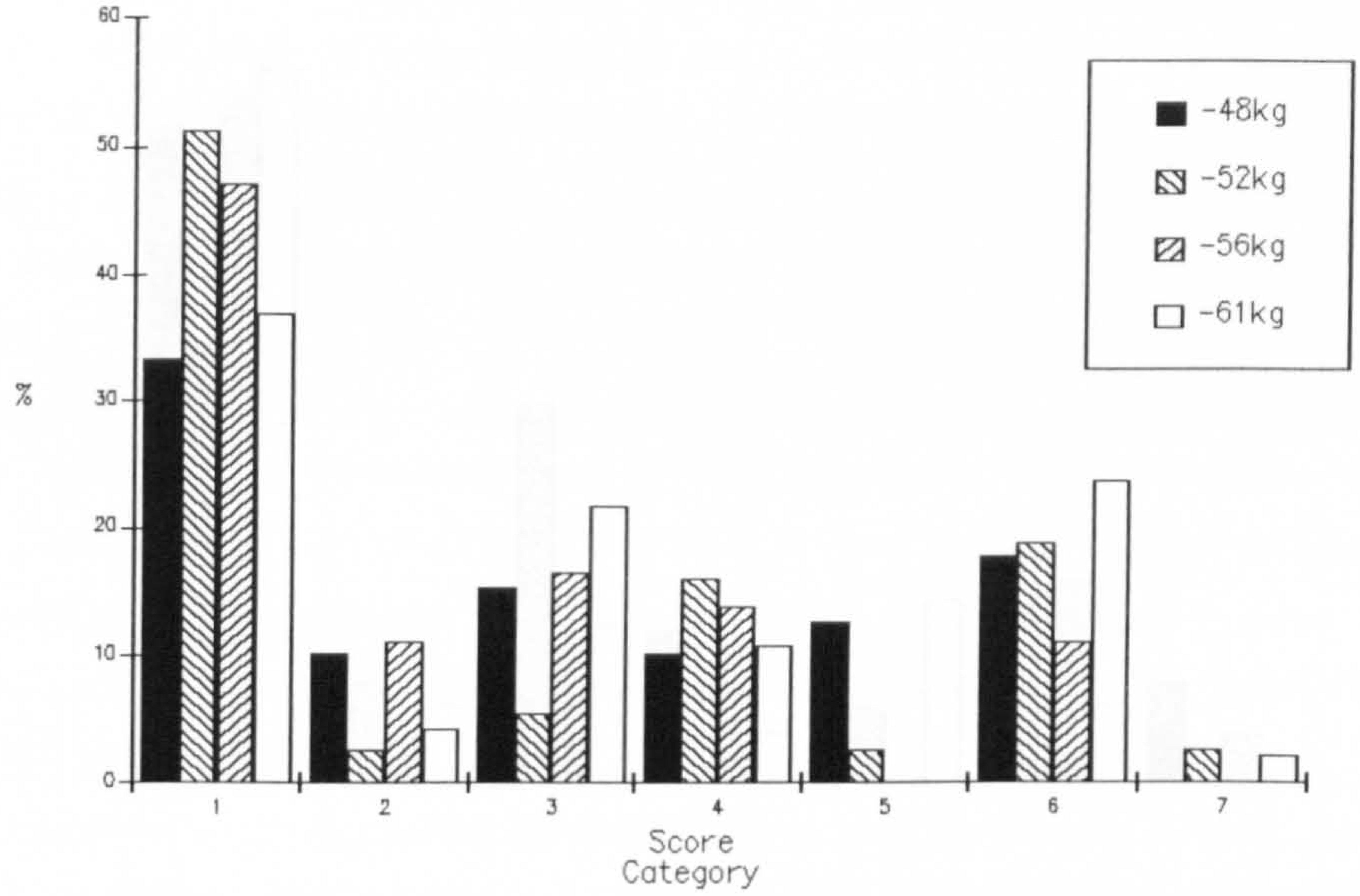


Figure 3.3 Distribution of scores for the female light weight categories.

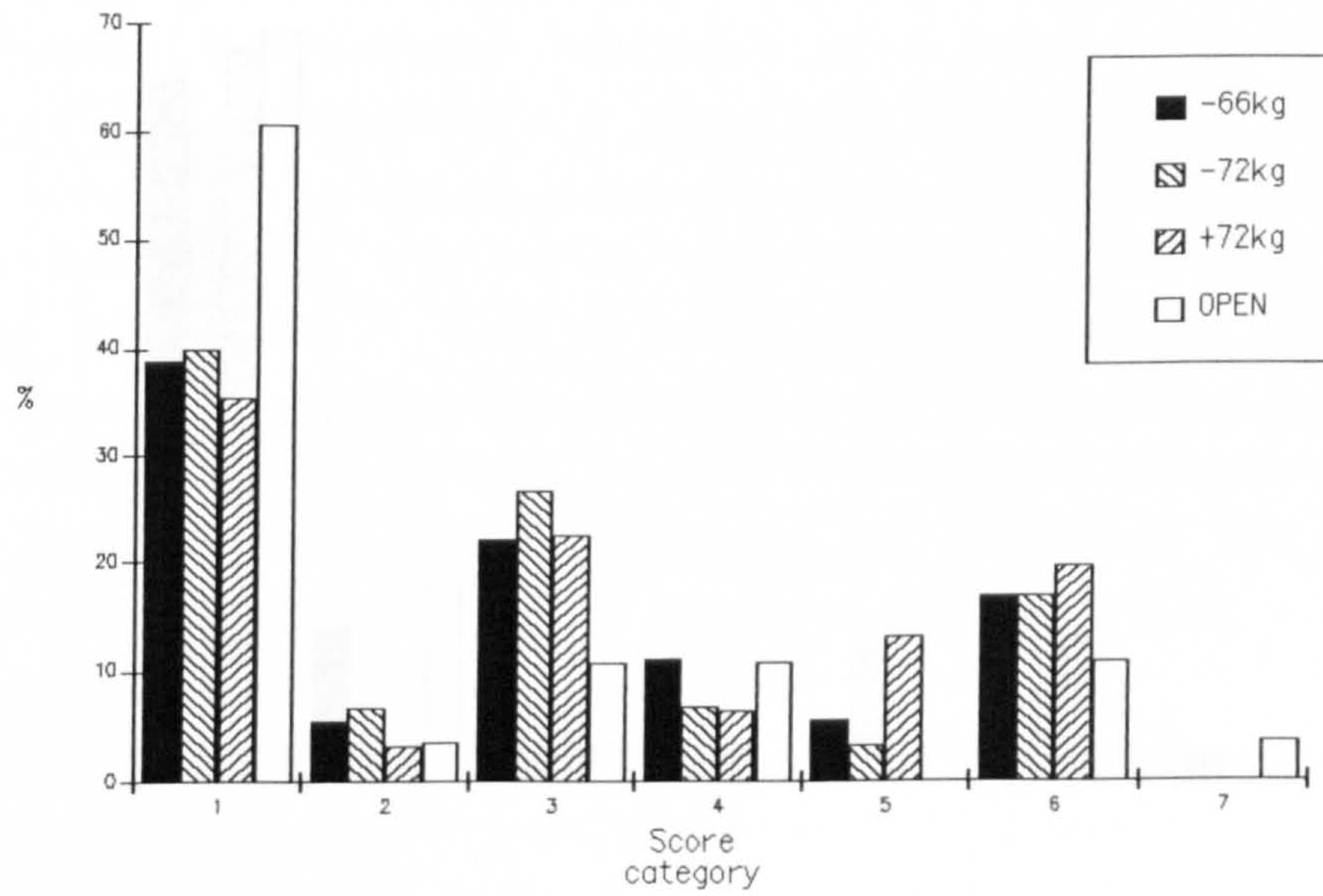


Figure 3.4 Distribution of scores for the female heavy weight categories.

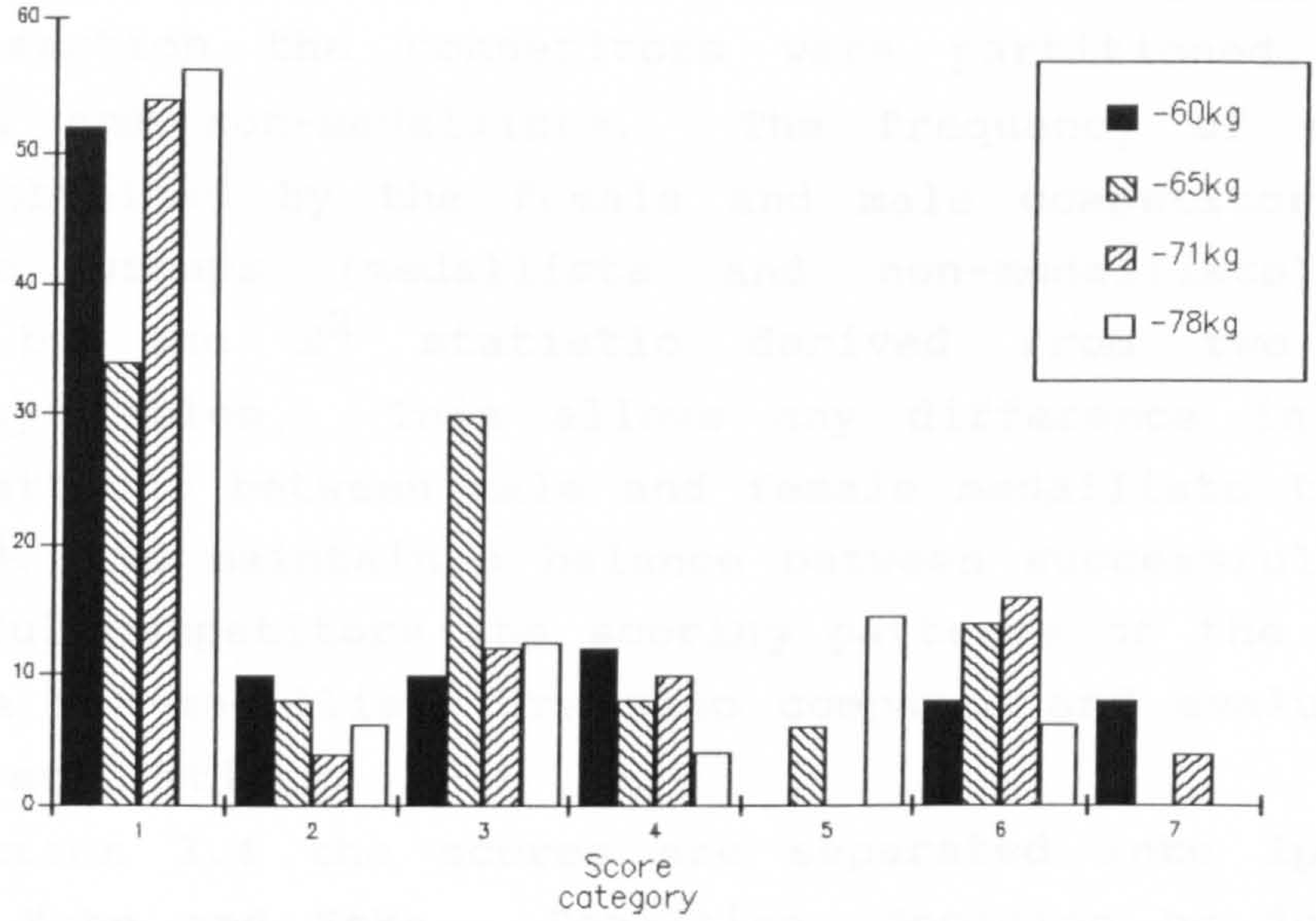


Figure 3.5 Distribution of scores for the male light weight categories.

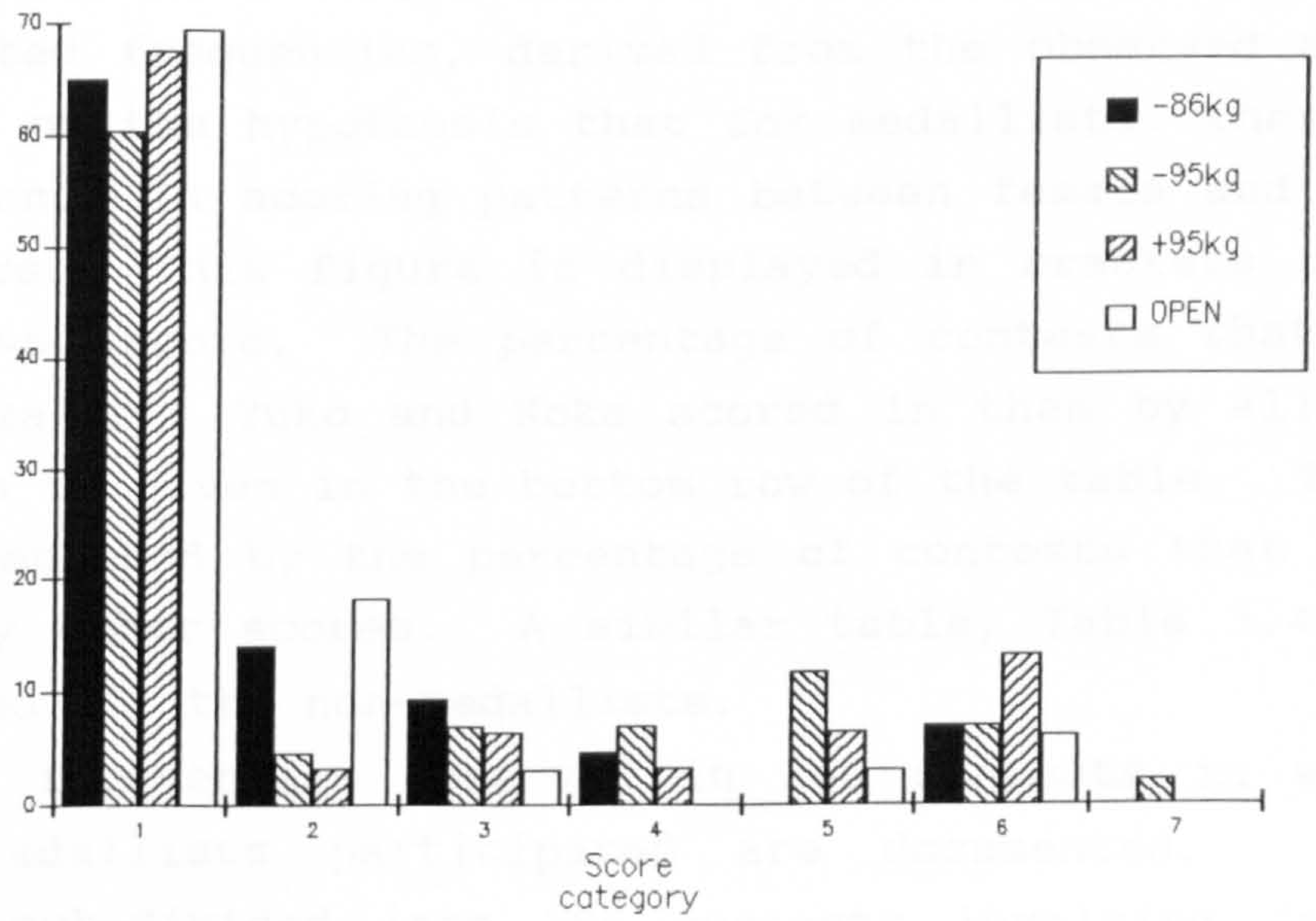


Figure 3.6 Distribution of scores for the male heavy weight categories.

3.5 COMPARISON OF SCORES OBTAINED BY MALES AND FEMALES

In this section the competitors were partitioned into medallists and non-medallists. The frequency of score category obtained by the female and male competitors in these two groups (medallists and non-medallists) is compared by the X^2 statistic derived from two way contingency tables. This allows any difference in the scoring patterns between male and female medallists to be identified. To maintain a balance between successful and unsuccessful competitors the scoring patterns of the male and female non-medallists are also compared and evaluated by the X^2 statistic.

As in section 3.4 the scores are separated into Ippon, Waza-ari, Yuko and Koka. Penalties, decision by judges and other scores are grouped into a single category called other scores.

Table 3.3 shows the score frequency observed in 271 contests in which all the medallists took part. This figure is subdivided into 143 contests in which the male medallists participated and 128 contests in which the female medallists took part.

The expected frequencies, derived from the observed data, are based on the hypothesis that for medallists, there is no difference in scoring patterns between female and male competitors. This figure is displayed in brackets below the observed score. The percentage of contests that had Ippon, Waza-ari, Yuko and Koka scored in them by all the medallists is given in the bottom row of the table. Table 3.3 is completed by the percentage of contests that were decided by other scores. A similar table, Table 3.4, is constructed for the non-medallists.

The score frequencies observed in 360 contests in which the non-medallists participated are documented. This table is sub-divided into 155 contests involving female non-medallists and 205 contests involving male non-medallists.

Table 3.3 Scoring patterns of female and male medallists

All medallists : 271 contests
Females 128 contests ; Males 143 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Female	57 (63)	7 (9)	19 (15)	16 (12)	29 (29)	128 (128)
Male	86 (80)	14 (12)	15 (19)	10 (15)	18 (17)	143 (143)
Totals	143	21	34	26	47	271
Percent of Total Contest	53	8	13	9	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female and male medallists.

Table 3.3 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.3 is 6.77.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female and male medallists.

Table 3.4 Scoring patterns of female and male non-medallists

All non-medallists : 360 contests
Females 155 contests ; Males 205 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Female	63 (72)	10 (10)	31 (25)	15 (12)	36 (36)	155 (155)
Male	109 (97)	15 (14)	26 (34)	13 (17)	42 (43)	205 (205)
Totals	172	25	57	28	78	360
Percent of Total Contest	48	7	16	8	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female and male non-medallists.

Table 3.4 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.4 is 7.72.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female and male non-medallists.

3.6 COMPARISON OF SCORES OBTAINED BY MEDALLISTS AND NON-MEDALLISTS WHEN PARTITIONED BY GENDER

In this section the competitors are partitioned by gender. This a natural progression from the sub-grouping used in the previous section. Again the frequency of score category for the two groups (medallists and non-medallists) is compared to identify any difference between the successful and the unsuccessful competitors. The scoring categories used in the previous section are retained.

Table 3.5 shows the score frequencies observed in 283 contests between female competitors. This total is subdivided into 128 contests in which the medallists participated and 155 contests which involved the non-medallists.

A similar table, Table 3.6, is constructed for the male competitors. There were 348 contests between male competitors at the World Championships. This total can be sub-divided into 143 contests involving medallists and 205 contests involving non-medallists. The formats of Tables 3.5 and 3.6 are the same as the Tables constructed in the previous section.

Table 3.5 Scoring patterns of medallists and non-medallists female

All Female competitors : 283 contests
Medallists 128 contests ; Non-Medallists 155 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Medallists	57 (55)	7 (8)	19 (22)	16 (14)	29 (29)	128 (128)
Non-Medallists	63 (67)	10 (9)	31 (27)	15 (17)	36 (35)	155 (155)
Totals	120	17	50	31	65	283
Percent of Total Contest	42	6	18	11	23	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by medallists and non-medallists in the female competitors.

Table 3.5 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.5 is 2.10.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for medallists and non-medallists in the female competitors.

Table 3.6 Scoring patterns of medallists and non-medallists male

All Male competitors : 348 contests
Medallists 143 contests ; Non-Medallists 205 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Medallists	86 (85)	14 (13)	15 (17)	10 (10)	18 (18)	143 (143)
Non-Medallists	109 (110)	15 (17)	26 (23)	13 (13)	42 (42)	205 (205)
Totals	195	29	41	23	60	348
Percent of Total Contest	56	8	12	7	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by medallists and non-medallists in the male competitors.

Table 3.6 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.6 is 0.96.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for medallists and non-medallists in the male competitors.

3.7 COMPARISON OF SCORES OBTAINED IN STANDING AND GROUNDWORK TECHNIQUES BY FEMALE MEDALLISTS, FEMALE NON-MEDALLISTS, MALE MEDALLISTS AND MALE NON-MEDALLISTS

Judo techniques can be separated into two quite distinct categories. These are standing techniques and groundwork techniques. This section explores the scoring patterns observed in the 1991 World Championships when the techniques were separated in this way.

Initially a X^2 statistic based on two-way contingency tables was sought. However, it became apparent in the analysis that the scoring patterns using the two techniques were quite distinct. It was not appropriate to use the X^2 statistic because many of the cells associated with groundwork techniques contained zero frequency. However the tables themselves give a descriptive synopsis of the scoring patterns obtained with the two different technique categories. Statistical analysis is not required to confirm that there is a significant difference between the frequency of scoring categories produced by standing and groundwork technique in all 4 cases considered.

Table 3.7 displays the scoring patterns for the standing and groundwork techniques of female medallists. Table 3.8 provides similar information for female non-medallists. The two tables, Table 3.9 and 3.10, provide a similar synopsis for the male competitors. It was decided that other scores would not be included in either standing or groundwork techniques. Hence the number of contests considered in this section is slightly less than totals analysed in the earlier sections.

Table 3.7 Scoring patterns for standing and groundwork techniques of female medallists

All female medallists : 99 contests
Standing techniques : 70 contests
Groundwork techniques : 29 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	28	7	19	16	70
Groundwork Techniques	29	0	0	0	29
Totals	57	7	19	16	99

Table 3.8 Scoring patterns for standing and groundwork techniques of female non-medallists

All female non-medallists : 119 contests
Standing techniques : 75 contests
Groundwork techniques : 44 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	23	10	31	11	75
Groundwork Techniques	40	0	0	4	44
Totals	63	10	31	15	119

Table 3.9 Scoring patterns for standing and groundwork techniques of male medallists

All male medallists : 125 contests
Standing techniques : 86 contests
Groundwork techniques : 39 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	48	13	15	10	86
Groundwork Techniques	38	1	0	0	39
Totals	86	14	15	10	125

Table 3.10 Scoring patterns for standing and groundwork techniques of male non-medallists

All male non-medallists : 163 contests
Standing techniques : 125 contests
Groundwork techniques : 389 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	72	14	26	13	125
Groundwork Techniques	37	1	0	0	38
Totals	109	15	26	13	163

3.8 COMPARISON OF SCORES OBTAINED IN THE DIFFERENT WEIGHT CATEGORIES FOR BOTH FEMALE AND MALE COMPETITORS

To provide a fair and standardised competition, Judo has evolved into 8 different weight categories for both female and male contestants. In this section the grouping used in section 3.4 is employed to study the frequency of scoring in light weight and heavy weight categories for female and male competitors.

The light weight female category consists of -48kg, -52kg, -56kg and -61kg, while the heavy weight female category was taken as -66kg, -72kg, +72kg and Open. For male competitors the light weight category was chosen as -60kg, -65kg, -71kg and -78kg, while -86kg, -95kg, +95kg and Open categories were designated as heavy weight.

Table 3.11 shows the scoring frequencies observed in 283 contests between all the female competitors. This table is subdivided into 158 contests between female light weight competitors and 125 contests in which the heavy weight competitors participated.

A similar table, Table 3.12, is constructed for male competitors. There were 348 contests in total, of which 198 were light weight bouts and 150 were heavy weight contests. The formats of Tables 3.11 and 3.12 are the same as those used in earlier sections.

Table 3.11 Scoring patterns for female light and heavy weight contestants

All female competitors : 283 contests
Light weight competitors : 158 contests
Heavy weight competitors : 125 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Light Weight Competitors	66 (67)	11 (9)	24 (28)	20 (14)	37 (36)	158 (158)
Heavy Weight Competitors	54 (53)	6 (7)	26 (22)	11 (17)	28 (29)	125 (125)
Totals	120	17	50	31	65	283
Percent of Total Contest	42	6	18	11	23	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by light weight contestants and heavy weight contestants in the female competitors.

Table 3.11 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.11 is 6.72.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for light weight and heavy weight female competitors.

Table 3.12 Scoring patterns for male light and heavy weight contestants

All male competitors : 348 contests
Light weight competitors : 198 contests
Heavy weight competitors : 150 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Light Weight Competitors	97 (110)	14 (16)	31 (23)	17 (13)	39 (35)	198 (198)
Heavy Weight Competitors	98 (84)	15 (13)	10 (18)	6 (10)	21 (25)	150 (150)
Totals	195	29	41	23	60	348
Percent of Total Contest	56	8	12	7	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by light weight contestants and heavy weight contestants in the male competitors.

Table 3.12 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.12 is 14.92.

This suggests that the null hypothesis should be rejected and the observed frequency of scoring category is different between the light weight and heavy weight male competitors. It would appear that the light weight male competitors scored less Ippon and more Yuko and Koka than expected from the observed data, whereas the heavy weight male competitors scored more Ippon and less Yuko and Koka than might be expected.

3.8.1 IPPON SCORED FROM STANDING AND GROUNDWORK TECHNIQUES

The difference in the observed scoring frequency between light weight and heavy weight male competitors suggests that the frequency with which Ippon is scored from standing and groundwork techniques should be investigated.

Table 3.13 gives the frequency of Ippon scored from standing and groundwork techniques by the female competitors who were partitioned in to light weight and heavy weight categories. This results in a 2 x 2 contingency table and so Yates' correction for continuity is employed.

Table 3.14 provides an analysis of the scoring frequency of Ippon for male competitors when they are partitioned by weight. Again the Yates' correction is used for this 2 x 2 contingency table.

Table 3.13 Scoring Ippon patterns for female light and heavy weight contestants

Female competitors : Ippon scored in 120 contests
Light weight competitors : 66 contests
Heavy weight competitors : 54 contests

	Standing techniques	Groundwork techniques	Totals
Light Weight Competitors	31 (28)	35 (38)	66 (66)
Heavy Weight Competitors	20 (23)	34 (31)	54 (54)
Totals	51	69	120
Percent of Total Contest	43	57	100

Null Hypothesis : There is no difference between the observed frequency of scoring Ippon from standing and groundwork techniques between light weight and heavy weight in the female competitors.

Table 3.13 is a two-way contingency table with two rows and two columns. Therefore there is 1 x 1 = 1 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 3.84. Yates' correction for continuity is used in these circumstances. Hence, based on the formula

$$X^2 = \sum_{i=1}^{4} [(O_i - E_i - 0.5)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.13 is 1.28.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring Ippon from standing and groundwork techniques between light weight and heavy weight female competitors.

Table 3.14 Scoring Ippon patterns for male light and heavy weight contestants

Male competitors : Ippon scored in 195 contests
Light weight competitors : 97 contests
Heavy weight competitors : 98 contests

	Standing techniques	Groundwork techniques	Totals
Light Weight Competitors	66 (60)	31 (37)	97 (97)
Heavy Weight Competitors	54 (60)	44 (38)	98 (98)
Totals	120	75	195
Percent of Total Contest	62	38	100

Null Hypothesis : There is no difference between the observed frequency of scoring Ippon from standing and groundwork techniques between light weight and heavy weight in the male competitors.

Table 3.14 is a two-way contingency table with two rows and two columns. Therefore there is 1 x 1 = 1 degrees of freedom associated with the X^2 statistic.
The critical value of the $X^2{}_{;0.05}$ is 3.84. Yates' correction for continuity is used in these circumstances. Hence, based on the formula

$$X^2 = \sum_{i=1}^{4} [(O_i - E_i - 0.5)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 3.14 is 4.29.

This suggests that the null hypothesis should be rejected. It appears that light weight male competitors scored more

Ippon by standing techniques and less Ippon by groundwork techniques than expected. Conversely the heavy weight male competitors scored less Ippon by standing techniques and more Ippon by groundwork techniques than expected from the observed data.

3.9 EVALUATION OF SCORING TECHNIQUES

This section considers the most successful scoring techniques observed at the 1991 World Championships. First those standing techniques that produced any form of score (Ippon, Waza-ari, Yuko and Koka) are assessed for both female and male competitors. Then techniques that produced Ippon alone are evaluated. Finally groundwork techniques are divided into these categories :

1, OSAE-WAZA (HOLDING TECHNIQUES)

2, KANSETSU-WAZA (ARM-LOCK TECHNIQUES)

3, SHIME-WAZA (STRANGLE TECHNIQUES)

and their relative success in scoring Ippon are illustrated. The paucity of other scores using groundwork techniques removed the necessity to consider any other score than Ippon. A key to the different standing and groundwork techniques and the abbreviation can be found at the front of this chapter.

Figure 3.7 shows the relative magnitude of the most successful standing techniques used by female competitors. Uchi-mata (UM), and then Ouchi-gari (OUG), followed by Seoi-nage (SN) were the three most successful scoring techniques. All techniques that only formed very small percentages of the total were grouped together to form an aggregate sector (sector number 1), while those techniques for which a descriptive name could not be found were lumped together to form the aggregate sector number 2.

Figure 3.8 shows a similar display of the successful standing techniques used by male competitors. For the men, Seoi-nage (SN) was the most successful scoring technique followed by Uchi-mata (UM) and then Osoto-gari (OSG). For the male competitors the technique, Ouchi-gari (OUG) was only ranked fifth. Aggregate sectors were constructed for all techniques with a low percentage of success, and those techniques for which a descriptive name could not be found.

When the techniques that were successful in producing Ippon alone were evaluated the picture changed slightly. For both female and male competitors the most successful standing technique was UM followed by SN. This information is displayed in Figures 3.9 and 3.10. Aggregate sectors were used again for all techniques with a low percentage of success and those techniques for which a descriptive name could not be found.

Figure 3.11 shows the relative distribution of groundwork techniques that scored Ippon for the female competitors. Figure 3.12 shows a similar display of groundwork techniques which were successful in producing Ippon for the male competitors. For both female and male competitors between 60 and 70 percent of Ippon were scored by holding techniques.

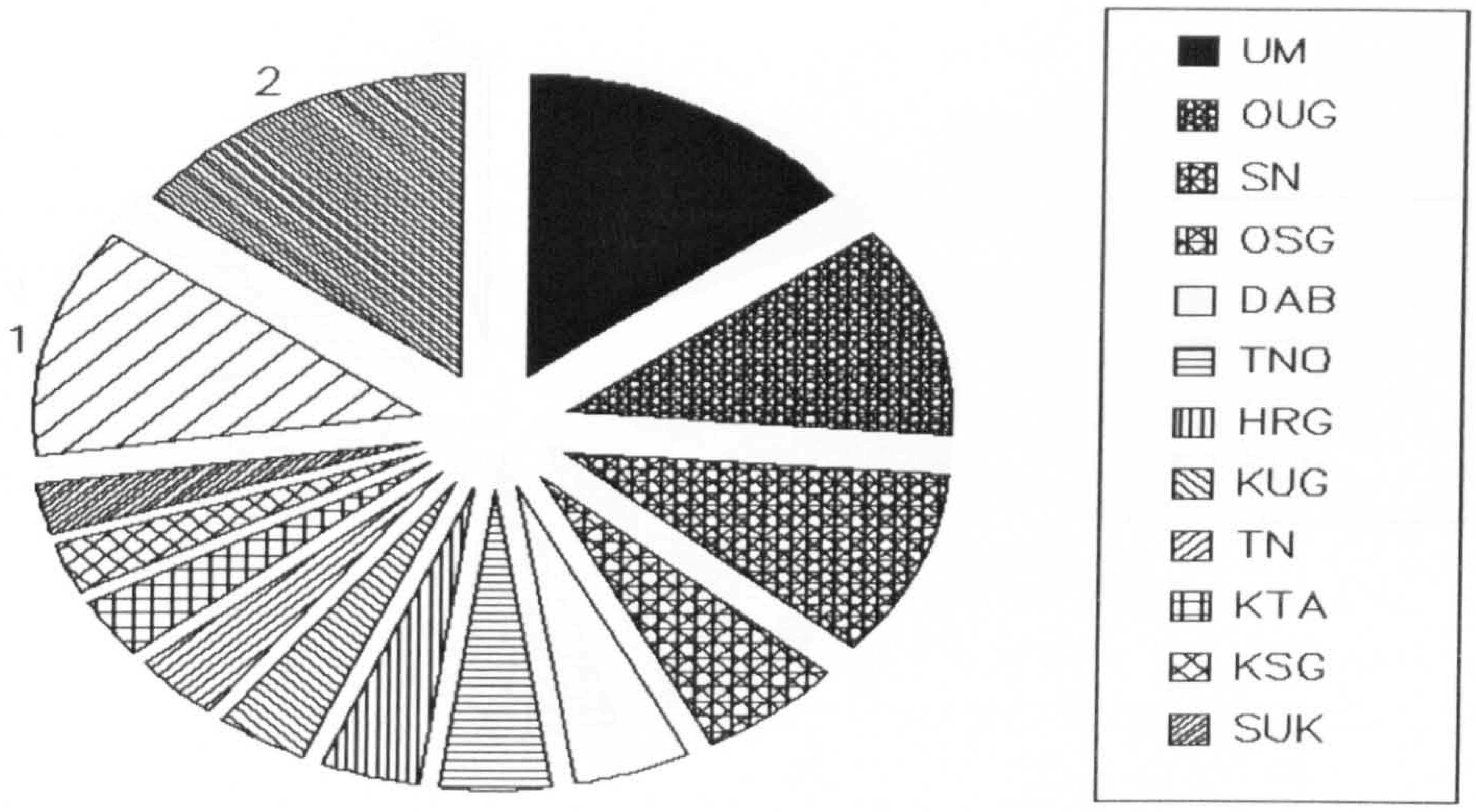


Figure 3.7 Distribution of successful standing techniques for the female competitors. (1, Aggregate sector of all techniques that comprised of a small percentage of the total. 2, Aggregate sector of these techniques for which a descriptive name was not available).

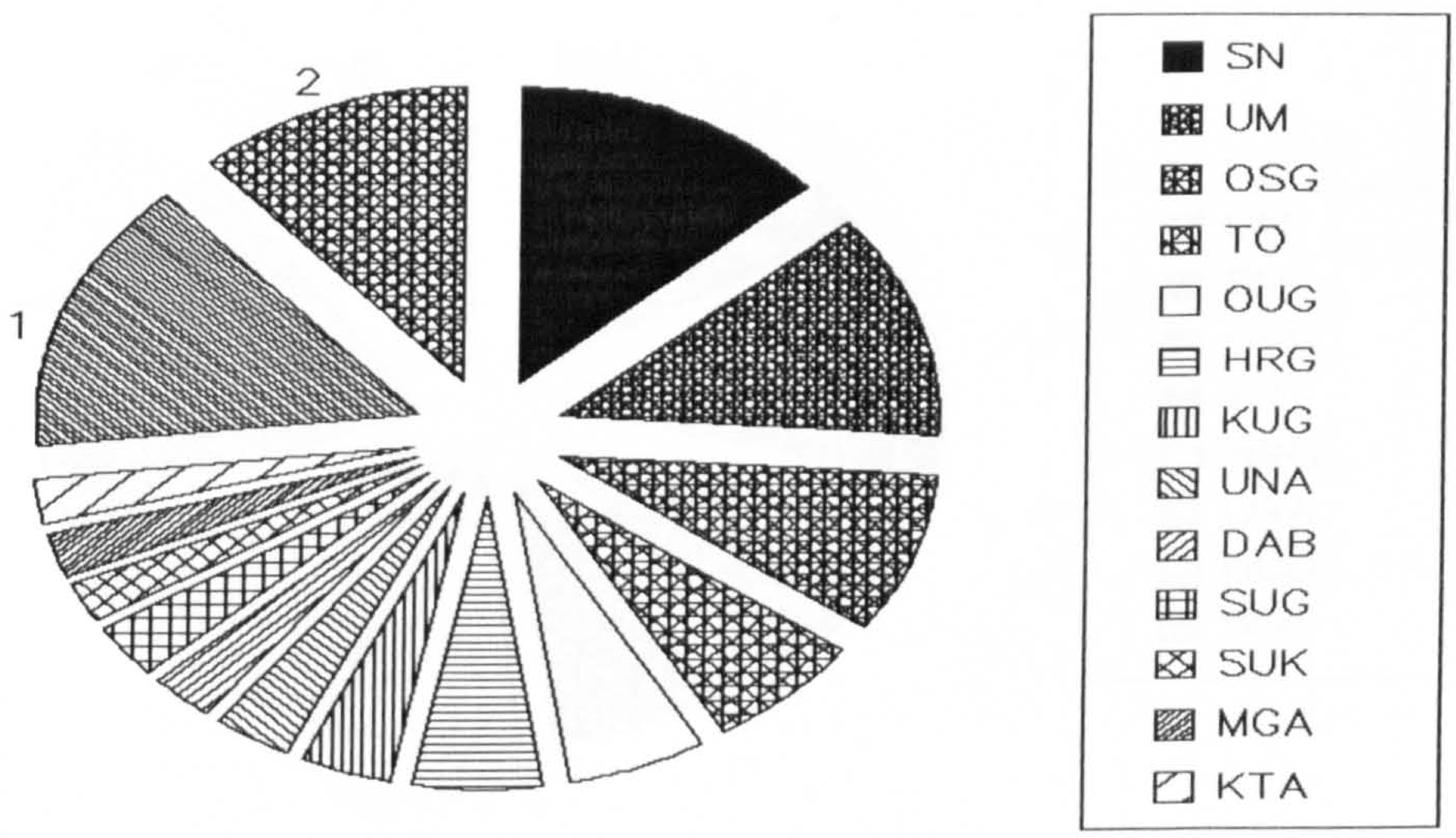


Figure 3.8 Distribution of successful standing techniques for the male competitors. (1, Aggregate sector of all techniques that comprised of a small percentage of the total. 2, Aggregate sector of these techniques for which a descriptive name was not available).

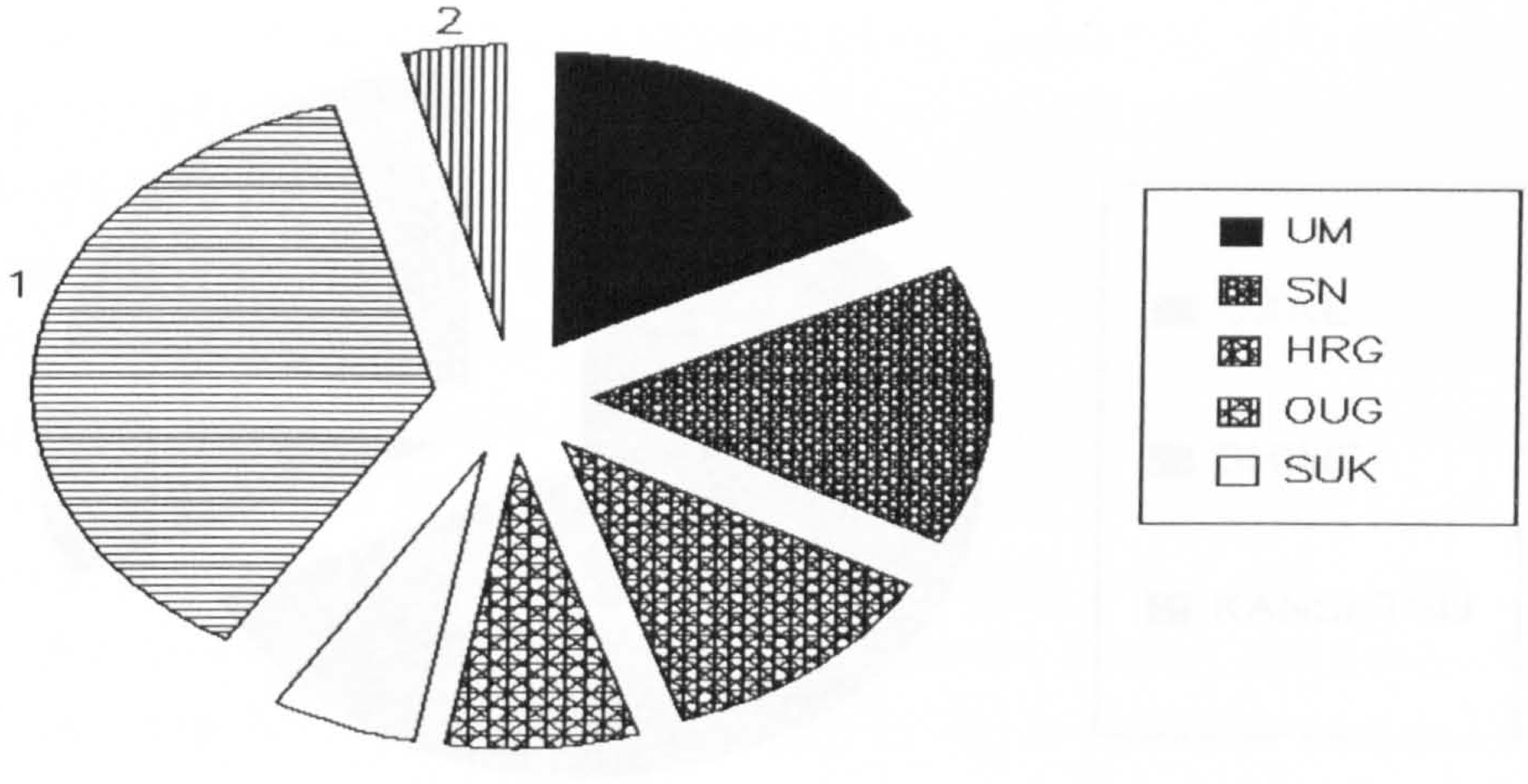


Figure 3.9 Distribution of successful standing techniques that scored Ippon for the female competitors. (1, Aggregate sector of all techniques that comprised of a small percentage of the total. 2, Aggregate sector of these techniques for which a descriptive name was not available).

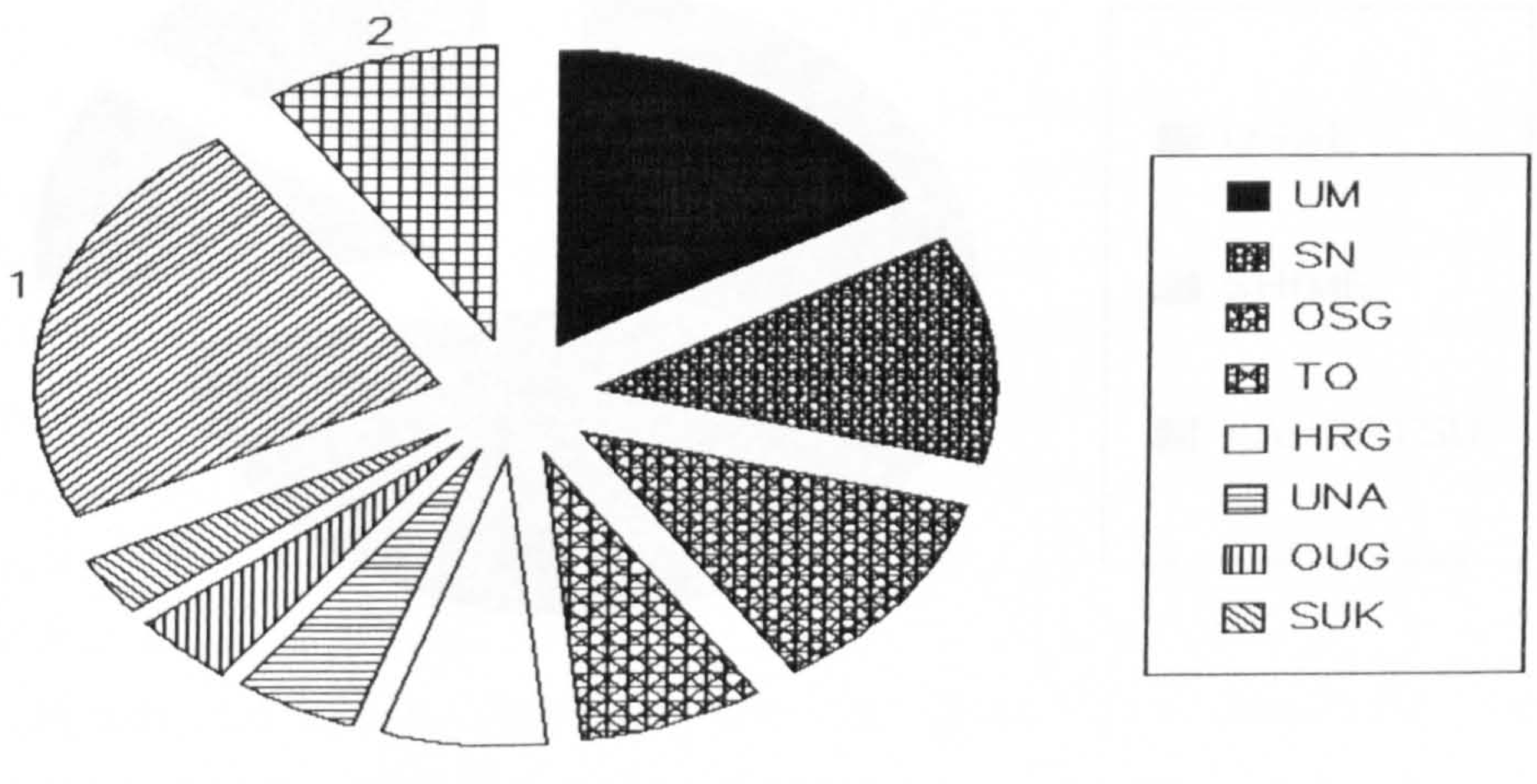


Figure 3.10 Distribution of successful standing techniques that scored Ippon for the male competitors. (1, Aggregate sector of all techniques that comprised of a small percentage of the total. 2, Aggregate sector of these techniques for which a descriptive name was not available).

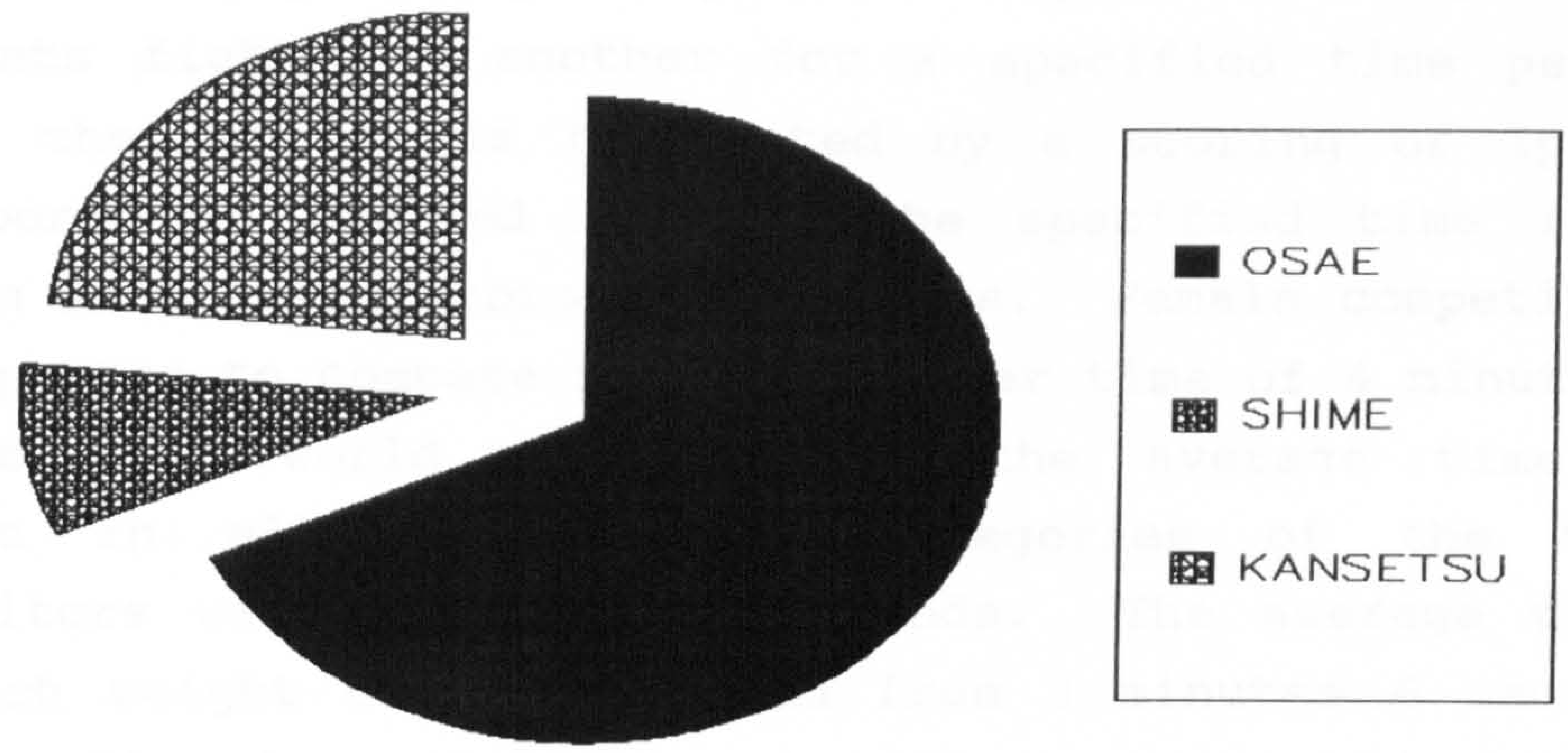


Figure 3.11 Distribution of groundwork techniques that scored Ippon for the female competitors.

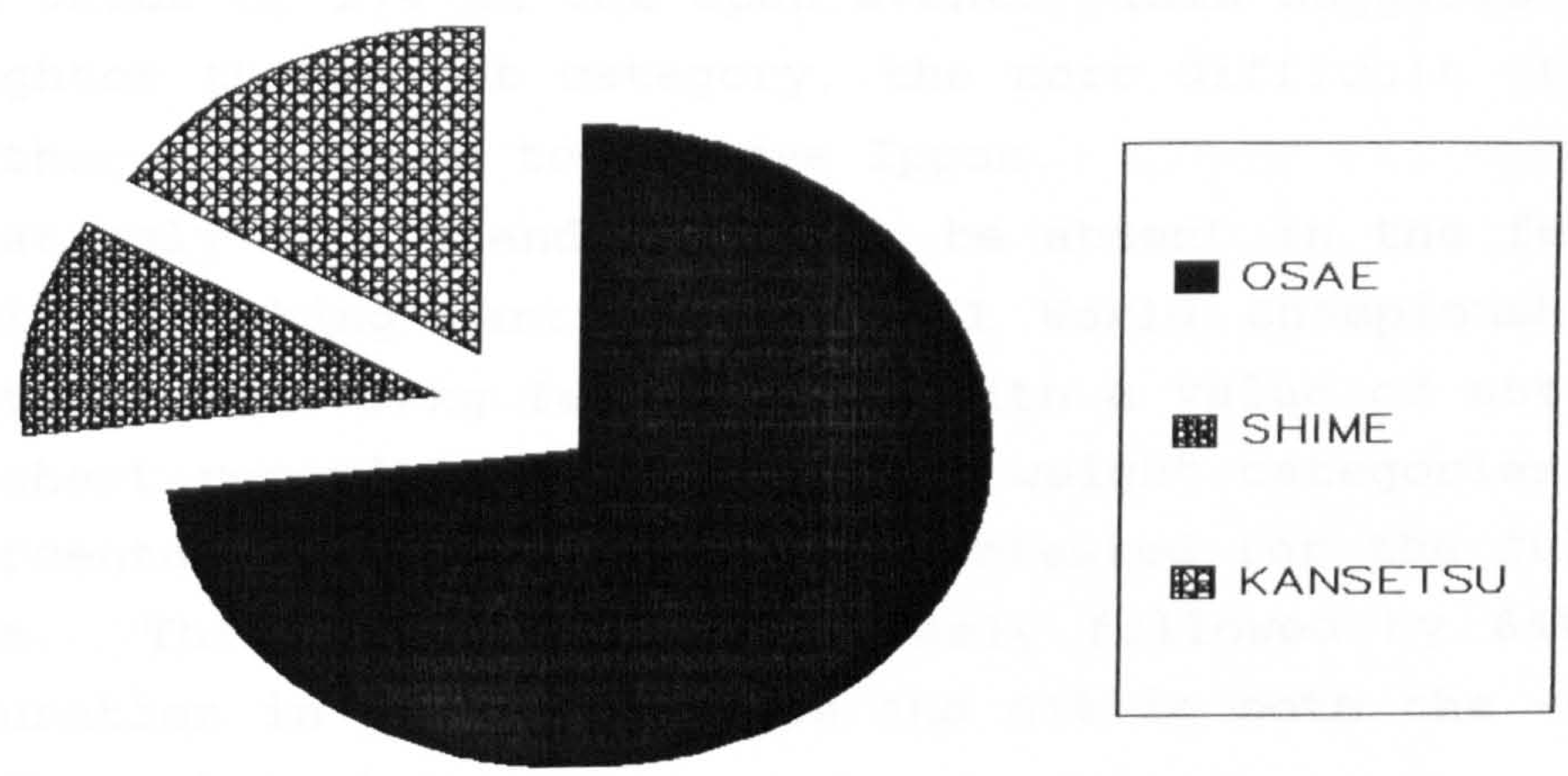


Figure 3.12 Distribution of groundwork techniques that scored Ippon for the male competitors.

3.10 DISCUSSION AND CONCLUSIONS

Judo is a physically competitive sport in which two opponents fight one another for a specified time period unless the contest is terminated by a scoring of Ippon. The sport has evolved so that the specified time limit between male competitors is 5 minutes. Female competitors are expected to compete for the shorter time of 4 minutes. In the 1991 World Championships the average time of contest in all eight weight categories of the male competitors was 3 minutes 19 seconds. The average times for each weight category ranged from 3 minutes 6 seconds in the -71kg class and +95kg class to 3 minutes 59 seconds in the -65kg class. The total number of contests was 348. In the -65kg weight category, the percentage of contests that ran for the full duration of 5 minutes was of the order of 60%. As the weight category of the contest increased the percentage of contests running the full duration decreased dramatically to 32% for +95kg and the lowest value of 27% in the Open event. This suggests that the lighter the weight category, the more difficult it was for either contestant to achieve Ippon.

Interestingly this trend seemed to be absent in the female competitors taking part in the 1991 World Championships. In fact, in the +72kg female class with a value of 65% had the highest record in all the female weight categories for the percentage of bouts that were contested for the full 4 minutes. This peak value was closely followed by 64% of full duration in the -48kg class and 61% in both the -61kg and -66kg categories.

There seems to be little evidence that the heavier weight categories terminated their bouts more readily with Ippon than the lighter weight contestants. The average time of competition for all female weight categories was 3 minutes 2 seconds with the highest average value of 3 minutes 21 seconds in the -48kg class and the lowest average value in the Open category. It is possible that the difference in distributions for the percentage of contests that ran the full duration lies in the scoring techniques employed by

the heavier weight men. For this reason the distribution of the scoring characteristics in each weight category, for both females and males was considered.
Scores were subdivided into 7 different categories and the percentage of contests decided by a specific category were displayed on a bar chart for both female and male competitors. These contestants were subdivided further into light weight and heavy weight categories. One striking feature of these distributions was the high percentage of Ippon scored by the heavy weight male competitors. Between 60% to 70% of contests were decided by Ippon in these male heavy weight classes.
With such a high percentage of contests decided by Ippon all the other scoring categories were associated with relatively low percentage values. In particular the referees were called on to make a decision in less than 10% of the bouts in all the heavy weight contests except the +95kg category. Even in this weight category the referees were only asked to make a subjective decision in 13% of cases.
The pattern of scoring achieved by the light weight male competitors is dominated less by the score of Ippon. Nevertheless over 50% of all contests between light weight male contestants were terminated by Ippon in all categories except the -65kg class. It is of interest that there were an unusually high percentage of contests decided by the single score of Yuko (over 30%) in this weight category. Ippon requires the competitor to throw his/her opponent with force and speed onto his/her back when using standing techniques. All three components must be present for Ippon to be scored. The score of Yuko lacks two of these three elements. From the raw statistics it is not clear whether contestants in the -65kg class were adept at reducing a potential Ippon to Yuko or the referees in these contests were more lenient in their interpretation of Ippon. Possibly it could have been a combination of both of these features.

Analysis of the scoring characteristics of the female competitors is equally as interesting as the analysis above for their male counterparts. A striking feature is the absence of a high percentage of contests terminated by Ippon. Only in the female Open class does the percentage of contests concluded by Ippon reach that level seen in the male competitors. Just over 60% of contests in the Open class finished with Ippon for the female competitors, whereas most of the other female weight categories demonstrated an Ippon percentage of less than 40%. The exceptions were the -52kg class (52% of the contests finished with Ippon) and the -56kg class (47% of the contests finished with Ippon).

The lower percentages of Ippon obtained by the female competitors meant that other scoring categories were relatively higher for some weight categories. For example, in the -61kg class over 20% of contests were decided by a single Yuko, while the judges' decision was needed in 23% of the contests. Combined together these percentages (43%) decided the winner of the contests in this weight category with a significantly higher percentage than Ippon alone (37%).

A similar picture emerges from the female heavyweight scoring data. Apart from the Open weight category, Ippon won the contest in less than 40% of cases for all the heavy weight categories. The percentage of contests decided by a single Yuko was relatively high with a peak of 25% in the -72kg class. Again the judges' decision was required in a significant number of contests. Almost 20% of bouts were decided by the referees' in the +72kg class.

It is of some interest that contests were rarely decided by a single Waza-ari or a single Koka in either female or male competitors. Usually the percentage of contests decided in this way was less than 10%. The main exception is in the Open event for male competitors where almost 20% of contests were decided by Waza-ari. This observation may reflect the difficulty in distinguishing between Ippon (all three criteria of force, speed and landing on the back required) and Waza-ari (where only two of the three criteria are essential). Perhaps a referee is more inclined to give Ippon when in doubt, especially in the male heavy weight contests. Koka is only scored if there is speed and force but the competitor lands on the thigh or buttocks, but not on the back. These statistics suggest that world class Judo players rarely achieve the speed and force necessary for a successful throw.

These results apply to standing techniques alone. In groundwork, Ippon is achieved when an opponent is held for 30 seconds (alternatively a strangle or arm-lock leads to submission). It is clear from section 3.7 that a successful hold nearly always leads to Ippon. Rarely does a competitor escape before the allotted time once a holding technique has been applied successfully. For this reason it is likely that groundwork techniques contributed significantly to the scores of Ippon, but all other scoring categories were demonstrated by using standing techniques.

With the observed differences in the frequency of scoring categories between all the female competitors and all the male competitors it is natural to enquire about the frequency of scoring categories obtained by the successful competitors (the medallists) and the unsuccessful competitors (the non-medallists). Section 3.5 compared the scoring frequencies obtained by the medallists separated by gender and the non-medallists partitioned in a similar manner.

Using the X^2 statistic there was no evidence that scoring patterns achieved by female medallists were any different to those obtained by male medallists. Similar remarks apply to the female and male non-medallists. With this information it seemed sensible to investigate whether the successful medallists scored differently in comparison to the non-medallists. The data were partitioned by gender and the scoring frequencies of medallists were compared with those of non-medallists for female competitors. A similar strategy was adopted for the male competitors. It came as a surprise to find that there was no statistical evidence to support the theory that medallists might score more frequently than non-medallists. Using the X^2 statistic the frequency of scoring categories was the same for both medallists and non-medallists in the female and male championships. Apparently for world standard competitors it is some other, more subtle, characteristic which separates the medallists from the non-medallists.

The next stage in the analysis was to study the pattern of scoring frequencies obtained from standing techniques and groundwork techniques.

The data were partitioned into female medallists, female non-medallists, male medallists and male non-medallists for this investigation. Tables 3.7 ~ 3.10 demonstrate that standing techniques produce totally different scoring patterns to groundwork techniques. Female medallists always scored Ippon with a groundwork technique, no other score was documented. Hence the other lower scoring categories were only achieved through the standing techniques. A similar pattern emerges from the female non-medallists data. However for these competitors 4 Koka were scored by groundwork techniques, when the opponent escaped from the holding techniques within 20 seconds (10 ~ 20 seconds) of its initiation. Male competitors also only scored Ippon with groundwork techniques except for a solitary Waza-ari in the male medallists and two of these scores in the male non-medallists. These observations suggest that at World Championships level, groundwork techniques, once initiated will almost always lead to Ippon and conclusion of the contest. The subjectivity of the judges' assessment of the score is removed in these circumstances.

Finally the female and male competitors were grouped by weight category into light weight and heavy weight contestants. No statistical difference could be demonstrated in the frequency of scoring categories between the female light weight and heavy weight groups. However, the light weight male competitors scored less

Ippon and more Yuko and Koka than expected. Conversely the heavy weight male competitors scored more Ippon and less Yuko and Koka than expected. This statistical result confirms the observation of section 3.4. Since groundwork techniques nearly always result in Ippon it seems likely that these statistical differences are a result of the judges' interpretation of a throw from standing techniques.

Perhaps the agility of the light weight male competitor reduces the probability of producing Ippon or possibly the heavy weight competitor appears to be thrown with more force and speed than his lighter competitor. It is likely that this statistical feature is multifactorial, but it is surprising that it is absent from the female competitors.

Because groundwork techniques nearly always produce Ippon it seemed logical to compare the frequency of Ippon scored from standing and groundwork techniques for light weight and heavy weight competitors.

The female competitors showed no difference in scoring frequency of Ippon from standing and groundwork techniques between light weight and heavy weight categories. In contrast, the light weight male competitors scored more Ippon with standing techniques and less Ippon with groundwork techniques than expected. The converse applied to the heavy weight male category. This observation suggests that the heavy weight male competitors were more likely to finish the contest with an Ippon once groundwork was started. Perhaps light weight male competitors are less likely to lose balance and favour standing techniques as a scoring mechanism. The result does suggest that efficient groundwork is an important part of the armoury of the heavy weight male competitor.

The most successful standing techniques employed by female competitors were UM, OUG and SN. Again SN and UM appeared as two of the most successful standing techniques used by male competitors. These observations were re-emphasised when the standing techniques that scored Ippon only were analysed. The standing techniques of UM and SN were the two most successful techniques for both female and male competitors. These standing techniques have been identified as favourite techniques of Judo competitors by Japanese research workers in Judo[13][16][17][18]. It is likely that most competitors revert to their most favourite technique when the contest is considered to be important (for example, World Championships) and the skill levels of the contestants are similar.

In addition, western and modern Judo competitors tend to have longer arms and legs than the eastern traditional contestants[20]. Because of these anthropometric differences they find UM an easier and more useful standing technique.

In groundwork techniques Osae-waza (holding techniques) accounted for between 60% and 70% winning scores (almost always Ippon). Some success was found with Juji-Gatame, which is an arm-lock technique, in both male and female competitors. In general when Judo competitors transfer from a standing position to a groundwork technique, with an attempted throw, they are more likely to move into Osae-waza than the other two groundwork techniques. It may be for this reason that the majority of Ippon through groundwork technique are scored by Osae-waza.

3.11 SUMMARY

General Information

* Number of contests	: 283 for women, 348 for men.
* Average time of contests	: 3 minutes 2 seconds for women 3 minutes 19 seconds for men
* Percentage of contests full duration	: Decreased with increase in weight category for male competitors, but not female competitors.
* Characterisation of scores in each contest	: Over 50% of contests concluded by Ippon in all weight categories, except -65kg, for male competitors. In this weight category 34% of contests concluded by Ippon, but almost 30% of contests decided by Yuko. Only -52kg and Open category in female competitions had such a high percentage of contests decided by Ippon.

Scoring Patterns

* Partitioning into medallists and non-medallists	: No difference in scoring patterns between female and male medallists. No difference in scoring patterns between female and male non-medallists.
* Partitioning by gender	: No difference in scoring patterns between female medallists and non-medallists. No difference in scoring patterns between male medallists and non-medallists.
* Partitioning by techniques	: Significant difference in scoring patterns between standing and groundwork techniques for both male and female competitors. Groundwork techniques almost always resulted in Ippon, with all other scores arising from standing

techniques.

* Partitioning by weight category : All scores. No difference in scoring pattterns between female light weight and heavy weight competitors.
Significant difference in scoring patterns for male competitors, Light weight competitors scored less Ippon and more Yuko and Koka than expected. Heavy weight competitions scored more Ippon and less Yuko and Koka than expected.
Ippon only. No difference in scoring of Ippon from standing and groundwork techniques between light weight and heavy weight female competitors.
Significant difference in scoring Ippon from standing and groundwork techniques between light weight and heavy weight male competitors. Light weight competitors scored more Ippon by standing techniques and less Ippon by groundwork techniques than expected, whereas heavy weight competitors scored less Ippon by standing techniques and more Ippon by groundwork techniques than expected.

Evaluation of scoring techniques

* Standing techniques : All scores. UM, OUG, SN the three most successful techniques for female competitors. SN, UM, OUG the three most successful techniques for male competitors.
Ippon only. UM, SN the two most successful techniques for both female and male competitors.

* Groundwork techniques : Between 60% to 70% of the Ippon that were scored were achieved by Osae-waza (holding technique).

CHAPTER 4

A STATISTICAL ANALYSIS OF THE RESULTS OF THE 1992 OLYMPIC GAMES JUDO EVENT HELD IN BARCELONA

4.1 INTRODUCTION

In 1992 the top performers in Judo gathered together again, this time in Barcelona, Spain to contest the Olympic Games Judo event. Both male and female competitors in different weight categories took part. Although women's Judo had been included in the World Championship before, it was the first time that women's Judo had appeared at the Olympics. The Japanese Judo Federation obtained a comprehensive set of results from these championships. This chapter is an analysis of these results.

First the statistical techniques used in the analysis are discussed and then the data are partitioned into different subsets in an attempt to identify any underlying pattern that might exist in a similar fashion to Chapter 3. The distribution of contest time for the entire competition for each weight category and for both males and females is studied in section 4.3. The length of the Olympic Judo contest is designated as 5 minutes for men and 4 minutes for women but a winning fall often finishes the contest before these time limits are reached.

The next section displays the scores that occurred in each contest for the entire competition. As for the World Championships, scores are separated into 7 different categories and the competitors are grouped by gender and weight. Of particular interest was the number of Ippon scored in each weight category and for the different genders.

In section 4.5, the competitors are grouped into medallists and non-medallists and the scores obtained by the males and females in these two different groups are assessed.

In the next section, the competitors are separated into female and male competitors and the scores obtained by the medallists and non-medallists in these two groups are compared.

In section 4.7, the competitors are separated into female medallists and non-medallists and male medallists and non-medallists and the scores obtained from standing and groundwork techniques are evaluated.

Section 4.8 considers the scores obtained in the different weight categories for both males and females.

Finally, all the scoring techniques for both standing and groundwork techniques are evaluated and ranked to find the most successful techniques used by the world's best Judo competitiors at the Olympic Games. In particular, those techniques which were most successful in producing Ippon are identified in a similar way to the World Championships. The overall results of the chapter in the context of World Judo, and key points arising from the analysis are identified.

4.2 STATISTICAL TECHNIQUES

This chapter has been constructed to investigate the statistical evidence arising from the results of the Judo events held at the Olympic Games in 1992. The same separation into different categories both of gender (male and female) and weight, as the 1991 World Championships was used for the Olympic Games. The competitors were grouped into the successful medallists within these different categories and the unsuccessful non-medallists. The techniques used during Judo competition were also separated into standing and groundwork.

The four major scores (in order of importance) that were obtained during competition were Ippon, Waza-ari, Yuko and Koka. In some cases the bout was decided on penalties or the judges' decisions. As in Chapter 3 the majority of the results were analysed by two-way classification into a contingency table. Again this type of distribution-free statistics makes no assumption about the distribution of scores with regard to the Gaussian nature or the homogeneity of variance between the two groups being compared. The Chi-square (X^2) technique provides a statistical test of the significance between the observed and expected data.

To assist in the visualisation of the data, the results are also expressed as bar charts, pie-charts and dot diagrams. Throughout this chapter statistical significance will always be assigned at the 5% level, unless otherwise stated.

ABBREVIATIONS USED IN THE TEXT FOR TECHNIQUES

The following abbreviations for Judo technique have been used.

Standingwork technique

DAB : Deashi-Barai (forward foot sweep)
HRG : Harai-Goshi (hip sweep)
HRM : Harai-Makikomi (hip sweep wrap-around)
KAD : Kata-Ashi-Dori (one leg catching)
KGU : Kata-Guruna (shoulder whirl)
KTA : Kuchiki-Taoshi (dead-tree drop)
KSG : Kosoto-Gari (small outside clip)
KSK : Kosoto-Gake (small outside hook)
KUG : Kouchi-Gari (small inside clip)
KUM : Kouchi-Makikomi (small inside clip wrap-around)
MGA : Morote-Gari (Two-arm clip)
OAB : Okuri-Ashi-Barai (assist foot sweep)
OGA : Osoto-Gaeshi (big outside clip counter)
OGO : Ogoshi (hip roll)
OSG : Osoto-Gari (big outside clip)
OUC : Ouchi-Gaeshi (big inside clip counter)
OUG : Ouchi-Gari (big inside clip)
SKG : Sode-Tsurikomi-Goshi (hip throw with a rising sleeve pull)
SN : Seoi-Nage (back-carry throw)
SOT : Sumi-Otoshi (corner drop)
STA : Sasae-Tsurikomi-Ashi (lifting-pull throw with supporting foot)
SUG : Sumi-Gaeshi (corner reversal)
SUK : Sukui-Nage (scoop throw)
TKG : Tsurikomi-Goshi (lift-pull hip throw)
TN : Tomoe-Nage (round throw)
TNO : Tani-Otoshi (valley drop)
TO : Tai-Otoshi (body drop)
UM : Uchi-Mata (thigh throw)
UNA : Uranage (inside-out throw)
UWA : Uki-Waza (floating technique)

Groundwork technique

HKG : Hon-Kesa-Gatame (scarf hold)
JG : Juji-Gatame (cross arm bar)
KKS : Kuzure-Kami-Shiho-Gatame (modified upper four-corner hold)
KSH : Kami-Shiho-Gatame (upper four-corner hold)
KYS : Kuzure-Yoko-Shiho-Gatame (modified side four-corner hold)
OEJ : Okuri-Eri-Jime (sliding lapel choke)
TSG : Tate-Shiho-Gatame (vertical four-corner hold)
UKG : Ushiro-Kesa-Gatame (back scarf hold)
YSG : Yoko-Shiho-Gatame (side four-corner hold)

4.3 DISTRIBUTION OF CONTEST TIMES

The reader is reminded that the full time duration of a Judo contest is 5 minutes for males and 4 minutes for females in all weight categories. Not all contests run for their full duration, but if an Ippon is scored the competition ends. Table 4.1 gives the number of contests in each weight category for female competitors at the Olympic Games, the number of the contests that went the full duration and the average time of competition in that weight category.

Table 4.1 The number of contests for female competitors

Women	Number of Contests	Number of Contests Full duration	Average Time of Competition	Percentage of Contests full duration
-48kg	35	25	3:24	71.4%
-52kg	35	23	3:18	65.7%
-56kg	32	21	3:08	65.6%
-61kg	39	21	2:54	53.8%
-66kg	31	19	3:05	61.3%
-72kg	32	15	2:39	46.9%
+72kg	31	12	2:51	38.7%

For the female competitors the percentage of contests that lasted the full 4 minutes was much higher in the lighter weight categories compared with the heavier weight categories. In fact, the highest percentage of contests full duration was the -48kg category, and the lowest percentage of contests full duration was the +72kg category. This trend was not observed in the male competitors. In terms of the number of contests, the -61kg had the highest number (39) and the +72kg and -66kg categories had the lowest (31). Therefore there was a difference of only 8 contests throughout the weight categories in the female competition.

The distribution of contest times in each weight category are displayed in Figure 4.1 for female competitors.

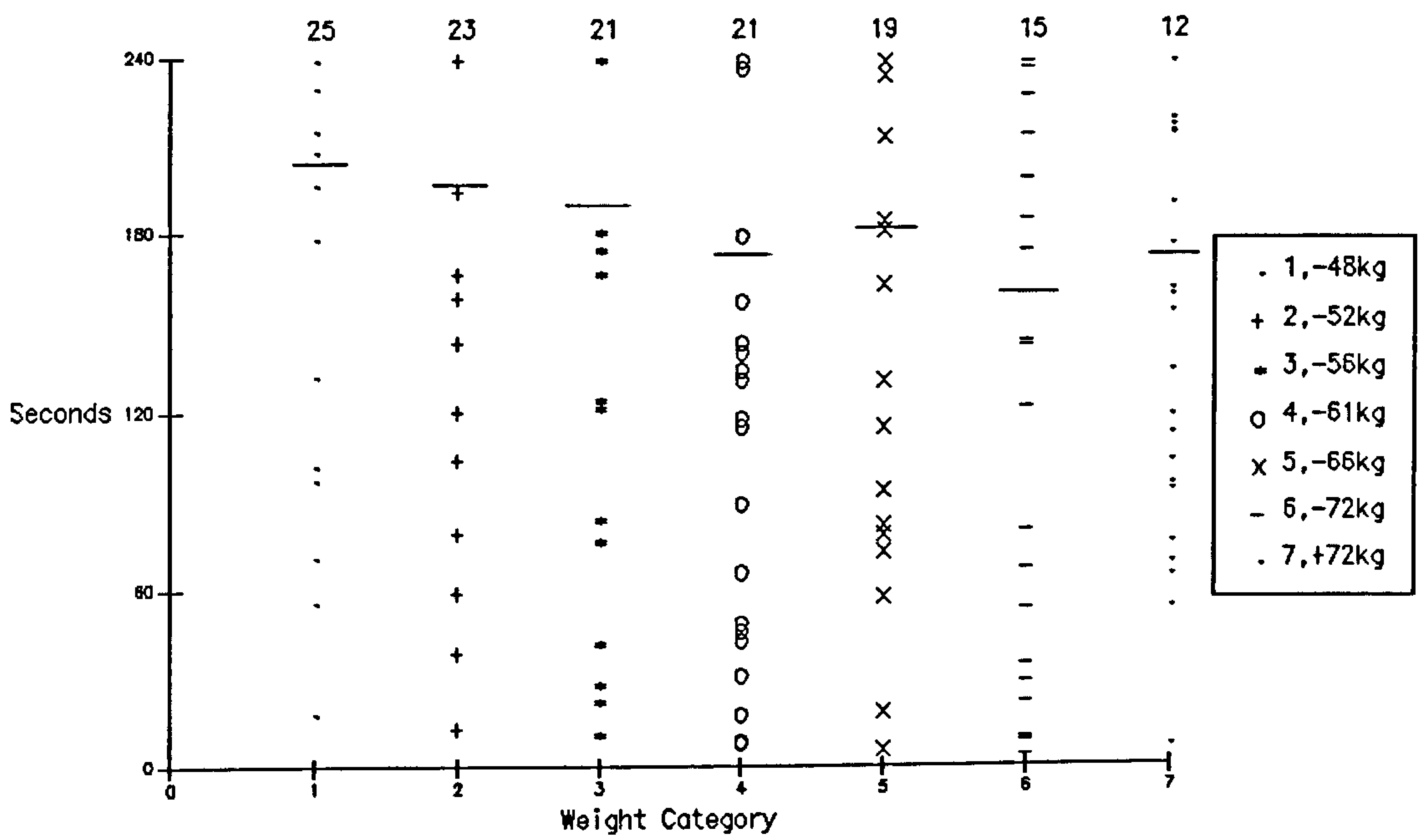


Figure 4.1 Illustration of contest time for all female competitors. The number of contests in which the competitors fought for the full 4 minutes is shown at the head of each column.

A similar table 4.2 has been constructed for male competitors.

Table 4.2 The number of contests for male competitors

Men	Number of Contests	Number of Contests Full duration	Average Time of Competition	Percentage of Contests full duration
-60kg	56	23	3:11	41.1%
-65kg	60	26	3:20	43.3%
-71kg	56	19	2:45	33.9%
-78kg	54	16	2:55	29.6%
-86kg	44	24	3:27	54.5%
-95kg	46	22	3:20	47.8%
+95kg	40	16	3:02	40.0%

The trend which was observed in the female competitors did not appear in the male competitors. However, the middle weight categories (-71kg and -78kg) seemed to show a very low percentage of contests that lasted the full 5 minutes. Both the lighter weight categories (-60kg and -65kg) and heavier weight categories (-95kg and +95kg) had more than 40% of the contests which lasted the full time duration. One must note however that, the -86kg category showed an abnormally high percentage.
With respect to the number of contests, the -65kg category had the highest number of contests (60), and the +95kg category had the lowest number of contests (40). This difference was 20 contests. For male competitors, the number of contests was much higher in the light weight categories compared with the heavy weight categories.
Figure 4.2 displays the distribution of contest times for the male competitors.

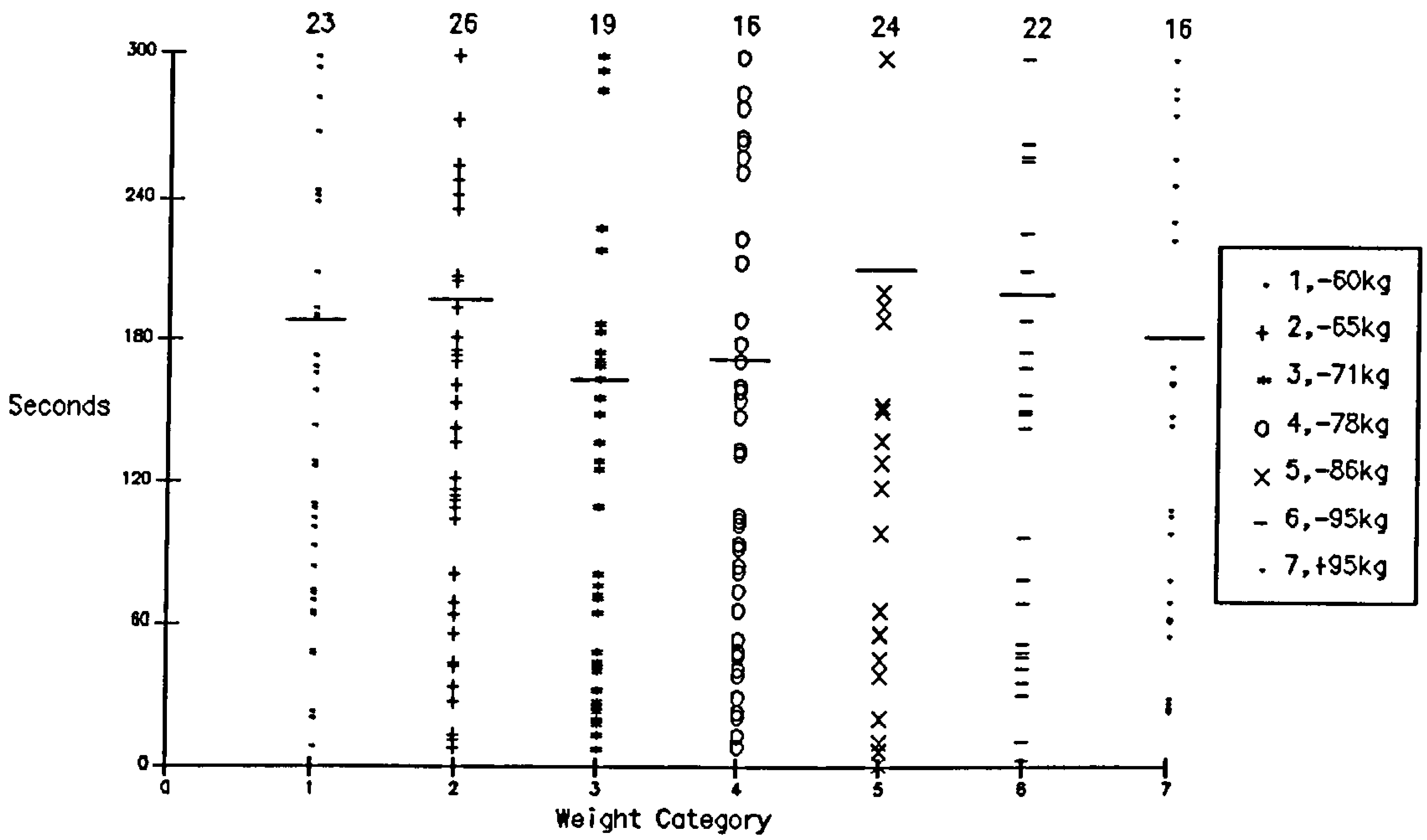


Figure 4.2 Illustration of contest time for all male competitors. The number of contests in which the competitors fought for the full 5 minutes is shown at the head of each column.

4.4 CHARACTERISATION OF THE SCORES IN EACH CONTEST

In this section all of the data were partitioned between the male and female competitors. The scores that occurred in each contest were separated into seven different categories as in Chapter 3

1 Ippon
2 Waza-ari
3 Yuko
4 Koka
5 Penalty
6 Judges' Decision
7 any other score

Again for ease of visualising the data, the male and female contestants were subdivided further into a group of light weight categories (male: -60kg, -65kg, -71kg, -78kg ; female: -48kg, -52kg, -56kg, -61kg) and a group of heavy weight categories (male: -86kg, -95kg, and +95kg ; female: -66kg, -72kg and +72kg). Unlike the World Championships, there is no Open event at the Olympic Games. In total, 591 contests were analysed.

Figure 4.3 shows the distribution of scores for the female light weight categories at the Olympic Games. The numbers on the horizontal axis refer to the score categories defined above.

In all female light weight categories, except for the -61kg category, the percentage of Ippon scored was less than 35%. Especially, low was the -48kg category where the percentage of Ippon scored was less than 30%. It is of some significance that no Waza-ari was scored in the -52kg category, yet the -48kg and -61kg categories recorded almost 15% of Waza-ari. This feature may be linked to the number of Yuko scored, because the -52kg category which was completely devoid of Waza-ari, had about 30% of the contests decided by Yuko. All the other categories had around 20% of their contests decided by Yuko. The -52kg and -56kg categories had more than 10% of their contests decided by Koka. In contrast, the -48kg and -52kg had less than 5% of the contests decided by Koka. A significant percentage of the contests required a judges' decision. Over 10% of contests in all the light weight categories were decided in this way. In particular in the -52kg category over 20% of contests were determined by a judges' decision. Only the -48kg weight category had about 15% of the contests decided by other scores. This classification was entirely absent in the -52kg and -61kg categories.

In the female heavy weight competition, only the -66kg category had less than 40% of contests decided by Ippon. The -72kg and +72kg categories had over 50% of contests decided by Ippon. In particular, the +72kg category had more than 60% of contests concluded by Ippon. In contrast, the scoring of Waza-ari was the highest in the -66kg category (about 15%). It was about three times higher than the other two categories. The -72kg weight category scored most Yuko (15%), while the lowest percentage of contests determined by a single Yuko was in the +72kg weight category.

Interestingly, for the scoring of Koka, the trend was very similar to that of Waza-ari. The -66kg category, which had the lowest Ippon percentage had almost three times more contests determined by Koka than the other two categories. Results of contests decided by penalty had a similar trend to the Waza-ari and Koka scoring. In the -66kg category almost 10% of contests were decided by penalty, but the -72kg and +72kg had less than 5% of contests decided by penalty. Only 5% of contests required a judges' decision in the -66kg category, whereas over 10% of contests were decided by the judges' in the other two weight categories.

In all male light weight contests, more than 55% of them ended in Ippon. Indeed, in the -78kg category almost 70% of the contests were concluded by Ippon. With such a high percentage of Ippon scored it is of some significance that less than 10% of the contests were decided by Waza-ari, in all but the -71kg weight category. The -65kg category, which had the lowest percentage of Ippon scored, showed the highest percentage in the number of Yuko scored (just less than 20%).

In comparison the other light weight categories showed a percentage of Yuko scored which was less than 10%. In the scoring of Koka, the -60kg category had a slightly higher average than the other categories, although the value was still less than 10% of the contests. This trend was also observed in the contests which were decided by penalties. All the light weight categories had less than 10% of the contests decided by penalties. Over 10% of the contests were concluded by a referees decision, in both the -65kg and the -71kg categories. In the case of the -60kg and the -78kg categories, less than 10% of contests required arbitration by the referees.

In male heavy weight competitions, approximately 45% of the contests were concluded by Ippon in the -86kg category, whereas more than 50% of the contests finished with Ippon in the -95kg and +95kg categories. Even with such a high rate of Ippon scored, the +95kg category had about 15% of the contests decided by Waza-ari, while in the -86kg and -95kg this was less than 10%. Interestingly, the number of Yuko contests recorded showed an exactly opposite trend to that observed with Waza-ari. Only the +95kg category had less than 10% of the contests decided by Yuko. Since the +95kg competitors often have a mass of more than 110kg, it is possible that these bigger bodies appeared to be more dynamic in the referees and judges eyes. There were no Koka scored in the -95kg category, while in the +95kg category only 5% of the contests had Koka scores recorded. Over 10% of contests were decided by penalties in the -86kg and the -95kg weight categories. Even the +95kg category had more than 5% of the bouts decided on penalties. No contests required a judges' decision in the +95kg weight category. This means that all contests in this category had a score recorded. In contrast, the -86kg weight category had more than 10% of the contests which were decided by the judges. If the heavy weight female and male competitions are compared, a similar trend emerged for both genders. Ippon is a more likely conclusion to the contest the heavier the weight category. This observation may be reflected in the different techniques used by these heavy weight competitors. This supposition will be considered in the following sections.

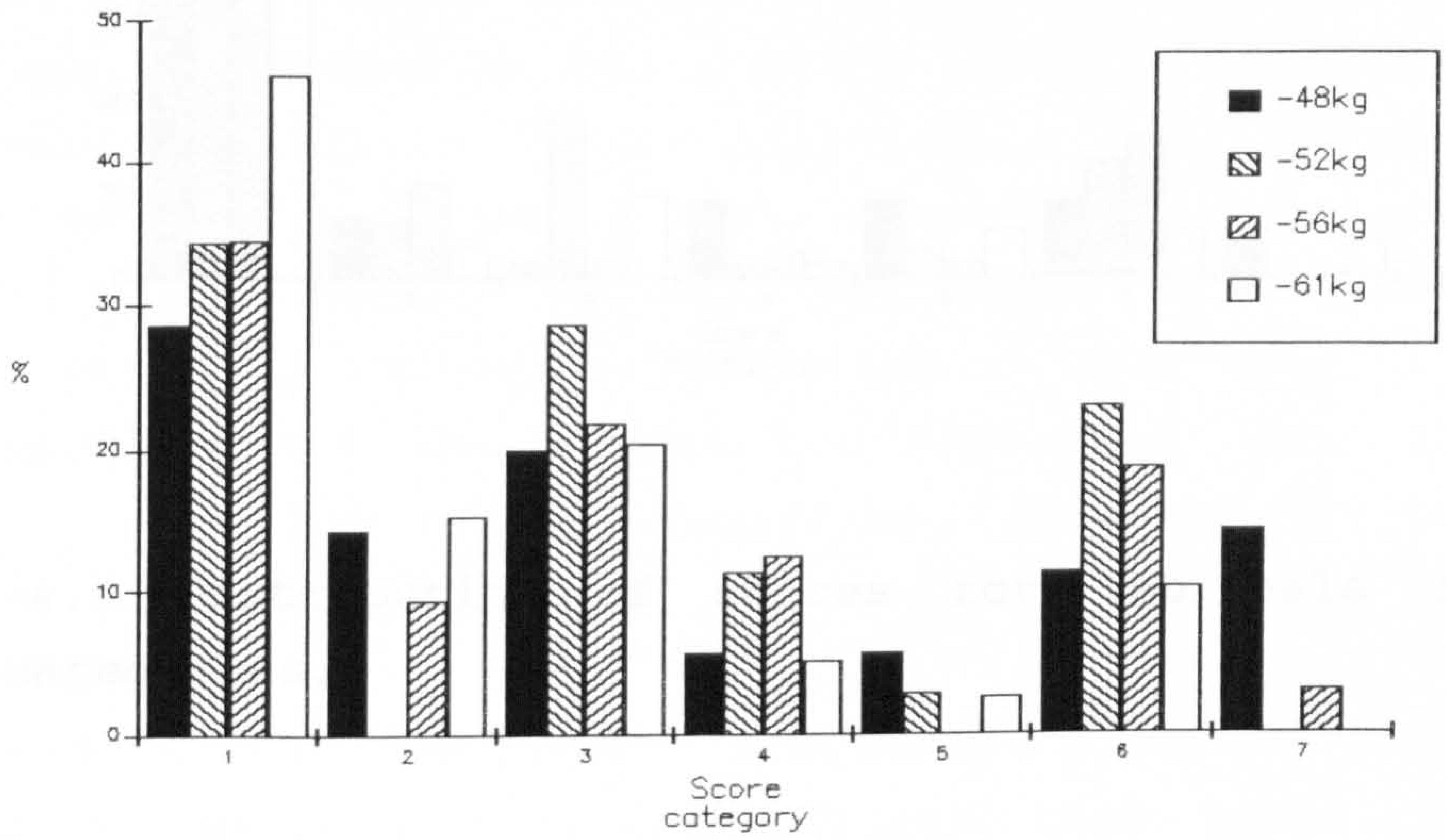


Figure 4.3 Distribution of scores for the female light weight categories.

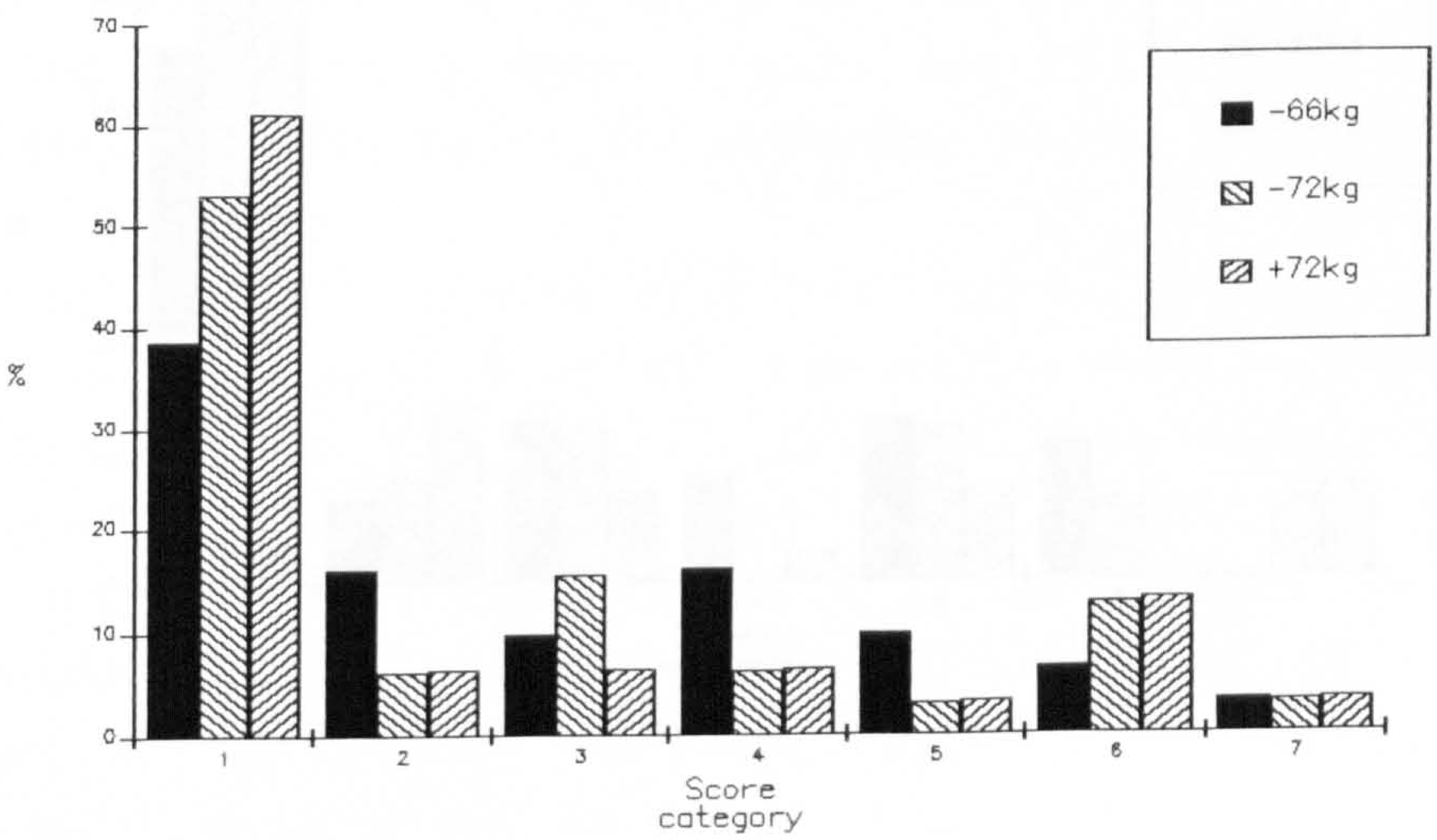


Figure 4.4 Distribution of scores for the female heavy weight categories.

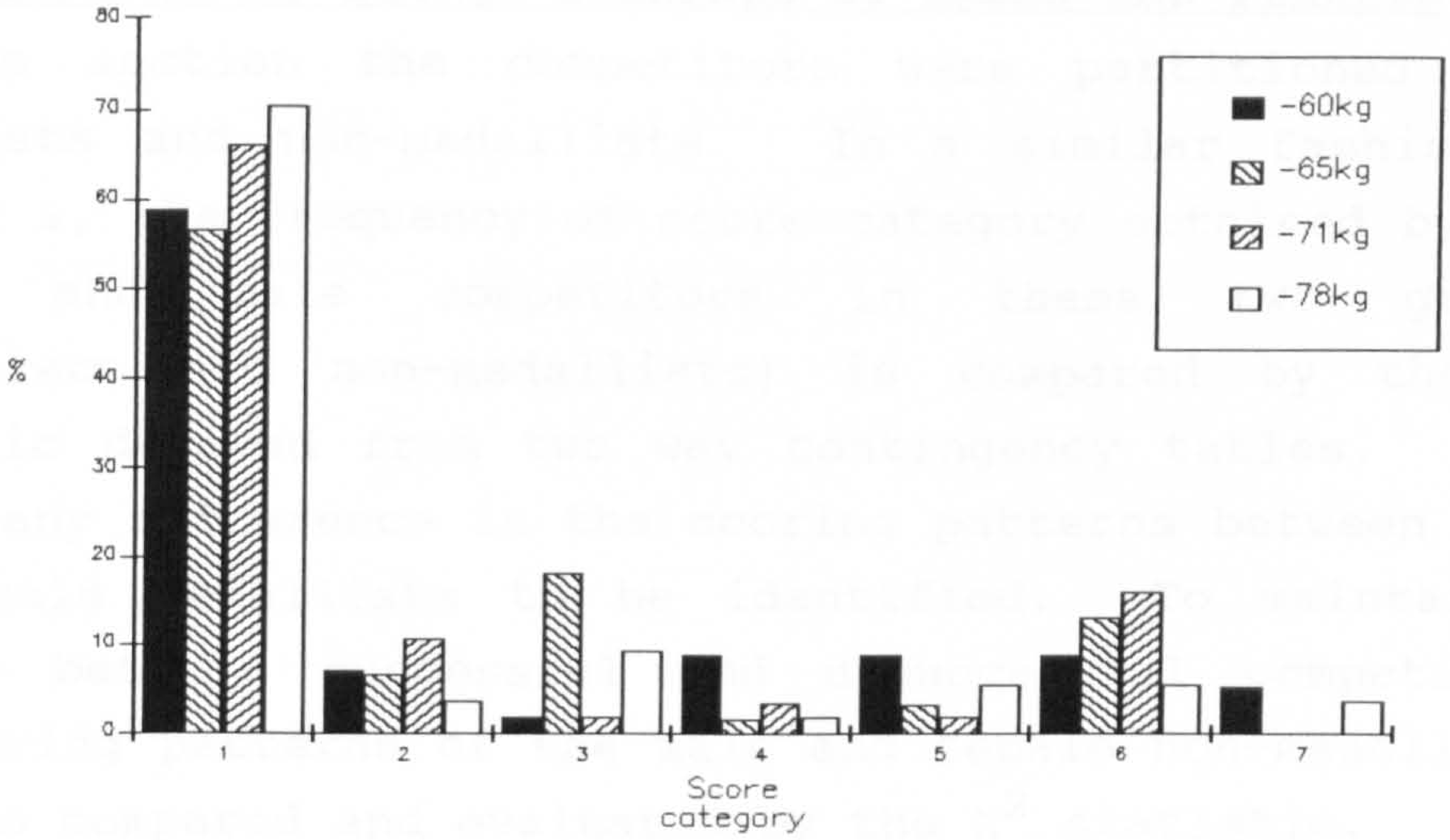


Figure 4.5 Distribution of scores for the male light weight categories.

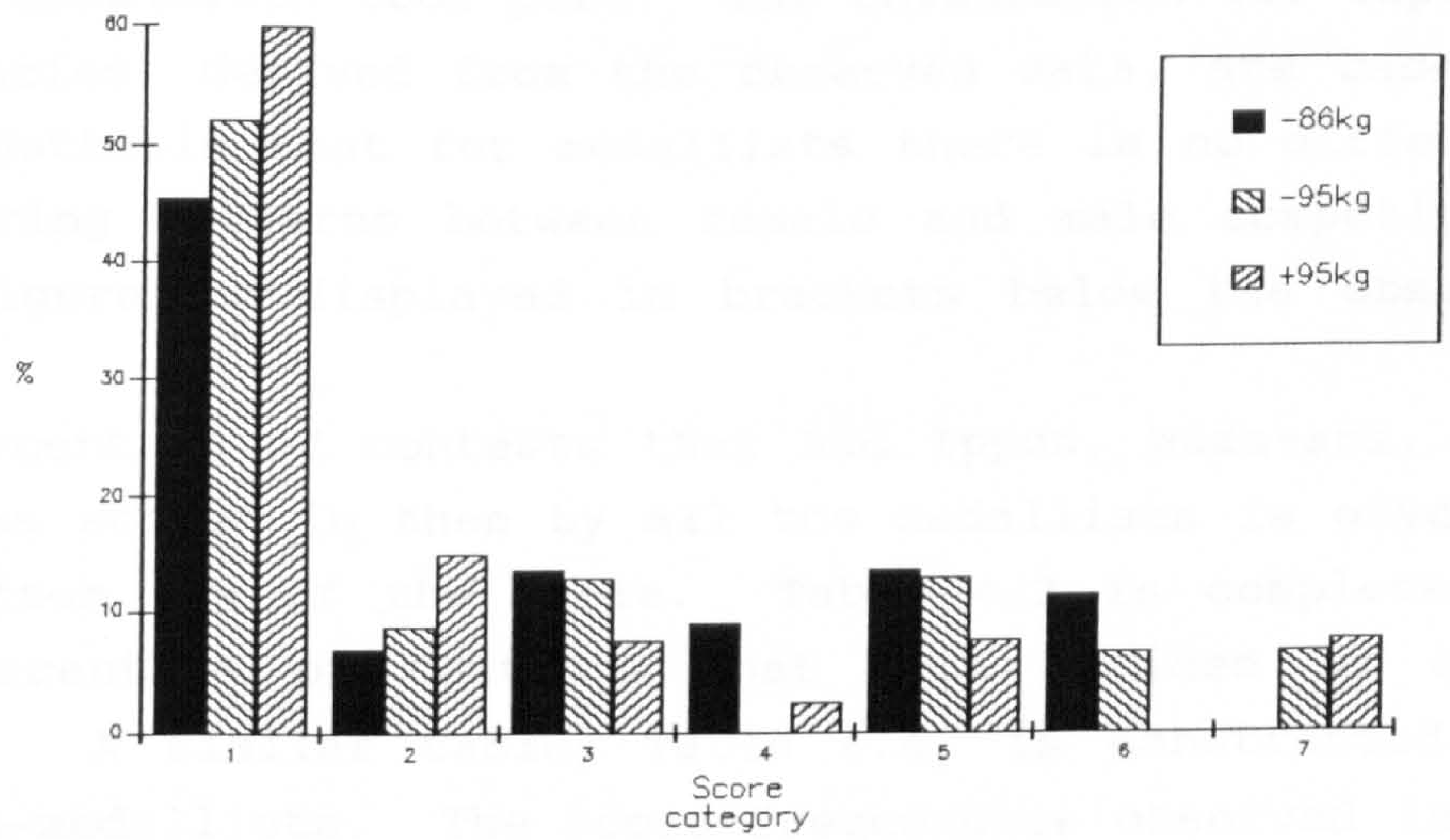


Figure 4.6 Distribution of scores for the male heavy weight categories.

4.5 COMPARISON OF SCORES OBTAINED BY MALES AND FEMALES

In this section the competitors were partitioned into medallists and non-medallists. In a similar fashion to Chapter 3, the frequency of score category obtained by the female and male competitors in these two groups (medallists and non-medallists) is compared by the X^2 statistic derived from two way contingency tables. This allows any difference in the scoring patterns between male and female medallists to be identified. To maintain a balance between successful and unsuccessful competitors the scoring patterns of the male and female non-medallists are also compared and evaluated by the X^2 statistic.

As in section 4.4 the scores are separated into Ippon, Waza-ari, Yuko and Koka. Penalties, decision by judges and other scores are grouped into a single category called other scores.

Table 4.3 shows the score frequency observed in 246 contests in which all the medallists took part. This figure is subdivided into 132 contests in which the male medallists participated and 114 contests in which the female medallists took part. The calculation for expected frequencies, derived from the observed data, are based on the hypothesis that for medallists there is no difference in scoring patterns between female and male competitors. This figure is displayed in brackets below the observed score.

The percentage of contests that had Ippon, Waza-ari, Yuko and Koka scored in them by all the medallists is given in the bottom row of the table. Table 4.3 is completed by the percentage of contests that were decided by other scores. A similar table, Table 4.4, is constructed for the non-medallists. The score frequencies observed in 344 contests in which the non-medallists participated are documented. This table is sub-divided into 120 contests involving female non-medallists and 224 contests involving male non-medallists.

Table 4.3 Scoring patterns of female and male medallists

All medallists : 246 contests
Females 114 contests ; Males 132 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Female	57 (59)	8 (10)	15 (15)	7 (7)	27 (23)	114 (114)
Male	71 (69)	14 (12)	17 (17)	8 (8)	22 (26)	132 (132)
Totals	128	22	32	15	49	246
Percent of Total Contest	52	9	13	6	20	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female and male medallists.

Table 4.3 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.3 is 2.18.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female and male medallists.

Table 4.4 Scoring patterns of female and male non-medallists

All non-medallists : 344 contests
Females 120 contests ; Males 224 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Female	41 (63)	15 (10)	27 (15)	14 (7)	23 (25)	120 (120)
Male	139 (117)	15 (20)	16 (28)	6 (13)	48 (46)	224 (224)
Totals	180	30	43	20	71	344
Percent of Total Contest	52	9	12	6	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female and male non-medallists.

Table 4.4 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 9.49, and the critical value of $X^2_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{n} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.4 is 41.33.

This suggests that the null hypothesis should be rejected and the observed frequency of scoring category is different between female and male non-medallists competitors. It would appear that the female non-medallists competitors scored less Ippon and more Yuko and Koka than expected from the observed data whereas the male non-medallists competitors scored more Ippon and less Yuko and Koka than might be expected.

4.6 COMPARISON OF SCORES OBTAINED BY MEDALLISTS AND NON-MEDALLISTS WHEN PARTITIONED BY GENDER

In this section the competitors are partitioned by gender. As in Chapter 3 this is a natural progression from the sub-grouping used in the previous section. Again the frequency of score category for the two groups (medallists and non-medallists) is compared to identify any difference between the successful and the unsuccessful competitors. The scoring categories used in the previous section are retained.

Table 4.5 shows the score frequencies observed in 234 contests between female competitors. This total is subdivided into 114 contests in which the medallists participated and 120 contests which involved the non-medallist.

A similar table, Table 4.6, is constructed for the male competitors. There were 356 contests between male competitors at the Olympic Games. This total can be subdivided into 132 contests involving medallists and 224 contests involving non-medallists. The formats of tables 4.5 and 4.6 are the same as the tables constructed in the previous section.

Table 4.5 Scoring patterns of medallists and non-medallists female

All Female competitors : 234 contests
Medallists 114 contests ; Non-Medallists 120 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Medallists	57 (48)	8 (11)	15 (20)	7 (10)	27 (24)	114 (114)
Non-Medallists	41 (50)	15 (12)	27 (22)	14 (11)	23 (26)	120 (120)
Totals	98	23	42	21	50	234
Percent of Total Contest	42	10	18	9	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by medallists and non-medallists in the female competitors.

Table 4.5 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.

The critical value of $X^2_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.5 is 9.72.

This suggests that the null hypothesis should be rejected and the observed frequency of scoring category is different between medallists and non-medallists in the female competitors. It would appear that the female medallists competitors scored more Ippon and less Waza-ari, Yuko and Koka than expected from the observed data whereas the female non-medallists competitors scored less Ippon and more Waza-ari, Yuko and Koka than might be expected.

Table 4.6 Scoring patterns of medallists and non-medallists male

All Male competitors : 356 contests
Medallists 132 contests ; Non-Medallists 224 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Medallists	71 (78)	14 (11)	17 (12)	8 (5)	22 (26)	132 (132)
Non-Medallists	139 (132)	15 (18)	16 (21)	6 (9)	48 (44)	224 (224)
Totals	210	29	33	14	70	356
Percent of Total Contest	59	8	9	4	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by medallists and non-medallists in the male competitors.

Table 4.6 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.6 is 9.37.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for medallists and non-medallists in the male competitors.

4.7 COMPARISON OF SCORES OBTAINED IN STANDING AND GROUNDWORK TECHNIQUES BY FEMALE MEDALLISTS, FEMALE NON-MEDALLISTS, MALE MEDALLISTS AND MALE NON-MEDALLISTS

It was explained in Chapter 3 that Judo techniques can be separated into two quite distinct categories. These are standing techniques and groundwork techniques. This section explores the scoring patterns observed in the 1992 Olympic Games Judo event when the techniques were separated in this way. Initially a X^2 statistic based on two-way contingency tables was sought. However, it became apparent in the analysis, just as in Chapter 3, that the scoring patterns using the two techniques were quite distinct. It was not appropriate to use the X^2 statistic because many of the cells associated with groundwork techniques contained zero frequency. However the tables themselves give a descriptive synopsis of the scoring patterns obtained with the two different technique categories. Statistical analysis is not required to confirm that there is a significant difference between the frequency of scoring categories produced by standing and groundwork technique in all four cases considered.

Table 4.7 displays the scoring patterns for the standing and groundwork techniques of female medallists. Table 4.8 provides similar information for female non-medallists. Two tables, Table 4.9 and 4.10, provide a similar synopsis for the male competitors. It was decided that other scores should not be included in either standing or groundwork techniques. Hence the number of contests considered in this section is slightly less than the totals analysed in the earlier sections.

Table 4.7 Scoring patterns for standing and groundwork techniques of female medallists

All female medallists : 87 contests
Standing techniques : 66 contests
Groundwork techniques : 21 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	36	8	15	7	66
Groundwork Techniques	21	0	0	0	21
Totals	57	8	15	7	87

Table 4.8 Scoring patterns for standing and groundwork techniques of female non-medallists

All female Non-medallists : 97 contests
Standing techniques : 72 contests
Groundwork techniques : 25 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	16	15	27	14	72
Groundwork Techniques	25	0	0	0	25
Totals	41	15	27	14	97

Table 4.9 Scoring patterns for standing and groundwork techniques of male medallists

All male medallists : 110 contests
Standing techniques : 95 contests
Groundwork techniques : 15 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	57	14	17	7	95
Groundwork Techniques	14	0	0	1	15
Totals	71	14	17	8	110

Table 4.10 Scoring patterns for standing and groundwork techniques of male non-medallists

All male non-medallists : 176 contests
Standing techniques : 139 contests
Groundwork techniques : 37 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
Standing Techniques	102	15	16	6	139
Groundwork Techniques	37	0	0	0	37
Totals	139	15	16	6	176

4.8 COMPARISON OF SCORES OBTAINED IN THE DIFFERENT WEIGHT CATEGORIES FOR BOTH FEMALE AND MALE COMPETITORS

To provide fair and standardised competition, Judo has evolved into 7 different weight categories for both female and male contestants. In this section the grouping used in section 4.4 is employed to study the frequency of scoring in light weight and heavy weight categories for female and male competitors. The light weight female category consists of -48kg, -52kg, -56kg and -61kg, while the heavy weight female category was taken as -66kg, -72kg and +72kg. For male competitors the light weight category was chosen as -60kg, -65kg, -71kg and -78kg, while -86kg, -95kg and +95kg categories were designated as heavy weight.

Table 4.11 shows the scoring frequencies observed in 234 contests between all the female competitors. This table is subdivided into 141 contests between female light weight competitors and 93 contests in which the heavy weight competitors participated.

A similar table, Table 4.12, is constructed for male competitors. There were 356 contests in total, of which 226 were light weight bouts and 130 were heavy weight contests. The formats of tables 4.11 and 4.12 are the same as those used in earlier sections.

Table 4.11 Scoring patterns for female light and heavy weight contestants

All Female competitors : 234 contests
Light weight competitors : 141 contests
Heavy weight competitors : 93 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Light Weight Competitors	51 (59)	14 (14)	32 (25)	12 (13)	32 (30)	141 (141)
Heavy Weight Competitors	47 (39)	9 (9)	10 (17)	9 (8)	18 (20)	93 (93)
Totals	98	23	42	21	50	234
Percent of Total Contest	42	10	18	9	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by light weight contestants and heavy weight contestants in the female competitors.

Table 4.11 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.11 is 8.1.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for light weight and heavy weight female competitors.

Table 4.12 Scoring patterns for male light and heavy weight contestants

All Male competitors : 356 contests
Light weight competitors : 226 contests
Heavy weight competitors : 130 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
Light Weight Competitors	142 (133)	16 (18)	18 (21)	9 (9)	41 (44)	226 (225)
Heavy Weight Competitors	68 (77)	13 (11)	15 (12)	5 (5)	29 (26)	130 (131)
Totals	210	29	33	14	70	356
Percent of Total Contest	59	8	9	4	20	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by light weight contestants and heavy weight contestants in the male competitors.

Table 4.12 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.12 is 3.97.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for light weight and heavy weight male competitors.

4.8.1 IPPON SCORED FROM STANDING AND GROUNDWORK TECHNIQUES

The difference in the observed scoring frequency between light weight and heavy weight male competitors suggests that the frequency with which Ippon is scored from standing and groundwork techniques should be investigated. Table 4.13 gives the frequency of Ippon scored from standing and groundwork techniques by the female competitors partitioned into light weight and heavy weight categories. This results in a 2 x 2 contingency table and so Yates' correction for continuity is employed.
Table 4.14 provides an analysis of the scoring frequency of Ippon for male competitors when they are partitioned by weight. Again the Yates' correction is used for this 2 x 2 contingency table.

Table 4.13 Scoring Ippon patterns for female light and heavy weight contestants

Female competitors : Ippon scored in 99 contests
Light weight competitors : 51 contests
Heavy weight competitors : 48 contests

	Standing techniques	Groundwork techniques	Totals
Light Weight Competitors	27 (28)	24 (23)	51 (51)
Heavy Weight Competitors	27 (26)	21 (22)	48 (48)
Totals	54	45	99
Percent of Total Contest	55	45	100

Null Hypothesis : There is no difference between the observed frequency of scoring Ippon from standing and groundwork techniques between light weight and heavy weight in the female competitors.

Table 4.13 is a two-way contingency table with two rows and two columns. Therefore there is 1 x 1 = 1 degree of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 3.84. Yates' correction for continuity is used in these circumstances. Hence, based on the formula

$$X^2 = \sum_{i=1}^{4} [(O_i - E_i - 0.5)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.13 is 0.2.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring Ippon from standing and groundwork techniques between light weight and heavy weight female competitors.

Table 4.14 Scoring Ippon patterns for male light and heavy weight contestants

Male competitors : Ippon scored in 195 contests
Light weight competitors : 97 contests
Heavy weight competitors : 98 contests

	Standing techniques	Groundwork techniques	Totals
Light Weight Competitors	109 (108)	33 (34)	142 (142)
Heavy Weight Competitors	51 (52)	17 (16)	68 (68)
Totals	160	50	210
Percent of Total Contest	76	24	100

Null Hypothesis : There is no difference between the observed frequency of scoring Ippon from standing and groundwork techniques between light weight and heavy weight in the male competitors.

Table 4.14 is a two-way contingency table with two rows and two columns. Therefore there is 1 x 1 = 1 degree of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 3.84. Yates' correction for continuity is used in these circumstances. Hence, based on the formula

$$X^2 = \sum_{i=1}^{4} [(O_i - E_i - 0.5)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

The X^2 statistic for Table 4.14 is 0.13.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring Ippon from standing and groundwork techniques between light weight and heavy weight male competitors.

4.9 EVALUATION OF SCORING TECHNIQUES

This section considers the most successful scoring techniques observed at the Olympic Games Judo event. First, just as in Chapter 3, those standing techniques that produced any form of score (Ippon, Waza-ari, Yuko and Koka) are assessed for both female and male competitors. Then those techniques that produced Ippon alone are evaluated. Finally groundwork techniques are divided into these categories :

1, OSAE-WAZA (HOLDING TECHNIQUES)

2, KANSETSU-WAZA (ARM-LOCK TECHNIQUES)

3, SHIME-WAZA (STRANGLE TECHNIQUES)

and their relative success in scoring Ippon are illustrated. The paucity of other scores using groundwork techniques removed the necessity to consider any other score than Ippon. A key to the different standing and groundwork techniques and the abbreviation can be found at the front of this chapter.

Figure 4.7 shows the relative magnitude of the most successful standing techniques used by female competitors. Uchi-mata (UM), and then Seoi-nage (SN), followed by Ouchi-gari (OUG) were the three most successful scoring techniques. All techniques that only formed very small percentages of the total were grouped together to form an aggregate sector (sector number 1).

Figure 4.8 shows a similar display of the successful standing techniques used by male competitors. For the men, Seoi-nage (SN) was the most successful scoring technique followed by Uchi-mata (UM) and then Ouchi-gari (OUG). This order was similar to that for the females.

When the techniques that were successful in producing Ippon alone were evaluated, the picture changed slightly. For both female and male competitors the most successful standing technique was UM. This information is displayed in figures 4.9 and 4.10.

Figure 4.11 shows the relative distribution of groundwork techniques that scored Ippon for the female competitors. Figure 4.12 shows a similar display of groundwork techniques which were successful in producing Ippon for the male competitors. For female competitors 78% of Ippon in groundwork were scored by holding techniques while 55% of Ippon were scored by this method for male competitors.

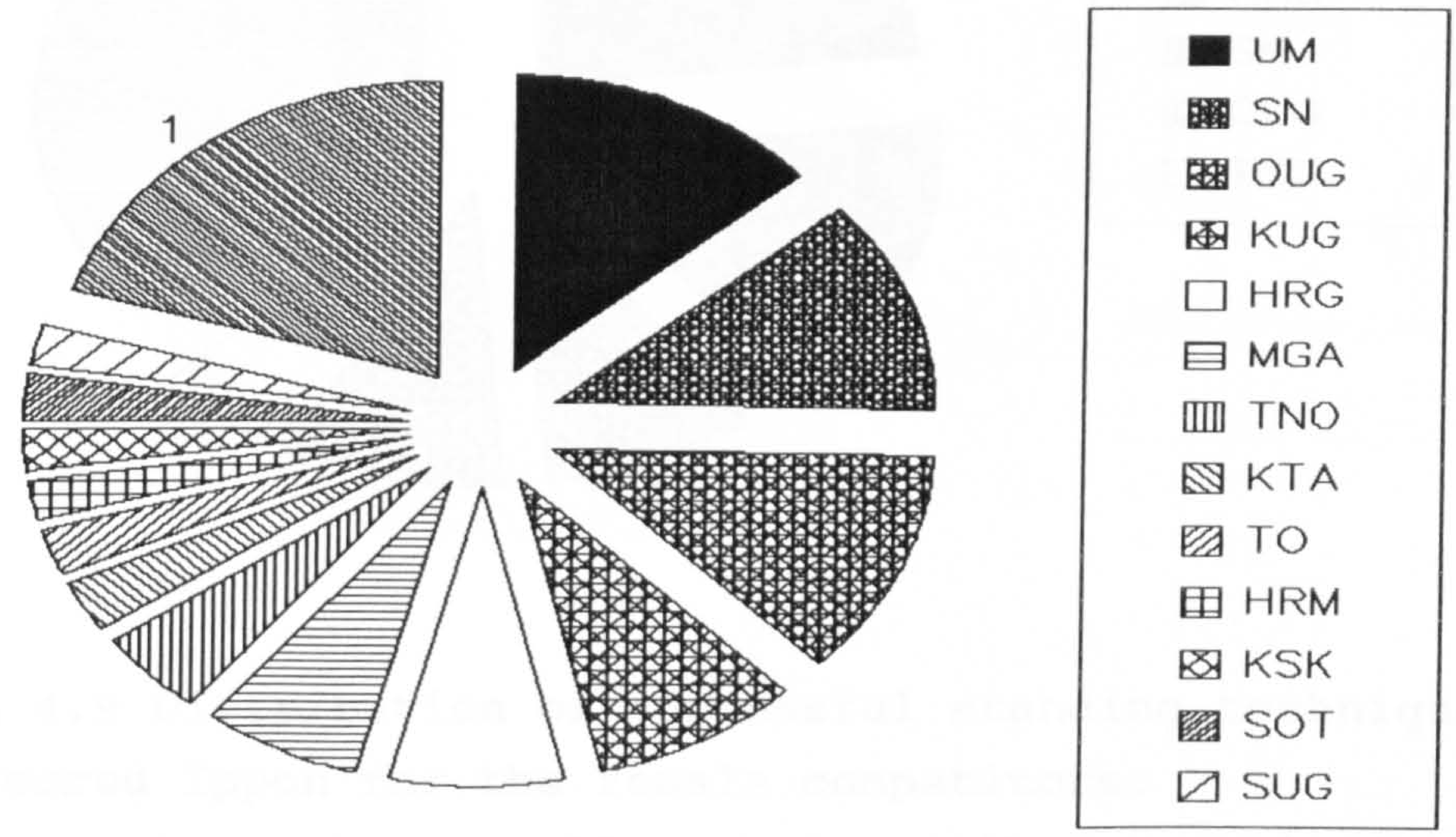


Figure 4.7 Distribution of successful standing techniques for the female competitors. (1, Aggregate sector of all techniques that comprised a small percentage of the total)

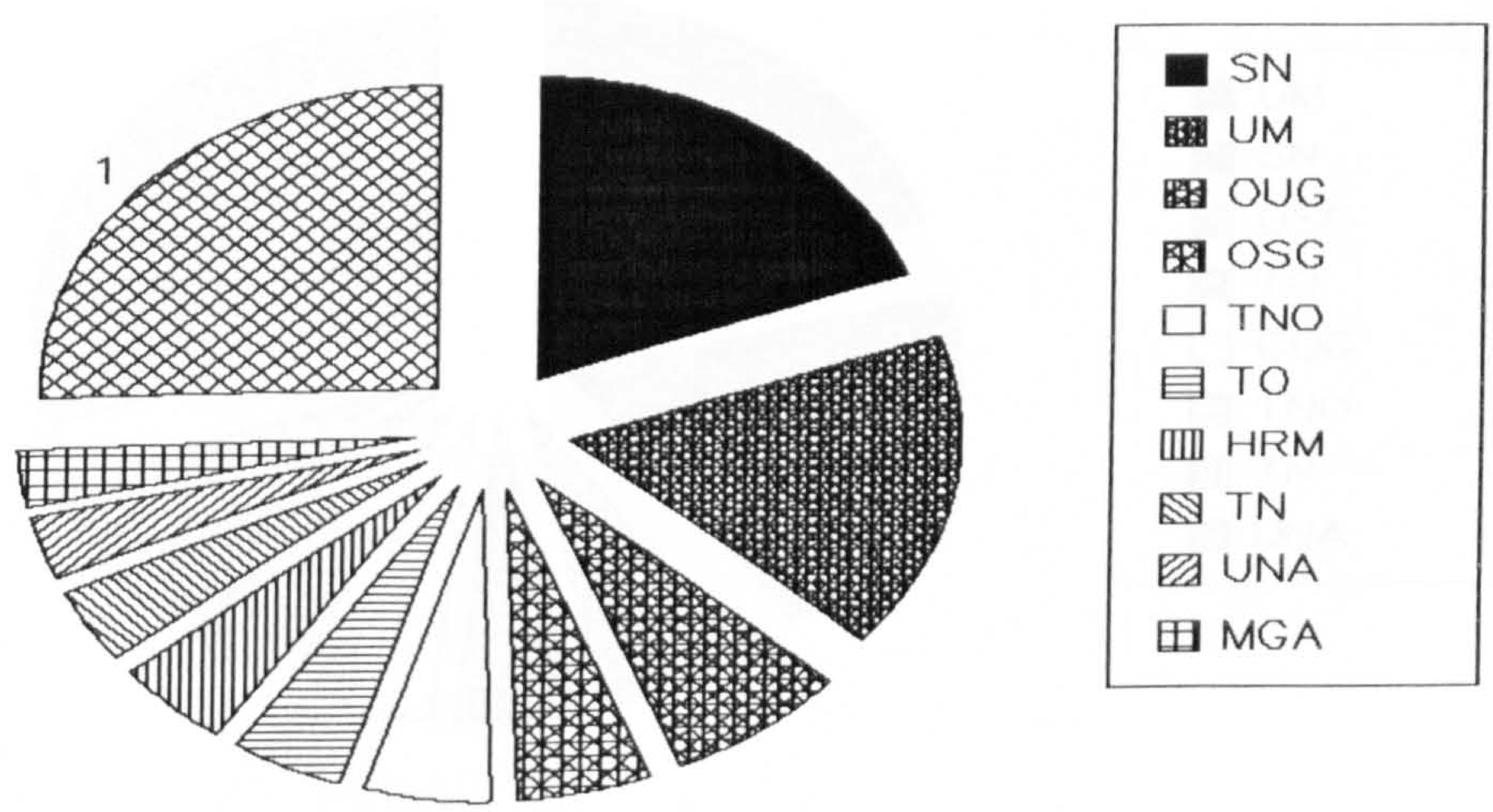


Figure 4.8 Distribution of successful standing techniques for the male competitors. (1, Aggregate sector of all techniques that comprised a small percentage of the total)

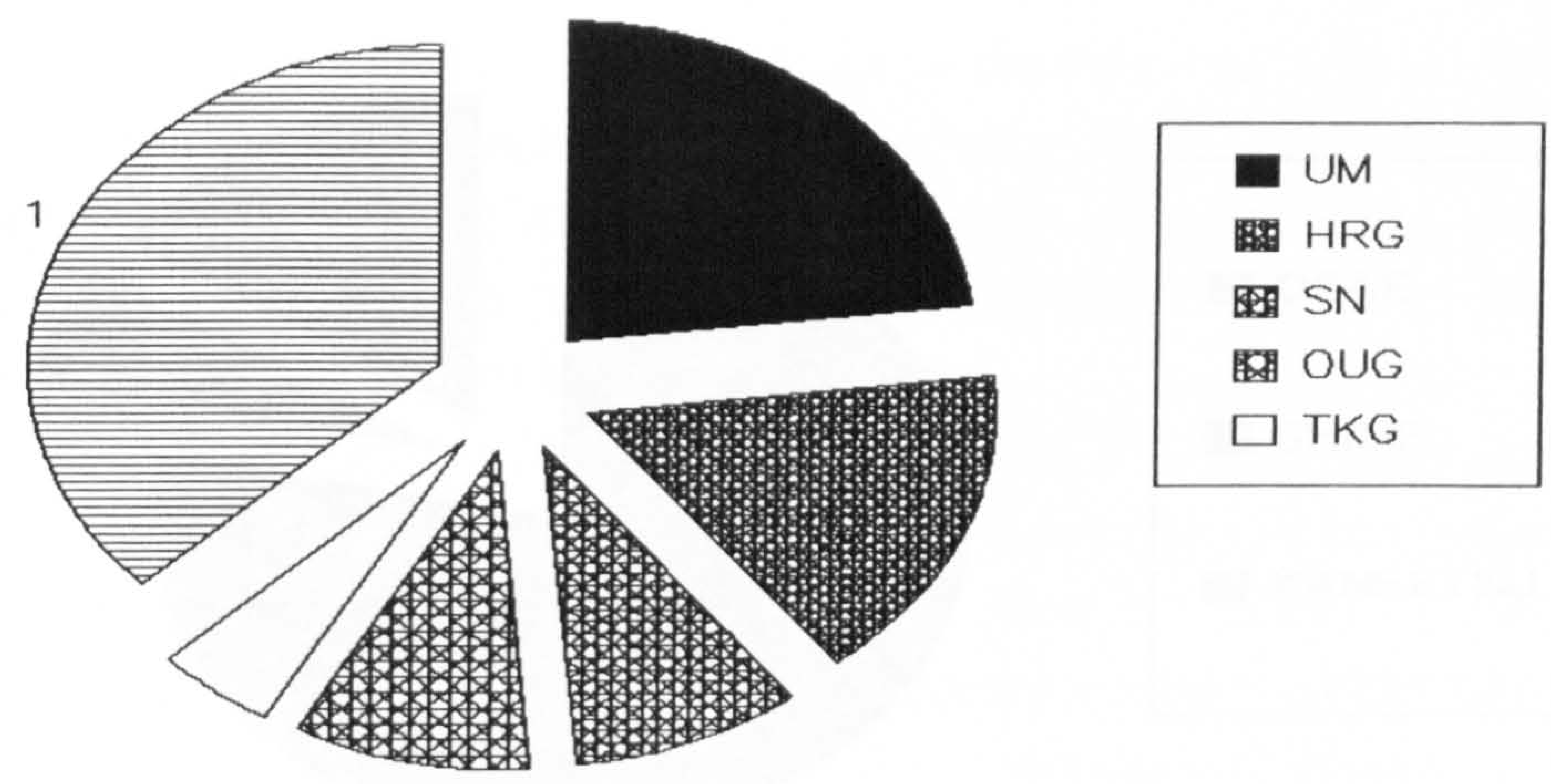


Figure 4.9 Distribution of successful standing techniques that scored Ippon for the female competitors.
(1, Aggregate sector of all techniques that comprised a small percentage of the total)

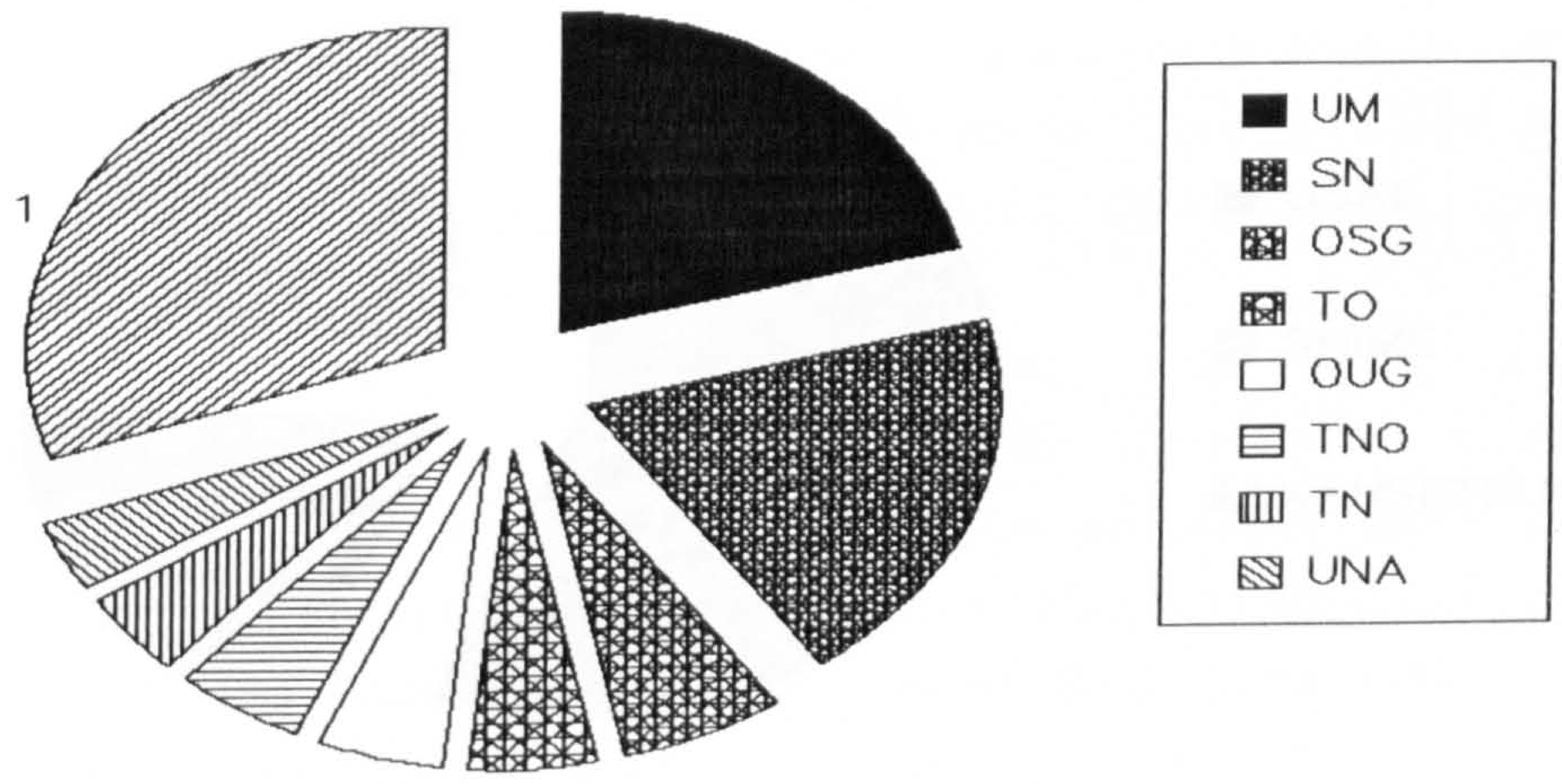


Figure 4.10 Distribution of successful standing techniques that scored Ippon for the male competitors. (1, Aggregate sector of all techniques that comprised a small percentage of the total)

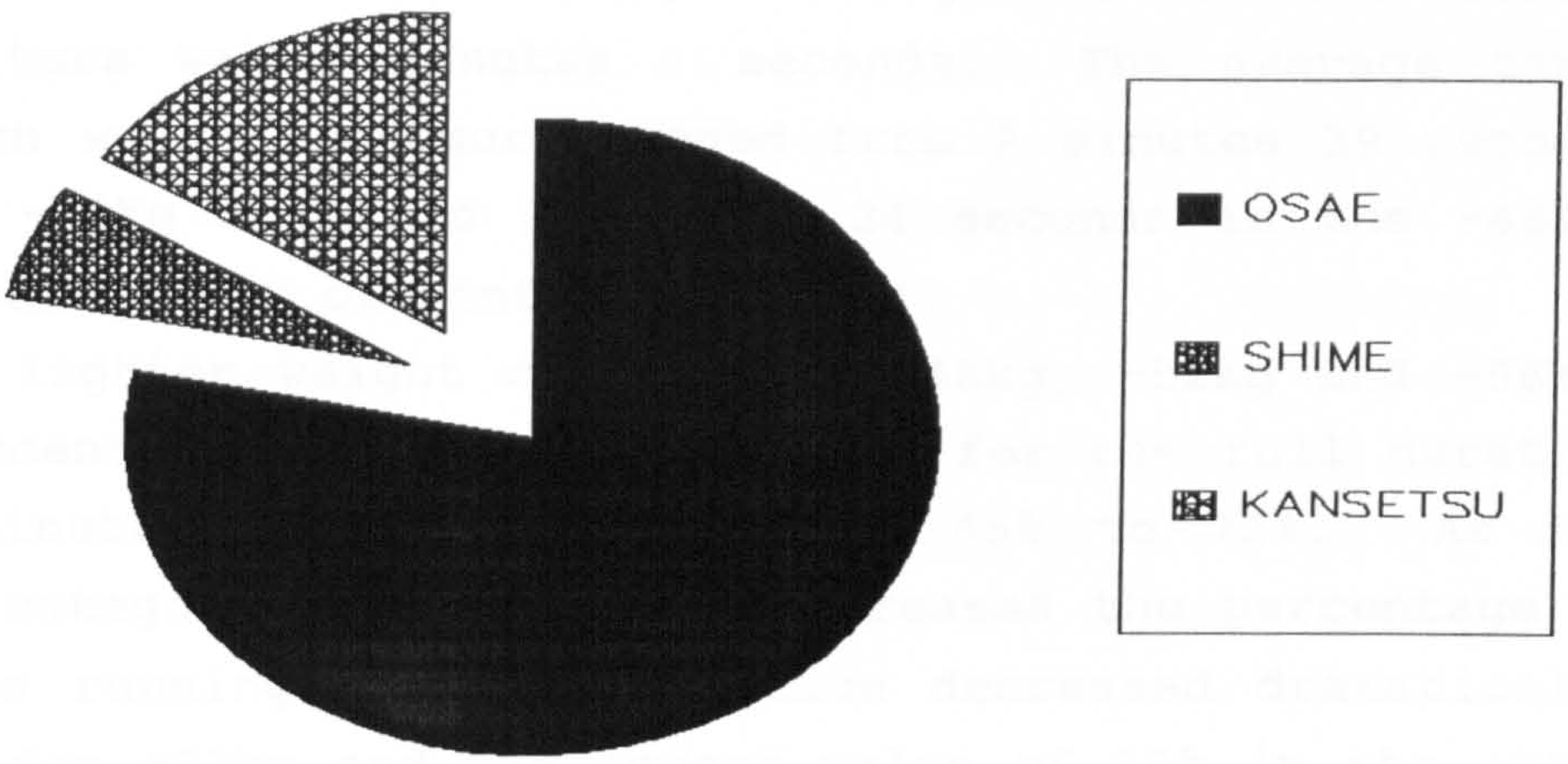


Figure 4.11 Distribution of groundwork techniques that scored Ippon for the female competitors.

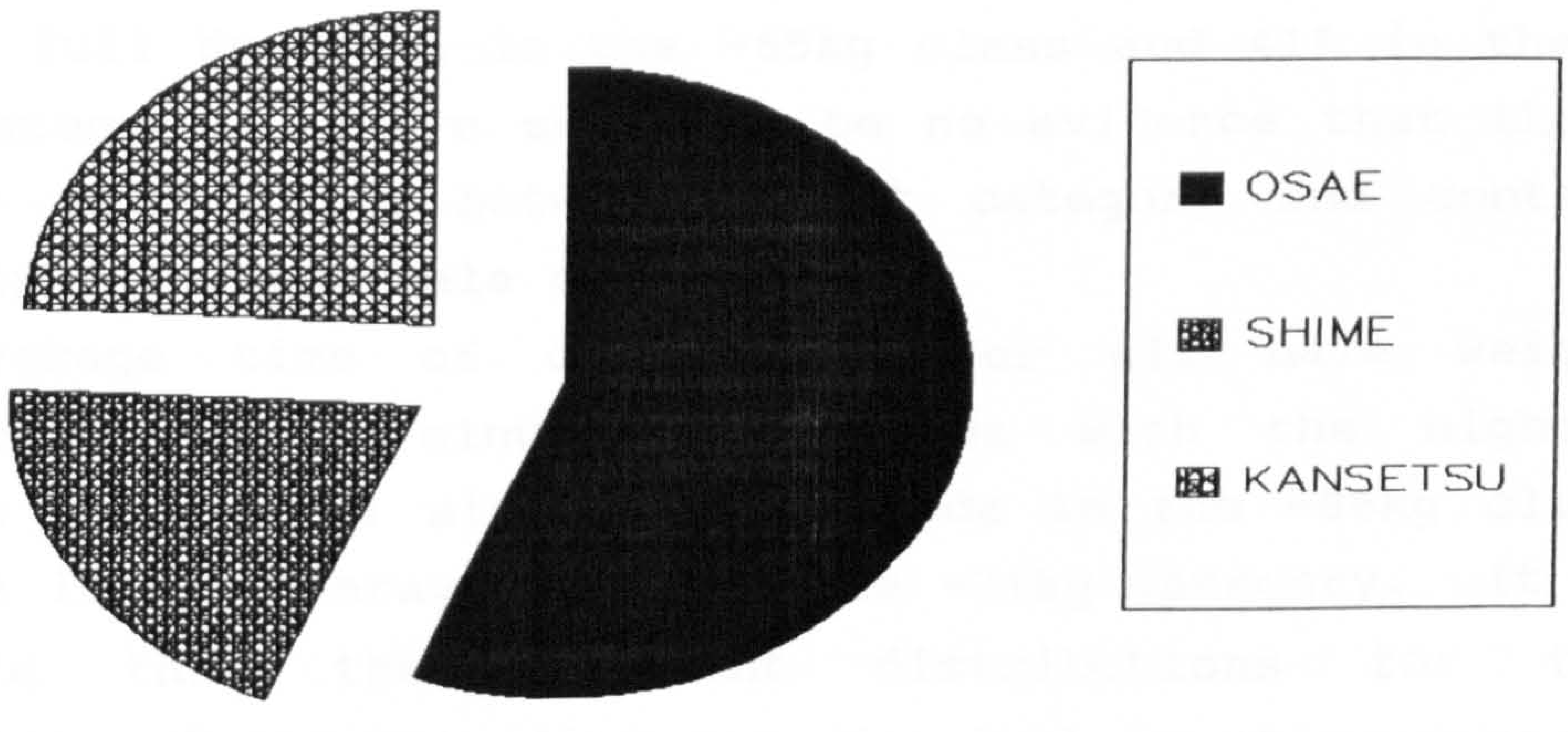


Figure 4.12 Distribution of groundwork techniques that scored Ippon for the male competitors.

4.10 DISCUSSION AND CONCLUSION

In the 1992 Olympic Games Judo event the average time of contest in all seven weight categories of the female competitors was 3 minutes 3 seconds. The average times for each weight category ranged from 2 minutes 39 seconds in the -72kg class to 3 minutes 24 seconds in the -48kg. The total number of contests was 234.

In the lighter weight categories (-48kg, -52kg and -56kg) the percentage of contests that ran for the full duration of 4 minutes was in the range of 65% to 72%. As the weight category of the contest increased the percentage of contests running the full duration decreased dramatically to 47% for -72kg and the lowest value of 39% in the +72kg weight category. This suggests that in the lighter weight category it was more difficult for either contestant to achieve Ippon. Interestingly this trend seems to be absent in the male competitors taking part in the 1992 Olympic Games. In fact, in the -86kg and -95kg male classes the percentage of bouts that were contested for the full 5 minutes were the highest and the 2nd highest recorded for all the male weight categories, with values of 55% and 48%. This peak value was closely followed by 43% of full duration in the -65kg class and 41% in the -60kg category. There seems to be no evidence that there is any correlation between weight category and contest duration for these male competitors.

The average time of competition for all male weight categories was 3 minutes 9 seconds with the highest average value of 3 minutes 27 seconds in the -86kg class and the lowest average value in the -71kg category. It is possible that the different distributions for the percentage of contests that ran the full duration depends on the scoring techniques employed by the heavier weight men. For this reason the distribution of the scoring characteristics in each weight category, for both females and males was considered.

Scores were subdivided into 7 different categories and the percentage of contests decided by a specific category was displayed on a bar chart for both female and male competitors. These contestants were subdivided further into light weight and heavy weight categories.

The -48kg event had the fewest contests which were decided by Ippon. It was 28.6%. Probably a contributory factor to this low percentage of Ippon scored was that 15% of the contests were decided by any other score. Actually any other score usually means that one of the competitors dropped out of the contest prior to competing, or at some time during the competition due to injury. If these bouts had taken place or had finished with a score then it is possible that the -48kg category would have had more contests that were finished by Ippon.

The scores associated with the standing techniques of Judo are decided by the referee and judges subjectively. This decision also has to be reached instantaneously. In addition, it is possible that each referee is influenced by different components in the technique. In the 1992 Olympic Games Judo event, the female -52kg weight category did not have any contests which were decided by Waza-ari, while the same weight category had the highest number of contests which were decided by Yuko. There were a relatively high percentage of contests decided by judges' decision as well. It is possible that these statistics could have been influenced by the referees' subjective decisions.

To score Ippon needs all three components of force, speed and landing on the back, whereas Waza-ari lacks one of these three factors. The female -48kg weight category had a low percentage (less than 30%) of contests concluded by Ippon, but a relatively high percentage decided by Waza-ari and Yuko. In fact, the aggregate percentage of contests decided by these two scores (32%) was higher than the percentage of bouts concluded by Ippon. It is possible that these light weights had the agility to prevent their opponents from throwing them onto the back or perhaps they did not give the impression of force or speed in the throw. In either situation, Waza-ari or Yuko would be the likely outcome rather than Ippon.

In the female heavy weight competition, the heaviest two categories had more than 50% of contests concluded by Ippon, especially the +72kg event which had more than 60% of bouts which were finished by Ippon. The -66kg weight category which had the lowest Ippon percentage, had the highest number of contests decided by Waza-ari (about 15%). This figure was about three times higher than the other two categories. Interestingly, this feature also appeared in the contests which were decided by Koka and those contests decided by Penalty. It is likely that these results were also influenced by the subjectivity of the referees. The heavier weight competitor perhaps appeared to show more dynamism during her throwing of an opponent because of their weight. In most cases, except for Yuko, the heavier weight categories had a lower percentage of smaller scoring categories compared to the -66kg category. At the 1992 Olympic Games Judo event, it appears that the heavy weight female competitors had more chance to score or lose by Ippon while the lighter weight competitions were often decided by lower category scores because of their body weight. For example, it is often easier for the lighter weight competitor to twist his/her body to escape scoring Ippon.

In all male light weight contests, more than 55% of contests were decided by Ippon. The percentage of contests concluded by Ippon in the -78kg category was particularly high with a value of 70%. Interestingly, the -65kg weight category, which had the fewest percentage of Ippon scored, had the highest percentage (about 20%) of Yuko scored, while all other light weight categories had less than 10% of contests which were decided by Yuko. Again it is likely that this result was influenced to some extent by the judging. To score Ippon needs force, speed and landing on the back, but to score Yuko needs only one factor out of these three. However this decision is based on the subjective assessment of the referee and judges, so that it is possible that in these weight categories there appeared to be insufficient evidence for a score of Ippon, but a score of Yuko was acceptable.

In male heavy weight competitions, the two heaviest weight categories had more than 50% of contests decided by Ippon. However, the -86kg weight category had only 45% of the contests decided in this way. It is worth noting the percentage of the contests which were decided by Waza-ari and by Yuko. The heaviest weight category, the +95kg weight category, had about 15% of the contests decided by Waza-ari, whereas in the -86kg and -95kg weight categories less than 10% of the contests were won by scoring Waza-ari. However, in the case of scoring Yuko, this trend was reversed. The -86kg and -95kg weight categories had more than 10% of contests which were decided by Yuko, while in the +95kg weight category, this value was reduced by a factor of two.

Interestingly, no contests were decided by Koka in the -95kg category. A similar observation can be made about those contests decided by a referees' decision. The +95kg competition had no bouts decided in this way. This means that all contests in this category had a score recorded. It is possible that the heavier weight competitors technique giving an Ippon percentage of 60% looks more dynamic compared to the lighter weight competitors in the -86kg and -95kg categories, because of their body weight. However, when all the male contests are considered this conclusion does not seem to be supported. The -71kg and -78kg weight categories had a much higher percentage of contests decided by Ippon compared with all of the heavy weight categories.

When considering the observed differences in the frequency of scoring categories between all the female competitors and all the male competitors, it is natural to study the frequency of scoring categories obtained by the successful competitors (the medallists) and the unsuccessful competitors (the non-medallists). Section 4.5 compared the scoring frequencies obtained by the medallists separated by gender and the non-medallists partitioned in similar manner.

Using the X^2 statistic there was no evidence that scoring patterns achieved by female medallists were any different to these obtained by male medallists. In contrast, it appears that female non-medallists scored less Ippon and more Yuko and Koka than expected. Conversely the male non-medallists scored more Ippon and less Yuko and Koka than expected. It is not clear why this difference of scoring patterns should be observed in the non-medallists but not in the medallists.

Following this analysis it seemed sensible to investigate whether the successful medallists scored differently to non-medallists. The data were partitioned by gender and the scoring frequencies of medallists were compared with those of non-medallists for female competitors. A similar strategy was adopted for the male competitors. There was statistical evidence to support the theory that female medallists might score Ippon more frequently but Yuko less frequently than female non-medallists. However for male competitors, this did not seem to be the case. Using the X^2 statistic the frequency of scoring categories was the same for both medallists and non-medallists in the male championships. Apparently at the world standard in the 1992 Olympic Games, there were more subtle characteristics which separated the male medallists from the male non-medallists. However, it can be assumed that the standard of the female non-medallists was significantly lower than that of the female medallists based on observed scoring patterns.

The next stage in the analysis was to study the pattern of scoring frequencies obtained from standing techniques and groundwork techniques. The data were partitioned into female medallists, female non-medallists, male medallists and male non-medallists for this investigation. Tables 4.7 ~ 4.10 demonstrate that standing techniques produce totally different scoring patterns to groundwork techniques. Female medallists and non-medallists always scored Ippon with a groundwork technique, no other score was documented. Hence the other lower scoring categories were only achieved through the standing techniques. Nearly all groundwork techniques scored Ippon in the male medallists. Only one Koka was scored when the opponent escaped from the holding technique within 20 seconds (10 ~ 20 seconds) of its initiation. The groundwork techniques of male non-medallists only scored Ippon, just like their female counterparts. Hence the other lower scoring categories were produced by standing techniques alone. These observations suggest that in the Olympic Games Judo competition groundwork techniques, once initiated, almost always led to Ippon and conclusion of the contest. The subjectivity of the judges' assessment of the score is removed in these circumstances.

Finally the female and male competitors were grouped by weight category into light weight and heavy weight contestants. No statistical difference could be demonstrated in the frequency of scoring categories between the light weight and heavy weight groups in both the female and male competitors. Since groundwork techniques almost always result in Ippon it seems likely that the lower scoring categories of Waza-ari, Yuko, and Koka result from the judges' interpretation of a throw from standing techniques. This means that the frequency distributions displayed in section 4.4 are a combination of scoring categories derived from totally different distributions. The first of these distributions arises from standing techniques and includes the lower scoring categories, while the second distribution consists solely of Ippon except for a single Koka scored by a male medallist.

Because of this latter distribution, it seemed logical to compare the frequency of Ippon scored from standing and groundwork techniques for light weight and heavy weight competitors. The female competitors showed no difference in scoring frequency of Ippon from standing and groundwork techniques between light weight and heavy weight categories. A similar pattern emerged from the male competitors data.

The concept that the heavy weight competitors were more likely to finish the contest with an Ippon once groundwork was started might be expected. However, from observation of Judo competitions, light weight competitors appear less likely to lose their balance than their heavier counterparts, and initiate groundwork techniques. Hence it might be expected that more Ippon are scored by standing techniques than groundwork techniques in the lower weight categories. The results from the 1992 Olympic Games do not support this expectation.

The most successful standing techniques employed by female competitors were UM, SN and OUG. Again SN UM and OUG appeared as three of the most successful standing techniques used by male competitors. These observations were reemphasised when the standing techniques that scored Ippon only were analysed. For both the female and male competitors the most successful technique was UM, SN was the 3rd most successful technique for females and the 2nd most successful technique for males. These standing techniques have been identified as favourite techniques of Judo competitors by Japanese research workers in Judo(13)(16)(17)(18). It is likely that most competitors revert to their most favourite technique when the contest is considered to be important (for example, The Judo competition at the Olympic Games) and the skill levels of the contestants are similar.

In groundwork techniques, Osae-waza (holding techniques) accounted for 78% of the winning scores (always Ippon) in the female competitors and 55% of the winning scores in the male competitors. Some success was found with Juji-Gatame, which is an arm-lock technique, in both female and male competitors. In general when Judo competitors transfer from a standing position to groundwork techniques, with an attempted throw, they are more likely to move into Osae-waza than the other two groundwork techniques. It may be for this reason that the majority of Ippon through groundwork technique are scored by Osae-waza.

4.11 SUMMARY

General information

* Number of contests	:	234 for women, 356 for men.
* Average time of contests	:	3 minutes 3 seconds for women. 3 minutes 9 seconds for men.
* Percentage of contests full duration	:	Decreased with increase in weight category for female competitors, but not male competitors.
* Characterisation of scores in each contest	:	Over 50% of contests concluded by Ippon in all weight categories, except -86kg, for male competitors. But even this weight category had more than 45% of contests concluded by Ippon. Only -72kg and +72kg category in female competitions had such high percentage of contests decided by Ippon. Most other categories had less than 40% of contests concluded by Ippon, instead they had a higher percentage of contests which were decided by Yuko.

Scoring Patterns

* Partitioning into medallists and non-medallists	:	No difference in scoring patterns between female and male medallists. Significant difference in scoring pattern between female and male non-medallists. Female non-medallists scored less Ippon and more Yuko and Koka than expected. Male non-medallists scored more Ippon and less Yuko and Koka than expected.
* Partitioning by gender	:	Significant difference in scoring pattern between female medallists and non-medallists. Female medallists scored more Ippon and less Yuko and Koka than expected.

Female non-medallists scored less Ippon and more Yuko and Koka than expected.

No difference in scoring pattern between male medallists and non-medallists.

* Partitioning by techniques : Significant difference in scoring patterns between standing and groundwork techniques for both female and male competitors. Groundwork techniques almost always resulted in Ippon, with all other score arising from standing techniques.

* Partitioning by weight categories : <u>All scores</u>. No difference in scoring patterns between female light weight and heavy weight competitors.

  No difference in scoring patterns between male light weight and heavy weight competitors.

  <u>Ippon only</u>. No difference in scoring of Ippon from standing and groundwork techniques between light weight and heavy weight female competitors. No difference in scoring of Ippon from standing and groundwork techniques between light weight and heavy weight male competitors.

<u>Evaluation of scoring techniques</u>

* Standing techniques : <u>All scores</u>. UM, SN, OUG the three most successful techniques for both female and male competitors.

  <u>Ippon only</u>. UM, HRG, SN the three most successful techniques for female competitors.

  SN, UM, OUG the three most

successful techniques for male competitors.

* Groundwork techniques : The most successful technique was Osae-waza (holding technique) which had a 78% score rate for female competitors and a 55% score rate for the male competitors.

CHAPTER 5

MOTION ANALYSIS OF UCHI-MATA AND SEOI-NAGE

5.1 INTRODUCTION

At two top level competitions, the 1991 World Championships and 1992 Olympic Games, it has been shown that Uchi-Mata and Seoi-Nage were the most successful techniques. It has also been suggested that these two techniques were the overall favourites for Judo players. Uchi-Mata and Seoi-Nage during competition, captured on video, are analysed in this Chapter. VHS video recordings of the competitions were supplied, as recorded by All Japan Judo Federation. The videos were analysed frame by frame using an Panasonic off-line Video Editor (AG-A570). One frame is equal to 0.04 seconds of action. Each competition final was assessed between 8 and 10 times to produce the full analysis.

Initially, the major components in Judo which are necessary for successful standing techniques are explained. Following identification of these basic principles, specific examples of Uchi-Mata and Seoi-Nage are analysed. The examples are drawn from video recordings at the World Championships and Olympic Games. The main movements and mechanics of these techniques are identified. Finally, specific methods of training, that use fixed and variable resistance to condition different components of these techniques, are identified. This chapter is intended to show how video analysis can be transferred to the gymnasium and weights room in attempt to complement the traditional methods of Judo training through Randori practice.

5.2 BASIC PRINCIPLES INVOLVED IN STANDING TECHNIQUES

There are three major elements in Judo which are necessary for a successful standing technique. These are :

* KUZUSHI : breaking the balance of an opponent.
* TSUKURI : creating the correct body position for execution of a throw.
* KAKE : the act of throwing an opponent.

* KUZUSHI

One of the main aims of Judo is to produce a situation when an opponent is caught off balance. In this state the line of action through the mass centre will invariabily lie outside the base of support created by the feet. To achieve this state a Judo player must exert control over his/her opponent by gripping the Judo suit at the best sites to prepare for a specific throw. Without a balanced state it is difficult to use any inherent strength effectively and so it is easier for the attacker to maintain control over his/her opponent. To break the balance of an opponent, translation, in the form of pushing or pulling, and rotation, about any of the three anatomical axes, are employed.

* TSUKURI

The elite Judo player is seeking to synchronise his/her body position for an attempted throw with the instant that the opponent loses control over his/her balance. The aim is to create an appropriate lever system that can take advantage of this instantaneous loss in balance. The fulcrum of the lever is through the lower limbs of the player attempting the throw. Since the effort usually lies between the load (the weight of the opponent) and the fulcrum, the lever is working at mechanical disadvantage, but the application of sufficient effort can create great speed and add to the dynamism of the throw. KUZUSHI and TSUKURI should happen virtually simultaneously to create the opportunity for KAKE.

* KAKE

This element is the completion of the movement that creates the opportunity for a throw and the beginning of the throw. It is not sufficient for an opponent simply to be dispatched to the mat. The throw must exhibit force and speed, which will be achieved with sufficient leverage, and an opponent must be thrown onto his/her back.

Standing techniques in Judo work splendidly when the three elements, KUZUSHI, TSUKURI and KAKE come together almost instantaneously as a single entity. If any one of these elements is lacking then the chances of completing a successful throw are greatly reduced.

5.3 THE MECHANICS OF UCHI-MATA AND SEOI-NAGE

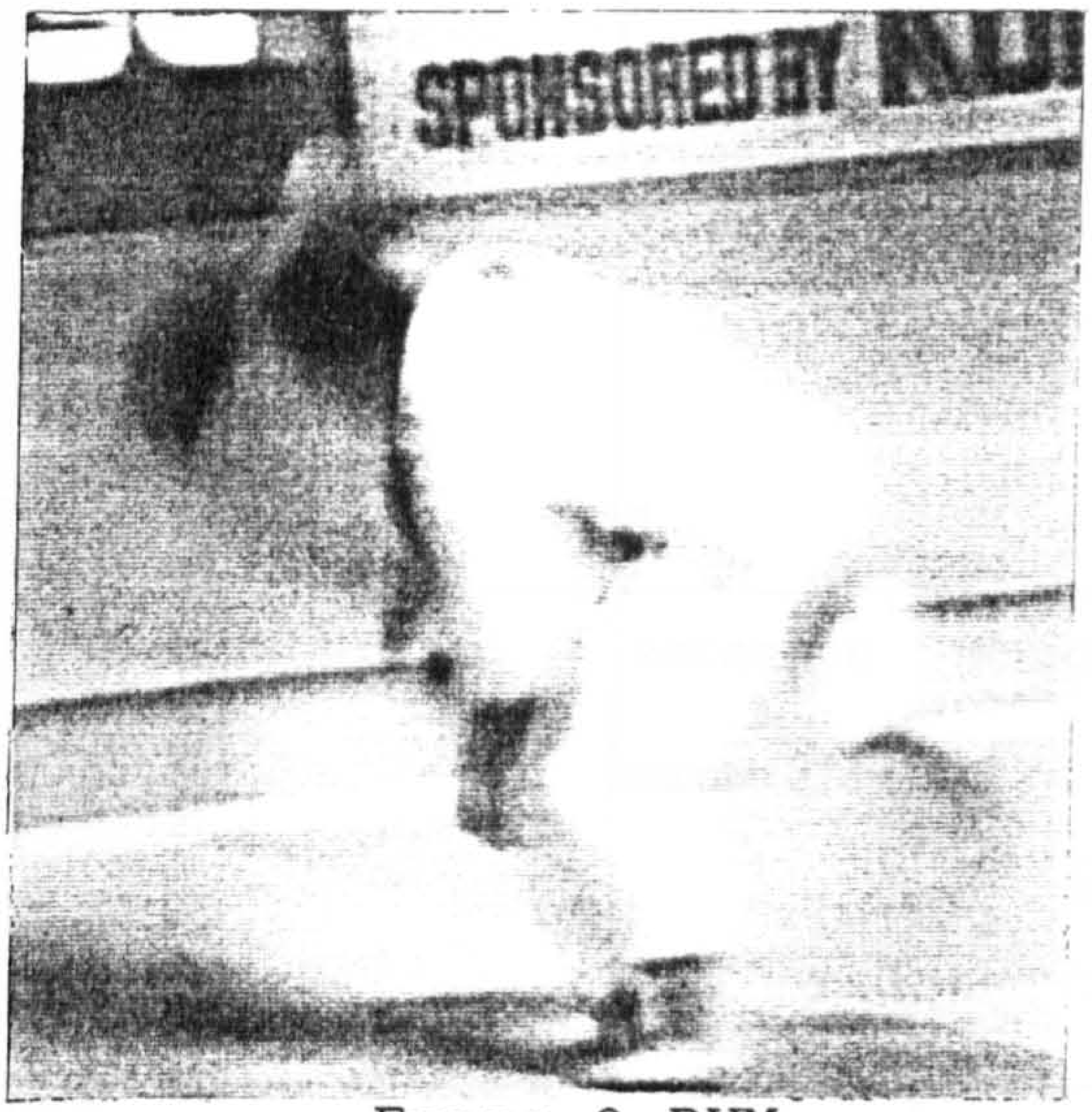
The two standing techniques of Uchi-Mata and Seoi-Nage have been identified as the most successful techniques both in the 1991 World Championships and the 1992 Olympic Games. This section explores the simple mechanics behind these throws using selected frames taken from video recordings of the World Championships and Olympic Games. The observations are interpreted in terms of the three basic principles identified above.

5.3.1 Right UCHI-MATA (RUM)

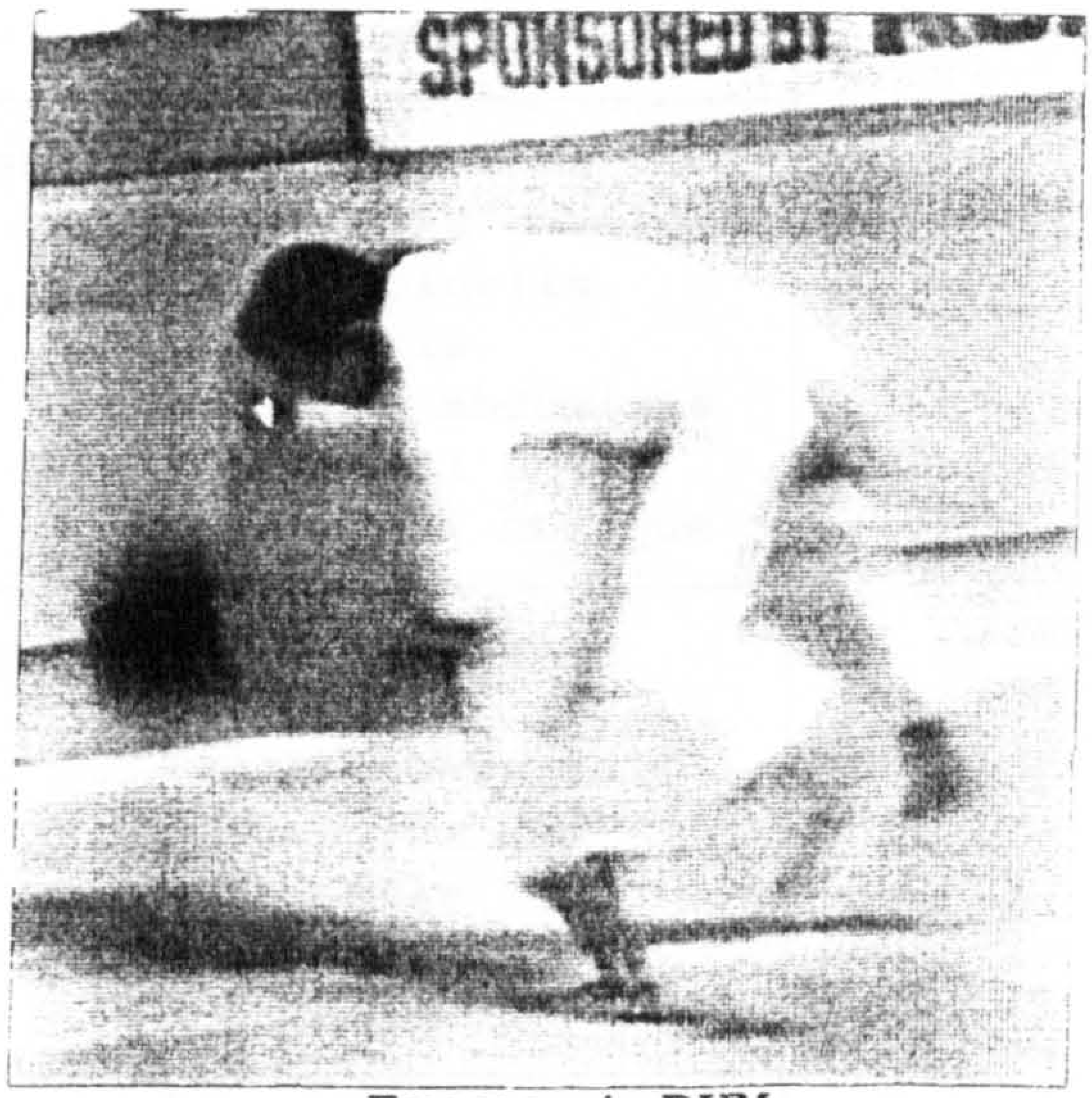
This standing technique is one of the leg techniques. Usually the opponent is brought off balance to the front (KUZUSHI). An opponent is advancing, retreating or turning. Frame 1 RUM shows the Judo player on the right being pulled off balance in preparation for Uchi-Mata. As the competitor was attacking and his hip joint centre was slightly anterior to that of the ankle joint. The trunk is slightly flexed. The Judo player on the left is gripping his opponent with his left hand under his opponent's elbow and his right arm placed over the shoulder to grip the back of his Judo suit. This pulls the unwary competitor forward to break his balance and leads to Frame 2 RUM. KUZUSHI is continued by a swift anti-clockwise rotation of the body that starts at the shoulder and continues through the trunk and hips. The weight of the potential thrower is transferred from the right to left leg by rapid adduction of the left leg across and behind the right leg in preparation for completion of KUZUSHI and the start of TSUKURI (through necessity there must be some overlap of these elements). The right elbow is flexed and the right shoulder is horizontally extended. This movement is combined with a flexed left elbow and horizontal extension of the shoulder. Because the upper-body is rotating this action pulls forward the player on the right and increases the flexion of his trunk. By Frame 3 RUM, KUZUSHI is completed by rotation of the body about the long axis through the left foot and insertion of the right leg in the gap created between the legs of the victim. The right leg of this contestant is swept away from the mat by the right leg of the thrower and the flexed elbows and extended shoulders continue to pull the opponent forward. KAKE starts at this stage. The thrower is rotating about a fulcrum at his left foot while simultaneously lifting his opponent off the floor with his sweeping leg. In addition the victim is pulled over and around the thrower's lower back and thigh to give Frame 4 RUM. Frame 4 RUM shows the ending of TSUKURI, the victim has lost contact with the floor and the leverage system for executing the throw is almost complete. Effort is being applied to the distributed weight of the contestant who is about to be thrown, at the right shoulder and inner right thigh, while the trunk of the thrower is flexing so that the upper-body is parallel to the mat. This position is helped by the sweeping movement of the right leg. Further flexion of the trunk leads to Frame 5 RUM and the completion of TSKURI and introduction of the final element of KAKE. The victim is lifted, rotated and released at the correct instant to produce an Uchi-Mata with force and speed. The rotations of the thrower and the extreme position of his head and sweeping leg twist the victim about the long axis through his head and feet to complete the throw, with the victim landing on his back. The combination of a fully flexed upper-body and fully abducted right leg results in the legs of the thrower being at 180° to one another in the vertical plane. This manoeuvre requires substantial flexibility as well as power and exquisite timing.

Frame 1 RUM

Frame 2 RUM

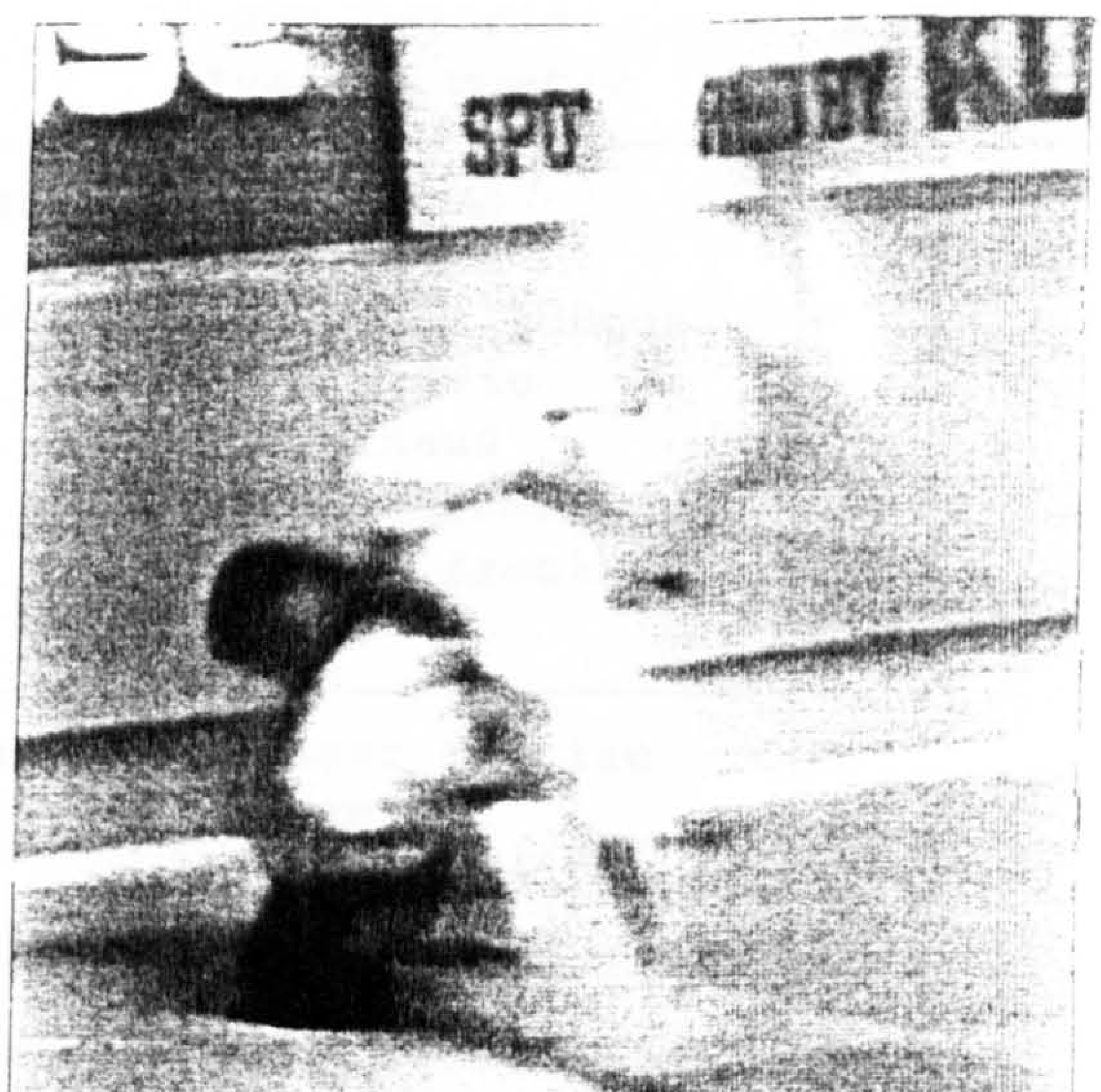


Frame 3 RUM



Frame 4 RUM

Frame 5 RUM



Frame 6 RUM

5.3.2 Summary of the main movements and muscle contractions during Uchi-Mata (right grip)

The main movements and the associated types of contraction are shown in table 5.1.

Table 5.1 Summary of Uchi-Mata Technique

Place	Action	Contraction	Muscles
Both the left and right elbow joints	Flexion	Isometric	*biceps brachii *brachialis *brachioradialis
Both the left and right shoulder joints	Extension	Isometric	*posterior deltoid *supraspinatus *teres major *latissimus dorsi
The trunk	Flexion	Concentric	*semispinalis thoracis *semispinalis cervicis *rectus abdominus *external and internal oblique
The vertebral column	Rotation & Extension	Concentric	*longissimus thoracis *illiocostalis lumborum and thoracis *quadratus lumborum
The left knee joint	Flexion	Eccentric	*rectus abdominus and femoris *vastus muscle
The left hip joint	Flexion	Concentric	*lliopsoas *Sartorius *Adductor longus and brevis *pectineus *rectus femoris *Tensor fasciae latae
The right hip joint	Abduction	Concentric	*tensor fasciae latae *gluteus medius and minimus *piriformis

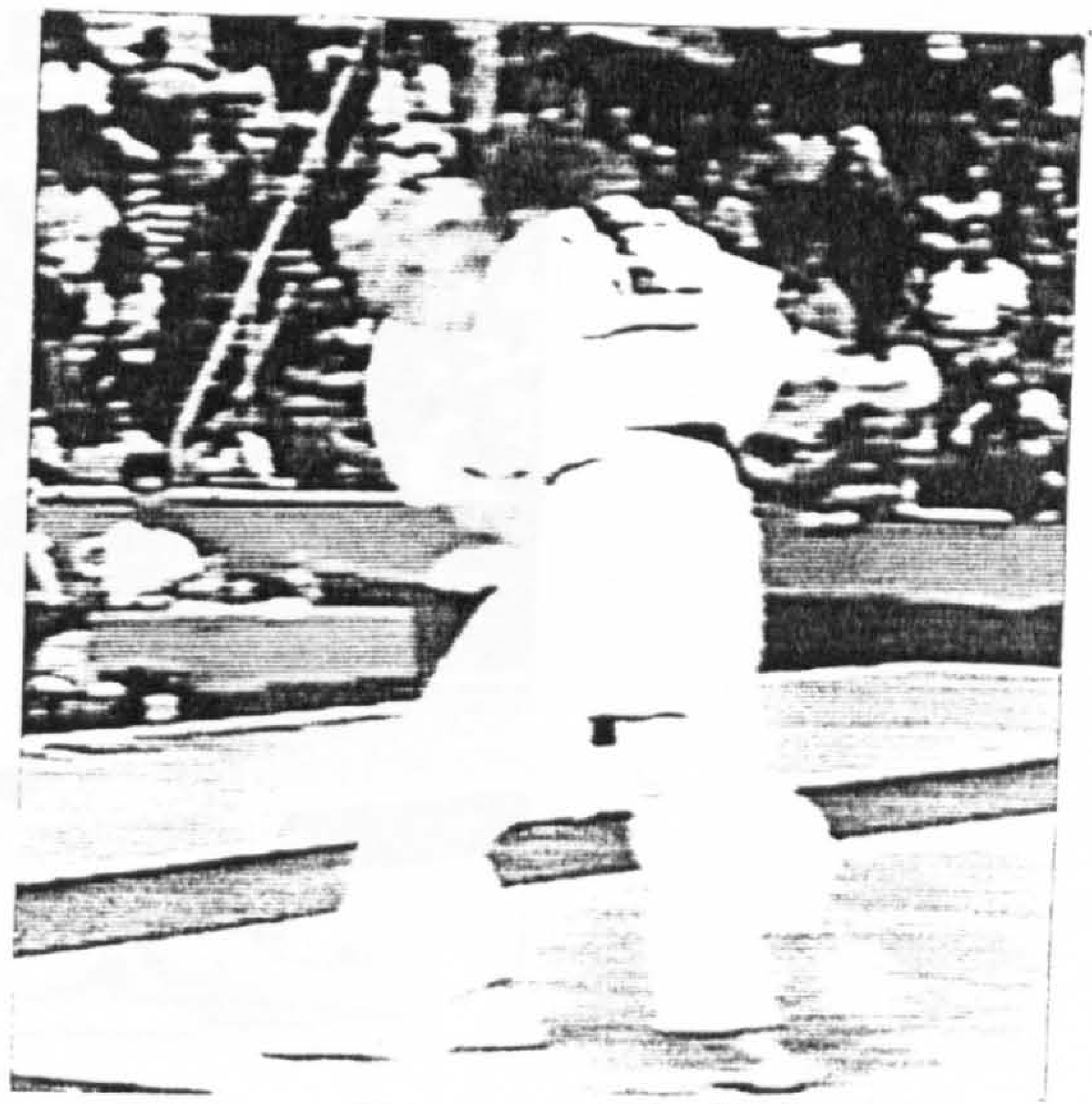
5.3.3 SEOI-NAGE

Seoi-Nage is a combination of two words. 'Seoi' means carrying on the back while 'Nage' means throwing. Hence Seoi-Nage means literally throwing by carrying on the back. For this throw the Judo player needs a combination of good posture, strong thighs and good balance. There are two kinds of Seoi-Nage. The first type is a two armed shoulder throw called Morote Seoi-Nage, while the second kind is a one armed shoulder throw called Ippon Seoi-Nage. Since there are subtle differences between these two types of Seoi-Nage both are analysed in this thesis. There are also two distinct styles of each Seoi-Nage. The first style is characterised by the thrower dropping onto both knees when executing the throw. In the second style the thrower remains standing while throwing his/her opponent over the shoulder. In the official results of the 1991 World Championships and 1992 Olympic Games no distinction was made between the two different types of Seoi-Nage. The video recordings, however, allow the differentiation between Ippon and Morote Seoi-Nage to be made. In both cases the opportunity for the throw arises when an opponent is pushing the prospective thrower with an upright stance, a high centre of gravity, and relatively stiff arms. The forward momentum generated by the prospective victim during the pushing action is converted by the thrower into a throw over the back and shoulder.

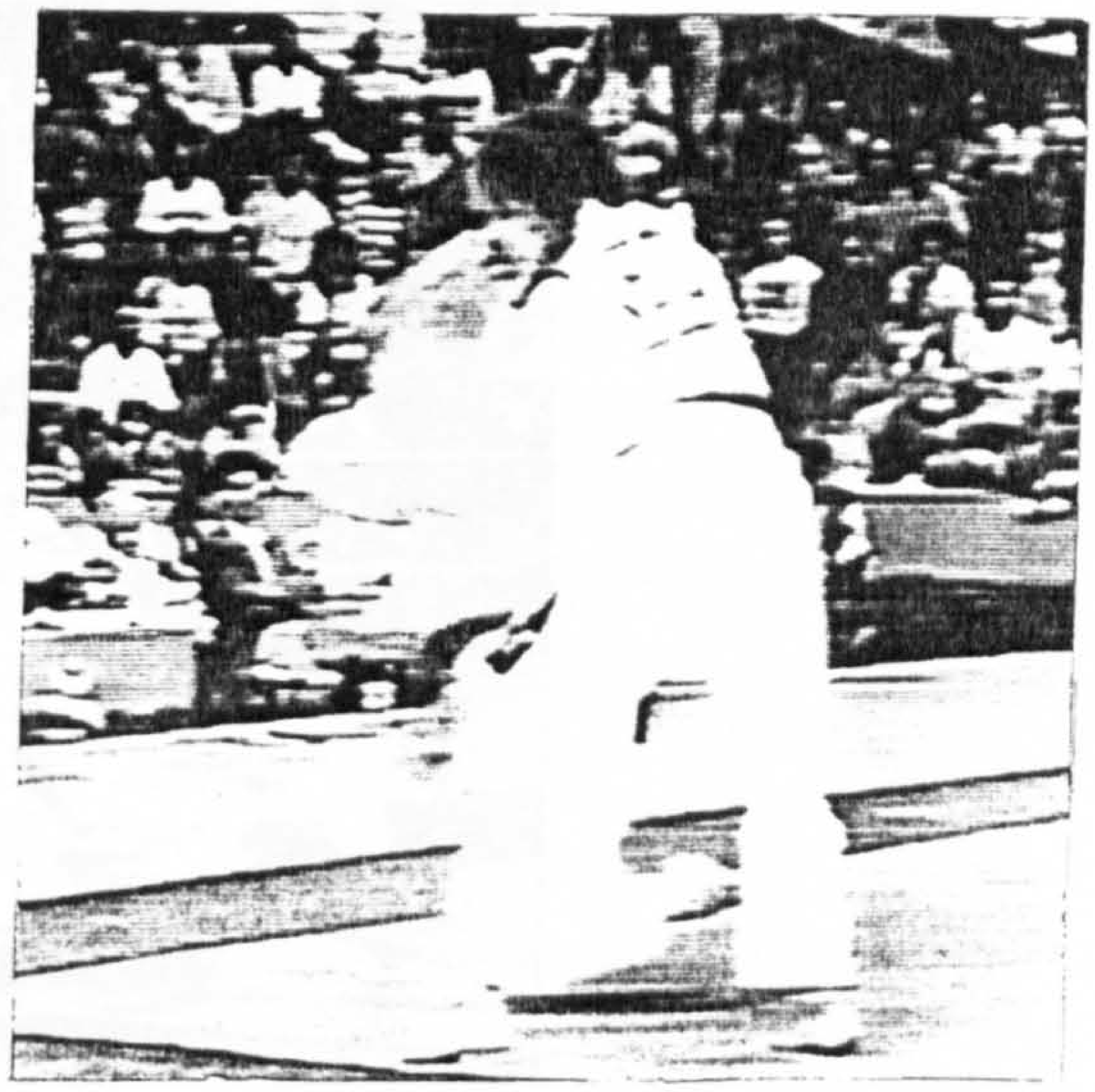
Left Morote SEOI-NAGE (LMSN)

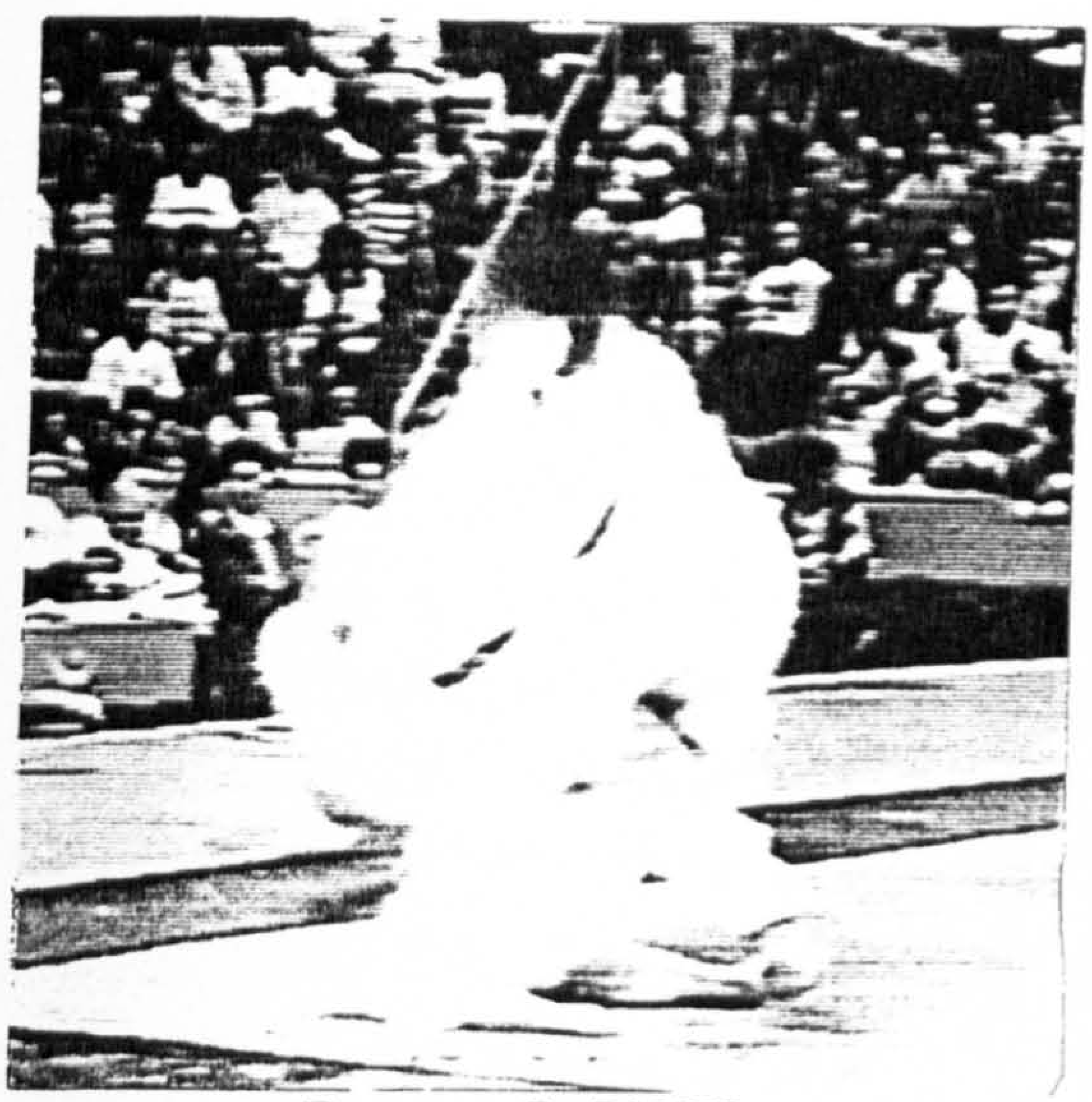
KUZUSHI is developed in Frames 1 and 2 LMSN. The right hand of the thrower is gripping the edge of the sleeve of her opponent while the left hand has grasped the lower portion of the opponent's right lapel. The player about to be thrown is in an upright position with a high centre of gravity (Frame 1 LMSN) and moving forward (Frame 2 LMSN). By Frame 3, 4 and 5 LMSN, KUZUSHI has been established and TSUKURI is being developed. The right fore-arm of the thrower is extended at about 90^{o} with a horizontally extended right shoulder. The left fore-arm is completely flexed with a pronated left wrist so that the elbow is inserted in the opponent's arm-pit. The left shoulder is being slightly adducted while the trunk is being extended and rotated clockwise to follow these arm movements. The clockwise rotation is initiated at the upper-body and continued through the hips and lower body so that the lower body can be inserted into the gap between the opponents legs. This is the vital movement for a successful Seoi-Nage. While lifting with the arms the thrower drops down low between the legs of the opponent. If the contestant had been able to prevent the thrower from squatting between her legs then the throw could have been avoided. Frames 5 and 6 LMSN show the overlap between the completion of TSUKURI and KAKE. The lower body of the thrower is completely flexed enabling her to lift up her opponent easily. The clockwise rotation in the trunk causes the opponent's body to be thrown over the left side of the thrower's body. This is assisted by a continuously flexed right fore-arm and horizontally extended right shoulder combined with a flexed left fore-arm and adducted left shoulder. In the final frames both the right and left hips are being flexed in combination with strongly and fully extended right and left legs.

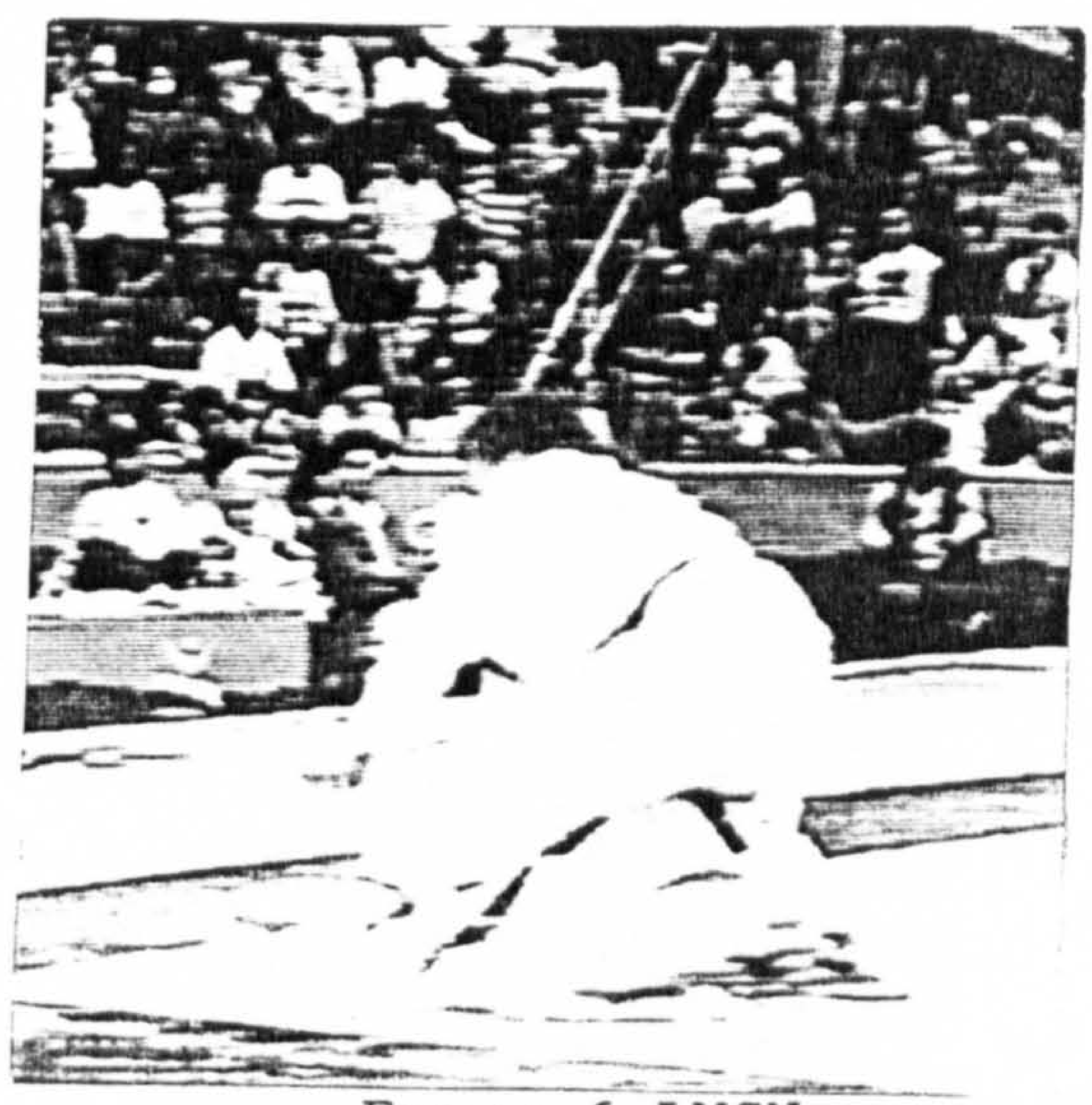

Frame 1 LMSN

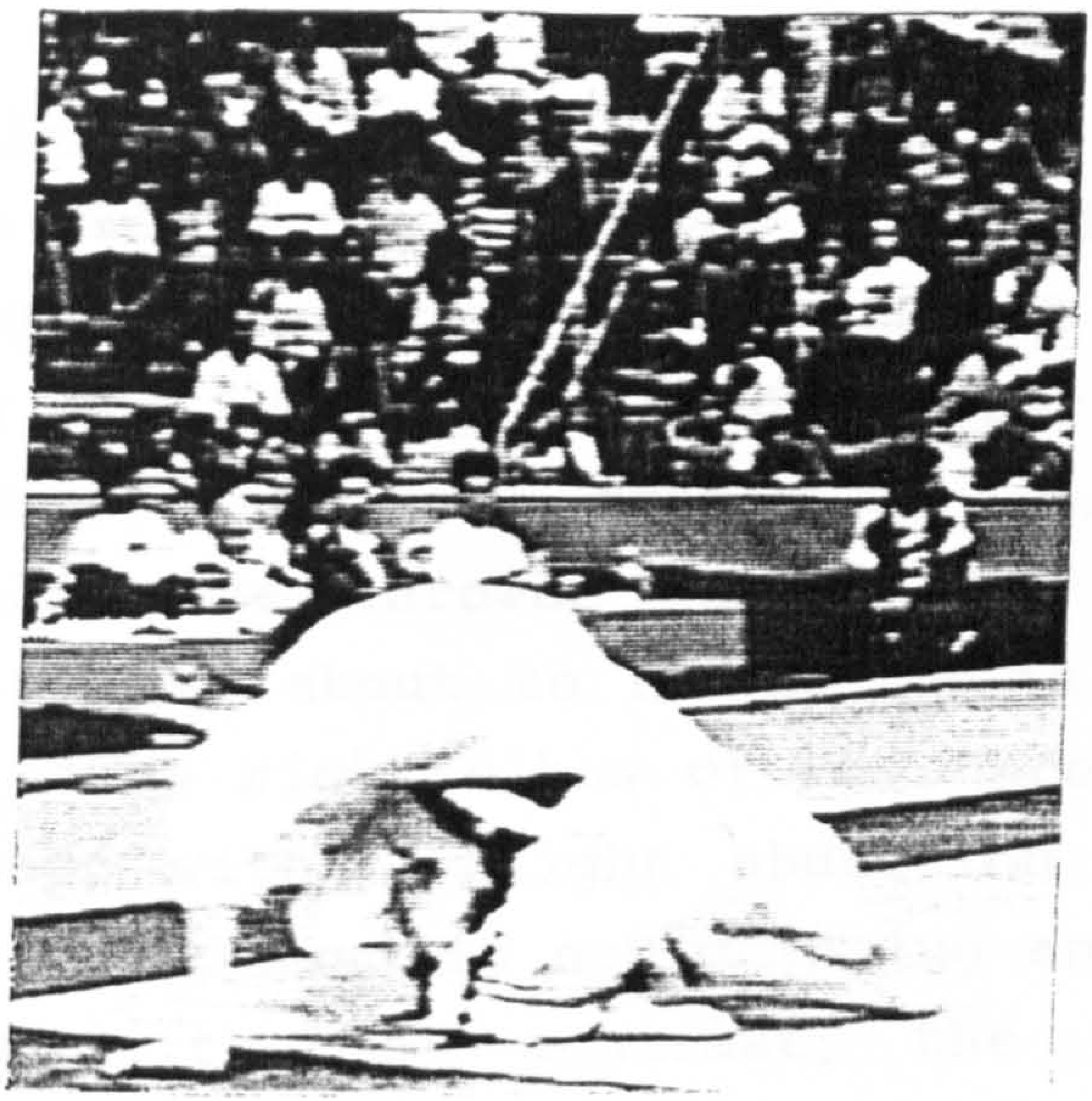

Frame 2 LMSN


Frame 3 LMSN

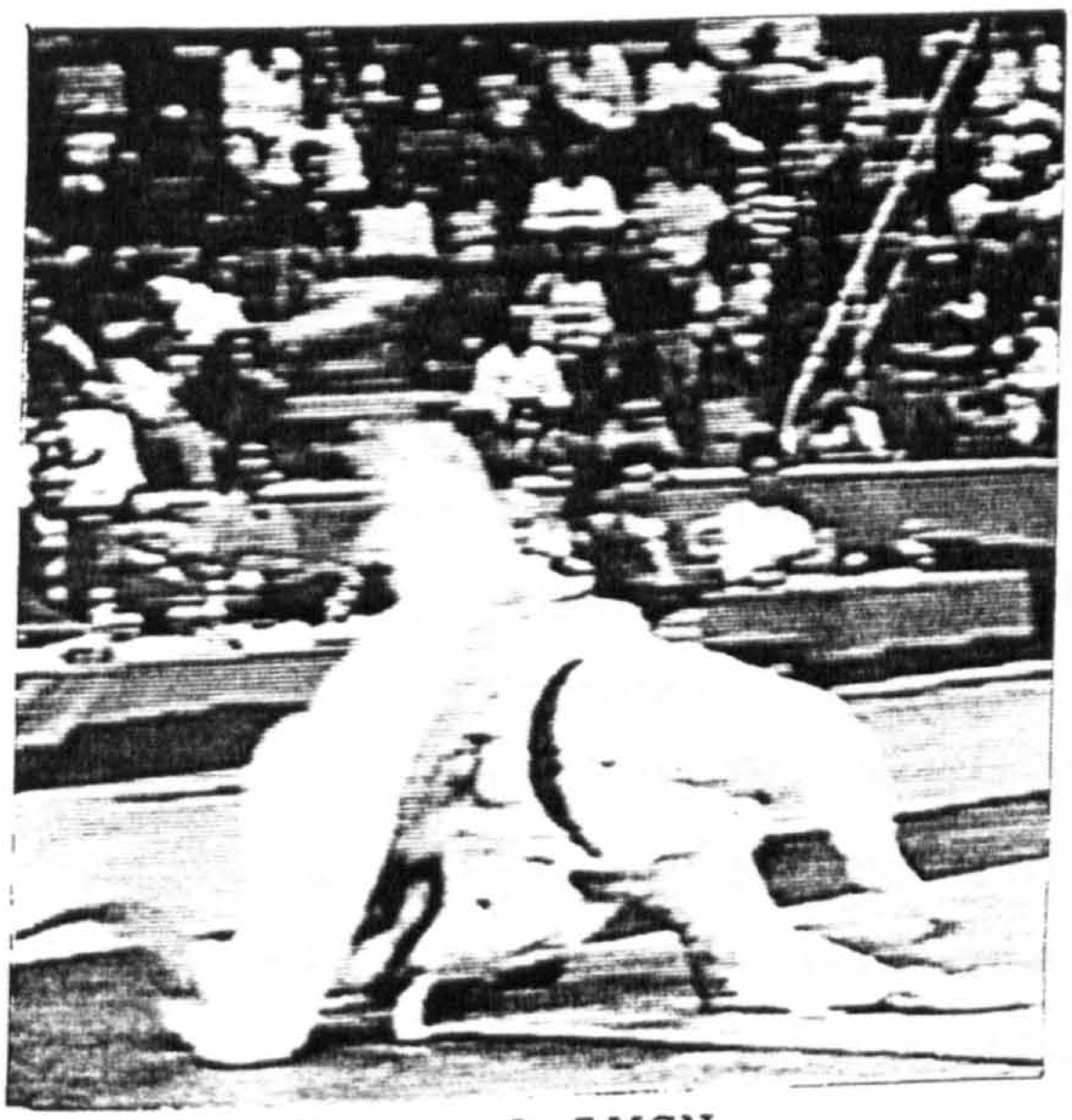

Frame 4 LMSN


Frame 5 LMSN


Frame 6 LMSN



Frame 7 LMSN

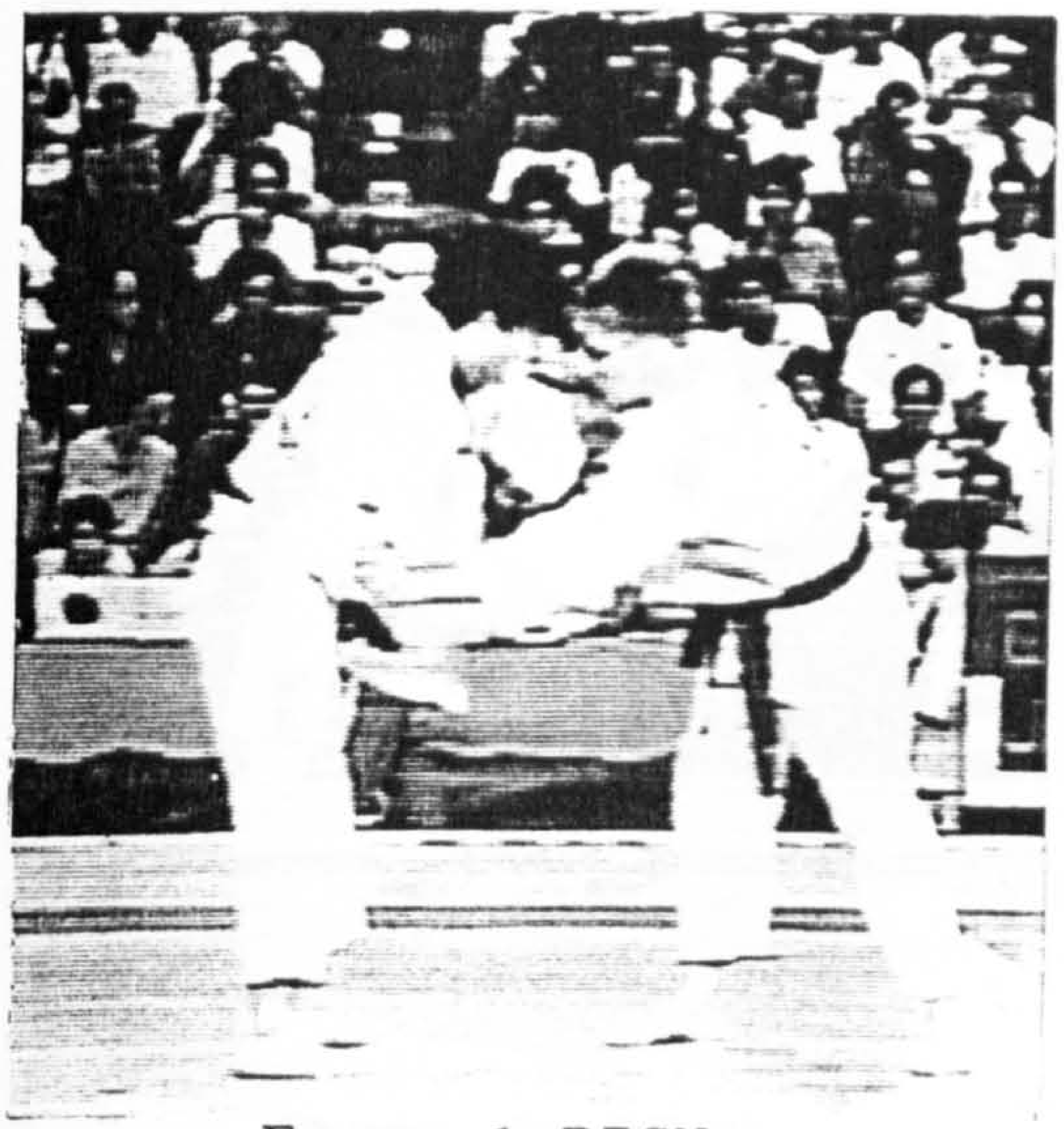


Frame 8 LMSN

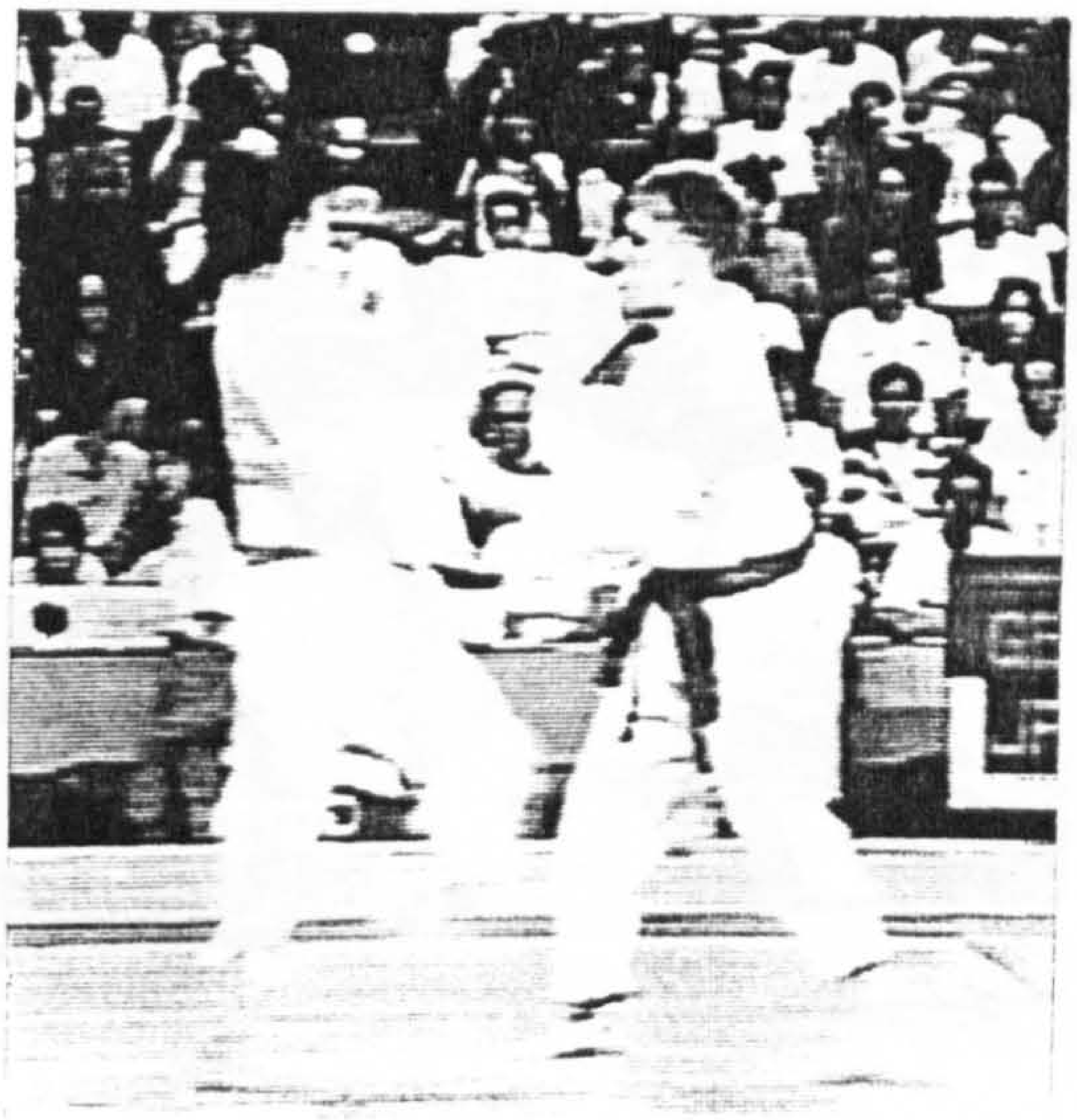
Right Ippon SEOI-NAGE (RISN)

This throw is characterised by a subtle change in direction during the technique to counteract the defensive ploy adopted by the opponent of the thrower. KUZUSHI is developed in the first three frames (Frames 1, 2 and 3 RISN). Initially the thrower is on the left and his opponent, who is just about to be thrown is on the right (Frame 1 RISN). The right elbow of the thrower is almost completely flexed, with a slight abduction of the right upper arm. The right hand is not gripping any part of the opponent's Judo suit. In contrast, the left hand is gripping the shoulder of the opponent's suit with the left upper arm horizontally flexed and the left elbow slightly extended. In Frame 2 RISN an anti-clockwise rotation is initiated in the upper body and continued with the hips and lower body so that the right leg of the thrower is brought forward to be placed, eventually, between the opponent's legs. The right elbow is still flexed with an adduction of the right shoulder. The left fore arm is slightly flexed with a horizontal flexion of the left upper arm. In Frames 3 and 4 RISN, KUZUSHI and TSUKURI are completed. The player about to be thrown is pulled forward off balance. The thrower's legs are widely spread in the sagittal plane providing a significant base of support and a position of strong dynamic equilibrium. As the opponent is pulled closer to the thrower in Frame 4 RISN, his left leg is drawn back closer to the right leg with a knee flexion of about 100^{o}. In this position it is likely that the thrower can achieve a greater amount of rotation to execute the throw. The horizontal extension of the thrower's left shoulder and a 90^{o} flexion of the left fore arm allows the opponent to be pulled forward and rotated anti-clockwise. The right elbow is fully flexed so that the opponent's right upper arm can be gripped by the thrower's right hand.

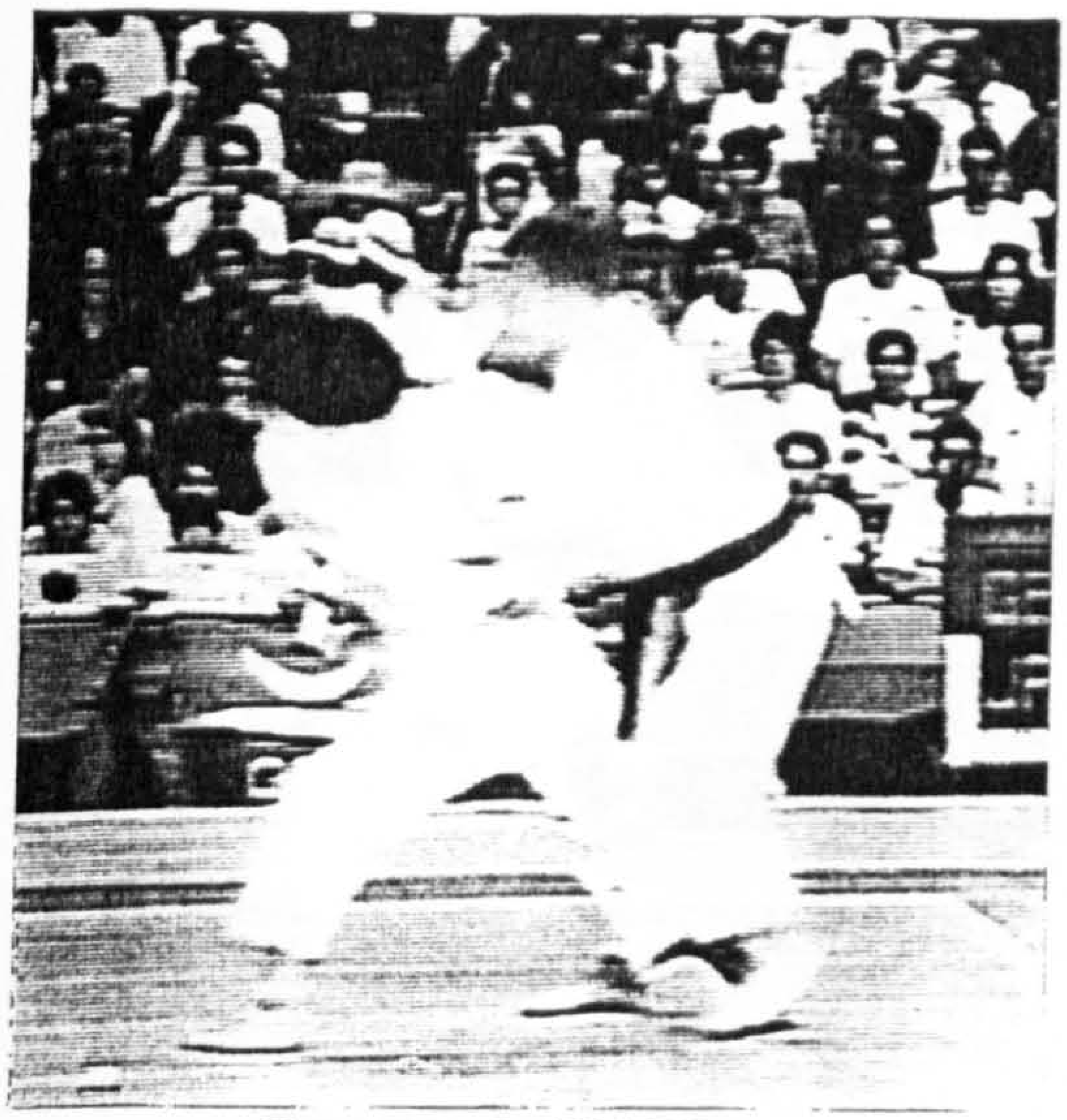
In Frames 5a, 5b, 6a and 6b RISN, KAKE is being developed, but the original plan to complete the throw has to be revised part way through the technique as the opponent takes evasive action. In Frame 5a RISN the thrower is developing his upper body movements to create the opportunity for lifting his opponent onto the thrower's back. However, sensing his possible demise, the opponent attempts to move to the left side of the thrower to avoid the possibility of IPPON. The thrower counteracts this manoeuvre by modifying his position with a movement of 45° in the clockwise direction. This is achieved by stepping backwards slightly with his right leg. This procedure is then followed by flexion of the thrower's trunk and an anti-clockwise rotation to raise the opponent onto his back and provide a platform for lifting his opponent off the floor. Frames 6 and 7 RISN shows the opponent in a horizontal position being carried on the thrower's back. Full flexion of the trunk and the wide base of support are shown in Frames 8a, 8b. The opponent is carried on the back of the thrower in a head down vertical position and is just about to be thrown for Ippon. A final anti-clockwise rotation of the trunk completes the throw successfully (Frames 9a, b and 10).



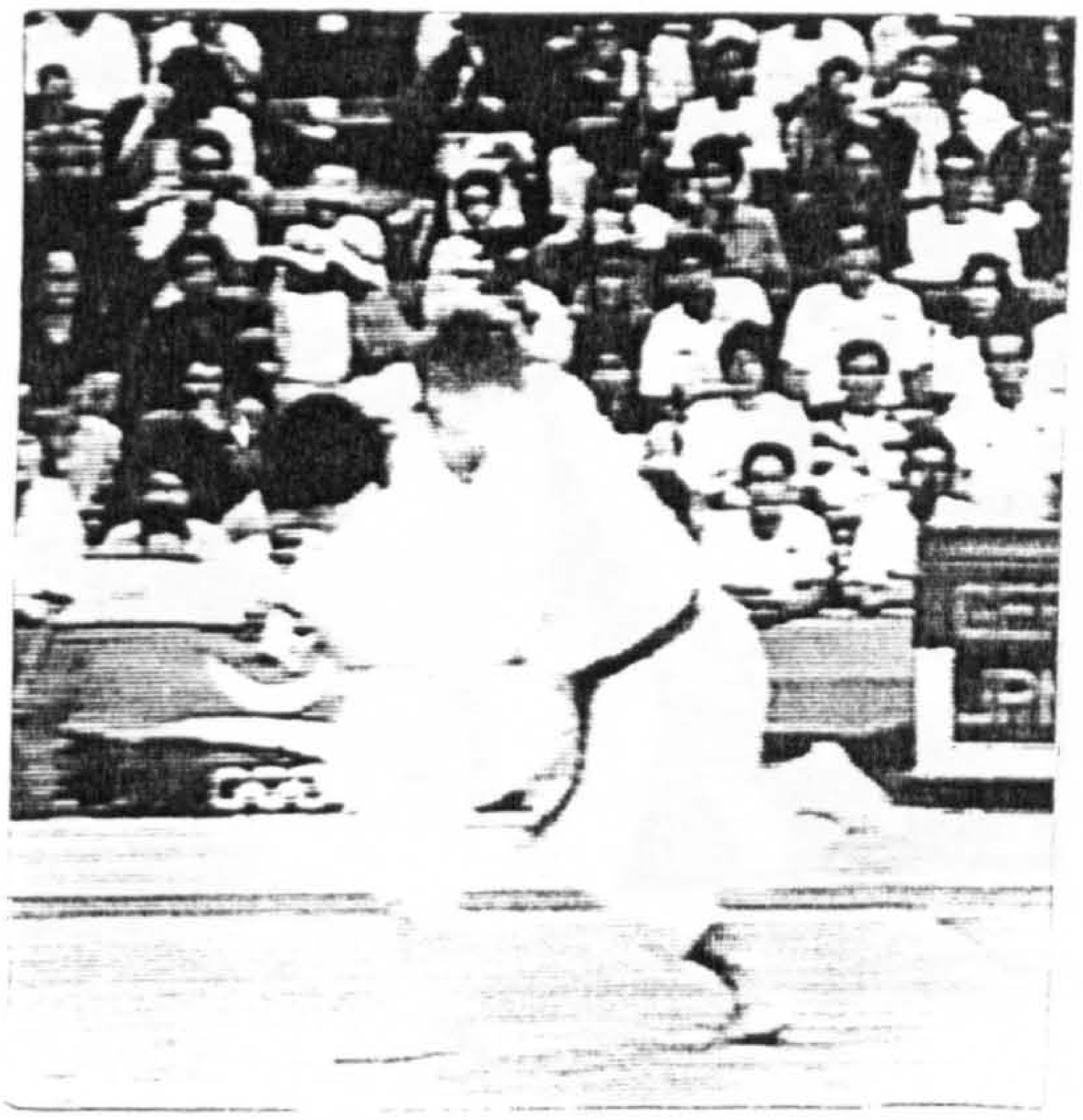
Frame 1 RISN



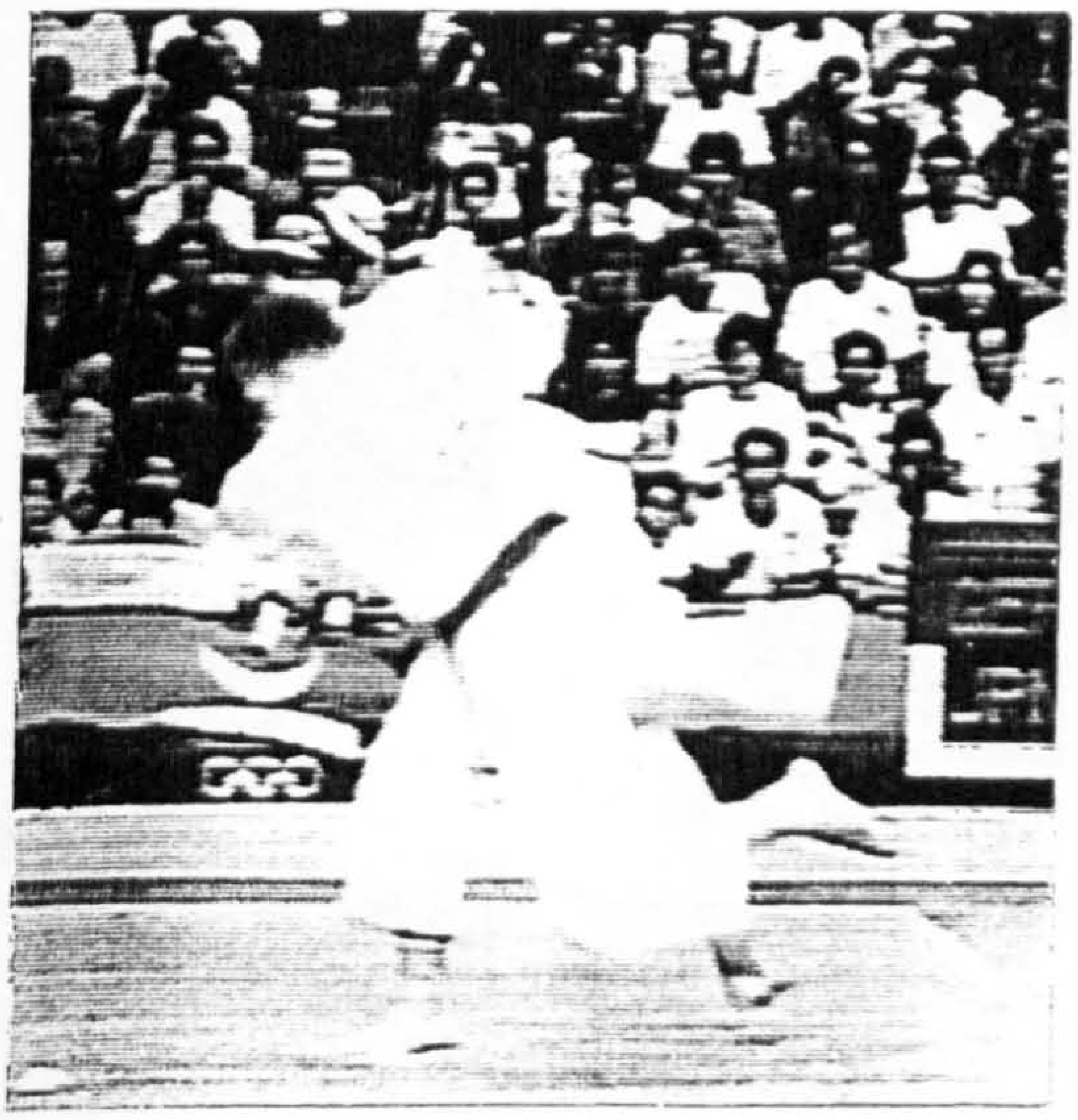
Frame 2 RISN



Frame 3 RISN

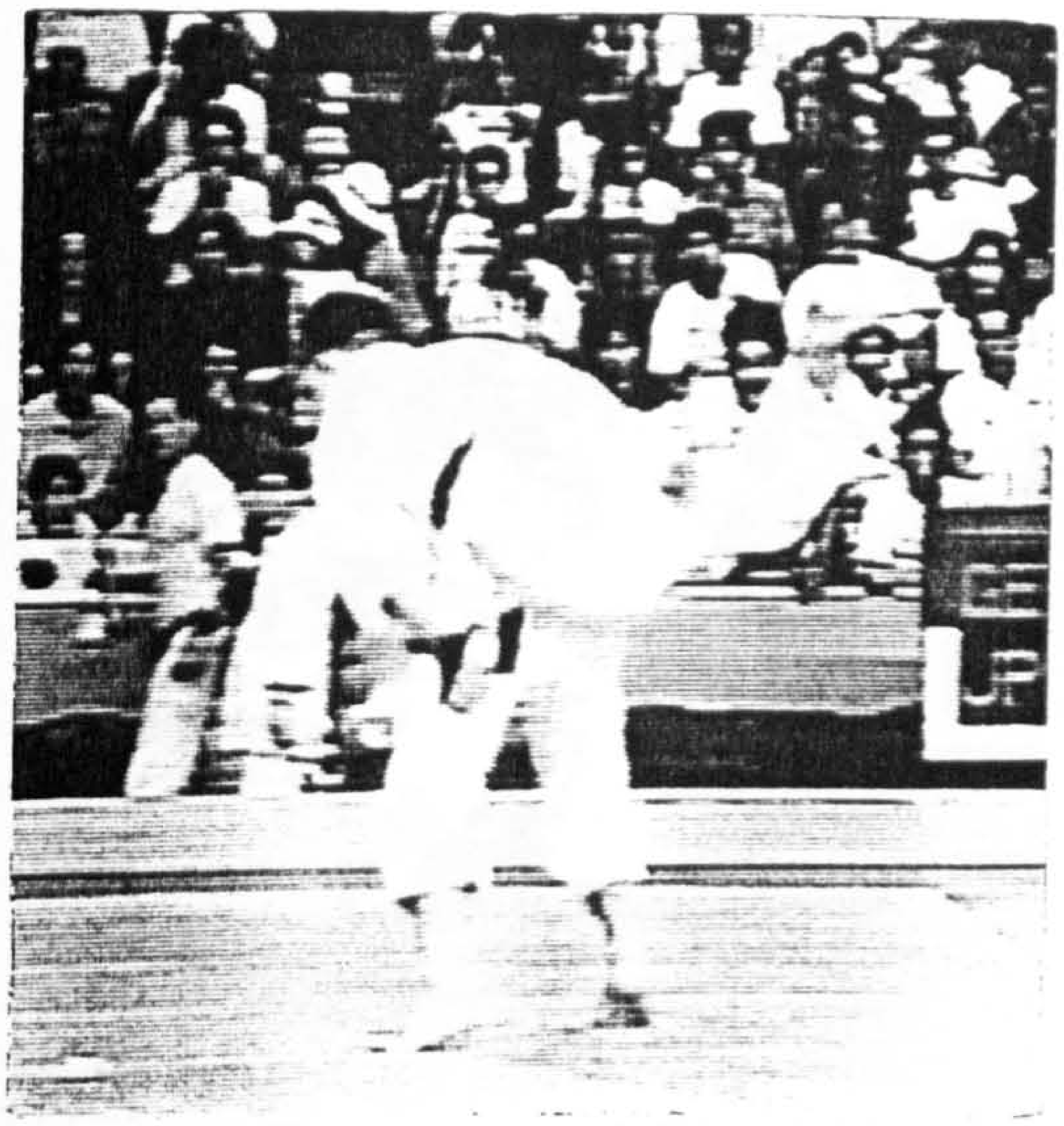


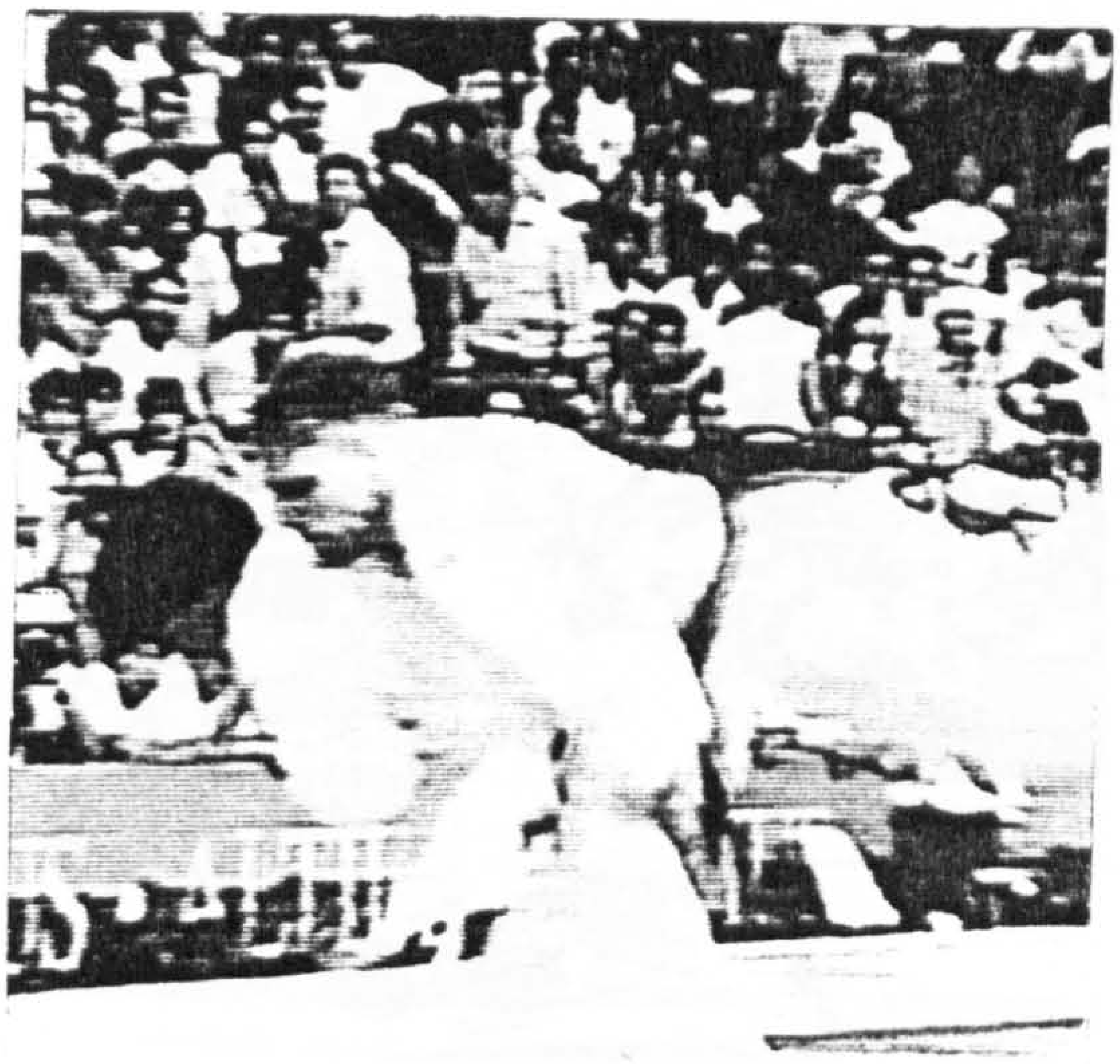
Frame 4 RISN

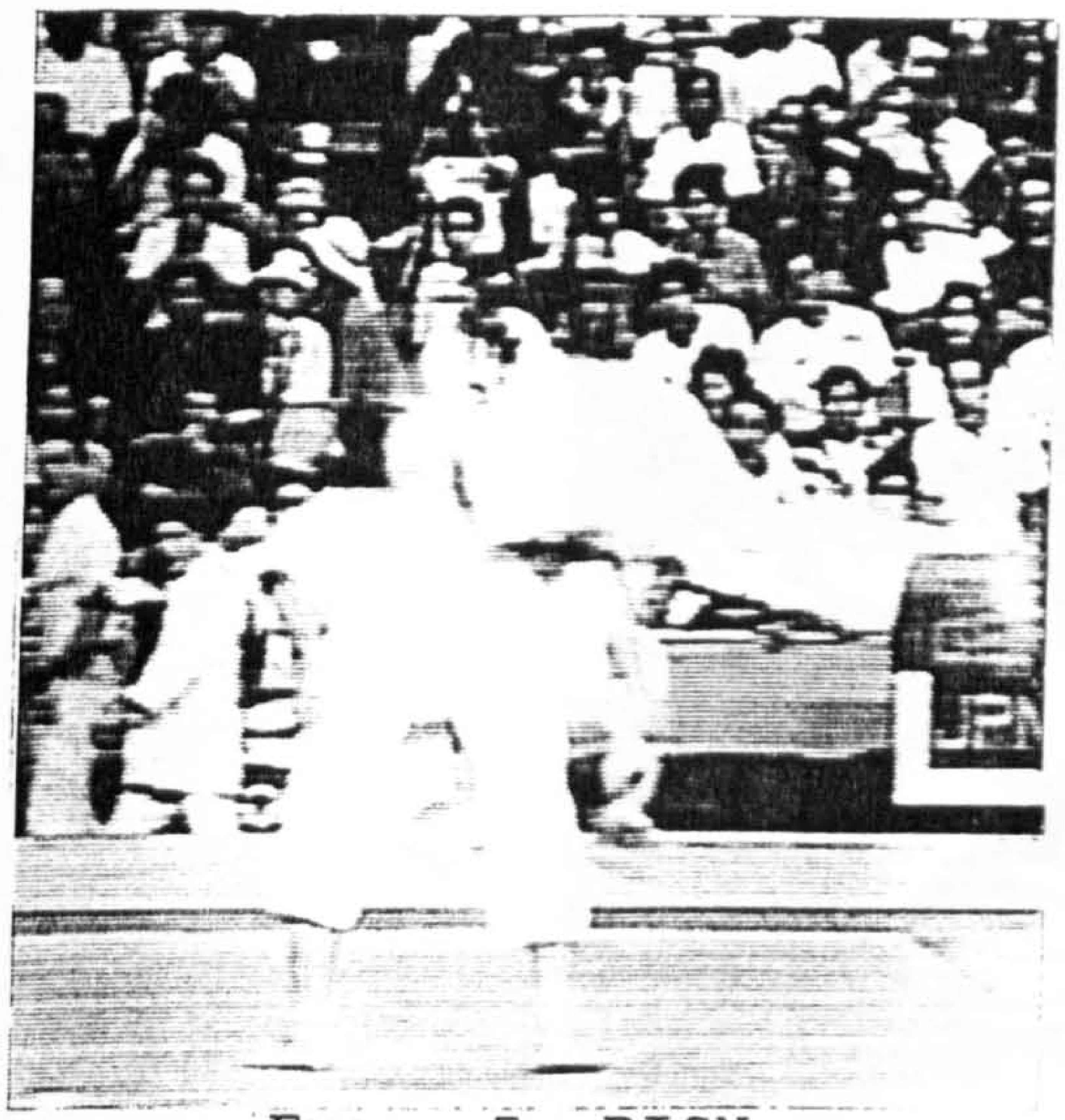


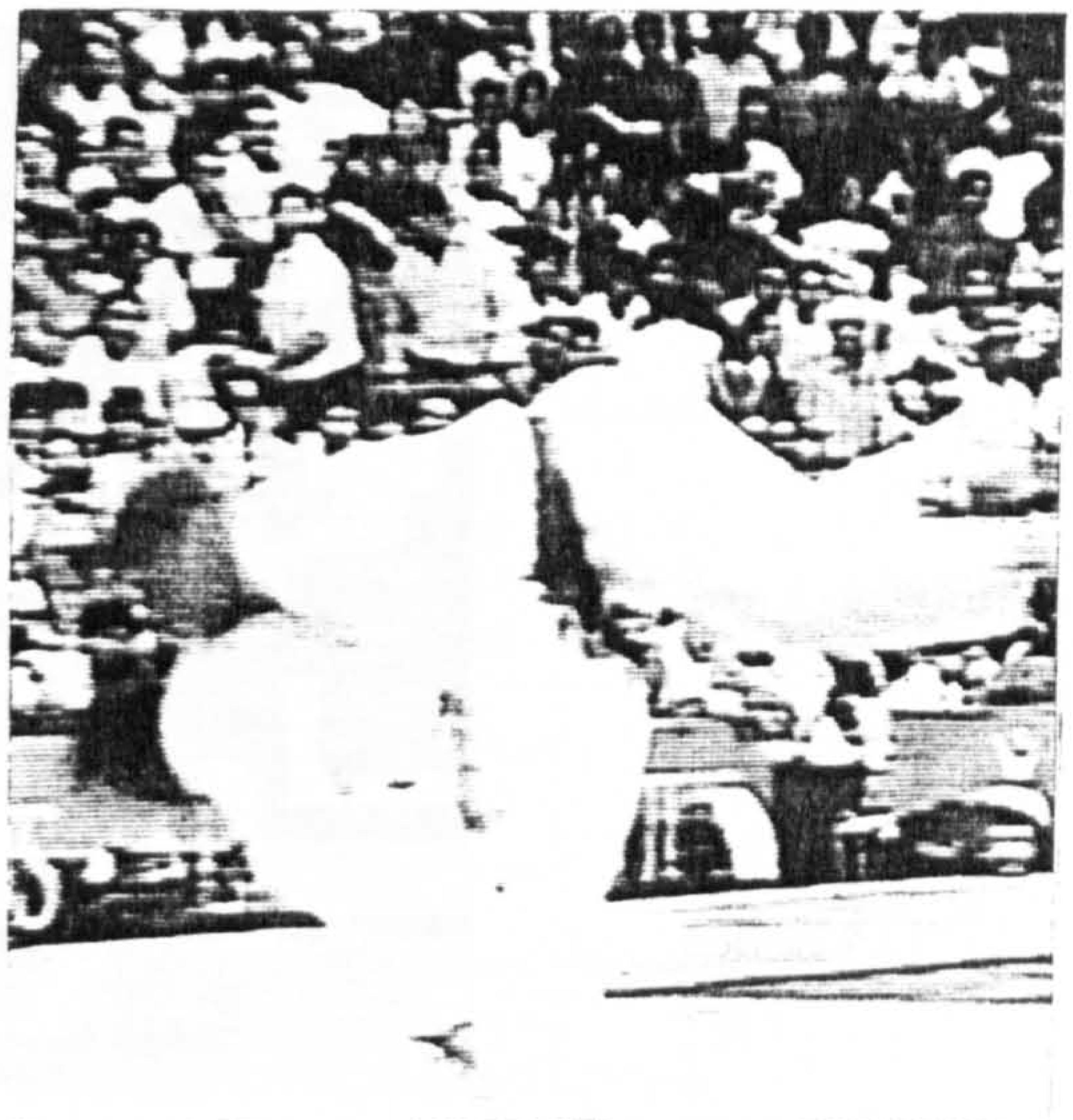
Frame 5a RISN

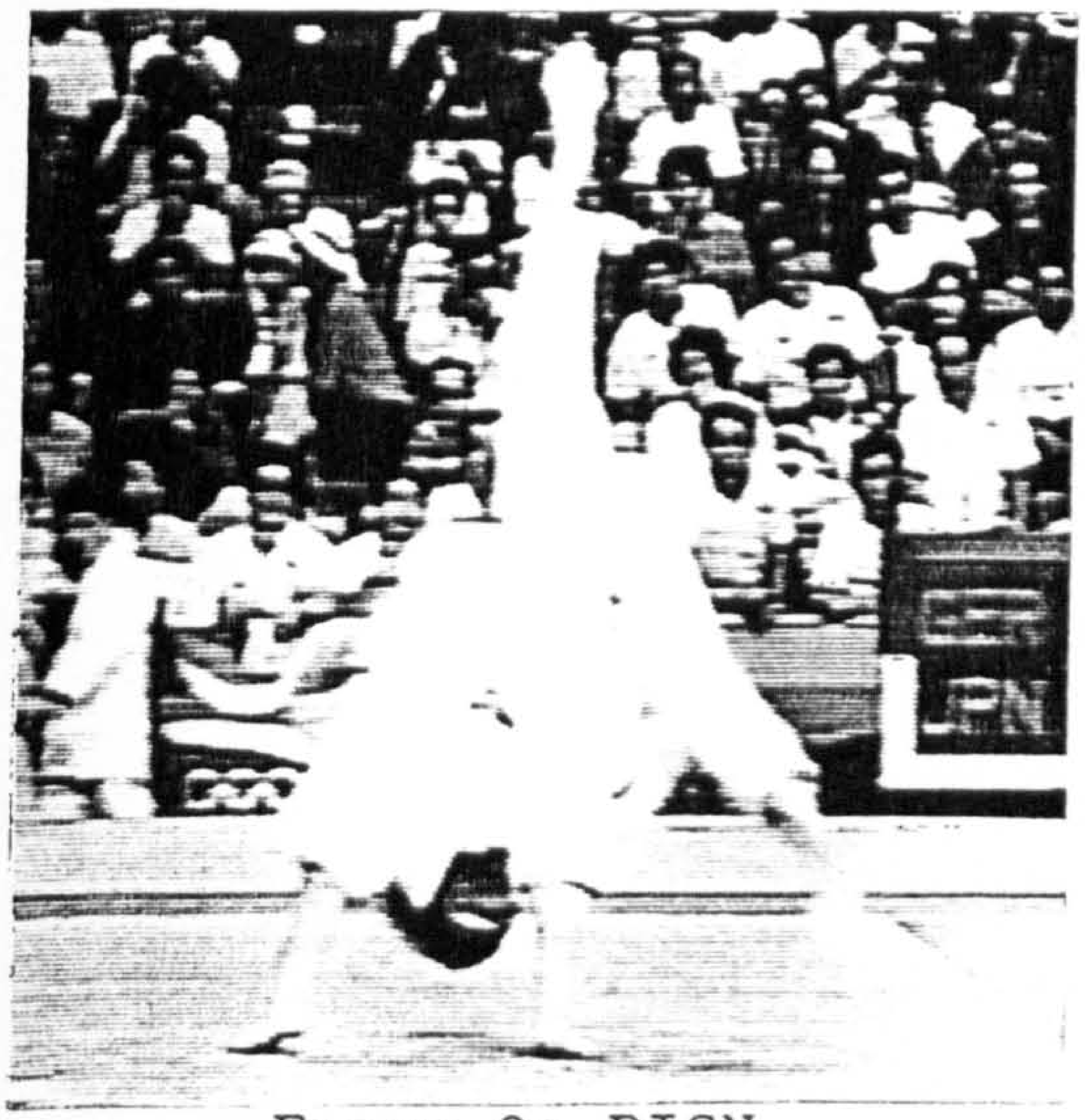
Frame 5b RISN


Frame 6a RISN


Frame 6b RISN


Frame 7a RISN


Frame 7b RISN


Frame 8a RISN


Frame 8b RISN

Frame 9a RISN

Frame 9b RISN

Frame 10 RISN

5.3.4 Summary of the main movements and muscle contractions during Seoi-Nage (right grip)

The main movements and the associated types of contraction are shown in table 5.2.

Place	Action	Contraction	Muscles
Both the left and right elbow joints For Morote SN the right Humeroradial joint	Flexion Pronation	Isometric Concentric	*biceps brachii *brachialis *brachioradialis *pronator teres
The left shoulder joint	Extension	Concentric	*posterior deltoid *supraspinatus *teres major *latissimus dorsi
For Ippon SN The right shoulder joint For Morote SN The right shoulder joint	Extension Adduction & Rotation	Isometric Concentric	*posterior deltoid *supraspinatus *teres major *latissimus dorsi *pectoralis major *latissimus dorsi *subscapularis
The trunk	Flexion	Concentric	*semispinalis thoracis *semispinalis cervicis *rectus abdominus *external and internal oblique
The vertebral column	Rotation & Extension	Concentric	*longissimus thoracis *illiocostalis lumborum and thoracis *quadratus lumborum
Both the left and right hip joints	Flexion	Concentric	*lliopsoas *Sartorius *Adductor longus and brevis *pectineus *rectus femoris *Tensor fasciae latae
Both the left and right knee joints	Extension	Concentric	*rectus femoris *vasti muscles

5.4 STRENGTH CONDITIONING PROGRAMMES DESIGNED SPECIFICALLY FOR THE STANDING TECHNIQUES OF UCHI-MATA AND SEOI-NAGE

Sections 5.3.2 and 5.3.5 have summarised the main movements and muscle contractions used in the two most successful standing techniques of Uchi-Mata and Seoi-Nage. Three main regions have identified.

* The arms and upper body
* The hips and trunk
* The legs

This section describes some strength conditioning exercises that can be used to improve performance in these standing techniques.

Main exercises for improving the strength in Arm movement used in SN and UM

Chest and Waist Pull
1, Constant resistance conditioning provided by weight
2, Variable Resistance conditioning by using rubber tubing

Seated Pulley Rowing

Upright Rowing

Optional exercise Arms

Bench Press

Chins

Dumbbell Curl

Lat Pull Down

Main exercises for improving strength in Trunk and hips movement used in SN and UM

Back Extension

Dead Lift

Side Lateral Bends

Sit-Ups (with twist)

Trunk Flex

Main exercises for improving strength in Legs movement used in SN and UM

Leg Abduction and Extension

1, Constant resistance conditioning provided by weight
2, Variable Resistance conditioning by using rubber tubing

Seated Leg Press

Squat

Optional exercise Legs

Leg Curl

Leg Extension

<u>Main exercise of the arms and upper body</u>

<u>1 Chest and Waist Pull</u>

<u>Pattern 1</u>

Attach a length of rubber tubing to a fixed metal frame. Stand facing the machine while gripping the rubber tube in one hand (Figure 5.1) and the knees are slightly flexed. The tube should then be pulled rapidly into the position depicted in Figure 5.2, using rotation the body and horizontal extension of the arm. At the end of the movement, the hand gripping the tube should be higher than eye level and the face should be turned away.

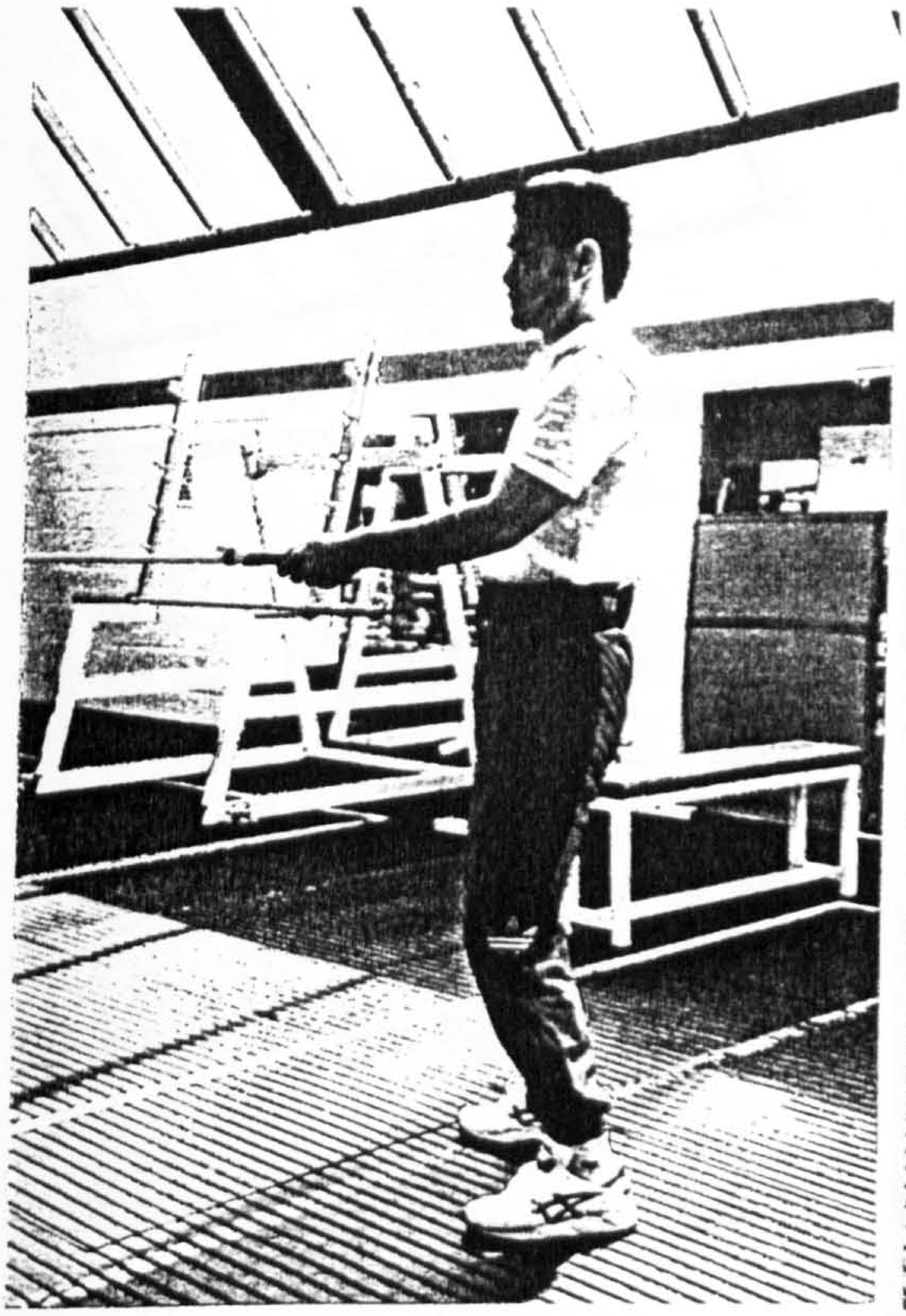


Figure 5.1 Stance phase for variable resistance conditioning (Pattern 1)

Figure 5.2 The final position for variable resistance conditioning (Pattern 1)

<u>Pattern 2</u>

Stand sideways relative to the frame, again gripping the rubber tube in one hand at the shoulder level (Figure 5.3). The tube should then be pulled rapidly into the position by horizontally extending the upper-arm as seen in Figure 5.4. However, during this movement, the angle of the elbow should not change, the arm should be held well away from the trunk and the trunk should be fixed. In this case only the muscles around the shoulder and in the arm will be causing the rubber tube to increase in length

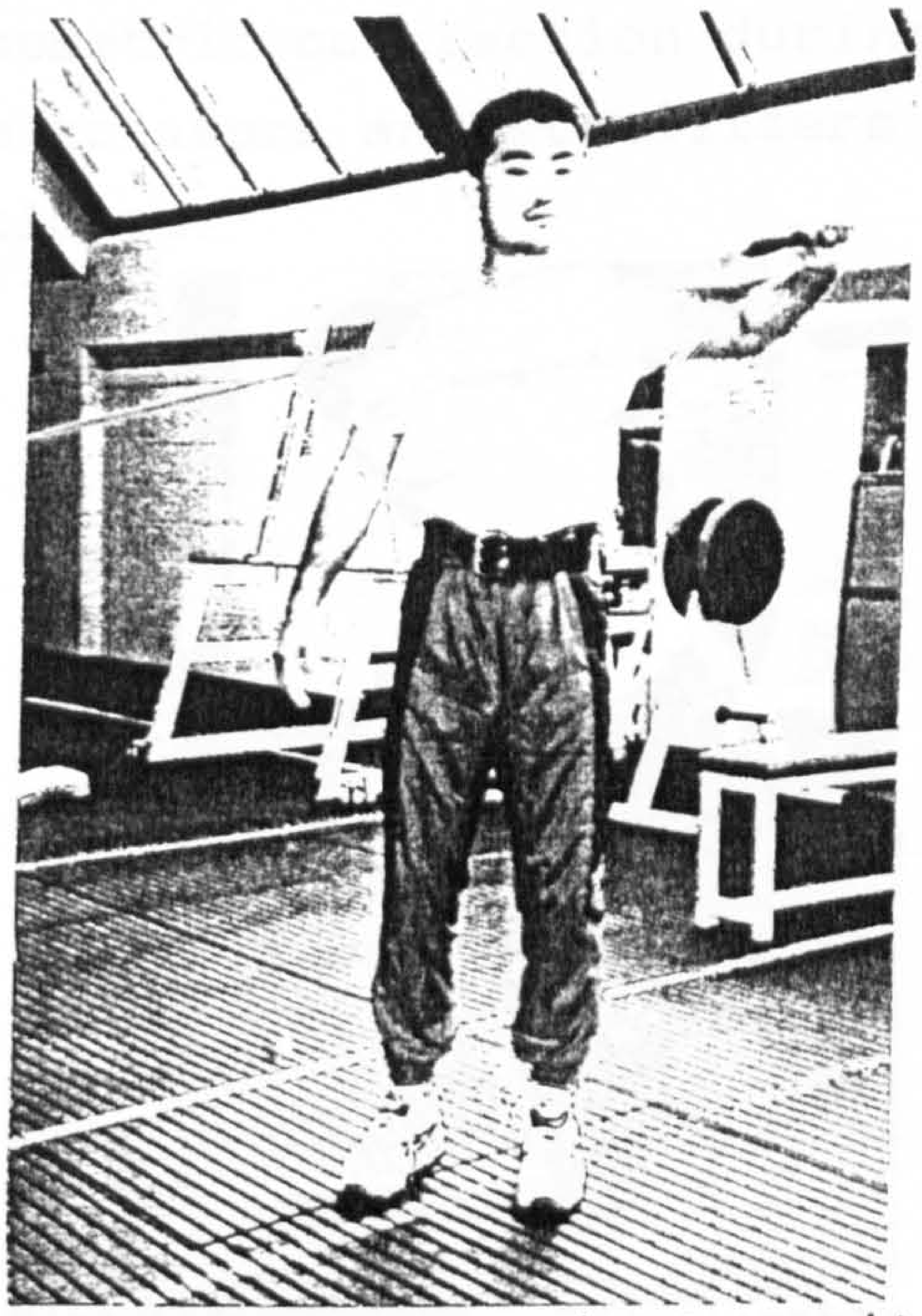


Figure 5.4 The final position for Pattern 2

Figure 5.3 The initial position for exercise Patterns 2 and 3

Figure 5.5 The final position for Pattern 3

Pattern 3

The initial standing position in this exercise is exactly the same as in Pattern 2, however, the knees are slightly flexed (Figure 5.3). Pulling on the rubber tubing causes the trunk to rotate through 90^{o} (Figure 5.5). The arm should be maintained in an isometric contraction during this exercise. Therefore the rotators and stabilizers of the trunk and hips are conditioned.

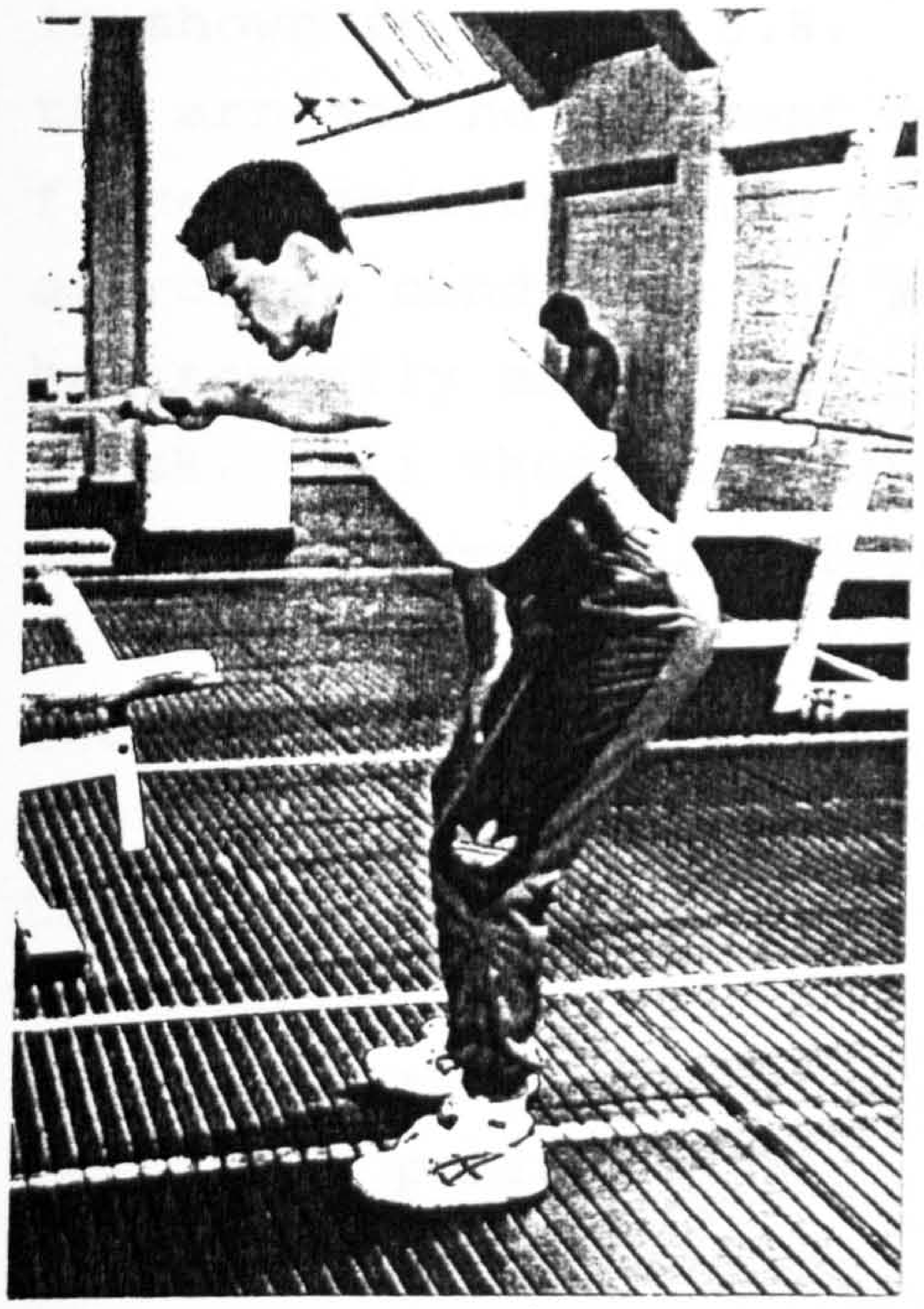


Figure 5.6 The initial position for exercise Patterns 4 and 5

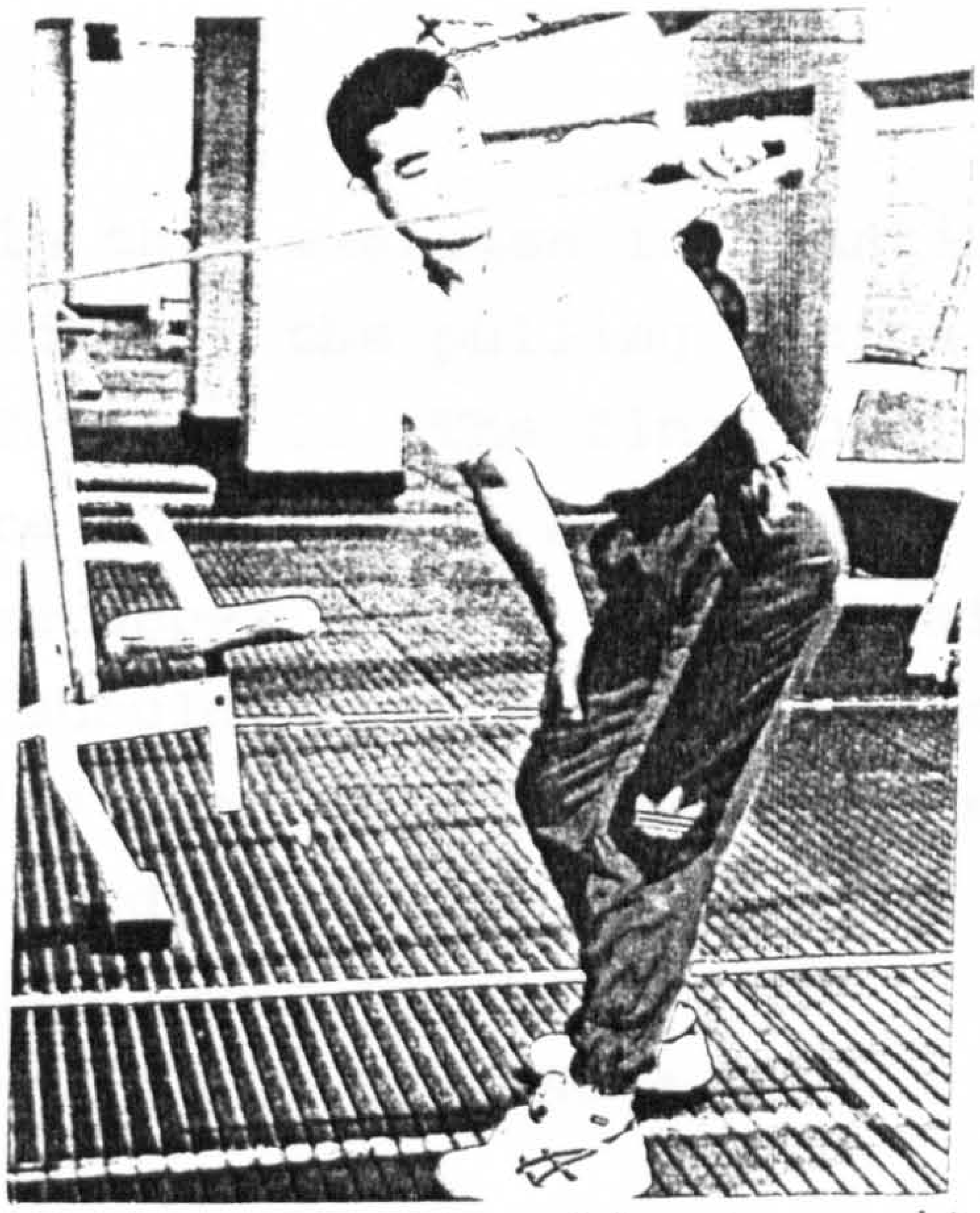


Figure 5.7 The final position for Pattern 4

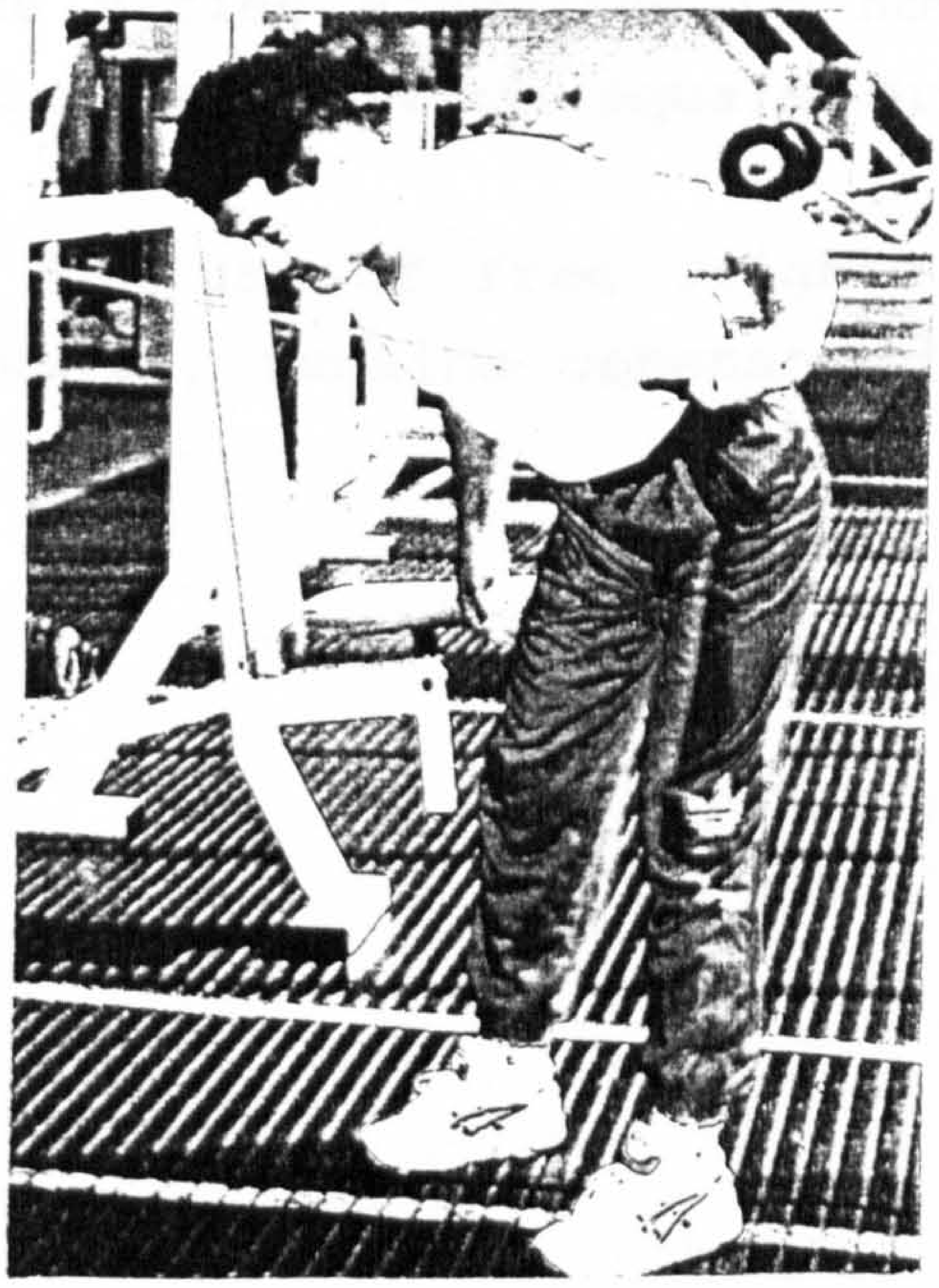


Figure 5.8 The final position for Pattern 5

Pattern 4

The initial stance position is again side on to the frame (Figure 5.6), however there is 45^{o}~60^{o} of flexion at the waist. This position is adopted because it is an integral part of KUZUSHI when attempting Uchi-Mata and Seoi-Nage. The pulling sequence is the same as that employed in Pattern 2. The final position of this exercise is shown in Figure 5.7.

Pattern 5

The initial stance position in this exercise is identical to that used in Pattern 4. However the pulling action is the same as that adopted in Pattern 3. The final position is shown in Figure 5.8. There should only be movement of the arm and no movement of the upper body. The initial flexed position of the trunk should be retained. These exercises condition the muscles that extend the fore-arms, horizontally extend the upper-body and also rotate the trunk. All these movements have been identified as important components of Uchi-Mata and Seoi-Nage.

The resistance created when the rubber tube is used during the movement of the exercise varies according to how far the rubber is stretched. Greater stretch equals greater resistance.
The resistance generated by the use of free weights, for example a pulley machine however, remains constant during the same movement.

2 Seated Pulley Rowing

A weight stack and pulley system on a multigym are used in this exercise. The feet are placed on the footpads, with the legs slightly flexed at the knees (Figure 5.9). Using an overgrasp grip on the bar, the bar is pulled into the chest. When the bar is being pulled, the elbows should be kept high in line with the shoulders (Figure 5.10).

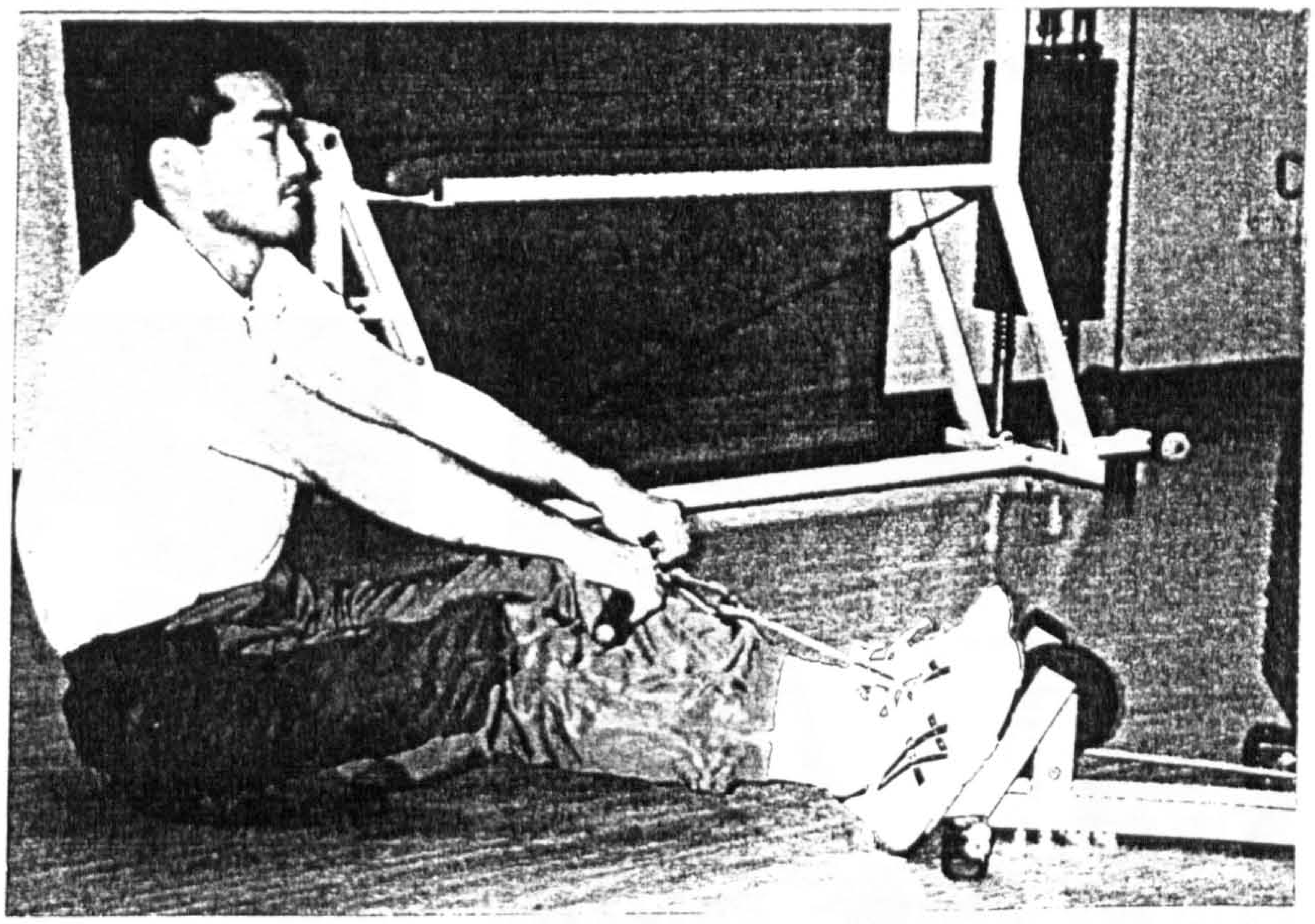


Figure 5.9
The initial position of the seated pulley rowing exercise

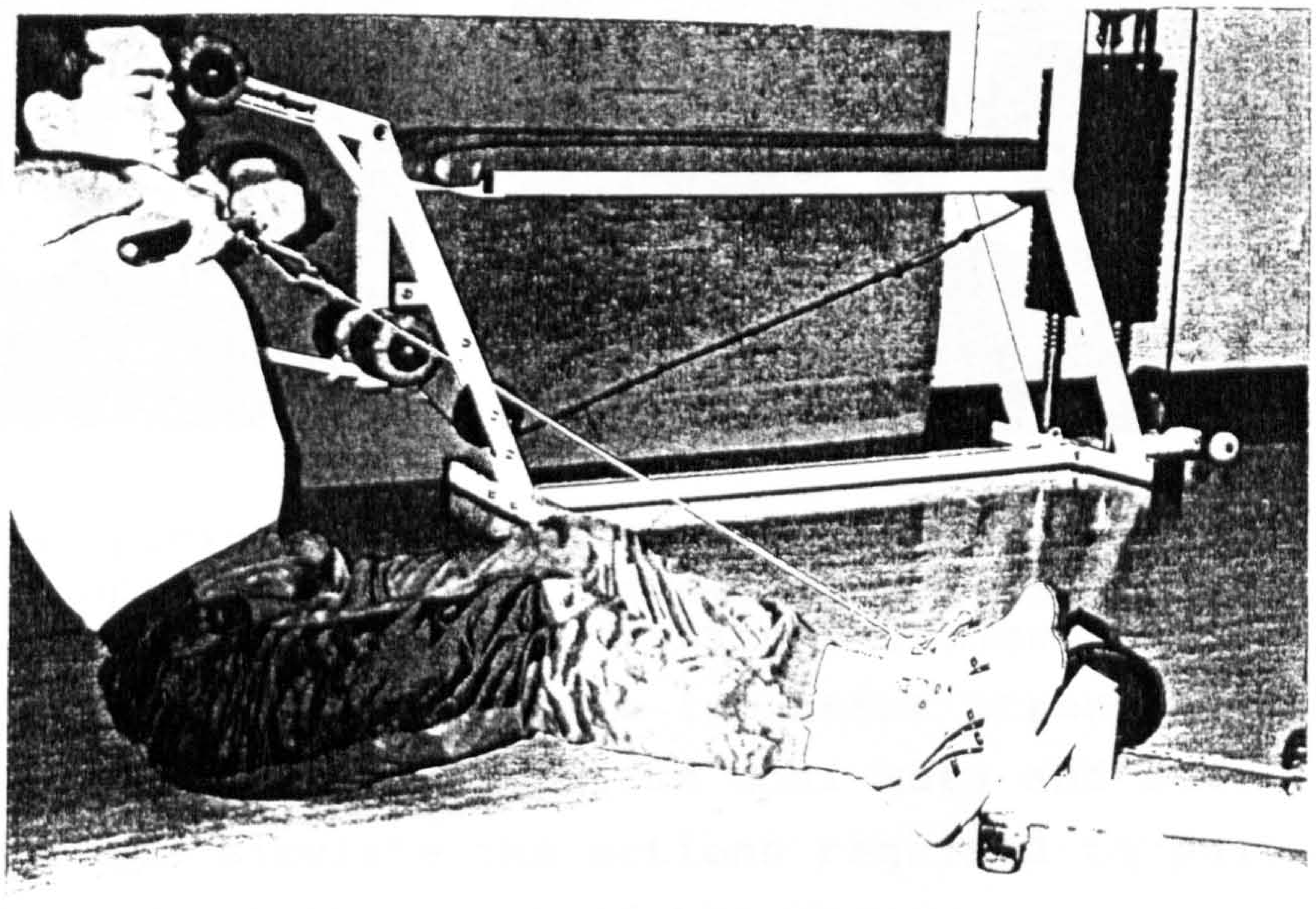


Figure 5.10
The final position of the seated pulley rowing exercise

3 Upright Rowing

Free weights or a multigym are used in this exercise. The feet are placed approximately shoulder width apart in a standing position (Figure 5.11). The bar is held with an overgrasp, and the bar is pulled up to the chin, keeping the elbow flexed and above the line of the bar at all times. The elbows should be fully flexed at the top of the pull (Figure 5.12). These exercises condition the muscles that flex the fore-arm and extend the upper-arms.

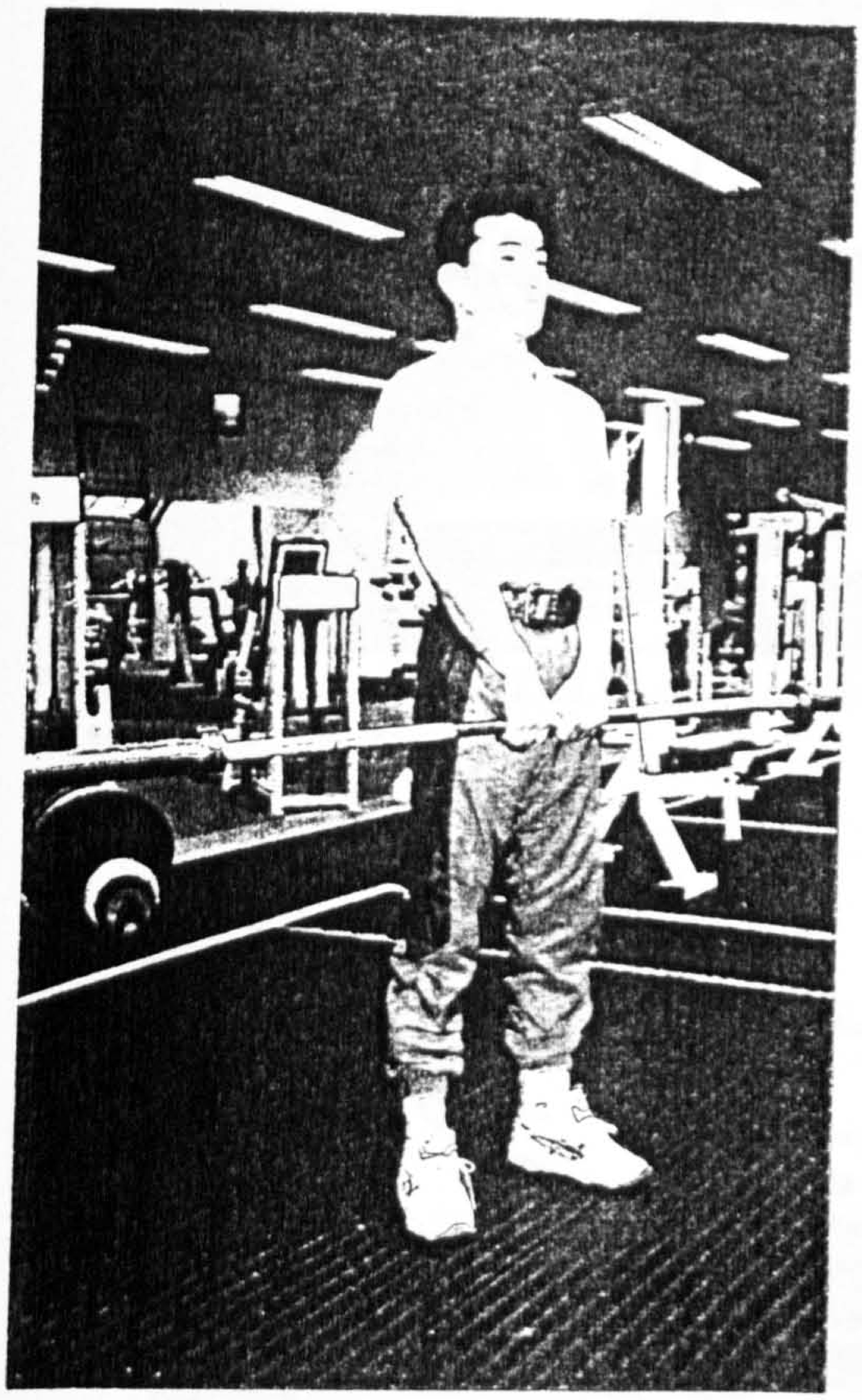


Figure 5.11 The initial position of the upright rowing exercise

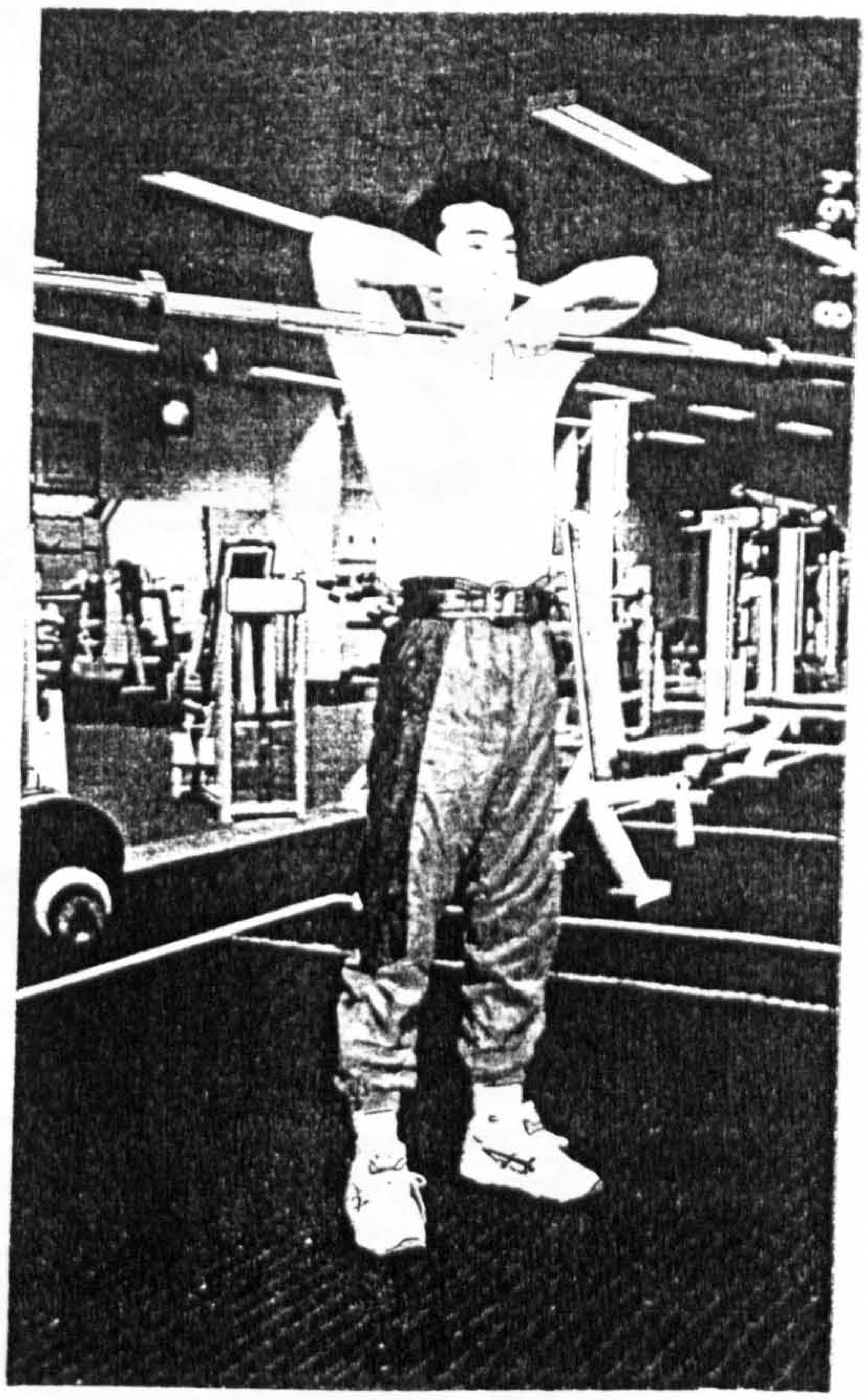


Figure 5.12 The final position of the upright rowing exercise

All of the exercises (1,2 and 3) are important strength conditioning components for KUZUSHI in Uchi-Mata and Seoi-Nage. The movements simulate the actions required to pull the opponent forward at the start of the throw.

4 Back Extension

In this exercise the upper body is flexed over the edge of a bench lying face downwards with the lower legs fixed (Figure 5.13). The upper-body is extended so that the entire body is parallel with the floor (Figure 5.14). It is important to avoid hyperextension of the spine as this causes abnormal intradisc pressure, which may lead to injury.

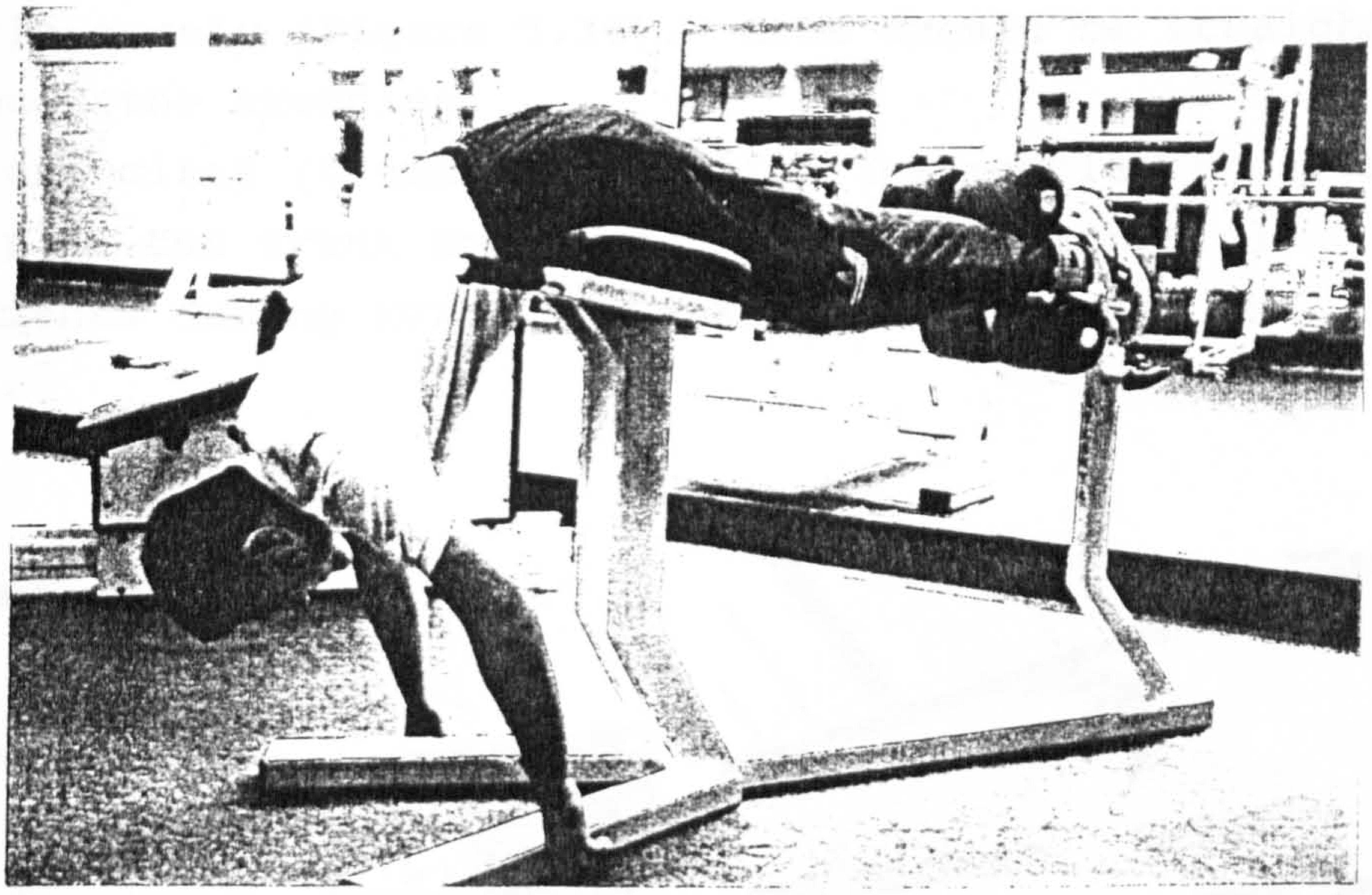


Figure 5.13 The initial position of the back extension exercise

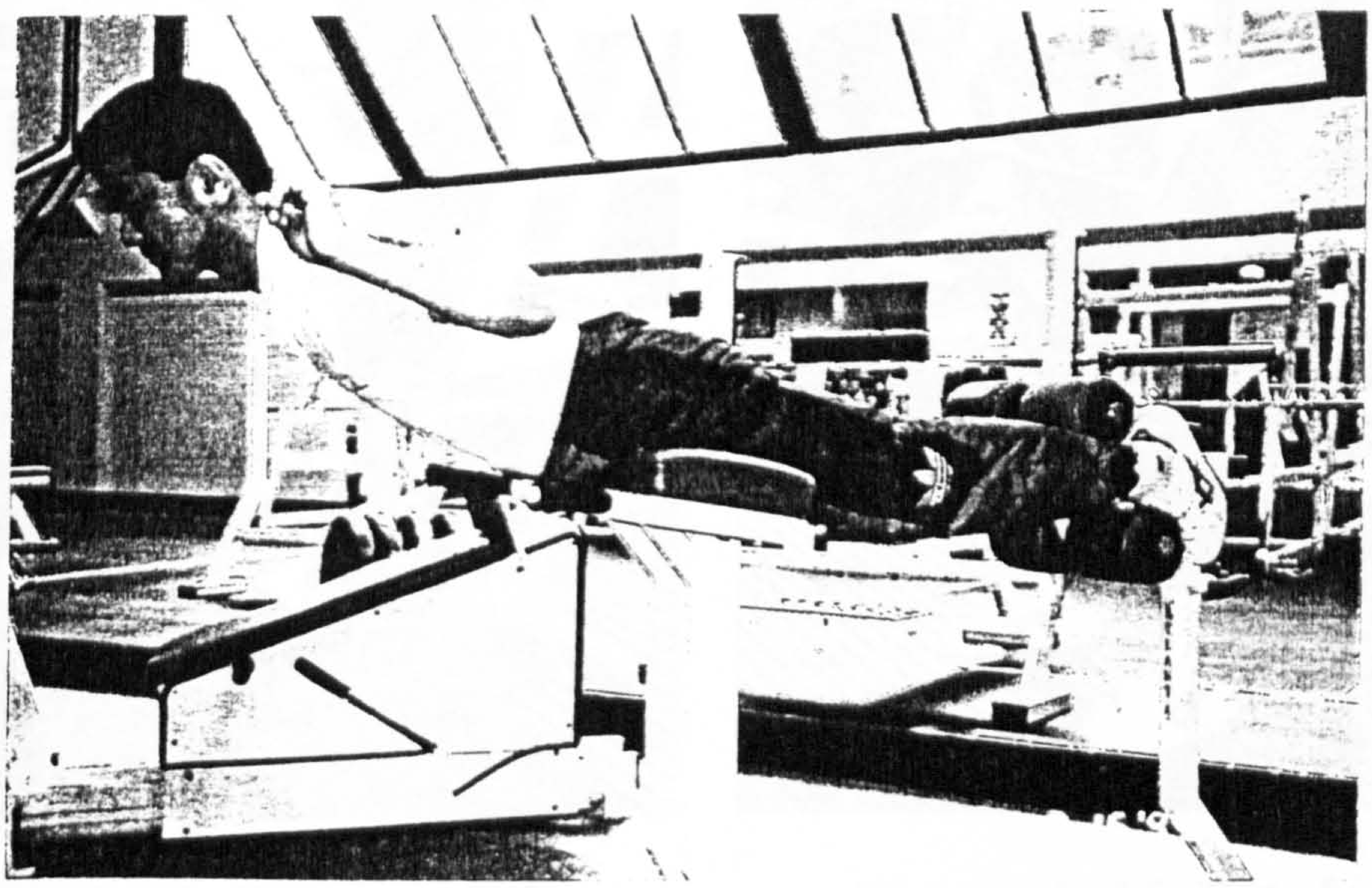


Figure 5.14 The final position of the back extension exercise

5 Dead Lift

Free weights are used in this exercise. The feet are placed approximately shoulder width apart in a standing position. The bar is grasped in an overgrasp grip. Initially, the knees are flexed. The back is kept straight and in a neutral position, neither flexed or extended (Figure 5.15). The free weights are then lifted up and backwards until the knees are fully extended using the legs only (Figure 5.16). Arms should be straight through the exercise.

The exercises (4 and 5) condition the muscles that extend and flex the trunk and hips. These are essential movements during KUZUSHI and KAKE of Uchi-Mata and Seoi-Nage.

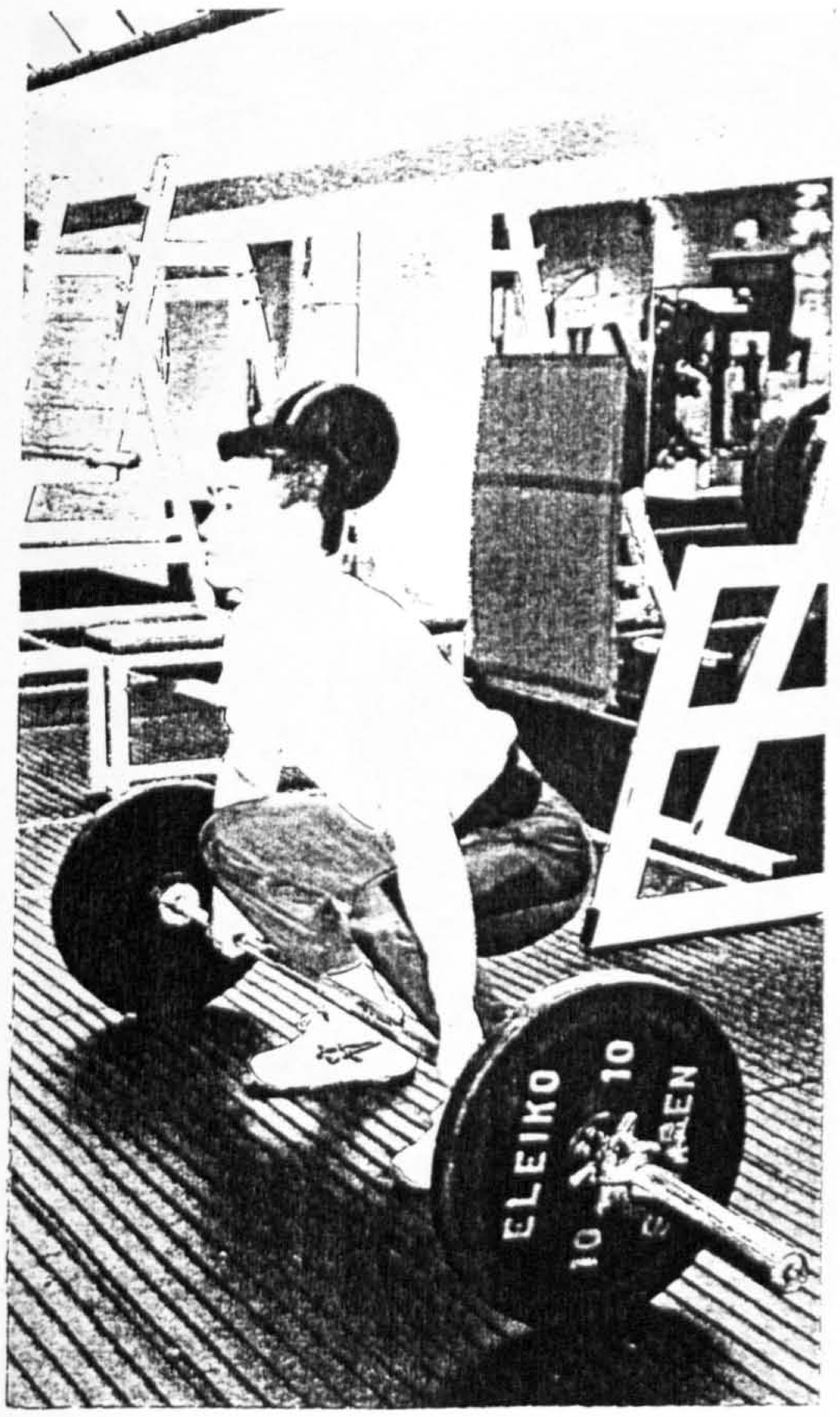


Figure 5.15 The initial position of the dead lift exercise

Figure 5.16 The final position of the dead lift exercise

6 Side Lateral Bends

Free weights in the form of dumbbells or a weight stack in a multigym station is used in this exercise. Standing sideways relative to the multigym station while gripping the bar (or dumbbell) the elbow is kept in an extended position and the arm is adducted (Figure 5.17). The bar is lifted by lateral flexion sideways, up and away from the main frame as far as possible (Figure 5.18). For better posture during exercise the opposite arm is bent to touch the head with the hand or fingers (Figure 5.17 and 5.18).

This exercise conditions the muscles that laterally flex the trunk.

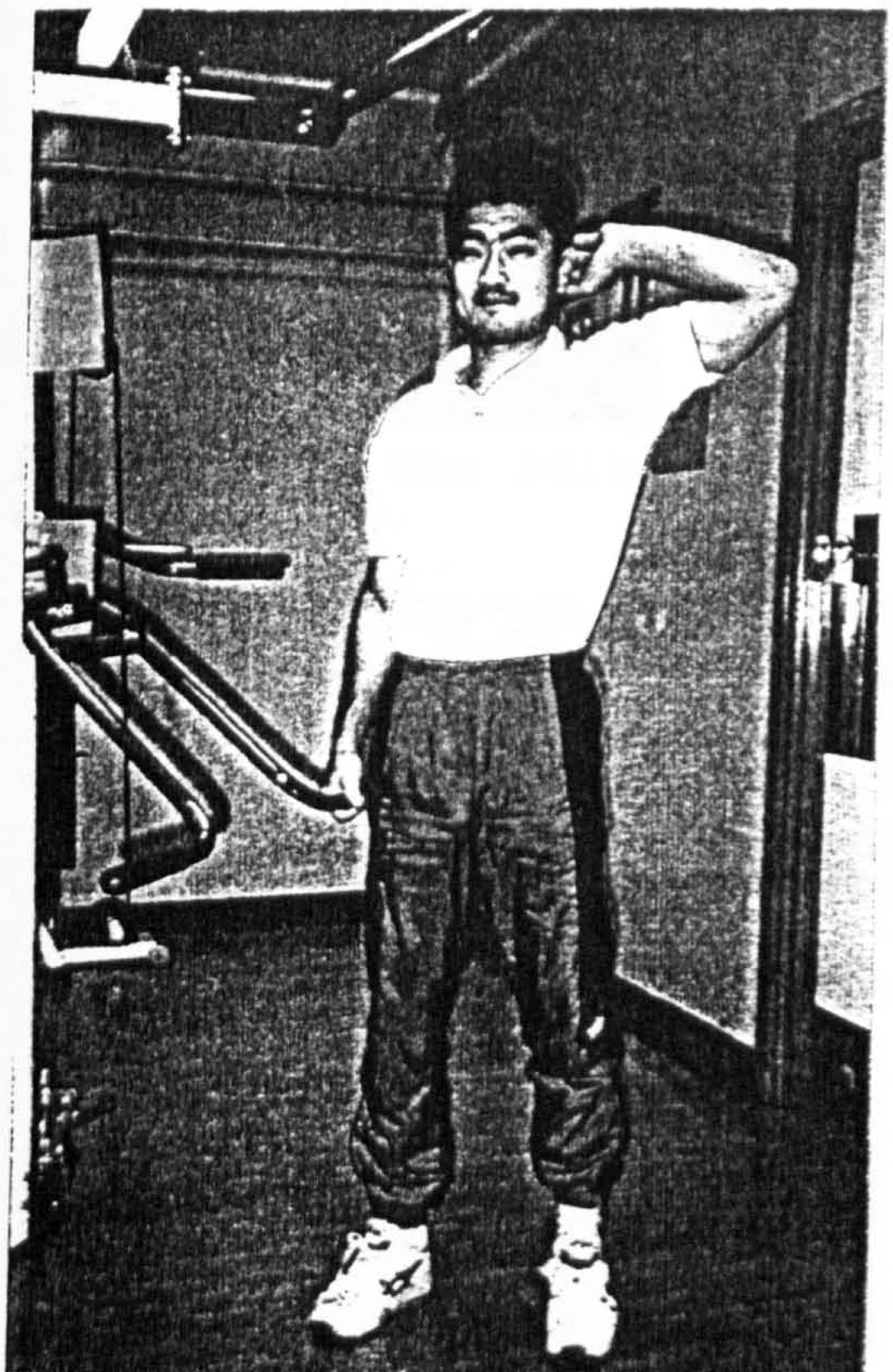


Figure 5.17 The initial position of the side lateral bends exercise

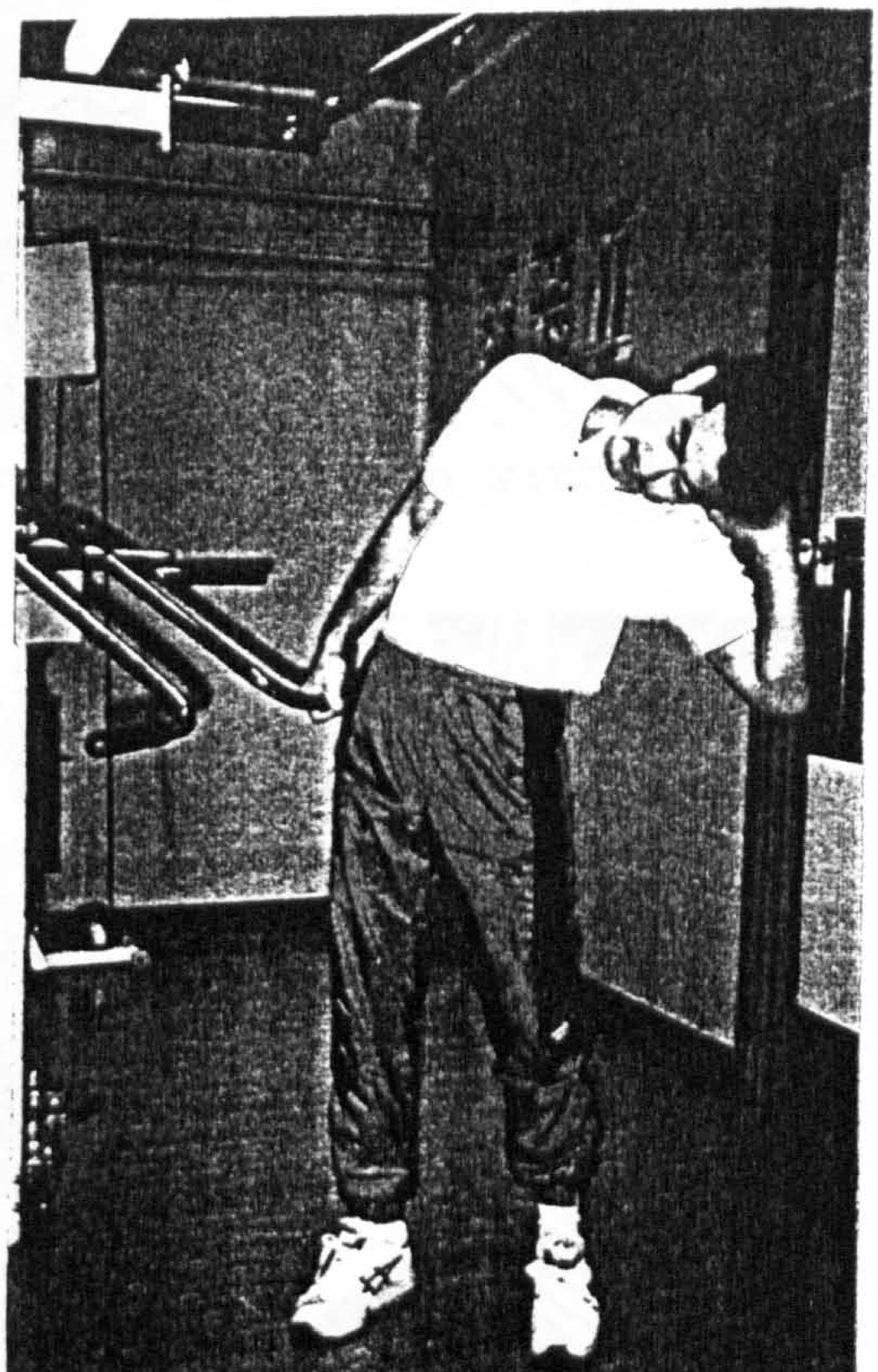


Figure 5.18 The final position of the side lateral bends exercise

7 Sit-Ups (with twist)

In this exercise the lower legs are placed on a bench with the knees flexed and the upper body lying flat on the ground. One hand is positioned on the side of the head whilst the opposite arm remains straight and flat against the floor (Figure 5.19). The aim of the exercise is to touch the elbow of one arm against the opposite knee (Figure 5.20).

This exercise conditions the muscles that flex and rotate the trunk.

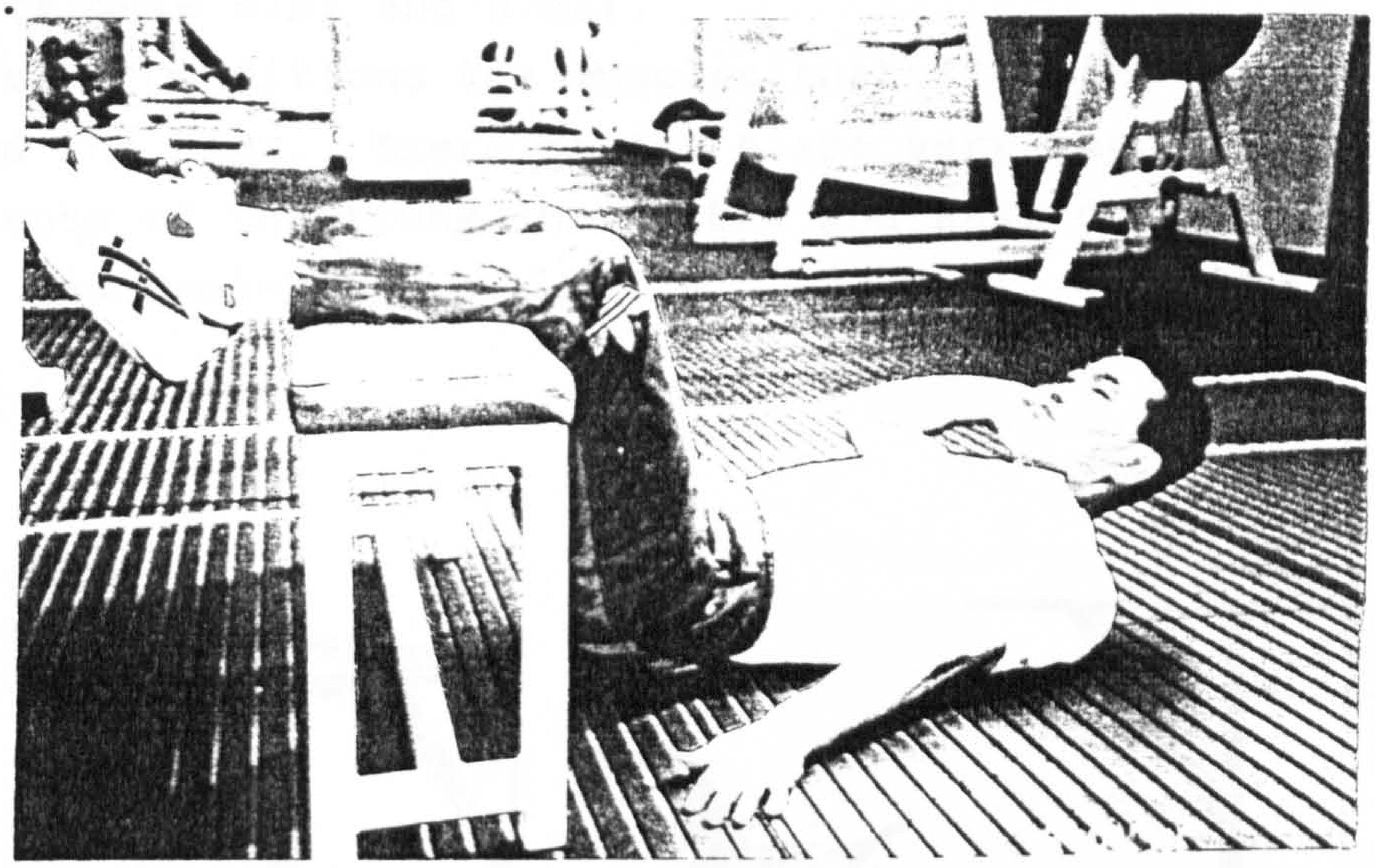


Figure 5.19 The initial position of the sit-up with twist exercise

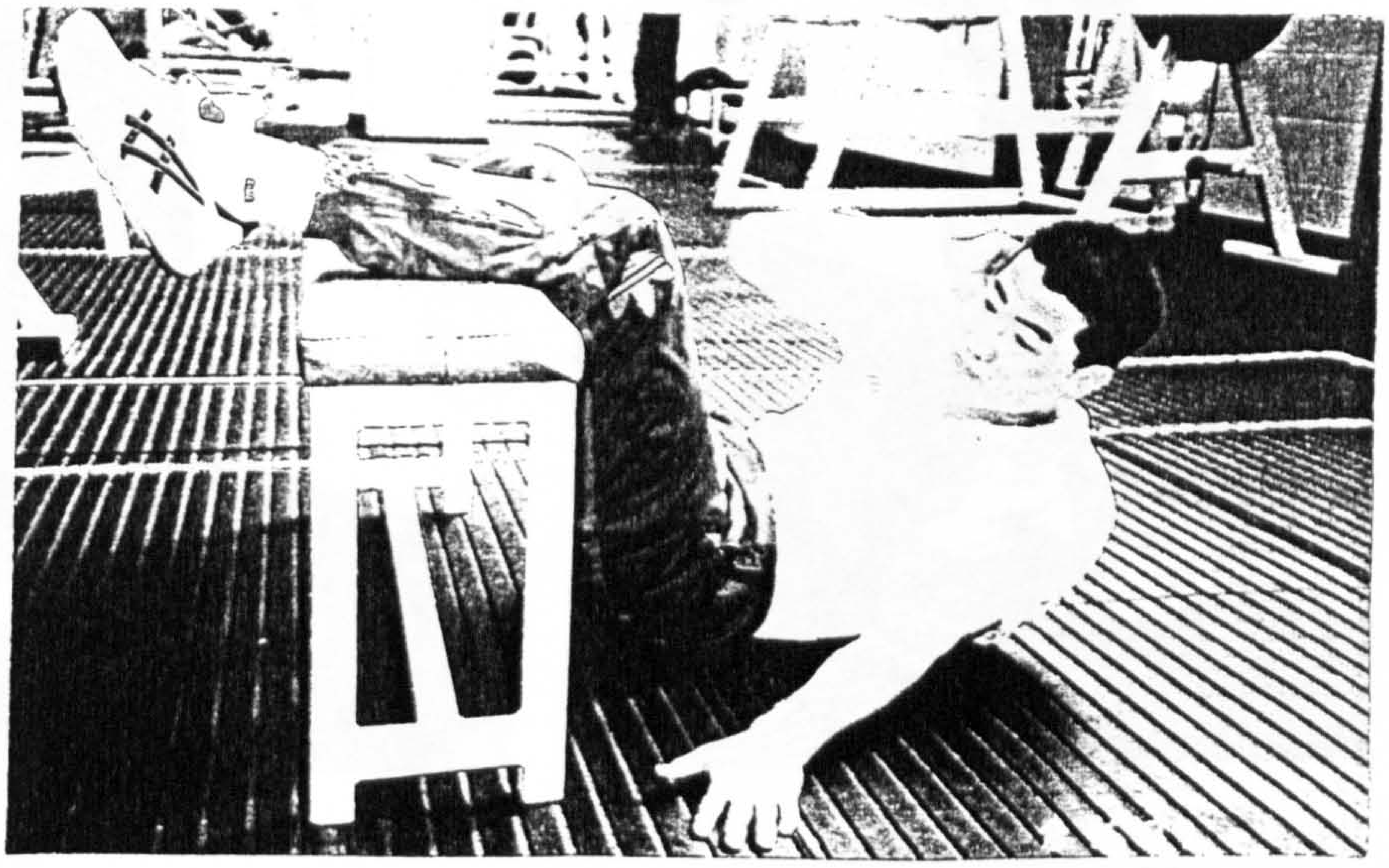


Figure 5.20 The final position of the sit-up with twist exercise

8 Trunk Flexion

Rubber tubing is attached securely to a rigid frame mounted on the wall at head height. In this exercise the feet are placed shoulder width apart. While standing with the back about 1 metre from the wall the tubing is held with the hands placed by the side of the head (Figure 5.21). The waist is then flexed in a forward motion as far as possible (Figure 5.22). The knees should be almost fully extended and legs should not move during the exercise (Figure 5.21 and 5.22).

This exercise conditions the muscles that flex the trunk and extend the hips. Exercise 4 - 8 are very important for movements of the trunk in TSUKURI and KAKE during Uchi-Mata and Seoi-Nage.

Figure 5.20 The initial position of the trunk flexion exercise

Figure 5.21 The final position of the trunk flexion exercise

9 Leg Abduction

In this exercise a solid framework is required for support. An initial position is adopted facing the machine and holding the handle (Figure 5.23). The leg is extended and abducted midway between full extension and full abduction. The knees should be extended during the exercise. This exercise also improves eccentric muscle contraction of the lower body which is supporting the body weight. This exercise conditions the muscles that abduct and extend the hips and legs.

Figure 5.23 The initial position of the leg abduction exercise

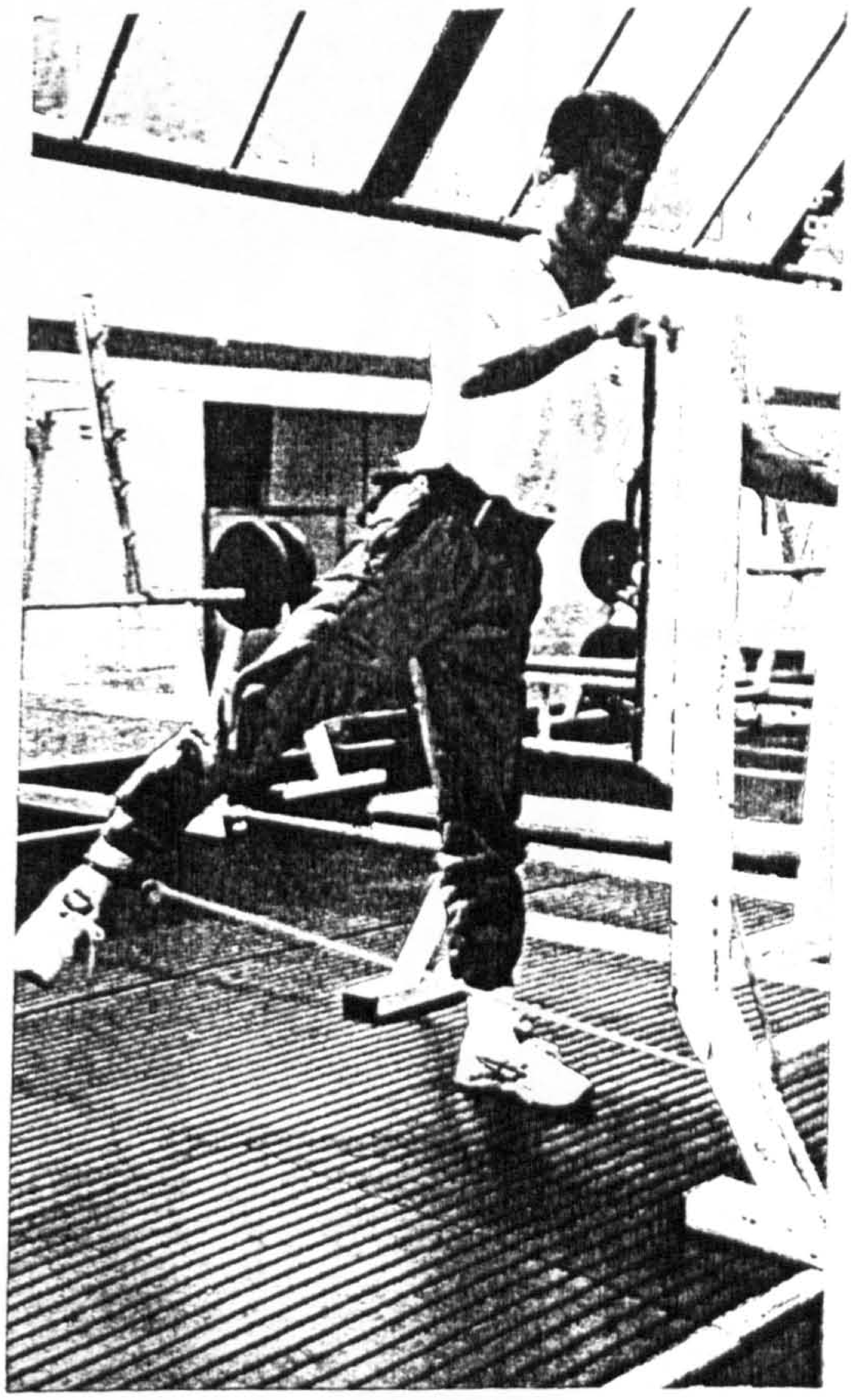


Figure 5.24 The final position of the leg abduction exercise

10 Seated Leg Press

This exercise is carried out on an appropriate multigym station. The seat is adjusted so that the knees are flexed at 90^{o} (Figure 5.25). Both feet are placed firmly on the footpad area, keeping the back firmly against the back rest. The feet are pushed away under control until the knees are extended completely, and then return slowly to the starting position.

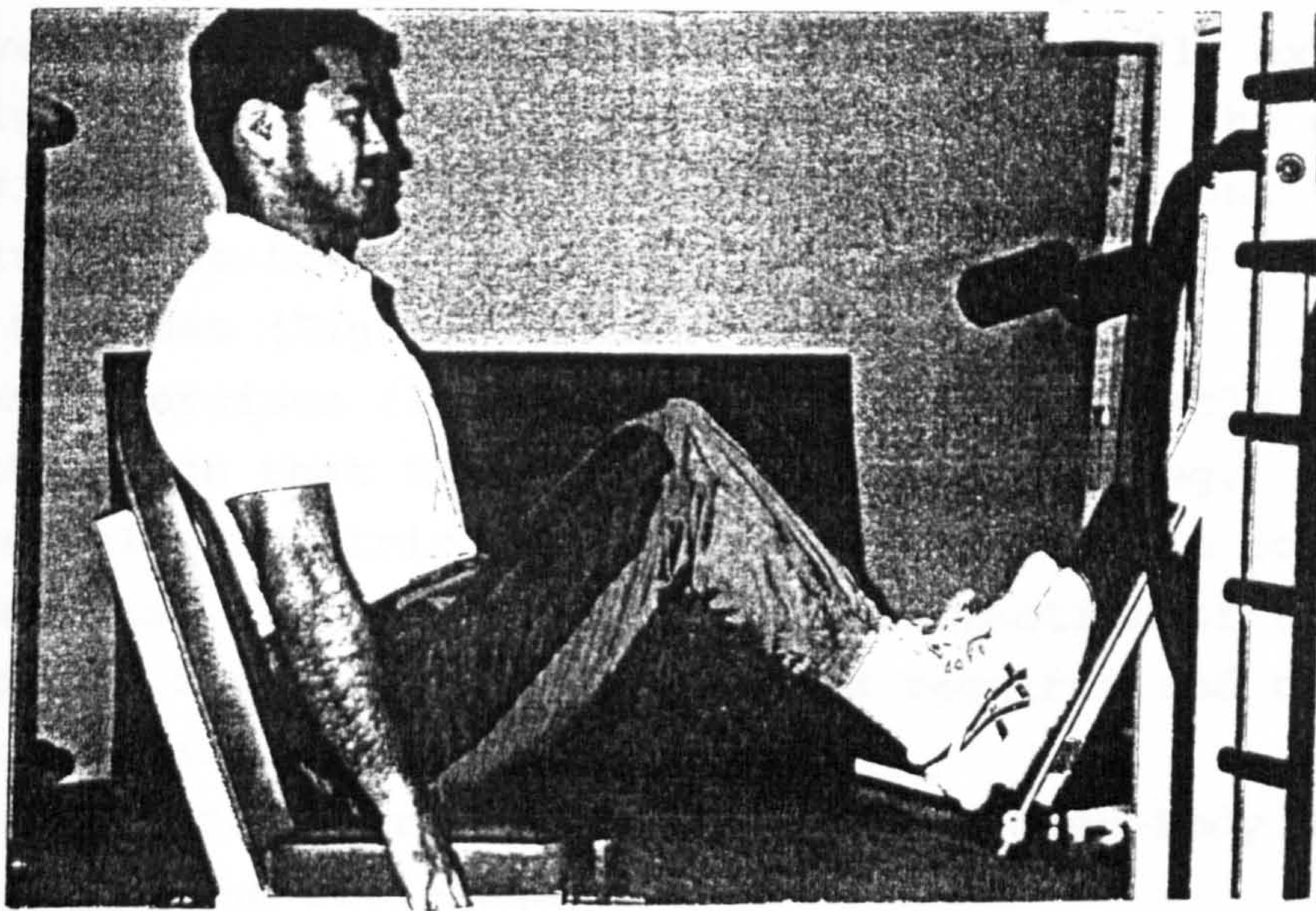


Figure 5.25 The initial position of the seated leg press exercise

Figure 5.26 The final position of the seated leg press exercise

11 Squat

This exercise can be carried out on a multigym station or with free weights. With the feet slightly wider than shoulder width apart, the lever bar is placed on the shoulder, when facing the squats station (Figure 5.27). The bar is grasped firmly with the hands, keeping the back straight and in a neutral position neither flexed or extended. The legs are thrust powerfully but smoothly in a vertical direction until the knees are fully extended (Figure 5.28). The load is then returned to the original position of the squat exercise. It is important to ensure that at the bottom of the movement an angle of 90° remains at the knee (Figure 5.27).

These exercises (10 and 11) condition the muscle contraction that flex and extend the lower-leg. A fast powerful concentric contraction is required in both exercises. During the eccentric contraction of the exercise a much slower movement is required and therefore an overload can be applied.

These exercises are important for the lower-body during Uchi-Mata and Seoi-Nage.

Figure 5.27 The initial position of the squat exercise

Figure 5.28 The final position of the squat exercise

5.5 APPLICATION OF THESE CONDITIONING PROGRAMMES

There are many different ways in which resistance training, described in Section 5.3.6 can be applied. For example different combinations of repetition, sets, loads and rest periods between sets can be used. Four components of fitness can be achieved by using this form of conditioning programme :

1, Strength
2, Speed
3, Power
4, Endurance

For superior standing techniques such as UM and SN, Strength and Speed leading to Power seem to be the most important factors. This deduction is based on the observation that a number of techniques may be attempted within a few seconds in a Judo competition. Speed can develop from UCHIKOMI (repetitive practice of throw) and Variable Resistance conditioning using rubber tube training. To complement this acquisition of Speed, the most important factors which can be developed by weight training are strength and power. One example of a well designed programme that concentrates on these factors based on work reported by[21][22][23][24][25][26] is shown below,

Example of a conditioning programme designed for Strength and Power

(S) Number of Sets (R) Number of repetitions (L) Load

1, Chest and Waist Pull
(1) Constant resistance conditioning provided by weight.
(2) Variable Resistance conditioning by using rubber tubing.

2, Seated Pulley Rowing
(S) 3 ~ 4 (R) 6 ~ 10 (L) 70 ~ 80% of 1 RM

3, Upright Rowing
(S) 3 ~ 4 (R) 8 ~ 12 (L) 50 ~ 70% of 1 RM

4, Back Extension

(S) 3 ~ 4 (R) 10 ~ 12 (L) None

5, Dead Lift

(S) 3 ~ 4 (R) 6 ~ 10 (L) 70 ~ 80% of 1 RM

6, Side Lateral Bends

(S) 3 ~ 4 (R) 6 ~ 10 (L) 70 ~ 80% of 1 RM

7, Sit-Ups (with twist)

(S) 3 ~ 4 (R) 10 ~ 12 (L) None

8, Trunk Flexion

Variable Resistance conditioning by using rubber tubing.

(S) 3 ~ 4 (R) 15 ~ 20 (L) as fast as possible

9, Leg Abduction and Extension

(1) Constant resistance conditioning provided by weight.

(2) Variable Resistance conditioning by using rubber tubing.

10, Seated Leg Press

(S) 3 ~ 4 (R) 6 ~ 10 (L) 70 ~ 80% of 1 RM

11, Squat

(S) 3 ~ 4 (R) 6 ~ 10 (L) 70 ~ 80% of 1 RM

The rest period between each set is approximately 3 minutes for all the exercise.

During weight training, it is important to adopt the correct breathing pattern. It is suggested that during the lifting of the resistance one should exhale, and inhale during the lowering of the resistance(27).

Periodization of the training programme

A well designed conditioning programme is based on four well defined components :

* Frequency
* Intensity
* Duration
* Overload

The table below is based on a periodization programme suggested by Stone et al(28).

Table 5.3 Weight training periodization for Judo competitors

Before Competiton	Term	Sets	Loads (% of 1RM)	Reps
10 ~ 7 weeks	2 or 3 weeks	3 ~ 5	50 ~ 70	8 ~12
7 ~ 4 weeks	2 or 3 weeks	3	70 ~ 80	6 ~ 8
4 ~ 2 weeks	2 weeks	3	80 ~ 90	3 ~ 5
2 weeks	10 days	2 ~ 3	90 ~ 100	1 ~ 3
5 days	None	*	*	*
Competitions				

This table gives an example of how weight training would be periodized, during a 10 weeks period, for example, from the end of the 1992 European Judo Championships to the 1992 Olympic Games Judo event.

Weight lifters and body builders may train between 3 to 4 or even 6 to 7 times a week. For the Judo player, due to his/her Judo training, weight training may be utilized 2 to 3 times a week. In modern competitive Judo weight training is a necessity. However, hypertrophy as result of too much dependence on weight training can have negative effects with regard to the smoothness of movement during the execution of a technique. Therefore it is vital that a balance is obtained between weight training and skill training.

5.6 SUMMARY

* There are three major elements in Judo which are necessary for a successful standing technique. These are KUZUSHI, TSUKURI and KAKE.

* <u>The main movements and muscle contractions during Uchi-Mata and Seoi-Nage.</u>

  (U)...for Uchi-Mata, (M)...for Morote Seoi-Nage,
  (I)...for Ippon Seoi-Nage

  * Flexion of the right and left fore-arm (Isometric).
  * (U) Horizontal extension and flexion of the right upper-arm (Isometric and Concentric).
    (M) Abduction of the right upper-arm (Concentric).
    (I) Extension of the right upper-arm (Isometric).
  * Horizontal extension of the left upper-arm (Concentric).
  * Full flexion and anti-clockwise rotation of the trunk (Concentric).
  * Abduction and extension of the right hip (Concentric).
  * (U) Flexion and extension of the left hip and left leg (Eccentric and Concentric).
    (M) Extension of the left hip (Concentric).
    (I) Abduction and Flexion of the left hip (Concentric).
  * (U) Abduction and extension of the right leg (Concentric).
    (M)(I) Extension of the right and left legs (Concentric).

* <u>Main exercises for improving the strength in Uchi-Mata and Seoi-Nage.</u>

  1, Chest and Waist Pull.
  2, Seated Pulley Rowing.
  3, Upright Rowing
  4, Back Extension
  5, Dead Lift
  6, Side Lateral Bends

7, Sit-Ups (with twist)
8, Trunk Flexion
9, Leg Abduction and Extension
10, Seated Leg Press
11, Squat

CHAPTER 6

VIDEO ANALYSIS OF THE FINAL BOUTS OF THE 1991 JUDO WORLD CHAMPIONSHIPS

6.1 INTRODUCTION

Chapters 3 and 4 presented the statistical analysis of the results of the 1991 World Judo Championships and the Judo competition at the Olympic Games held in 1992. Both events took place at Barcelona, Spain. To complement the full set of results from these contests, the Japanese Judo Federation also obtained a video recordings of each bout at both championships. This chapter provides an analysis of the video recording of each final in each weight category for both women and men at the 1991 World Judo Championships. The following chapter (Chapter 7) provides a similar analysis for the Olympic Games.

Six different categories were used to analyse the video recordings. They were :

A : Number of techniques

B : Variety of techniques

C : Effect of techniques

D : Total time of gripping advantage

E : Total time of attack during groundwork

F : Time segments for different activities in the contest

This information was supported by data on the height, weight and age of the champion in each weight category and the scores achieved as the champions progressed from round to round.

The chapter is concluded by a discussion of the analysis and an assessment of how the winners achieved success.

6.2 KEY TO THE ANALYSIS

A: Number of techniques : The number of times a recognised technique (attempt at a throw) was used in the contest.

B: Variety of techniques : The different techniques (throws) that were attempted, but not always successfully, during the contest.

C: Effect of techniques : The techniques which did not produce a throw or movement that could be classified as being at least a KOKA or above were sub-divided into 4 different categories.

a) The player was thrown to the mat on his/her front, or the opponent was thrown clearly through the air.
b) The attacking player gained some significant advantage over the defending player; for example, the technique caused the defending player to lose his/her balance.
c) The attacking player gained minimal advantage with techniques such as KUG (small inside clip) and KSG (small outside clip) which appeared like a kick on the video recording.
d) No advantage was gained by the attacker from the attempted technique. The technique had no effect on the the defender.

D: Total time of grip advantage : The interval of time when one player had an advantage of grip over his/her opponent. There are three different possibilities for a grip advantage. These are :

Player 1	Player2
2 hands gripping	No hand gripping
2 hands gripping	1 hand gripping
1 hand gripping	No hand gripping

E: Total time of attack during groundwork : This is the total time for which the player was attacking during groundwork. Simply, it was considered that the player who is on top of his/her opponent had a advantage, and was considered to be the attacker.

F: Time segments for different activities in the contest : The total time for the contest, including stoppage; the time spent in groundwork techniques; the time spent recovering after MATTE had been called; the discrepancy time was the difference between the actual fighting time and the official contest time (discrepancy time = Total time - MATTE time - 5 min [4 min for women]). The number of times MATTE was called (n) is given after the total MATTE time as /n.

ABBREVIATIONS USED IN THE TEXT FOR TECHNIQUES

The following abbreviations for Judo technique have been used.

Standingwork technique

DAB : Deashi-Barai (forward foot sweep)
HRG : Harai-Goshi (hip sweep)
HRM : Harai-Makikomi (hip sweep wrap-around)
KAD : Kata-Ashi-Dori (one leg catching)
KGU : Kata-Guruna (shoulder whirl)
KTA : Kuchiki-Taoshi (dead-tree drop)
KSG : Kosoto-Gari (small outside clip)
KSK : Kosoto-Gake (small outside hook)
KUG : Kouchi-Gari (small inside clip)
KUM : Kouchi-Makikomi (small inside clip wrap-around)
MGA : Morote-Gari (Two-arm clip)
OAB : Okuri-Ashi-Barai (assist foot sweep)
OGA : Osoto-Gaeshi (big outside clip counter)
OGO : Ogoshi (hip roll)
OSG : Osoto-Gari (big outside clip)
OUC : Ouchi-Gaeshi (big inside clip counter)
OUG : Ouchi-Gari (big inside clip)
SKG : Sode-Tsurikomi-Goshi (hip throw with a rising sleeve pull)
SN : Seoi-Nage (back-carry throw)
SOT : Sumi-Otoshi (corner drop)
STA : Sasae-Tsurikomi-Ashi (lifting-pull throw with supporting foot)
SUG : Sumi-Gaeshi (corner reversal)
SUK : Sukui-Nage (scoop throw)
TKG : Tsurikomi-Goshi (lift-pull hip throw)
TN : Tomoe-Nage (round throw)
TNO : Tani-Otoshi (valley drop)
TO : Tai-Otoshi (body drop)
UM : Uchi-Mata (thigh throw)
UNA : Uranage (inside-out throw)
UWA : Uki-Waza (floating technique)

Groundwork technique

HKG : Hon-Kesa-Gatame (scarf hold)
JG : Juji-Gatame (cross arm bar)
KKS : Kuzure-Kami-Shiho-Gatame (modified upper four-corner hold)
KSH : Kami-Shiho-Gatame (upper four-corner hold)
KYS : Kuzure-Yoko-Shiho-Gatame (modified side four-corner hold)
OEJ : Okuri-Eri-Jime (sliding lapel choke)
TSG : Tate-Shiho-Gatame (vertical four-corner hold)
UKG : Ushiro-Kesa-Gatame (back scarf hold)
YSG : Yoko-Shiho-Gatame (side four-corner hold)

6.3 THE 1991 WORLD JUDO CHAMPIONSHIPS FINALS (WOMEN)

Table 6.1 The height, weight and age of each female champion

WEIGHT CATEGORY	HEIGHT	WEIGHT	AGE
-48kg	162cm	48kg	24y
-52kg	159cm	52kg	25y
-56kg	165cm	55kg	28y
-61kg	164cm	61kg	24y
-66kg	177cm	66kg	22y
-72kg	169cm	72kg	20y
+72kg	173cm	100kg	20y
Open	173cm	95kg	22y

Table 6.2 The results obtained by the female champion for each round

WOMEN'S

	-48kg	-52kg	-56kg	-61kg
1st	KINSA	KINSA	IPPON(JG)	YUKO(UWA)
2nd	WAZA(OUG)	KINSA	IPPON(OSG)	IPPON(JG)
3rd	CHUI	KOKA(UM)	IPPON(HKG)	IPPON(OUC)
Semi	IPPON(OGO)	IPPON(SN)	IPPON(UM)	IPPON(YSG)
Final	KINSA	KINSA	WAZA(UM)	IPPON(AWAS)

	-66kg	-72kg	+72kg	Open
1st	IPPON(OEJ)	*	*	IPPON(HKG)
2nd	IPPON(UM)	IPPON(YSG)	YUKO(MGA)	IPPON(SN)
3rd	KOKA(UM)	KOKA(?)	IPPON(KYS)	IPPON(KKS)
Semi	IPPON(UKG)	YUKO(UM)	KEIKOKU	IPPON(KKS)
Final	IPPON(KYS)	KOKA(UM)	YUKO(SN)	WAZA(KUM)

-48kg final
This contest was decided by KINSA (Judges' decision)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		21		18
B: Variety of techniques	OAB	7	TO	4
	UM	6	OAB	4
	TO	3	OUG	3
	KUG	2	TN	2
	KSG	2	SN	2
	STA	1	KUG	1
			KSG	1
			MGA	1
C: Effect of techniques	a)	0		0
	b)	3		4
	c)	18		14
	d)	0		0

C1: Number and effect of techniques during the last 2 minutes of the contest

		Winner	Loser
		8	7
	b)	1	2
	c)	7	5
D: Advantage gripping (s)		19	3
E: Groundwork techniques (s)		15	23

F: Time --	Total	4:59
	Groundwork	0:42
	Matte	0:54/4 (+5)

Summary of the contest

This was a very close contest. As far as the number of techniques and their effect were concerned, both players were almost the same, with a slight advantage for the victor. This was as true during the last 2 minutes as it was within the contest as a whole. However, the winner had a significantly greater time with grip advantage. This may have been one of the factors in her victory. In connection with this observation, it is interesting to note that the winner was 10cm taller than the loser.

-52kg final
This contest was decided by KINSA (Judges' decision)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		19		35
B: Variety of techniques	KUG	7	OAB	10
	SN	6	KUG	8
	OSG	2	OUG	4
	UM	2	SN	3
	OAB	1	UM	3
	MGA	1	MGA	3
			KSG	2
			HRG	1
			HRM	1
C: Effect of techniques	a)	1		0
	b)	4		4
	c)	14		31
	d)	0		0
C1: Number and effect of techniques during the last 2 minutes of the contest		5		7
	b)	2		2
	c)	3		5
D: Advantage gripping (s)		1		11
E: Groundwork techniques (s)		19		34

F: Time --		
	Total	6:13
	Groundwork	0:55
	Matte	1:54/16 (+19)

Summary of the contest

This contest was also very close. Neither player scored any points. With respect to the number of techniques used, the number used in the last 2 minutes of the contest, the time with a grip advantage and time spent attacking during groundwork, the loser was better than the winner. Maybe the winning factor was the effectiveness of techniques (the winner got one (a)).

However, there may have been other factors that decided the contest which did not appear in this analysis such as the winner constantly moving forward (which could be interpreted as more aggression). Eventually the outcome of this contest was decided on a split decision.

-56kg final
This contest was decided by WAZA-ARI (UM)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI		
KOKA	SHIDO		1

		Winner		Loser
A: Number of techniques		16		16
B: Variety of techniques	OAB	5	KUG	4
	KUG	3	OAB	4
	OUG	3	TN	3
	UM	3	KSG	2
	SN	1	SN	1
	KSG	1	DAB	1
C: Effect of techniques	a)	0		1
	b)	1		2
	c)	14		13
	d)	0		0
D: Advantage gripping (s)		1		0
E: Groundwork techniques (s)		50		15

F: Time --	Total	5:21
	Groundwork	1:05
	Matte	1:10/8 (+11)

Summary of the contest

This contest was decided by WAZA-ARI created by standing technique. The number of techniques, their variety, their effect and the time with a grip advantage were almost the same for both contestants. The winner seemed to have the advantage in time spent on the attack during groundwork. This was partly because the loser attempted TOMOE-NAGE three times. It is quite likely that these players had similar judo ability and skill but, in this case, the winner was fortunate and performed a successful UCHI-MATA for her WAZA-ARI.

-61kg final

This contest was decided by IPPON (AWASEWAZA: UNA and KYS)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI		
KOKA	SHIDO	2	

	Winner		Loser	
A: Number of techniques		9		10
B: Variety of techniques	OUG	2	KUG	4
	SN	2	HRM	2
	UNA	2	SUK	1
	SKG	1	UM	1
	UM	1	SN	1
	KSG	1	STA	1
C: Effect of techniques	a)	0		0
	b)	3		2
	c)	3		8
	d)	0		0
D: Advantage gripping (s)		3		1
E: Groundwork techniques (s)		46		2

F: Time --		
	Total	3:26 (2:39)
	Groundwork	0:58
	Matte	0:48/6 (+1)

Summary of the contest

This contest was decided by IPPON. This conclusion was reached by a combination technique of AWASE-WAZA (UNA & KYS where two WAZA-ARI make IPPON). In this case, the winner threw the loser by URANAGE (a score of WAZA-ARI), and when the loser was on the mat, the winner held her by KUZURE-YOKO-SHIHO-GATAME continuously, for a second WAZA-ARI. The number of techniques employed and the variety of these techniques were almost the same for both contestants. During groundwork, the winner attacked more than the loser. With regard to the effectiveness of techniques, the loser seemed to perform slightly better than the winner. However, the reader must be aware that none of these techniques are less than KOKA, whereas the winner scored two KOKA even before she produced IPPON.

-66kg final
This contest was decided by IPPON (KYS)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		11		17
B: Variety of techniques	UM	6	OUG	5
	OSG	3	UM	5
	OUG	2	OAB	4
			KSG	2
			KUG	1
C: Effect of techniques	a)	1		0
	b)	3		2
	c)	7		15
	d)	0		0
D: Advantage gripping (s)		3		1
E: Groundwork techniques (s)		128		4

F: Time --	Total	6:10 (4:26)
	Groundwork	2:16
	Matte	1:39/4 (+8)

Summary of the contest

This contest was decided by IPPON. The technique used to obtain this score was KUZURE-YOKO-SHIHO-GATAME during groundwork. With respect to the number of techniques, the loser was slightly better than the winner. However, in the effectiveness of techniques, the winner was superior to the loser, and the biggest difference between the two contestants was the time spent attacking during groundwork (difference 124 seconds). The winner held the loser right at the end of the contest, to obtain IPPON. In this case, once a hold down is called, the time will continue even though the contest extends beyond the 4 minutes limit.

-72kg final

This contest was decided by KOKA (UM)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	1
KOKA	SHIDO	1	

		Winner		Loser
A: Number of techniques		6		8
B: Variety of techniques	UM	4	OUG	3
	STA	1	STA	2
	OUC	3	SUK	1
			OAB	1
			KUG	1
C: Effect of techniques	a)	2		1
	b)	1		2
	c)	2		5
	d)	0		0
D: Advantage gripping (s)		10		0
E: Groundwork techniques (s)		0		85

F: Time --		
	Total	6:13
	Groundwork	1:26
	Matte	2:20/5 (-7)

Summary of the contest

This was a close contest although the result was decided by a score of KOKA. Both players had one penalty of CHUI and the winner only achieved the KOKA during the last 10 seconds of the contest. The loser attacked more in both standingwork and groundwork. However, the winner was slightly better in the effectiveness of techniques and the time spent with a grip advantage. It is likely that the winner's KOKA victory by UCHI-MATA was gained from the advantage she obtained from superior gripping.

+72kg final
This contest was decided by YUKO (SN)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO	2	1

		Winner		Loser
A: Number of techniques		11		4
B: Variety of techniques	SN	6	MGA	3
	KUG	4	OSG	1
	MGA	1		
C: Effect of techniques	a)	1		0
	b)	3		2
	c)	5		2
	d)	0		0
D: Advantage gripping (s)		4		0
E: Groundwork techniques (s)		30		81

F: Time -- Total 5:19
Groundwork 2:01
Matte 1:17/9 (+2)

Summary of the contest

This contest was decided by YUKO scored with a SEOI-NAGE from a standing technique. The winner also scored a KOKA from SEOI-NAGE earlier in the contest. The winner was better than the loser in most factors such as the number of techniques and their effect. Both players showed a lack of variety of techniques. However, during groundwork, the loser seemed to attack more than the winner, but this statistic stemmed mainly from the winner's repeated attacks using SEOI-NAGE during standingwork. Not all these attacks were successful and left the winner at a disadvantage during the ensuing groundwork.

OPEN WOMEN final

This contest was decided by WAZA-ARI (KUG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI	1	1
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		14		4
B: Variety of techniques	SN	8	UNA	3
	KUM	6	UM	1
C: Effect of techniques	a)	0		1
	b)	3		1
	c)	9		1
	d)	0		0
D: Advantage gripping (s)		4		3
E: Groundwork techniques (s)		22		78

F: Time --	Total	5:41
	Groundwork	1:45
	Matte	1:03/11 (+38)

Summary of the contest

This contest was decided by a WAZA-ARI obtained from a KOUCHI-GARI during standingwork. Both players also scored one YUKO. The winner scored YUKO by using SEOI-NAGE, the loser scored YUKO by URANAGE. Simply, as far as the number of techniques was concerned, the winner created three times more attacking opportunities than the loser. The variety of techniques used was limited to only two from each player. In groundwork, the loser seemed to attack more but, perhaps, this situation was caused by the winner's repeated use of SEOI-NAGE.

6.4 THE 1991 WORLD JUDO CHAMPIONSHIPS FINALS (MEN)

Table 6.3 The height, weight and age of each male champion

WEIGHT CATEGORY	HIGHT	WEIGHT	AGE
-60kg	159cm	60kg	25y
-65kg	175cm	65kg	24y
-71kg	169cm	71kg	23y
-78kg	179cm	78kg	22y
-86kg	170cm	86kg	24y
-95kg	194cm	94kg	25y
+95kg	194cm	107kg	26y
Open	193cm	130kg	23y

Table 6.4 The result obtained by the male champion for each round

MEN'S	-60kg	-65kg	-71kg	-78kg
1st	*	*	*	IPPON(HRM)
2nd	IPPON(UM)	IPPON(OEJ)	IPPON(SKG)	IPPON(UNA)
3rd	IPPON(JG)	YUKO(TO)	IPPON(OEJ)	IPPON(JG)
4th	IPPON(HRG)	YUKO(DAB)	KOKA(DAB)	IPPON(UNA)
Semi	KOKA(OSG)	YUKO(OAB)	IPPON(SN)	KEIKOKU
Final	KINSA	CHUI	YUKO(SKG)	WAZA(UKG)

	-86kg	-95kg	+95kg	Open
1st	IPPON(TO)	IPPON(SKG)	*	IPPON(OSG)
2nd	WAZA(OUG)	IPPON(TKG)	IPPON(KKS)	IPPON(TSG)
3rd	IPPON(OSG)	IPPON(JG)	IPPON(KSH)	IPPON(HRG)
Semi	WAZA(KUG)	IPPON(JG)	IPPON(UKG)	IPPON(YSG)
Final	IPPON(KUG)	IPPON(JG)	IPPON(JG)	IPPON(TO)

-60kg final
This contest was decided by KINSA (Judges' decision)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	**KEIKOKU**		
YUKO	**CHUI**	**1**	**1**
KOKA	**SHIDO**		

		Winner		Loser
A: Number of techniques		12		11
B: Variety of techniques	KUG	6	KUG	5
	MGA	2	OUG	2
	TN	2	OAB	1
	KGU	1	OSG	1
	UM	1	HRM	1
			MGA	1
C: Effect of techniques	a)	1		0
	b)	6		3
	c)	5		8
	d)	0		0
C1: Number and effect of techniques during the last 2 minutes of the contest		5		2
	b)	4		1
	c)	1		1
D: Advantage gripping (s)		32		16
E: Groundwork techniques (s)		63		29

F: Time -- Total 7:06
Groundwork 1:34
Matte 1:46/11 (+20)

Summary of the contest

This was a very close contest. Both players had one penalty of CHUI. The number of techniques attempted and the variety of the these techniques were almost the same. However, the winner did attack more during the last 2 minutes of the contest, and he had superior groundwork and gripping advantage. Probably, these factors influenced the judges.

-65kg final
This contest was decided by CHUI (Penalty)

Final scoreboad

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		1

		Winner	Loser
A: Number of techniques		23	14
B: Variety of techniques		KUG 14	KUG 9
		TO 3	OSG 5
		OUG 2	
		OSG 2	
		OGA 1	
		KGU 1	
C: Effect of techniques	a)	0	0
	b)	7	6
	c)	16	8
	d)	0	0
D: Advantage gripping (s)		8	22
E: Groundwork techniques (s)		40	5

F: Time -- Total 7:48
Groundwork 46
Matte 2:44/7 times (discrepancy +4)

Summary of the contest

In all the finals analysed, only this category was decided by a penalty. The loser did not attack at all during the time period 4:33 ~ 4:51 (18seconds). This resulted in CHUI. In the number of techniques, the variety of these techniques and the groundwork, the winner was superior to the loser. But in the gripping advantage, the loser was the better. This suggests that many of the techniques employed by the winner were designed to escape from his perceived inferior position.

-71kg final
This contest was decided by YUKO (SKG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		6		7
B: Variety of techniques	SN	2	SN	5
	OAB	1	MGA	1
	TN	1	OAB	1
	SKG	1		
	KUG	1		
C: Effect of techniques	a)	0		0
	b)	3		2
	c)	2		4
	d)	0		1
D: Advantage gripping (s)		33		3
E: Groundwork techniques (s)		56		4

F: Time --	Total	9:11
	Groundwork	1:08
	Matte	3:58/12 (+13)

Summary of the contest

This contest was decided by YUKO scored by a SODE-TSURIKOMI-GOSHI. The number of techniques attempted was almost the same. However, in all other factors such as the variety of techniques and the gripping advantage, the winner was superior to the loser. The winner was clearly superior in this contest. It is of interest that the loser tried techniques that seemed to have no effect whatsoever on the winner. This was unique to all the finals analysed in the 1991 World Championships.

-78kg final
This contest was decided by YUKO (KUG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU	1	1
YUKO	CHUI	2	
KOKA	SHIDO		

		Winner		Loser	
A: Number of techniques			10		12
B: Variety of techniques		KSG	3	TNO	4
		OGO	3	SN	2
		UM	1	OAB	1
		OUG	1	TN	1
		TKG	1	UM	1
		KUG	1	SKG	1
				KSG	1
				SUK	1
C: Effect of techniques	a)		1		0
	b)		3		5
	c)		4		6
	d)		0		0
D: Advantage gripping (s)			15		2
E: Groundwork techniques (s)			71		13

F: Time --	Total	7:04
	Groundwork	1:42
	Matte	2:15/13 (-11)

Summary of the contest

This was one of the hardest contests. Initially, the loser scored WAZA-ARI (the second biggest score) by using TANI-OTOSHI after 17 seconds of the contest, then the winner snatched victory from the jaws of defeat by scoring a WAZA-ARI and two YUKO. As far as the number of techniques was concerned the loser had a slightly higher count than the winner. This was probably because he was losing by YUKO after 2:47. However, both in gripping and groundwork, the winner was mainly in control.

-86kg final

This contest was decided by IPPON (KUG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		

		Winner		Loser
A: Number of techniques		4		7
B: Variety of techniques	KUG	3	KUG	3
	OSG	1	OAB	2
			STA	1
			OGA	1
C: Effect of techniques	a)	0		0
	b)	2		1
	c)	0		6
	d)	0		0
D: Advantage gripping (s)		0		0
E: Groundwork techniques (s)		8		0

F: Time --		
	Total	1:12 (0:56)
	Groundwork	0:12
	Matte	0:14/2 (+2)

Summary of the contest

This winner scored YUKO early in the contest, after 9 seconds, by using KOUCHI-GARI. A minute later, he threw the loser for IPPON with the same technique. It seemed that the winner threw the loser with his favourite technique before the latter was able to create a good attacking opportunity with his own standing techniques.

-95kg final

This contest was decided by IPPON (JG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI	2	1
KOKA	SHIDO	1	1

		Winner		Loser
A: Number of techniques		4		9
B: Variety of techniques	OSG	2	SUK	4
	UM	1	SN	2
	TKG	1	KGU	2
			OUG	1
C: Effect of techniques	a)	1		1
	b)	1		5
	c)	1		2
	d)	0		0
D: Advantage gripping (s)		22		1
E: Groundwork techniques (s)		72		38

F: Time --	Total	6:32 (4:18)
	Groundwork	1:55
	Matte	2:22/10 (-8)

Summary of the contest

This was one of the hardest fought contests. The winner secured victory when defeat seemed likely after his opponent scored YUKO in only 1 minute. With respect to the number of techniques attempted, their variety and their effect, the loser was superior to the winner. However, the winner seemed to be in control for most of the contest through his gripping and groundwork, and eventually he produced IPPON with his favourite groundwork technique of JUJI-GATAME.

+95kg final
This contest was decided by IPPON (JG)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI		
KOKA	SHIDO		1

		Winner		Loser
A: Number of techniques		7		7
B: Variety of techniques	TO	4	KSG	2
	OUG	1	SUK	1
	TKG	1	OUG	1
	KAD	1	STA	1
			MGA	1
			UM	1
C: Effect of techniques	a)	1		2
	b)	2		4
	c)	3		1
	d)	0		0
D: Advantage gripping (s)		26		0
E: Groundwork techniques (s)		73		0

F: Time --	Total	4:39 (3:45)
	Groundwork	1:17
	Matte	1:04/7 (+10)

Summary of the contest

This contest was decided by JUJI-GATAME during groundwork, however, the winner also scored WAZA-ARI by TAI-OTOSHI during the contest. The number of techniques attempted was the same, and with respect to the variety of techniques and their effect, the loser was slightly better than the winner. This was probably the result of the loser having lost a WAZA-ARI in 1:43 and being desperate to achieve a score. However, with respect to groundwork and gripping, the winner had a clear advantage, especially in groundwork which led to the eventual IPPON.

OPEN MEN final
This was decided by IPPON (TO)

Final scoreboard

Score	Penalty	Winner	Loser
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO	1	

		Winner		Loser
A: Number of techniques		8		9
B: Variety of techniques	KSG	3	UM	5
	UM	1	KSG	4
	OUG	1		
	OSG	1		
	STA	1		
	TO	1		
C: Effect of techniques	a)	0		1
	b)	4		2
	c)	3		6
	d)	0		0
D: Advantage gripping (s)		2		0
E: Groundwork techniques (s)		12		0

F: Time --	Total	3:53 (2:32)
	Groundwork	0:12
	Matte	1:28/8 (-7)

Summary of the contest

This contest was decided by a body drop throw (TAI-OTOSHI) for IPPON. The number of techniques and their effect were almost the same for both competitors. Despite this similarity, the winner appears to be in control (visually) throughout the contest. Perhaps as a result of this, the loser got a SHIDO penalty for passivity (he did not make an attack between 1:19 to 2:25).

6.5 DISCUSSION AND CONCLUSION

In sporting contests a frequent question that is asked is, 'why did she or he became champion ?'. This question is just as relevant to Judo as any other sport. The present Chapter and its companion, Chapter 7, were designed, in an attempt to find an answer to this question, with regards to the 1991 World Championships and the 1992 Olympic Games. In this chapter, the video recording of each final of every weight category for both women and men were analysed to identify those KEY factors which seem to distinguish the champion from the less successful competitors. The analysis was centred around six different factors.

The number of standing techniques attempted by a competitor was thought to be perhaps the most important factor in achieving a score. In addition, if there was no score at the end of the contest it was thought that the number of techniques attempted by a competitor would certainly influence the subjective judgement of the referee and judges. However, the number of techniques attempted does not always signify the most aggressive competitor.

A Judo player may introduce a large number of techniques into the contest simply in an attempt to escape from a perceived grip advantage held by her/his opponent. Such an example can be observed in the -65kg final for men. It is interesting to note that in the lower weight categories for both male and female competitors, the number of techniques attempted tends to be significantly higher than in the heavier weight categories.

Out of the 8 finals analysed for women in only 3 finals did the winner use more techniques than the loser, one contest showed an equal number of techniques used by both players. For the men only 2 of the champions used more techniques than the silver medallist with one contest, again even. However, in the 3 contests decided by judges (KINSA) and the one decided by a penalty (CHUI) the winner used more techniques than the loser. It may not be a coincidence that these 4 contests were the 2 lowest weight categories in the male and female competitions.

The variety of techniques used was also thought to provide an indication of a potential champion, especially if the contest was a close one. Some competitors, particularly in the lower weight categories, demonstrated a wide types of techniques, whereas others tried only 2 or 3 varieties of standing techniques. It seems that the heavier competitors were reluctant to commit themselves to a range of different techniques.

The effectiveness of the techniques was also considered to be important. For the purposes of this thesis the effect of the technique was separated into four different categories, from a well defined throw without sufficient characteristics for a score to a technique that seemed to produce no effect on the defender.

In the majority of cases the effect of the technique fell into category 3, in which the attacking player gained minimal advantage. Nevertheless even these small effects could have an influence in a close contest like in the -48kg final for women. However, despite superior statistics for the number, variety and effectiveness of her standing techniques the silver medallist in the -52kg final for women was not sufficiently aggressive enough to secure a win in the only final that was decided by a split decision in the entire championships.

The contact that a Judo player makes with his or her opponent is through gripping the Judo suit, often at the lapel or wrist. With subtle changes in force and direction the elite Judo player is able to create conditions of dynamic instability through a grip advantage. In some cases this grip advantage is converted into a throw or an attempted throw. For this reason the interval of time a competitor held a gripping advantage over an opponent was considered to be a possible factor which could contribute to success.

In only one of the eight finals analysed for the men did the loser spend more time with a grip advantage than the winner. This was in the -65kg final (8 seconds winner, 22 seconds loser) when the contest was decided by a penalty. Similar statistics applied with regards to the women's championships. Only in the -52kg category (1 second winner, 11 seconds loser) when the contest was decided by the judges, on a split decision, did the loser have an advantage over the winner.

There are two types of techniques in Judo. These are techniques attempted when standing and techniques that have evolved from a position when both competitors are on the ground. In groundwork techniques the player who is on top of his/her opponent has a distinct advantage and is considered to be attacking. For this reason the time spent on the attack during groundwork was thought to be a possible ingredient for success.

In the finals for the female contestants only 3 of the champions demonstrated an advantage during groundwork. In these 3 cases the time spent on attack was extensive and in 2 of the 3 cases this resulted in Ippon. In contrast, all the male champions spent greater intervals of time on the attack during groundwork compared with the silver medallists. Perhaps this statistic reflects the superior strength of male competitors in the sense that once an elite male competitor gains the advantage during groundwork he is very difficult to dislodge.

The final category of the video analysis was the time segments for different activities in the contest. This concept was introduced to reflect the total time of the bout compared with the actual fighting time during the contest, as well as the total time spent in recovery. Judo can be considered as a multiple activity sport, where flurries of activity are interspersed with recovery. It is possible to draw a loose analogy with multiple sprint or activity sports like soccer, basketball, hockey or rugby. These games have different physical requirements to continuous rhythmic activities like running, swimming, rowing or cycling. The necessity for short bouts of high activity superimposed on a framework of strength and endurance may be the reason why Judo is a young, but mature, person's sport. The oldest female champion was 28 years old and four champions were 20 - 22 years old. A similar picture emerged for the men. The age range of the male champions lay between 22 years and 26 years.

Analysis of the results obtained by the champions in the women's competition for each round and the results of the finals themselves revealed two separate groups. The first could be termed a hyperdominant group. The second could be considered as a hypodominant group. The hyperdominant group scored 4 IPPON in the five rounds they contested. This group consisted of -56kg, -61kg, -66kg and Open weight categories. The hypodominant group scored only a single IPPON in all five rounds (round 1 was missing in the -72kg and +72 kg categories). This group consisted of the -48kg, -52kg, -72kg and +72kg weight categories.

The two lowest weight categories had final rounds that were very close, with KINSA deciding the gold and silver medal positions at the end of the contest. In both cases the defending champion was defeated in the final. Perhaps the quickness of movement and agility of the competitors in the lower weight categories (both male and female) reduces the probability of IPPON when the contestants are almost of equal ability at the world class level.

A similar pattern emerged for the male competitors. Again there was a hyperdominant group and hypodominant group, but the characteristics of these groups were slightly different to that of their female counterparts. The hyperdominant group consisted purely of the heavyweight contestants. All the champions in this group concluded their final with IPPON. Moreover in the -95kg, +95kg and Open categories these champions won every round with IPPON. In the -86kg weight category the champion won three of his rounds, including the final, by IPPON and scored WAZA-ARI in the other two.

The hypodominant group consisted entirely of light weight contestants. No finals in this group were concluded by IPPON. In fact, the -60kg and -65kg weight categories were decided by KINSA and CHUI respectively. The champion of the -65kg class only won his first contest by IPPON. Although the other champions in the light weight categories were dominant in the earlier rounds, with scores of IPPON up to the third round, as the competition progressed the contests became much closer.

6.6 SUMMARY

* Number of Techniques :	The number of techniques attempted does not always signify the most aggressive competitor. In the lower weight categories for the both female and male competitors the number of techniques attempted tends to be significantly higher than in the heavier weight categories.
* Variety of Techniques :	It seems that the heavier weight competitors were reluctant to commit themselves to a range of different techniques when compared to the lighter weight competitors.
* Effect of Techniques :	The effectiveness of techniques, could have an important influence on the result of a close contest.
* Total time of grip advantage :	In only one of the eight finals analysed for both female and male competitors, did the loser spend more time with a grip advantage than the winner.
* Total time of attack during groundwork :	All the male champions spent greater intervals of time on the attack during groundwork compared with the silver medallists. However, only 3 out of the 8 female champions demonstrated an advantage during groundwork.
* Time segments for different activities in the contest :	Judo can be considered as a multiple activity sport, where flurries of activity are interspersed with recovery. Probably this is one of the reasons why Judo appears to be a young person's sport.

* The results obtained by the champions for each round : Analysis of the results obtained by the champion for each round was separated into two distinct groups.

These were a hyperdominant and a hypodominant group.

The hyperdominant group consisted of -56kg, -61kg, -66kg and Open weight categories for female competitors, and -86kg, -95kg, +95kg and Open weight categories for male competitors. While, the hypodominant group consisted of -48kg, -52kg, -72kg and +72kg for female competitors and -60kg, -65kg, -71kg and -78kg for male competitors.

CHAPTER 7

VIDEO ANALYSIS OF THE FINAL BOUTS OF THE 1992 OLYMPIC GAMES JUDO EVENT

7.1 INTRODUCTION

This chapter provides an analysis of the video recording of each final in each weight category for both women and men at the 1992 Olympic Games Judo event. It is presented in a similar fashion to Chapter 6.

Again, six different categories were used to analyse the video recordings, they were :

- **A : Number of Techniques**
- **B : Variety of Techniques**
- **C : Effect of Techniques**
- **D : Total time of grip advantage**
- **E : Total time of attack during groundwork**
- **F : Time segments for different activities in the contest**

This information was also supported by data on the height, weight and age of the champion in each weight category and the scores achieved as the champions progressed from round to round.

This chapter is concluded by a discussion of the analysis and an assessment of how the winners achieved success.

7.2 KEY TO THE ANALYSIS

A: Number of techniques : The number of times a recognised technique (attempt at a throw) was used in the contest.

B: Variety of techniques : The different techniques (throws) that were attempted, but not always successfully, during the contest.

C: Effect of techniques : The techniques which did not produce a throw or movement that could be classified as being at least a KOKA or above were sub-divided into 4 different categories.

a) The player was thrown to the mat on his/her front, or the opponent was thrown clearly through the air.
b) The attacking player gained some significant advantage over the defending player; for example, the technique caused the defending player to lose his/her balance.
c) The attacking player gained minimal advantage with techniques such as KUG (small inside clip) and KSG (small outside clip) which appeared like a kick on the video recording.
d) No advantage was gained by the attacker from the attempted technique. The technique had no effect on the the defender.

D: Total time of grip advantage : The interval of time when one player had an advantage of grip over his/her opponent. There are three different possibilities for a grip advantage. These are :

Player 1	Player2
2 hands gripping	No hand gripping
2 hands gripping	1 hand gripping
1 hand gripping	No hand gripping

E: Total time of attack during groundwork : This is the total time for which the player was attacking during groundwork. Simply, it was considered that the player who is on top of his/her opponent had a advantage, and was considered to be the attacker.

F: Time segments for different activities in the contest (total time, groundwork time, MATTE time and discrepancy time) : The total time for the contest, including stoppage; the time spent in groundwork techniques; the time spent recovering after MATTE had been called; the discrepancy time was the difference between the actual fighting time and the official contest time (discrepancy time = Total time - MATTE time - 5 min [4 min for women]). The number of times MATTE was called (n) is given after the total MATTE time as / n.

ABBREVIATIONS USED IN THE TEXT FOR TECHNIQUES

The following abbreviations for Judo technique have been used.

Standingwork technique

DAB : Deashi-Barai (forward foot sweep)
HRG : Harai-Goshi (hip sweep)
HRM : Harai-Makikomi (hip sweep wrap-around)
KAD : Kata-Ashi-Dori (one leg catching)
KGU : Kata-Guruna (shoulder whirl)
KTA : Kuchiki-Taoshi (dead-tree drop)
KSG : Kosoto-Gari (small outside clip)
KSK : Kosoto-Gake (small outside hook)
KUG : Kouchi-Gari (small inside clip)
KUM : Kouchi-Makikomi (small inside clip wrap-around)
MGA : Morote-Gari (Two-arm clip)
OAB : Okuri-Ashi-Barai (assist foot sweep)
OGA : Osoto-Gaeshi (big outside clip counter)
OGO : Ogoshi (hip roll)
OSG : Osoto-Gari (big outside clip)
OUC : Ouchi-Gaeshi (big inside clip counter)
OUG : Ouchi-Gari (big inside clip)
SKG : Sode-Tsurikomi-Goshi (hip throw with a rising sleeve pull)
SN : Seoi-Nage (back-carry throw)
SOT : Sumi-Otoshi (corner drop)
STA : Sasae-Tsurikomi-Ashi (lifting-pull throw with supporting foot)
SUG : Sumi-Gaeshi (corner reversal)
SUK : Sukui-Nage (scoop throw)
TKG : Tsurikomi-Goshi (lift-pull hip throw)
TN : Tomoe-Nage (round throw)
TNO : Tani-Otoshi (valley drop)
TO : Tai-Otoshi (body drop)
UM : Uchi-Mata (thigh throw)
UNA : Uranage (inside-out throw)
UWA : Uki-Waza (floating technique)

Groundwork technique

HKG : Hon-Kesa-Gatame (scarf hold)
JG : Juji-Gatame (cross arm bar)
KKS : Kuzure-Kami-Shiho-Gatame (modified upper four-corner hold)
KSH : Kami-Shiho-Gatame (upper four-corner hold)
KYS : Kuzure-Yoko-Shiho-Gatame (modified side four-corner hold)
OEJ : Okuri-Eri-Jime (sliding lapel choke)
TSG : Tate-Shiho-Gatame (vertical four-corner hold)
UKG : Ushiro-Kesa-Gatame (back scarf hold)
YSG : Yoko-Shiho-Gatame (side four-corner hold)

7.3 THE 1992 OLYMPIC GAMES JUDO EVENT FINALS (WOMEN)

Table 7.1 The height, weight and age of each female champion

WEIGHT CATEGORY	HEIGHT	WEIGHT	AGE
-48kg	162cm	48kg	25y
-52kg	156cm	52kg	24y
-56kg	165cm	56kg	28y
-61kg	170cm	61kg	25y
-66kg	168cm	66kg	22y
-72kg	169cm	72kg	21y
+72kg	173cm	95kg	23y

Table 7.2 The result obtained by the female champion for each round

WOMEN'S

	-48kg	-52kg	-56kg	-61kg
1st	*	KINSA	*	IPPON(MGA)
2nd	IPPON(TKG)	IPPON(SN)	IPPON(OUG)	SHIDO
3rd	KIKEN	KINSA	KINSA	IPPON(KSA)
Semi	IPPON(UM)	KINSA	IPPON(JG)	IPPON(JG)
Final	KOKA(MGA)	KOKA(TNO)	YUKO(KSK)	KINSA

	-66kg	-72kg	+72kg
1st	SOGO	*	KINSA
2nd	YUKO(KSK)	IPPON(STA)	YUKO(HRG)
3rd	IPPON AWAS	IPPON AWAS	IPPON(HRG)
Semi	KINSA	IPPON AWAS	IPPON(KSH)
Final	WAZA(UM)	KINSA	IPPON(KSH)

-48kg final
This contest was decided by KOKA (KAD)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO	2	

		Winner		Opponent	
A: Number of techniques		20		25	
B: Variety of techniques		TO	9	KUG	9
		UM	4	UM	4
		OAB	3	STA	3
		KUG	1	SN	3
		KSG	1	OSG	2
		MGA	1	TN	1
		KAD	1	KSG	1
				KAD	1
				OAB	1
C: Effect of techniques	a)	1		1	
	b)	2		8	
	c)	15		16	
	d)	0		0	
D: Advantage gripping (s)		10		9	
E: Groundwork techniques (s)		7		3	

F: Time --	Total	5:22
	Groundwork	0:16
	Matte	1:20/11 (+11)

Summary of the contest

This contest was decided by 2 KOKA,(MOROTE-GARI & KATA-ASHI-DORI), created by standingwork. These techniques are useful for a player who is taller and who has longer arms. As far as the number of techniques attempted, the variety of these techniques and the effectiveness of the techniques, the loser was superior to the winner. During this contest the loser mainly took the offensive. However, from only a few opportunities during the contest the winner scored two KOKA.

-52kg final
This contest was decided by YUKO (KSG)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		

		Winner		Opponent
A: Number of techniques		13		21
B: Variety of techniques	SN	8	KUG	10
	KSG	2	UM	5
	OSG	1	SUK	2
	TO	1	KSG	1
	KUG	1	OSG	1
			OUG	1
			HRM	1
C: Effect of techniques	a)	2		2
	b)	7		6
	c)	3		13
	d)	0		0
D: Advantage gripping (s)		4		1
E: Groundwork techniques (s)		42		85

F: Time -- Total	6:32
Groundwork	2:08
Matte	2:34/14 (-2)

Summary of the contest

This contest was decided by YUKO from a KOSOTO-GAKE which is one of the standing techniques. With respect to the number of techniques attempted, the variety of these techniques and time spent attacking during groundwork, the loser was superior to the winner. In the effectiveness of techniques, a) and b) were almost the same. In fact, the loser mainly stepped forward with small techniques such as c), but the winner attacked her with SN which is a useful technique when the opponent comes forward. The loser often lost her balance even though the technique SN was far from strong.

-56kg final
This contest was decided by YUKO (KSG)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		1

		Winner		Opponent
A: Number of techniques		10		20
B: Variety of techniques	OAB	2	UM	7
	KSK	2	OAB	3
	OUG	2	SN	3
	UM	2	DAB	3
	TO	1	SUG	3
	KSG	1	KAD	1
C: Effect of techniques	a)	1		0
	b)	2		7
	c)	6		12
	d)	0		0
D: Advantage gripping (s)		10		5
E: Groundwork techniques (s)		66		27

F: Time -- Total 6:03
Groundwork 1:33
Matte 1:57/8 (+6)

Summary of the contest

This contest was decided by YUKO created by standing technique. With respect to the number of attempts, the loser was superior to the winner. The loser attacked more with combination techniques (more than one technique). The loser scored KOKA with her combination techniques (UCHI-MATA & SUMI-GAESHI). As far as the variety of techniques, both players were the same. In time spent on the attack during groundwork, the winner was superior to the loser. It is quite likely that these players were of similar Judo ability and skill, and in this case, the winner was fortunate. She was probably influenced by the atmosphere, the winner being Spanish.

-61kg final
This contest was decided by KINSA (Judges' decision)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Opponent	
A: Number of techniques			9		9
B: Variety of techniques		KUG	3	KAD	2
		OUG	3	UM	1
		OAB	1	SUK	1
		TO	1	HRM	1
		OSM	1	OUG	1
				KSG	1
				KUG	1
				OSG	1
C: Effect of techniques	a)		0		0
	b)		2		4
	c)		7		5
	d)		0		0
D: Advantage gripping (s)			4		4
E: Groundwork techniques (s)			111		38

F: Time --		
	Total	6:37
	Groundwork	2:29
	Matte	2:27/6 (+10)

Summary of the contest

This contest was very close and was eventually decided by KINSA. With respect to the number of techniques attempted, and time with a grip advantage, both players were the same. However, in time spent attacking during groundwork, the winner had a much greater advantage. In fact, 62% of this contest was spent on the ground. Hence the perceived advantage in groundwork obtained by the victor could easily have been the predominant factor which influenced the final decision of the judges.

-66kg final
This contest was decided by WAZA-ARI (UM)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI	2	
KOKA	SHIDO	1	1

	Winner		Opponent	
A: Number of techniques		22		22
B: Variety of techniques	UM	10	UM	9
	KSK	3	KSK	6
	OAB	3	KSG	3
	DAB	2	OUG	2
	OUG	1	KUG	2
	OUC	1		
	KUG	1		
	KSG	1		
C: Effect of techniques	a)	0		1
	b)	4		7
	c)	15		14
	d)	0		0
D: Advantage gripping (s)		7		9
E: Groundwork techniques (s)		35		9

F: Time --		
	Total	5:13
	Groundwork	0:44
	Matte	1:11/7 (+2)

Summary of the contest

This contest was decided with a WAZA-ARI by UCHI-MATA during standingwork. The winner also scored two YUKO. Both players had a SHIDO because of passivity. The number of technique was the same but the winner demonstrated a wider variety of techniques. With respect to the effectiveness of techniques, the loser was slightly better than the winner. However, the winner did spend more time with an advantage during groundwork. It is likely that the winner kept the advantage during the contest from the evidence of these scores.

-72kg final

This contest was decided by KINSA (Judges' decision)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Opponent
A: Number of techniques		16		21
B: Variety of techniques	KUG	6	STA	6
	UM	5	KUG	5
	STA	2	OUG	4
	SUK	1	OSG	2
	OGA	1	KAD	1
	HRM	1	UM	1
			HRG	1
			KSG	1
C: Effect of techniques	a)	1		1
	b)	7		4
	c)	8		16
	d)	0		0
D: Advantage gripping (s)		1		3
E: Groundwork techniques (s)		9		76

F: Time --	Total	5:49
	Groundwork	1:25
	Matte	1:37/8 (+12)

Summary of the contest

This was a very close contest. As far as the number of techniques attempted, the loser was slightly superior to the winner, while the winner was superior to the loser from the point of view of effectiveness of techniques b). The biggest difference was in time spent attacking during groundwork; the loser was superior to the winner. In the final analysis it is probably that the effectiveness of the winner's techniques was one of the reasons why she got the final decision. However, the winner threw her opponent just after the contest had finished. The cheering of the audience drowned the referee's announcement. For this reason the referee and judges might have been impressed even though this technique was after time (SOREMADE) had been called.

+72kg final

This contest was decided by IPPON (KSH)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		

		Winner		Opponent
A: Number of techniques		7		3
B: Variety of techniques	SN	6	UM	2
	KUG	1	UNG	1
	OUG	1		
C: Effect of techniques	a)	0		0
	b)	4		0
	c)	2		3
	d)	0		0
D: Advantage gripping (s)		0		1
E: Groundwork techniques (s)		92		16

F: Time --		
	Total	4:02 (2:41)
	Groundwork	1:48
	Matte	1:33/5 (-12)

Summary of the contest

This contest was decided by IPPON. The technique used to obtain this score was KAMI-SHIHO-GATAME during groundwork. In most areas, the winner was superior to the loser, especially during time spent attacking during groundwork. In fact the winner scored IPPON by KSH after throwing the loser with OUG which scored YUKO. The winner appeared to be in control throughout the contest.

7.4 THE 1992 OLYMPIC GAMES JUDO EVENT FINALS (MEN)

Table 7.3 The height, weight and age of each male champion

WEIGHT CATEGORY	HEIGHT	WEIGHT	AGE
-60kg	168cm	60kg	23y
-65kg	178cm	65kg	25y
-71kg	169cm	71kg	24y
-78kg	180cm	78kg	22y
-86kg	180cm	86kg	29y
-95kg	200cm	94kg	20y
+95kg	188cm	120kg	21y

Table 7.4 The result obtained by the male champion for each round

MEN'S

	-60kg	-65kg	-71kg	-78kg
1st	IPPON(HRG)	*	*	IPPON(UM)
2nd	IPPON(HRG)	IPPON(OSG)	IPPON(TN)	IPPON(OSG)
3rd	IPPON(TGU)	IPPON(OSG)	WAZA(KUM)	IPPON(SAJ)
4th	SOGO	IPPON(YSG)	KINSA	IPPON(UM)
Semi	WAZA(UNA)	CHUI	IPPON(SN)	IPPON(UM)
Final	KOKA	WAZA(OSG)	KINSA	IPPON(UM)

	-86kg	-95kg	+95kg
1st	*	*	*
2nd	IPPON(UM)	IPPON AWAS	IPPON(KYS)
3rd	IPPON(JG)	YUKO(OSG)	WAZA(HRM)
4th	YUKO(HRM)	WAZA(UM)	KOKA(HKG)
Semi	YUKO(SN)	YUKO(KTA)	WAZA(TO)
Final	YUKO(SN)	YUKO(UM)	IPPON AWAS

-60kg final
This contest was decided by KOKA (STA)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO	1	

	Winner		Opponent	
A: Number of techniques		29		31
B: Variety of techniques	SUK	10	KUG	8
	SN	6	STA	6
	STA	3	OUG	5
	KUG	3	TO	3
	HRM	2	KAD	3
	OUG	1	OSG	2
	KGU	1	HRM	1
	KSG	1	SKG	1
	TO	1	KUB	1
	OTH	1	UM	1
C: Effect of techniques	a)	3		1
	b)	12		9
	c)	12		21
	d)	0		0
D: Advantage gripping (s)		15		4
E: Groundwork techniques (s)		24		15

F: Time -- Total 8:34
Groundwork 0:41
Matte 3:25/24 times (discrepancy +9)

Summary of the contest

This contest was decided by KOKA. The number of techniques attempted was almost the same for each contestant. These numbers were very high. In addition both competitors demonstrated a wide variety of techniques. Both players used 10 kinds of techniques. However, the winner managed to break his opponent's balance more often, and it was by repeating these kinds of minor techniques, that the winner eventually succeeded in getting a score. The winner was also superior in the time advantage during gripping and time spent attacking during groundwork.

-65kg final
This contest was decided by WAZA-ARI (OSG)

Final scoreboad

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI	1	
KOKA	SHIDO	1	1

		Winner		Opponent	
A: Number of techniques		17		35	
B: Variety of techniques		OSG	5	OAB	9
		KSG	4	SN	6
		OAB	4	UM	5
		OUG	2	STA	5
		KUG	1	TN	3
		KSK	1	KUG	3
				OUG	2
				DAB	1
				OGA	1
C: Effect of techniques	a)	3		0	
	b)	4		4	
	c)	8		30	
	d)	0		0	
D: Advantage gripping (s)		6		8	
E: Groundwork techniques (s)		31		0	

F: Time --		
	Total	7:46
	Groundwork	36
	Matte	2:47/12 times (discrepancy -1)

Summary of the contest

This contest was decided by WAZA-ARI produced by OSOTO-GARI. With respect to the number of techniques attempted, and in their variety, the loser was superior to the winner. However, the winner scored 1 WAZA-ARI, 1 YUKO and 1 KOKA, and so his techniques were more effective than the loser's. The loser tried, unsuccessfully as it happens, to make the opening for a major technique by using several minor techniques such as technique c). The winner did not have an advantage in gripping but spent far more time on the attack during groundwork than the loser.

-71kg final
This contest was decided by KINSA (judges' decision)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI		
KOKA	SHIDO		

		Winner		Opponent
A: Number of techniques		16		24
B: Variety of techniques	OAB	7	TO	7
	SKG	3	SN	6
	SN	1	OAB	3
	TN	1	MTG	3
	KUG	1	OUG	2
	KSG	1	UM	1
	UMS	1	OSG	1
	KSK	1	KUG	1
C: Effect of techniques	a)	4		1
	b)	3		5
	c)	9		17
	d)	0		1
D: Advantage gripping (s)		22		10
E: Groundwork techniques (s)		10		13

F: Time --	Total	7:11
	Groundwork	28
	Matte	2:01/16 (+10)

Summary of the contest

This contest seemed to be a close contest. With respect the number of techniques attempted, the loser was superior to the winner, while in the variety of techniques, both players were the same. However, as far as the effectiveness of techniques, the winner was superior to the loser, although these techniques were not enough to score KOKA. The loser tried a lot of techniques which followed from a poor gripping position, and he was stepping back whereas the winner mainly stepped forward. Probably, because of these factors the winner got the verdict. In addition, during this contest the Judo players didn't grip each other at all for long periods of time.

-78kg final
This contest was decided by IPPON (UM)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI	1	
KOKA	SHIDO		1

		Winner		Opponent
A: Number of techniques		16		10
B: Variety of techniques	UM	6	UM	3
	STA	4	KSK	3
	KSK	3	DAB	2
	OSG	1	KUG	1
	OUG	1	OUG	1
	KUG	1		
C: Effect of techniques	a)	3		0
	b)	4		1
	c)	7		9
	d)	0		0
D: Advantage gripping (s)		13		0
E: Groundwork techniques (s)		3		0

F: Time -- Total	5:51 (3:53)
Groundwork	0:07
Matte	2:18/10 (-20)

Summary of the contest

This contest was decided by UCHI-MATA scoring IPPON. In all areas, the winner was superior to the loser. The score of SHIDO for the opponent was created by standing on the danger zone of the mat (red area) for more than 5 seconds. The winner did not give the loser an opportunity to attack at all. The contest was fought throughout at the winner's pace.

-86kg final
This contest was decided by YUKO (UM)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	**KEIKOKU**		
YUKO	**CHUI**	**1**	
KOKA	**SHIDO**	**1**	**1**

		Winner		Opponent
A: Number of techniques		18		16
B: Variety of techniques	UM	10	UM	8
	KSG	2	KSG	3
	SN	2	OSG	2
	MTG	2	OAB	1
	KSK	1	KUG	1
	OUG	1	HRG	1
C: Effect of techniques	a)	0		1
	b)	4		8
	c)	11		7
	d)	0		0
D: Advantage gripping (s)		3		15
E: Groundwork techniques (s)		79		1

F: Time -- Total 7:55
Groundwork 1:32
Matte 2:50/12 (+5)

Summary of the contest

This contest was decided by YUKO from a UCHI-MATA that was scored after only 11 seconds from the start of the contest. With respect to the number of techniques attempted and the variety of techniques both players were almost same. The loser was superior to the winner in the effect of techniques and the time spent with grip advantage. In fact the winner received a SHIDO because he didn't attack enough. The winner scored KOKA from a MOROTE-GARI just before the end of match. In this contest, it was easy to distinguish between the defensive player and the attacking player. The winner defended his YUKO score throughout the contest skilfully.

-95kg final
This contest was decided by YUKO (UM)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU		
YUKO	CHUI	2	
KOKA	SHIDO	1	

		Winner		Opponent
A: Number of techniques		14		4
B: Variety of techniques	OSG	4	SKG	2
	KSK	4	STA	1
	UM	3	KAD	1
	OUG	1		
	KUG	1		
	HRM	1		
C: Effect of techniques	a)	0		0
	b)	6		1
	c)	5		3
	d)	0		0
D: Advantage gripping (s)		16		19
E: Groundwork techniques (s)		16		87

F: Time --	Total	6:52
	Groundwork	1:43
	Matte	1:55/8 (-3)

Summary of the contest

This contest was decided by 2 YUKO from two UCHI-MATA. The winner was 200cm tall and the loser was 182cm tall. UCHI-MATA is a very useful technique for taller players. In most areas, the winner was superior to the loser. However, with respect to the time spent attacking during groundwork, the loser was superior to the winner. Nevertheless, he could not get a score during groundwork. The difference in size of the players is not as important in groundwork as it is in standingwork. The winner got a penalty of SHIDO for not attacking enough over a period of several seconds.

+95kg final
This contest was decided by IPPON (AWASE-WAZA : TKG & KSG)

Final scoreboard

Score	Penalty	Winner	Opponent
WAZA-ARI	KEIKOKU	1	
YUKO	CHUI		
KOKA	SHIDO		

		Winner	Opponent
A: Number of techniques		4	0
B: Variety of techniques	TKG	1	
	KSG	1	
	UM	1	
	OAB	1	
C: Effect of techniques	a)	0	0
	b)	1	0
	c)	1	0
	d)	0	0
D: Advantage gripping (s)		7	0
E: Groundwork techniques (s)		0	0
F: Time -- Total		1:23 (1:04)	
Groundwork		0:03	
Matte		0:25/2 (-6)	

Summary of the contest

This contest was decided by IPPON. This conclusion was reached by two WAZA-ARI from TSURIKOMI-GOSHI and TANI-OTOSHI during standingwork. This contest was the shortest competition in all the 1992 Olympic Games Judo finals. The winner did not allow the loser to attack at all. After the first WAZA-ARI, the winner attacked immediately before the loser recovered from the shock of having a WAZA-ARI scored against him. It appeared as though there was nothing that the loser could do to prevent defeat.

7.5 DISCUSSION AND CONCLUSION

In this Chapter, the video recording of each final of every weight category for both women and men at the 1992 Olympic Games Judo event was analysed. This helped to identify the KEY factors which seem to distinguish the Olympic champions, rather than the World champions, from the less successful competitors as in Chapter 6. The analysis was centred around the same six factors introduced in Chapter 6.

The statistics related to the number of standing techniques attempted was surprising. In the women's contests, out of the 7 finals analysed, only 1 final, which was decided by IPPON, was associated with a winner who used more techniques than the loser. In two of the contests the number of attacks were equally divided between winner and loser. For the men, the champions of all the heavier weight categories (-78kg, -86kg, -95kg and +95kg) used more techniques than the silver medallists. In contrast, in the lighter weight categories (-60kg, -65kg and -71kg), the champions used less techniques than the silver medallist.

It is interesting note that in the lower weight categories for male competitors, the number of techniques attempted tends to be significantly higher than in the heavier weight categories, although this trend was not so marked in the female competitors. One explanation for these observations is based on a score by the eventual winner in the middle of the contest. This score causes the loser to attack more frequently in order to regain the lost points. As a result the loser finishes the contest by having a higher attacking average than the winner.

There were 3 contests which were decided by KINSA (referees' decision). It is of some interest that in all of these contests, the silver medallists attempted more techniques than the champion. As far as the judges were concerned the number of standing techniques attempted did not necessarily signify the most aggressive competitor. It can be concluded that although many of the losers had higher values for the number of techniques attempted compared to the subsequent champion, many of these techniques could be classified as minor ones. Also a certain number of these techniques could have been used in order to get the particular competitor out of a disadvantageous situation. The number of techniques used is likely to be lower in those contests that are terminated by IPPON, especially if this occurs near the start of the competition as in the +95kg weight category for men.

The use of a variety of techniques is a vital factor in competition. This was demonstrated by K.Tsujihara(29) in 1988, when he examined the all Japan Judo championships.

The range of techniques is also very important for understanding the characteristic of each player and each weight category. With the male competitors, there was a significant trend which showed that the lighter weight categories demonstrated a wider variety of techniques when compared to the heavier weight categories. However, this trend did not appear with the women competitors. It might be expected that the champion would use a wider range of techniques in comparison to the silver medallist. However, this was not the case with either the female or the male competitors.

Interestingly, there were three contests which were decided by KINSA (referees' decision) in all the finals. Out of these three contests, two of the silver medallists used a wider range of techniques, and even in the remaining contest the range of techniques that were attempted was the same for both the champion and silver medallist. One can therefore say, from the evidence presented at the 1992 Olympic Games, that the variety of techniques produced by a Judo competitor does not directly lead to victory, which seems to contradict the conclusion reached by K.Tsujihara(29).

In Judo competition, there are four separate scores which are associated with both standing and groundwork techniques. However, in I.J.F (International Judo

Federation) rules, the referee and judges have to decide the winner, from the posture and effectiveness of the competitors techniques when the score is exactly the same or there is no score between the players.

In Chapter 6 and in this chapter, the effectiveness of standing techniques was subdivided into four separate categories. In two out of the three contests which were decided by KINSA the champion's techniques were more effective. The odd man out in these cases was the -61kg weight category in which more than 60% of the contest was spent on the ground. Overall, in only 3 out of 14 contests considered did the silver medallists show more effectiveness in their techniques. For the male competitors, it seemed that the lighter weight players used more minor techniques effectively, when compared with the heavier weight players. It is possible to speculate that the lighter weight male Judo players create the chances for their techniques from their movement. It would appear, therefore, that minor techniques are more necessary in the men's lighter weight categories than in the heavier weight categories.

Gripping is the first stage in any Judo bout and can therefore be regarded as very important. Most competitors try to use their favourite grip from which they can create the opening for conversion into a throw or attempted throw. Some of the great Judo players can throw their opponent nearly every time when he/she has obtained his or her favourite grip. In Chapter 6 and this chapter, the interval of time a competitor held a gripping advantage over an opponent was considered. In the finals of both the female and male categories, the gripping advantage time of the champion and the silver medallists was roughly equal. However, when one considers only those results which showed a grip advantage of more than 3 seconds, in 6 out of 8 finals analysed (female 2, male 6), the champion spent more time with a grip advantage than the silver medallist. It seems that the time spent with a grip advantage becomes important if the player can grip with an advantage for more than a few seconds.

In groundwork technique, the player who is on top of his/her opponent has a distinct advantage and is considered to be attacking. In the female -61kg weight category final, more than 60% of the contest was spent on the ground, and the champion had a distinct advantage over the silver medallist. As a result the split decision went in her favour. In the finals for the female contestants, 5 out of 7 champions demonstrated an advantage during groundwork, and one of the contests resulted in IPPON by a groundwork technique. Similar statistics are applicable to the men. At the 1992 Olympic Games, 11 out of 14 contests lasted for the full time duration. It would seem that, time spent in groundwork in an advantageous position is very important in a close contest, even though the groundwork technique doesn't result in an actual score.

The different time segments for the different activities in the contests were analysed. In the female category, the -52kg weight category had the longest MATTE time and greatest number of MATTE called (154 seconds, 14 times). Overall, for these female competitiors MATTE time ranged from 71 seconds to 154 seconds with the number of MATTE called ranging from 5 to 14. In the male category the -60kg weight category had the longest MATTE time and greatest number of MATTE called (205 seconds, 24 times). Overall, MATTE time ranged from 25 seconds to 205 seconds with the number of MATTE called ranging from 2 to 24.

A MATTE call creates a short rest interval in the contest, therefore one should not consider the physical requirements of Judo to be the same as those required for rhythmic repetitive activities. Judo contests can be considered as events of high intensity punctuated by short intervals of rest for up to 6 to 7 minutes. Perhaps, Judo is closer to soccer, basketball or rugby rather than running, swimming or cycling. The oldest female champion was 29 years old and all the other champions were under 25 years of age. A similar picture emerged for the men, the oldest champion was 29 years old and all the other champions were under 24 years of age. The relatively young age of Judo champions, suggests that Judo activity at the top competitive level requires that mixture of strength, speed and endurance which can only be found in mature but relatively young athletes.

Analysis of the results obtained by the champions in the women's competition for each round, and the results of the finals themselves did not show two separate groups such as the hyperdominant and hypodominant groups described in Chapter 6. Only the -72kg category's champion had 3 contests out of the 4 rounds decided by IPPON. All other weight category champions had more than 2 contests which were not decided by IPPON, and all categories, except the -48kg, had at least one contest which was decided by KINSA. The female competitors seemed to have harder contests from the beginning in the Olympic Games. The women champions achieved a score from a variety of techniques. Probably the champions need a repertoire of different techniques which can be changed depending on the circumstance. A similar pattern emerged for the male competitors. Only the -78kg category's champion won every round with IPPON. All the other category champions had more than 2 contests which were not decided by IPPON. But there was only one contest which was decided by KINSA. All male champions won by IPPON up to the 3rd round. Probably, as the competition progressed the contests became much closer. In fact in the semi-final and final, only 4 out of 14 contests were decided by IPPON. All male champions seemed to have their own useful technique, for instance, the -65kg champion won several times by OSOTO-GARI throughout the tournament. One can therefore say that a prerequisite of the champions is that they have at least one strong technique.

7.6 SUMMARY

* Number of Techniques :	Number of techniques attempted did not always signify the most aggressive competitor. In the lower weight categories for the male competitors, the number of techniques attempted tends to be significantly higher than in the heavy weight categories. However, this trend didn't appear so marked with regard to the female competitors.
* Variety of Techniques :	The trend that the champion used a wider range of techniques in comparison to the silver medallist was not the case with both female and male competitors. In the male competitors, there was a significant trend which showed that the lighter weight categories demonstrated a wider variety of techniques when compared to the heavier weight categories.
* Effect of Techniques :	Only in 3 out of 14 contests did the silver medallists show more effectiveness in their techniques than the champions.
* Total time of grip advantage :	In the finals of both the female and male categories, the advantage of gripping time of the champions and the silver medallists was roughly equal. It seemed that the time spent with a grip advantage became important if the player could grip for more than a few seconds.

* Total time of attack during groundwork :	In the finals for the female contestants, 5 out of the 7 champions demonstrated an advantage during groundwork. Similar statistics can be applied to the men.
* Time segments for different activities in the contest :	The Judo contest can be considered as a random interval multiple activity sport lasting for 6 to 7 minutes. Judo champions tend to be relatively young. This suggests that Judo activity at a high competitive level is a mixture of strength, speed and endurance which lasts for a short period of time only.
* The results obtained by the champion for each round :	Analysis of the results obtained by the champion for each round could not be separated into two groups, which were hyperdominant and hypodominant groups, as in Chapter 6. The female competitors seemed to have harder contests from the beginning. However, all male champions won by IPPON up to the 3rd round. Probably, as the competition progressed the contests became much closer.

CHAPTER 8

COMPARISON BETWEEN THE 1991 WORLD CHAMPIONSHIPS AND THE 1992 OLYMPIC GAMES JUDO EVENT

8.1 INTRODUCTION

In 1991 and 1992 the top performers in Judo gathered together in Barcelona, Spain to contest the World Judo Championships and the Olympic Games Judo event. These two top level Judo competitions were held at the same geographical location, and only one year apart. Hence they provided an ideal opportunity to construct a comparative study. This chapter is an analysis of this comparison between the two competitions, some of it based on the data presented in previous chapters 3 and 4.

Mainly four different factors were used to compare the 1991 World Championships and the 1992 Olympic Games. They were :

8.2 Competitors taking part

8.3 Scoring patterns

8.4 Techniques

8.5 Result of the 1991 and 1992 finals and the result obtained by the champion for each round

The chapter is concluded by a discussion of the analysis, in the context of World Judo, and key points arising from these observations.

8.2 RELEVANT INFORMATION ABOUT THE COMPETITORS PARTICIPATING IN THE 1991 CHAMPIONSHIPS AND THE 1992 GAMES

8.2.1 Geographical partitioning of the contestants

The International Judo Federation consists of five Continental Unions. These are

* The European Judo Union (EJU)
* The Pan American Judo Union (PAJU)
* The African Judo Union (AJU)
* Judo Union Asia (JUA)
* Oceanic Judo Union (OJU)

The figure below, Figure 8.1, shows the number of countries that belong to these respective Judo Unions.

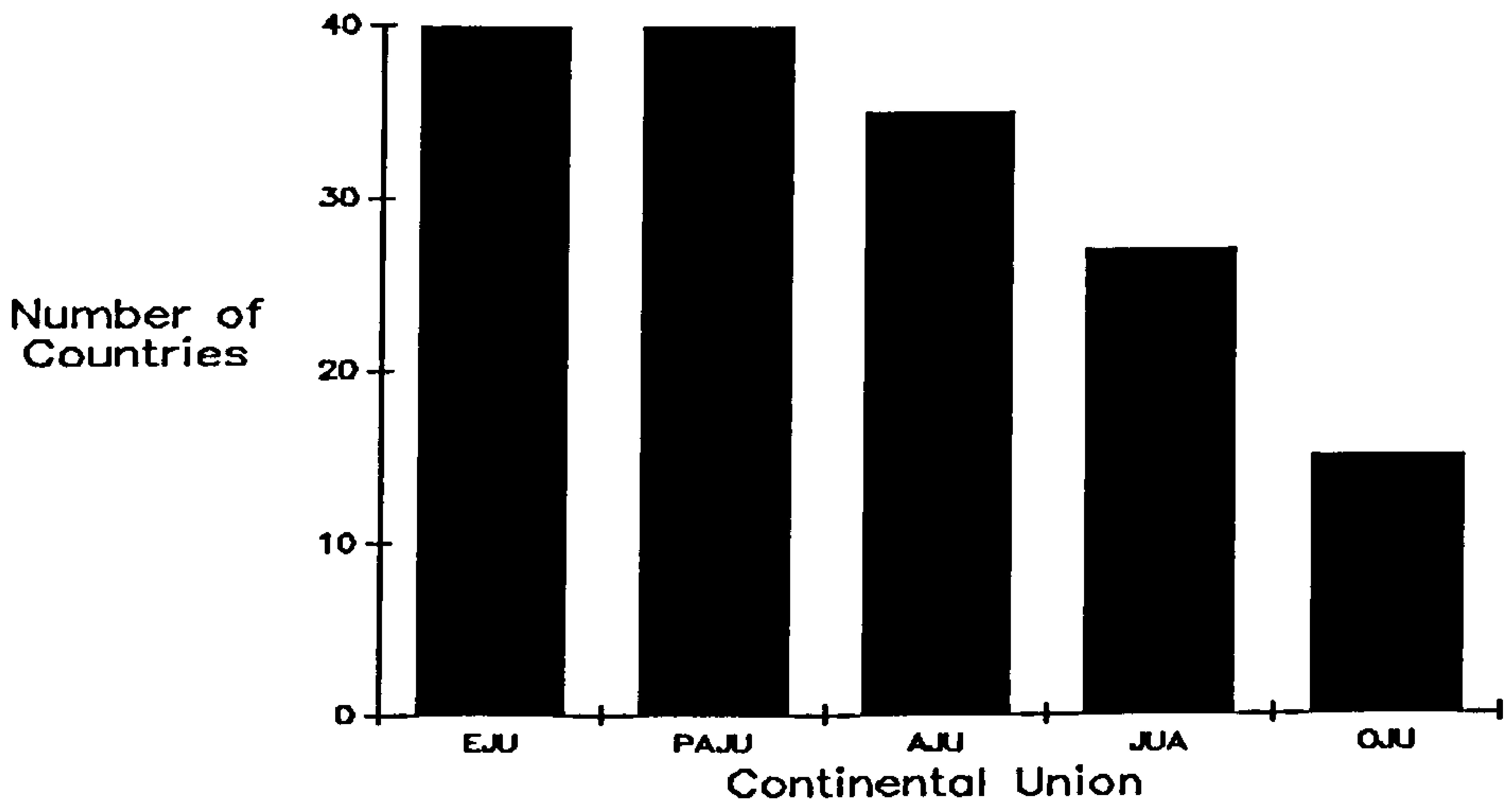


Figure 8.1 The number of countries in each Continental Union of the I.J.F

Each country in each Union is allowed to send one competitor for each weight category to the World Championships and the Olympic Games respectively. There is no Open event at the Olympic Games so that it was expected that the number of competitors would be slightly less at the Olympic Games, held in 1992, compared with the World Championships, held in 1991. Although this was true for the majority of the Judo Unions there was a notable exception in the male competitors from the African Judo

Union. The number of competitors from each Union participating in the 1991 Championships and 1992 Games is given below in Figure 8.2 and 8.3. It is clear that the Championships and Games were dominated by competitors from Europe.

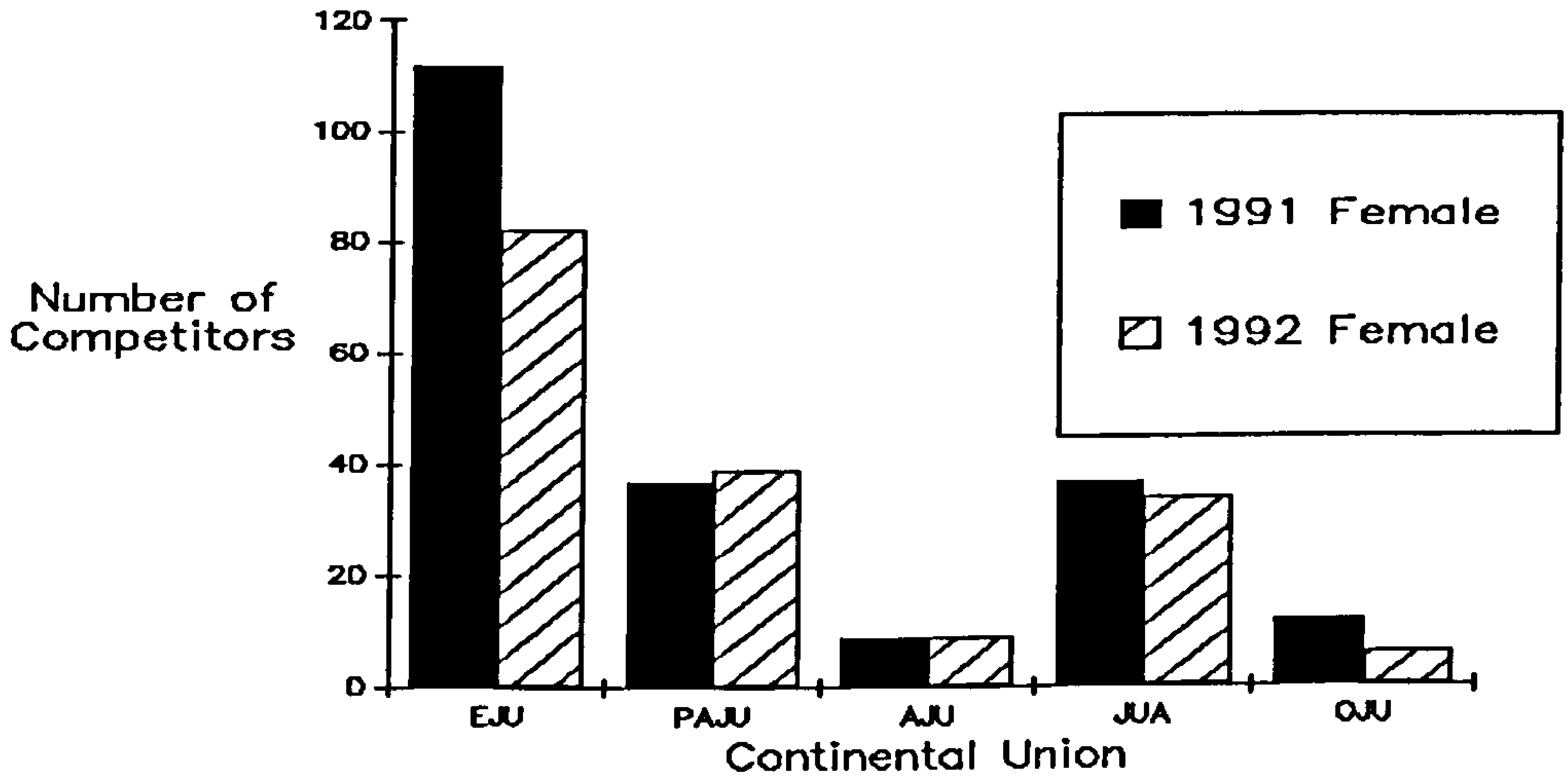


Figure 8.2 Comparisons from each continental union taking part for female in 1991 and 1992

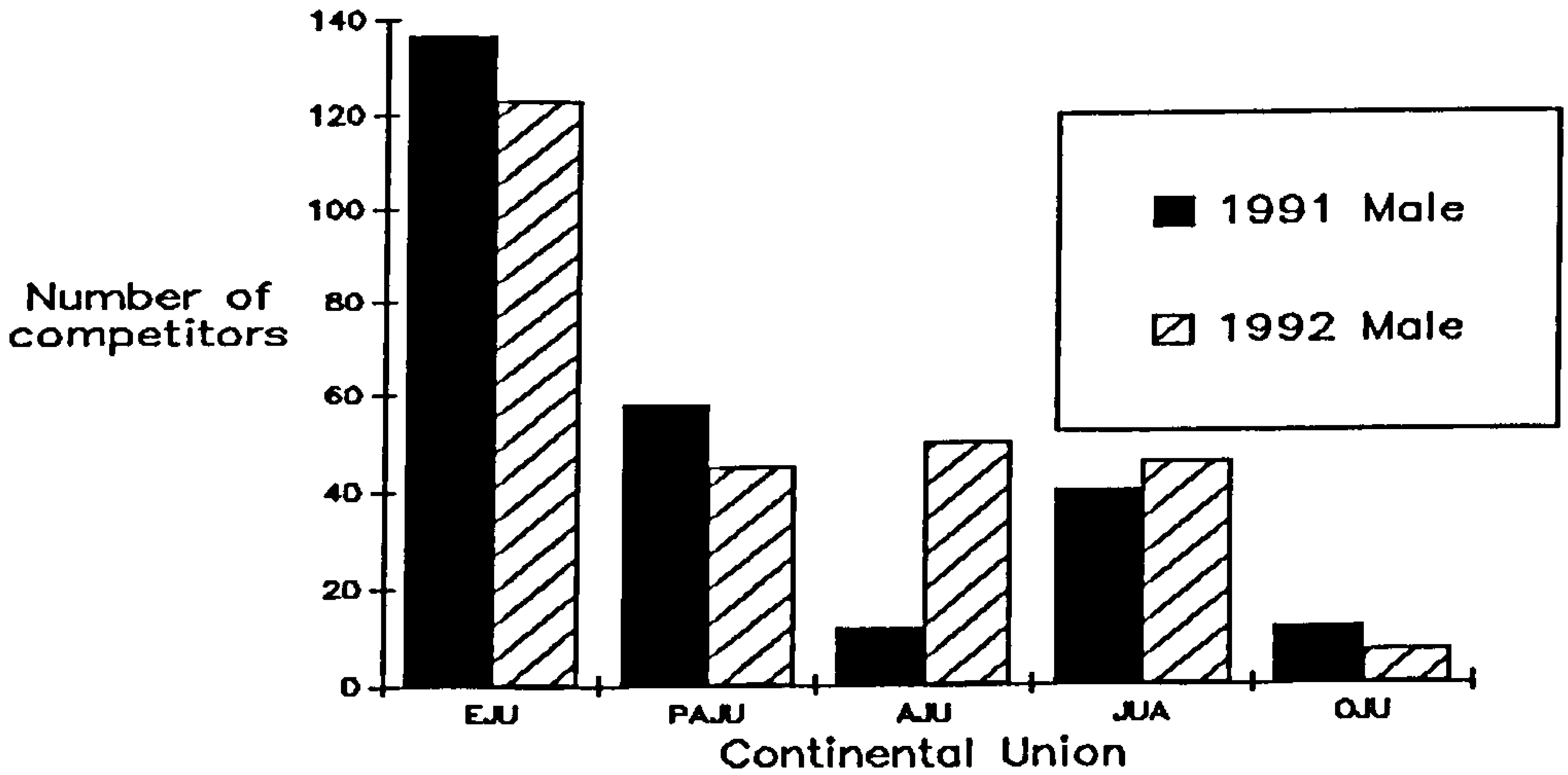


Figure 8.3 Comparisons from each continental union taking part for male in 1991 and 1992

8.2.2 Number of contestants participating in the 1991 Championships and 1992 Games partitioned by weight category

Table 8.1 below gives the number of female competitors in each weight category in the 1991 World Championships and the 1992 Olympic Games. The third column in the Table indicates the number of competitors participating in both events. The numbers in brackets indicate those competitors who entered the championships but did not take part through injury or illness. Over two hundred female competitors took part in the World Championships. The number was reduced to 166 for the 1992 Olympic Games. Ninety competitors took part in both events. Although 16 competitors in the +72kg class fought in 1991 and 1992 some of these contestants took part in the Open event in the 1991 World Championships. Bearing this fact in mind, it is clear that more competitors in the light weight categories returned to Barcelona for the Olympic Games after the World Championships than in the heavy weight categories.

Table 8.1 Number of female competitors participating in the 1991 World Championships and the 1992 Olympic Games

Women	1991	1992	1991&1992
-48kg	28	24(2)	14
-52kg	27	25	12
-56kg	26	24(1)	17
-61kg	35	29	16
-66kg	26	21	9
-72kg	23	22	6
+72kg	22	21	16
Open	20		
TOTALS	207	166(3)	90

Table 8.2 below gives the number of male competitors in each weight category in the two competitions. Surprisingly, in the light of the statistics associated with the female competitors, more male competitors fought in the Olympic Games than the World Championships. There was an increase from 258 competitors to 272 competitors from 1991 to 1992, with 120 competitors taking part in both events. Again there was no Open event in the Olympic Games so some of the contestants in the Open World Championships returned to fight in the +95kg class at the Olympic Games. Just as for the female competitors, the number of these contestants who took part in both events tended to be higher in the light weight categories.

Table 8.2 Number of male competitors participating in the 1991 World Championships and the Olympic Games

Men	1991	1992	1991&1992
-60kg	38	43	21
-65kg	37	46	19
-71kg	38	44	22
-78kg	36	42	13
-86kg	32	33	17
-95kg	32	35(1)	12
+95kg	23	29(1)	16
Open	22		
TOTALS	258	272(2)	120

8.2.3 A comparison of the results of the medallists in 1991 with those of the medallists in 1992

Table 8.3 gives a list of the female medallists in the 1991 World Championships. Their subsequent performances in the Olympic Games, in the following year are also documented. Of the women who reached the finals in the World Championships there were finalists in 3 out of 7 weight categories who also contested the final in the Olympic Games. This statistic includes the finalists of the Open category at the World Championships who contested the +72kg weight category at the Olympic Games. Sixteen of the 32 medallists in the 1991 World Championships became medallists in the 1992 Olympic Games. Six of the World Championships medallists did not compete in the 1992 Olympic Games. For comparative purposes Table 8.4 documents the female medallists in the 1992 Olympic Games and their previous performances in the 1991 World Championships. Of the 14 finalists at the Olympic Games, 12 competitors had won medals at the World Championships. Eight of the 28 medallists in the Olympic Games had not competed in the World Championships. These statistics suggest that both the Championships and Olympic Games were dominated by the same female competitors as far as the medal positions were concerned.

Table 8.5 gives the male medallists at the 1991 World Championships and their subsequent performance in the Olympic Games. Only the Open weight category finalists went on to contest the final in the Olympic Games, but this was in the +95kg weight category (there is no Open contest at the Olympic Games). However, Yoon in the -60kg category and Koga in the -71kg category did appear in the final of the Olympic Games. Thirteen of the 32 medallists in the World Championships went on to score medals in the Olympic games the next year. Only 6 of the World Championships medallists did not compete at the Olympic Games. Table 8.6 gives the male medallists at the 1992 Olympic games and their previous performance at the World Championships. Only 7 of the 28 medallists had not competed at the World Championships. Five of the gold medallists at the World Championships went on to collect a medal at the Olympic games, but only Koga of Japan managed to repeat his gold medal winning performance. These statistics suggest a relative domination of the World Championships and Olympic Games by a small group of male competitors, in a manner similar to that observed for the female contestants.

Table 8.3 The female medallists in the 1991 World Championships and their subsequent performance in the 1992 Olympic Games (* : the competitor did not compete)

Women	1991 World Championships			1992 Olympic Games
-48kg	1 C.Nowak	(FRA)	----	Gold
	2 K.Briggs	(GBR)	----	5th position
	3 R.Tamura	(JPN)	----	Silver
	3 L.Verdecia	(CUB)	----	*
-52kg	1 A.Giungi	(ITA)	----	5th position
	2 S.Rendle	(GBR)	----	Bronze
	3 M.Perez	(CUB)	----	1st round
	3 M.Ueda	(JPN)	----	*
-56kg	1 M.Blasco	(ESP)	----	Gold
	2 N.Flagotheier	(BEL)	----	5th position
	3 N.Fairbrother	(GBR)	----	Silver
	3 Li.Z.Yun	(CHN)	----	*
-61kg	1 F.Eickhoff	(FRG)	----	5th position
	2 D.Bell	(GBR)	----	3rd round
	3 C.Fleury	(FRA)	----	Gold
	3 Y.Arad	(ISR)	----	Silver
-66kg	1 E.Pierantozzi	(ITA)	----	Silver
	2 O.Revjiminez	(CUB)	----	Gold
	3 R.Fujimoto	(JPN)	----	2nd round
	3 K.Howey	(GBR)	----	Bronze
-72kg	1 M.Kim	(KOR)	----	Gold
	2 Y.Tanabe	(JPN)	----	Silver
	3 M.V.Marion	(NED)	----	*
	3 L.Meignan	(FRA)	----	Bronze
+72kg	1 J.Y.Moon	(KOR)	----	1st round
	2 Y.Zhang	(CHN)	----	*
	3 M.Lee	(NED)	----	*
	3 B.Maksymow	(POL)	----	5th position
OPEN	1 X.Zhuang	(CHN)	----	Gold (+72kg)
	2 E.Rodriguez	(CUB)	----	Silver (+72kg)
	3 C.Weber	(FRG)	----	5th position (+72kg)
	3 N.Lupino	(FRA)	----	Bronze (+72kg)

Table 8.4 The female medallists in the 1992 Olympic Games and their previous performance in the 1991 World Championships

Women	1992 Olympic Games			1991 World Championships
-48kg	1 C.Nowak (FRA)	----	Gold
	2 R.Tamura (JPN)	----	Bronze
	3 H.Senyurt (TUR)	----	1st round
	3 A.S.Carmenaty (CUB)	----	*
-52kg	1 A.Munoz (ESP)	----	3rd round
	2 N.Mizoguchi (JPN)	----	*
	3 L.Zhongyun (CHN)	----	*
	3 S.Rendle (GBR)	----	Bronze
-56kg	1 M.Blasco (ESP)	----	Gold
	2 N.Fairbrother (GBR)	----	Bronze
	3 C.Tateno (JPN)	----	2nd round
	3 D.Gonzalez (CUB)	----	*
-61kg	1 C.Fleury (FRA)	----	Bronze
	2 Y.Arad (ISR)	----	Bronze
	3 D.Zhang (CHN)	----	*
	3 E.Petrova (EUN)	----	2nd round
-66kg	1 O.Revjiminez (CUB)	----	Silver
	2 E.Pierantozzi (ITA)	----	Gold
	3 H.Rankels (BEL)	----	*
	3 K.Howey (GBR)	----	Bronze
-72kg	1 M.Kim (KOR)	----	Gold
	2 Y.Tanabe (JPN)	----	Silver
	3 I.D.Kok (NED)	----	*
	3 L.Meignan (FRA)	----	Bronze
+72kg	1 X.Zhuang (CHN)	----	Gold (OPEN)
	2 E.Rodriguez (CUB)	----	Silver (OPEN)
	3 Y.Sakaue (JPN)	----	*
	3 N.Lupino (FRA)	----	Bronze (OPEN)

Table 8.5 The male medallists in the 1991 World Championships and their subsequent performance in the 1992 Olympic Games

Men	1991 World Championships			1992 Olympic Games
-60kg	1 T.Koshino	(JPN)	----	Bronze
	2 H.Yoon	(GBR)	----	Silver
	3 P.Pradayrol	(FRA)	----	5th position
	3 N.Gousseinov	(URS)	----	Gold
-65kg	1 U.Quellmalz	(FRG)	----	Bronze
	2 M.Okuma	(JPN)	----	*
	3 S.Kosmynin	(URS)	----	2nd round
	3 J.Pedro	(USA)	----	3rd round
-71kg	1 T.Koga	(JPN)	----	Gold
	2 J.Ruiz	(ESP)	----	3rd round
	3 H.Chung	(KOR)	----	Bronze
	3 V.Dguebovaze	(URS)	----	*
-78kg	1 D.Lascau	(FRG)	----	1st round
	2 J.Laats	(BEL)	----	5th position
	3 B.Varsev	(URS)	----	*
	3 H.Yoshida	(JPN)	----	Gold
-86kg	1 H.Okada	(JPN)	----	Bronze
	2 J.Wanag	(USA)	----	1st round
	3 W.Legien	(POL)	----	Gold
	3 G.Vismara	(GBR)	----	2nd round
-95kg	1 S.Traineau	(FRA)	----	3rd round
	2 P.Nastula	(POL)	----	5th position
	3 M.Meiling	(FRG)	----	*
	3 J.Sosnar	(TCH)	----	2nd round
+95kg	1 S.Kosorotov	(URS)	----	*
	2 G.Moreno	(CUB)	----	5th position
	3 N.Ogawa	(JPN)	----	Silver
	3 K.S.Kim	(KOR)	----	2nd round
OPEN	1 N.Ogawa	(JPN)	----	Silver (+95kg)
	2 D.Khakhaleichvili	(URS)	----	Gold (+95kg)
	3 I.Csosz	(HUN)	----	Bronze (+95kg)
	3 G.Mathonnet	(FRA)	----	*

Table 8.6 The male medallists in the 1992 Olympic Games and their previous performance in the 1991 World Championships

Men	1992 Olympic Games			1991 World Championships
-60kg	1 N.Gousseinov	(EUN)	----	Bronze
	2 H.Yoon	(GBR)	----	Silver
	3 R.Trautman	(GER)	----	5th position
	3 T.Koshino	(JPN)	----	Gold
-65kg	1 R.Sampaio	(BRA)	----	*
	2 J.Csak	(HUN)	----	2nd round
	3 U.Quellmalz	(FRG)	----	Gold
	3 I.Harnandez	(CUB)	----	*
-71kg	1 T.Koga	(JPN)	----	Gold
	2 B.Hajtos	(HUN)	----	5th position
	3 H.Chung	(KOR)	----	Bronze
	3 S.O.Smadga	(ISR)	----	*
-78kg	1 H.Yoshida	(JPN)	----	Bronze
	2 J.N.Morris	(USA)	----	2nd round
	3 B.Damaisin	(FRA)	----	*
	3 B.J.Kim	(KOR)	----	2nd round
-86kg	1 W.Legien	(POL)	----	Bronze
	2 P.Tayot	(FRA)	----	5th position
	3 H.Okada	(JPN)	----	Gold
	3 N.Gill	(CAN)	----	1st round
-95kg	1 A.Kovacs	(HUN)	----	*
	2 R.Stevens	(GBR)	----	*
	3 D.Sergeev	(EUN)	----	*
	3 T.Maijer	(NED)	----	3rd round
+95kg	1 D.Khakhaleichvili	(EUN)	----	Silver (OPEN)
	2 N.Ogawa	(KOR)	----	Gold (OPEN), Bronze (+95kg)
	3 D.Douillet	(FRA)	----	2nd round
	3 I.Csosz	(HUN)	----	Bronze

8.3 SCORING PATTERNS

8.3.1 Comparison of results obtained from Chapter 3 and 4 on scoring patterns

In this section, the scoring patterns of the two groups of competitors in the 1991 World Championships and the 1992 Olympic Games are compared by the X^2 statistic derived from two way contingency tables. This allows any difference in the scoring patterns between 1991 competitors and 1992 competitors to be identified. In addition, the data are partitioned by gender and the scoring patterns for both female and male competitors in 1991 and 1992 are compared and evaluated by using the X^2 statistic.

Table 8.7 shows the score frequency observed in 1221 contests. This figure is subdivided into 631 contests in the 1991 World Championships and 590 contests in the 1992 Olympic Games. The expected frequencies, derived from the observed data, is based on the hypothesis, that there is no difference in scoring patterns between the 1991 World Championships and the 1992 Olympic Games competitors. This figure is displayed in brackets below the observed score. The percentage of contests that had Ippon, Waza-ari, Yuko and Koka scored in them by all the competitors is given in the bottom row of the table. Table 8.7 is completed by the percentage of contests that were decided by other scores. Similar tables, Table 8.8 and Table 8.9, are constructed when the data are partitioned by gender.

Table 8.7 Scoring patterns of 1991 World Championships and 1992 Olympic Games competitors

Total contests : 1221 contests
1991 World Championships 631 contests
1992 Olympic Games 590 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	315 (322)	46 (51)	91 (86)	54 (46)	125 (127)	631 (632)
1992	308 (301)	52 (47)	75 (80)	35 (43)	120 (118)	590 (589)
Totals	623	98	166	89	245	1221
Percent of Total Contest	51	8	14	7	20	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by the 1991 World Championships and 1992 Olympic Games.

Table 8.7 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.7 is 4.87.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns between competitors taking part in the 1991 World Championships and 1992 Olympic Games.

Table 8.8 Scoring patterns of female competitors in the 1991 World Championships and 1992 Olympic Games

Female total contests : 517 contests
1991 World Championships 283 contests
1992 Olympic Games 234 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	120 (119)	17 (22)	50 (50)	31 (28)	65 (63)	283 (282)
1992	98 (99)	23 (18)	42 (42)	21 (24)	50 (52)	234 (235)
Totals	218	40	92	52	115	517
Percent of Total Contest	42	8	18	10	22	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female competitors in the 1991 World Championships and 1992 Olympic Games.

Table 8.8 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 9.49, and the critical value of $X^2_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.8 is 3.39.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female competitors taking part in the 1991 World Championships and 1992 Olympic Games.

Table 8.9 Scoring patterns of male competitors in the 1991 World Championships and 1992 Olympic Games

Male total contests : 704 contests
1991 World Championships 348 contests
1992 Olympic Games 356 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	195 (200)	29 (29)	41 (37)	23 (18)	60 (64)	348 (348)
1992	210 (205)	29 (29)	33 (37)	14 (19)	70 (66)	356 (356)
Totals	405	58	74	37	130	704
Percent of Total Contest	58	8	11	5	18	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by male competitors in the 1991 World Championships and 1992 Olympic Games.

Table 8.9 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.9 is 4.31.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for male competitors in the 1991 World Championships and 1992 Olympic Games.

8.3.2 Comparison of the scoring patterns of medallists and non-medallists in each gender in 1991 and 1992

In this section the competitors are partitioned into medallists and non-medallists of each gender.

Table 8.10 shows the score frequencies observed in 242 contests between female medallists. This total is subdivided into 128 for the 1991 World Championships and 114 for the 1992 Olympic Games.

Similar tables, Table 8.11, Table 8.12 and Table 8.13 are constructed for the female non-medallists, male medallists and male non-medallists. The formats of these tables are the same as those tables constructed in the previous section.

Table 8.10 Scoring patterns of female medallists in the 1991 World Championships and 1992 Olympic Games

Female medallists total contests : 242 contests
1991 World Championships 128 contests
1992 Olympic Games 114 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	57 (60)	7 (8)	19 (18)	16 (12)	29 (30)	128 (128)
1992	57 (54)	8 (7)	15 (16)	7 (11)	27 (26)	114 (114)
Totals	114	15	34	23	56	242
Percent of Total Contest	47	6	14	10	23	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.10 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.10 is 3.55.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.11 Scoring patterns of female non-medallists in the 1991 World Championships and 1992 Olympic Games

Female non-medallists total contests : 275 contests
1991 World Championships 120 contests
1992 Olympic Games 155 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	41 (45)	15 (11)	27 (25)	14 (13)	23 (26)	120 (120)
1992	63 (59)	10 (14)	31 (33)	15 (16)	36 (33)	155 (155)
Totals	104	25	58	29	59	275
Percent of Total Contest	38	9	21	11	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by female non-medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.11 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.11 is 4.26.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for female non-medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.12 Scoring patterns of male medallists in the 1991 World Championships and 1992 Olympic Games

Male medallists total contests : 275 contests
1991 World Championships 143 contests
1992 Olympic Games 132 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	86 (82)	14 (15)	15 (17)	10 (9)	18 (21)	143 (144)
1992	71 (75)	14 (13)	17 (15)	8 (9)	22 (19)	132 (131)
Totals	157	28	32	18	40	275
Percent of Total Contest	57	10	12	7	14	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by male medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.12 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.12 is 2.18.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for male medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.13 Scoring patterns of male non-medallists in the 1991 World Championships and 1992 Olympic Games

Male non-medallists total contests : 429 contests
1991 World Championships 205 contests
1992 Olympic Games 224 contests

	Ippon	Waza-ari	Yuko	Koka	other	Totals
1991	109 (119)	15 (14)	26 (20)	13 (9)	42 (43)	205 (205)
1992	139 (129)	15 (16)	16 (22)	6 (10)	48 (47)	224 (224)
Totals	248	30	42	19	90	429
Percent of Total Contest	58	7	10	4	21	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced by male non-medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.13 is a two-way contingency table with two rows and five columns. Therefore there are 1 x 4 = 4 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 9.49, and the critical value of $X^2{}_{;0.01}$ is 13.28. Based on the formula

$$X^2 = \sum_{i=1}^{10} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.13 is 8.61.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns for male non-medallists in the 1991 World Championships and 1992 Olympic Games.

8.3.3 Comparison of the scoring patterns with standing techniques in 1991 and 1992

This section explores the comparison of the scoring patterns with standing techniques in the 1991 World Championships and the 1992 Olympic Games. The scoring categories are separated into Ippon, Waza-ari, Yuko and Koka.

Table 8.14 shows the score frequencies observed in 135 contests between female medallists. This total is subdivided into 69 contests in the 1991 World Championships and 66 contests in the 1992 Olympic Games. Similar tables, Table 8.15, Table 8.16 and Table 8.17 are constructed for the female non-medallists, male medallists and male non-medallists.

Table 8.14 Scoring patterns with Standing Techniques by female medallists in the 1991 World Championships and 1992 Olympic Games

All female medallists : 135 contests
1991 World Championships : 69 contests
1992 Olympic Games : 66 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	27 (32)	7 (8)	19 (17)	16 (12)	69 (69)
1992	36 (31)	8 (7)	15 (17)	7 (11)	66 (66)
Totals	63	15	34	23	135
Percent of Total Contest	47	11	25	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced using standing techniques by female medallists in 1991 World Championships and 1992 Olympic Games.

Table 8.14 is a two-way contingency table with two rows and four columns. Therefore there are 1 x 3 = 3 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 7.82, and the critical value of $X^2{}_{;0.01}$ is 11.34. Based on the formula

$$X^2 = \sum_{i=1}^{r} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.14 is 5.11.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns with standing techniques for female medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.15 Scoring patterns with Standing Techniques by female non-medallists in the 1991 World Championships and 1992 Olympic Games

All female non-medallists : 147 contests
1991 World Championships : 75 contests
1992 Olympic Games : 72 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	23 (20)	10 (13)	31 (30)	11 (13)	75 (76)
1992	16 (19)	15 (12)	27 (28)	14 (12)	72 (71)
Totals	39	25	58	25	147
Percent of Total Contest	27	17	39	17	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced using standing techniques by female non-medallists in 1991 World Championships and 1992 Olympic Games.

Table 8.15 is a two-way contingency table with two rows and four columns. Therefore there are 1 x 3 = 3 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 7.82, and the critical value of $X^2_{;0.01}$ is 11.34. Based on the formula

$$X^2 = \sum_{i=1}^{8} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.15 is 3.07.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns with standing techniques for female non-medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.16 Scoring patterns with Standing Techniques by male medallists in the 1991 World Championships and 1992 Olympic Games

All male medallists : 181 contests
1991 World Championships : 86 contests
1992 Olympic Games : 95 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	48 (50)	13 (13)	15 (15)	10 (8)	86 (86)
1992	57 (55)	14 (14)	17 (17)	7 (9)	95 (95)
Totals	105	27	32	17	181
Percent of Total Contest	58	15	18	9	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced using standing techniques by male medallists in 1991 World Championships and 1992 Olympic Games.

Table 8.16 is a two-way contingency table with two rows and four columns. Therefore there are 1 x 3 = 3 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2_{;0.05}$ is 7.82, and the critical value of $X^2_{;0.01}$ is 11.34. Based on the formula

$$X^2 = \sum_{i=1}^{8} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.16 is 1.09.

This suggests that there is insufficient statistical evidence to reject the null hypothesis. There was therefore no difference in scoring patterns with standing techniques for male medallists in the 1991 World Championships and 1992 Olympic Games.

Table 8.17 Scoring patterns with Standing Techniques by male non-medallists in the 1991 World Championships and 1992 Olympic Games

All male non-medallists : 264 contests
1991 World Championships : 125 contests
1992 Olympic Games : 139 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	72 (82)	14 (14)	26 (20)	13 (9)	125 (125)
1992	102 (92)	15 (15)	16 (22)	6 (10)	139 (139)
Totals	174	29	42	19	264
Percent of Total Contest	66	11	16	7	100

Null Hypothesis : There is no difference between the observed frequency of scoring categories produced using standing techniques by male non-medallists in 1991 World Championships and 1992 Olympic Games.

Table 8.17 is a two-way contingency table with two rows and four columns. Therefore there are 1 x 3 = 3 degrees of freedom associated with the X^2 statistic.
The critical value of $X^2{}_{;0.05}$ is 7.82, and the critical value of $X^2{}_{;0.01}$ is 11.34. Based on the formula

$$X^2 = \sum_{i=1}^{8} [(O_i - E_i)^2 / E_i]$$

Where,

O_i is the i^{th} observed frequency,

and,

E_i is the i^{th} expected frequency.

the X^2 statistic for Table 8.17 is 9.13.

This suggests that the null hypothesis should be rejected. It appears that 1992 male non-medallists scored more Ippon by standing techniques and less Yuko and Koka than expected. Conversely the 1991 male non-medallists scored less Ippon and more Yuko and Koka by standing techniques than expected from the observed data.

8.3.4 Comparison of the scoring patterns with groundwork techniques in 1991 and 1992

This section explores the comparison of the scoring patterns achieved with groundwork techniques in the 1991 World Championships and the 1992 Olympic Games. The scoring categories are separated into Ippon, Waza-ari, Yuko and Koka. It was not appropriate to use the X^2 statistic because many of the cells associated with groundwork techniques contained zero frequency. However the tables themselves give a descriptive synopsis of the scoring patterns obtained.

Table 8.18 displays the scoring pattern achieved with groundwork techniques by female medallists. Similar tables, Table 8.19, Table 8.20 and Table 8.21 are constructed for the female non-medallists, male medallists and male non-medallists.

Table 8.18 Scoring patterns with groundwork techniques by female medallists in 1991 World Championships and 1992 Olympic Games

All female medallists : 51 contests
1991 World Championships : 30 contests
1992 Olympic Games : 21 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	30	0	0	0	30
1992	21	0	0	0	21
Totals	51	0	0	0	51

Table 8.19 Scoring patterns with groundwork techniques by female non-medallists in 1991 World Championships and 1992 Olympic Games

All female non-medallists : 69 contests
1991 World Championships : 44 contests
1992 Olympic Games : 25 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	40	0	0	4	44
1992	25	0	0	0	25
Totals	65	0	0	4	69

Table 8.20 Scoring patterns with groundwork techniques by male medallists in 1991 World Championships and 1992 Olympic Games

All male medallists : 54 contests
1991 World Championships : 39 contests
1992 Olympic Games : 15 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	38	1	0	0	39
1992	14	0	0	1	15
Totals	52	1	0	1	54

Table 8.21 Scoring patterns with groundwork techniques by male non-medallists in 1991 World Championships and 1992 Olympic Games

All male non-medallists : 75 contests
1991 World Championships : 38 contests
1992 Olympic Games : 37 contests

	Ippon	Waza-ari	Yuko	Koka	Totals
1991	37	1	0	4	38
1992	37	0	0	0	37
Totals	74	2	0	4	75

8.4 COMPARISON OF TECHNIQUES

This section compares the most successful scoring techniques employed during the 1991 World Championships and the 1992 Olympic Games. Those standing techniques that produced any form of score are assessed, and the percentage of scores obtained with a particular technique are calculated. A similar analysis is undertaken for these groundwork techniques that scored Ippon. Finally the finals at the 1991 World Championships and 1992 Olympic Games are compared for the number of techniques and the percentage of time spent in groundwork.

8.4.1 Comparison of successful standing techniques in 1991 and 1992

Figures 8.4 and 8.5 show the most successful standing techniques in the 1991 World Championships and the 1992 Olympic Games in each gender. A similar pattern emerges from both competitions, with UM and SN predominant for both men and women.

For female competitors, in both the 1991 World Championships and 1992 Olympic Games, the most successful standing technique was UM. In the 1991 World Championships the second and third most successful techniques were OUG and SN. These second and third places were interchanged in the 1992 Olympic Games, but only by a small percentage.

In the case of male competitors, in both the 1991 World Championships and the 1992 Olympic Games, the most successful technique was SN, followed closely by UM. Also some success was achieved with OUG especially in the 1992 Olympic Games.

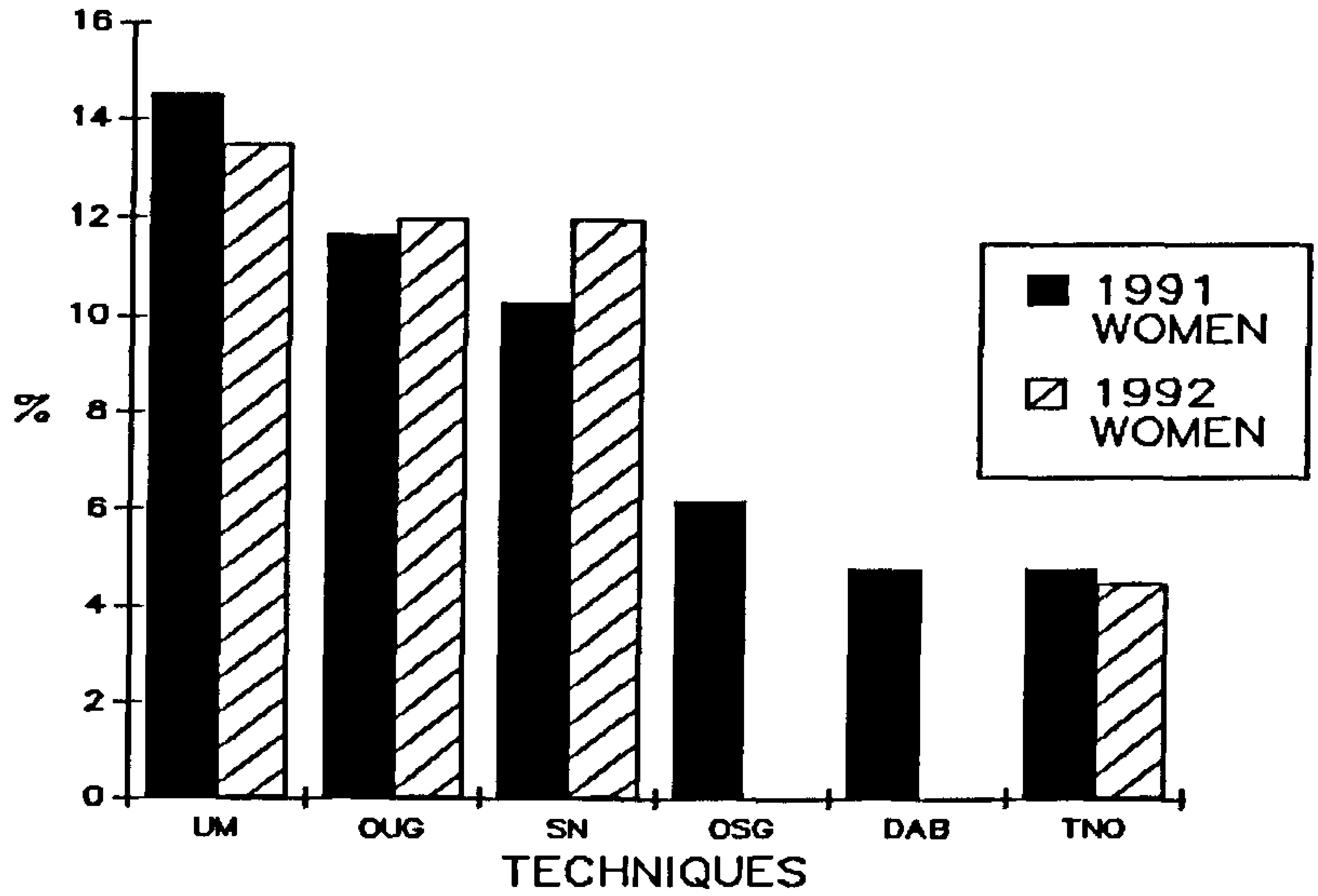


Figure 8.4 Comparison of the most successful standing techniques of the female competitors in 1991 and 1992

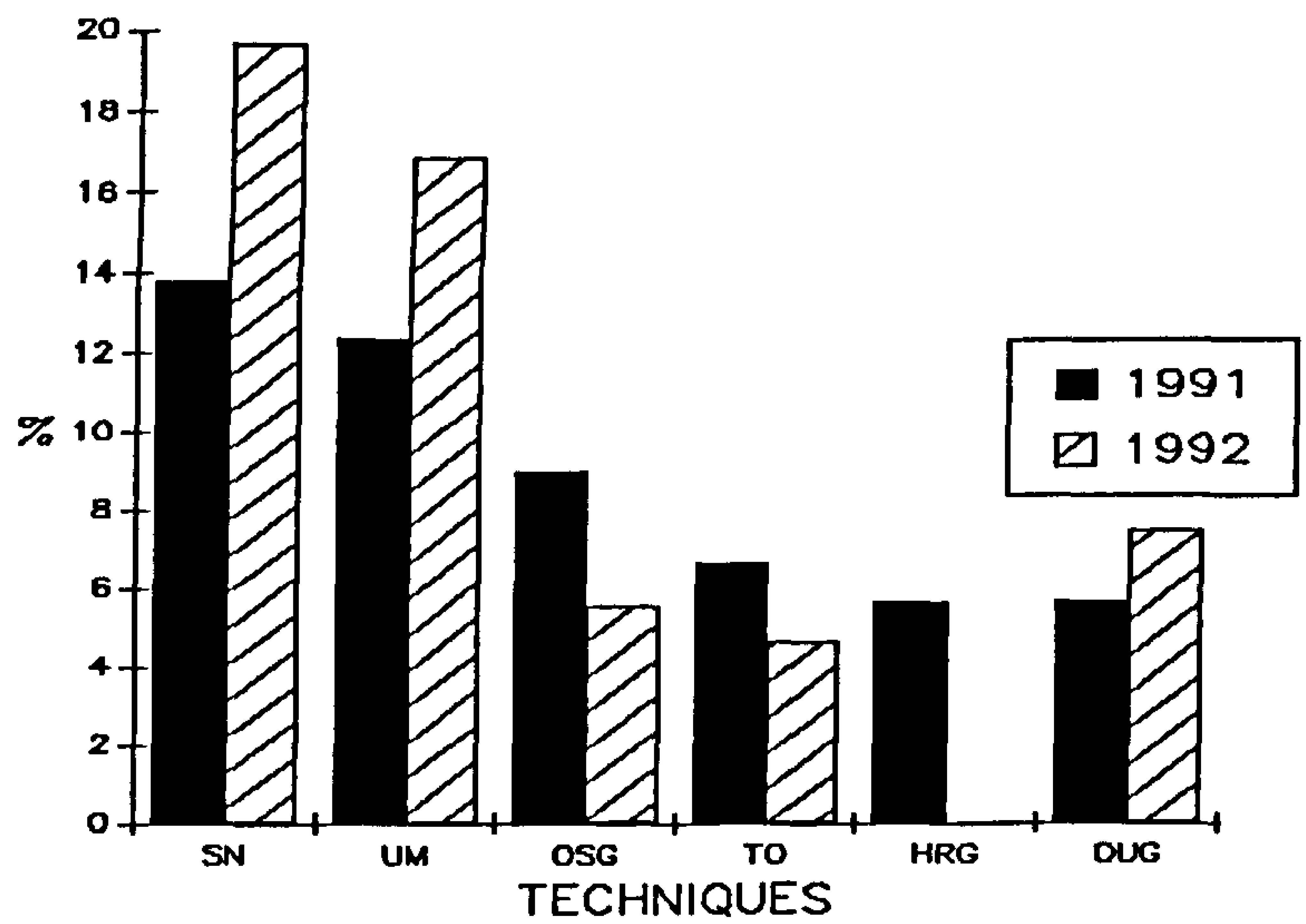


Figure 8.5 Comparison of the most successful standing techniques of the male competitors in 1991 and 1992

8.4.2 Comparison of the most successful groundwork techniques in 1991 and 1992

Figure 8.6 shows the relative distribution of groundwork techniques that scored Ippon for the female competitors in the 1991 World Championships and the 1992 Olympic Games. Figure 8.7 shows a similar display of groundwork techniques which were successful in producing Ippon for the male competitors. For female competitors more than 65% of Ippon in groundwork were scored by OSAE-WAZA (HOLDING TECHNIQUES) in the both 1991 World Championships and the 1992 Olympic Games, while more than 55% of Ippon were scored by this method by male competitors. In the 1992 Olympic Games, female competitors seemed to score more Ippon by OSAE-WAZA and less Ippon by KANSETSU-WAZA (ARM-LOCK TECHNIQUES) and SHIME-WAZA (STRANGLE TECHNIQUES) compared with the 1991 World Championships. In contrast, the male competitors seemed to score more Ippon by KANSETSU-WAZA (ARM-LOCK TECHNIQUES) and SHIME-WAZA (STRANGLE TECHNIQUES) and less Ippon by OSAE-WAZA compared to the 1991 World Championships.

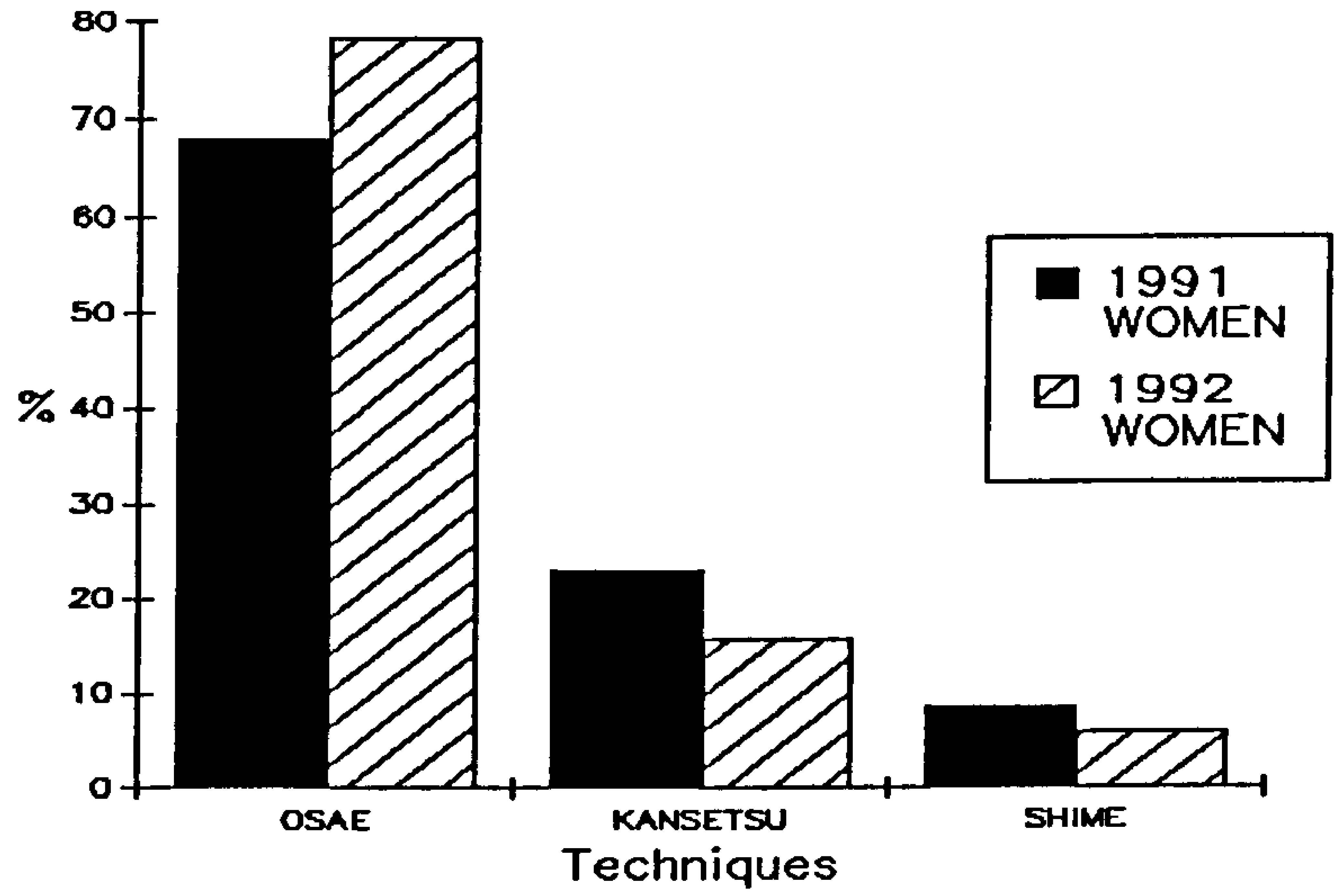


Figure 8.6 Comparison of the most successful groundwork techniques of the female competitors in 1991 and 1992

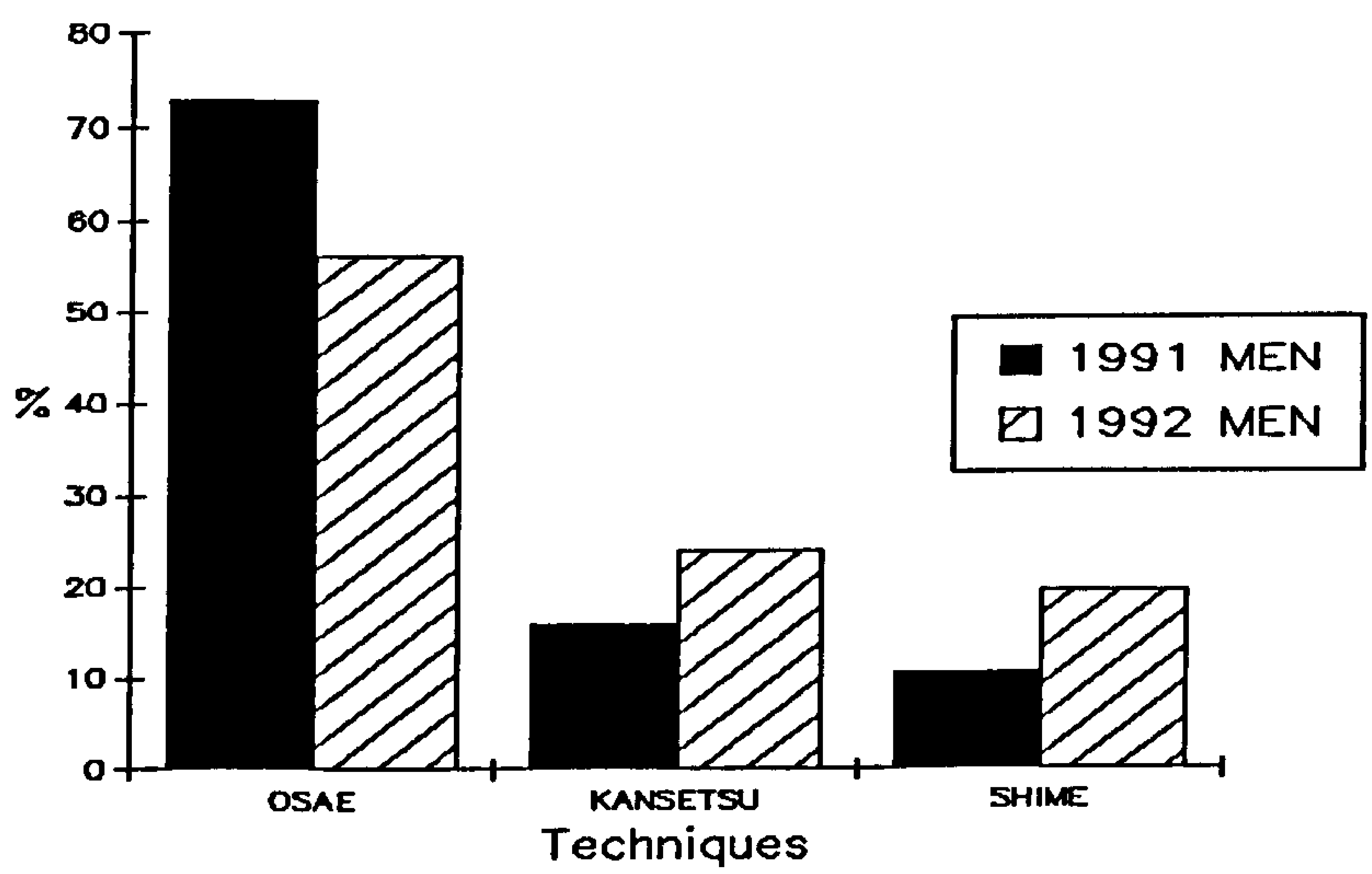


Figure 8.7 Comparison of the most successful groundwork techniques of the male competitors in 1991 and 1992

8.4.3 Number of techniques used each minute

Table 8.22 shows the number of techniques used per minute by the female finalists in the 1991 World Championships and 1992 Olympic Games. Figure 8.8 shows the comparison of the number of techniques used per minute between the finals of the 1991 World championships and the finals of the 1992 Olympic Games for female competitors. The rate of use of techniques in the finals of the 1992 Olympic Games was significantly greater than in the 1991 World Championships ($T=2.0$, $P<0.025$). The finalists in the -66kg and -72kg weight categories were the same in 1991 and 1992 yet the number of techniques used per minute was totally different from 1991 to 1992. In the -66kg category the two finalists produced almost the same rate of use of techniques, in 1991 and 1992, whereas in the -72kg weight category there was massive increase from just over 5 techniques per minute to over 14 techniques per minute.

Table 8.22 The number of techniques used per minute for female finalists in 1991 and 1992

	1991	1992
-48kg	11.8	12.1
-52kg	17.5	18.2
-56kg	10.5	12.2
-61kg	11.3	11.9
-66kg	12.9	13.5
-72kg	5.4	14.3
+72kg	7.6	11.3
Open	8.0	
Mean	10.6	13.4
S.D	3.7	2.4

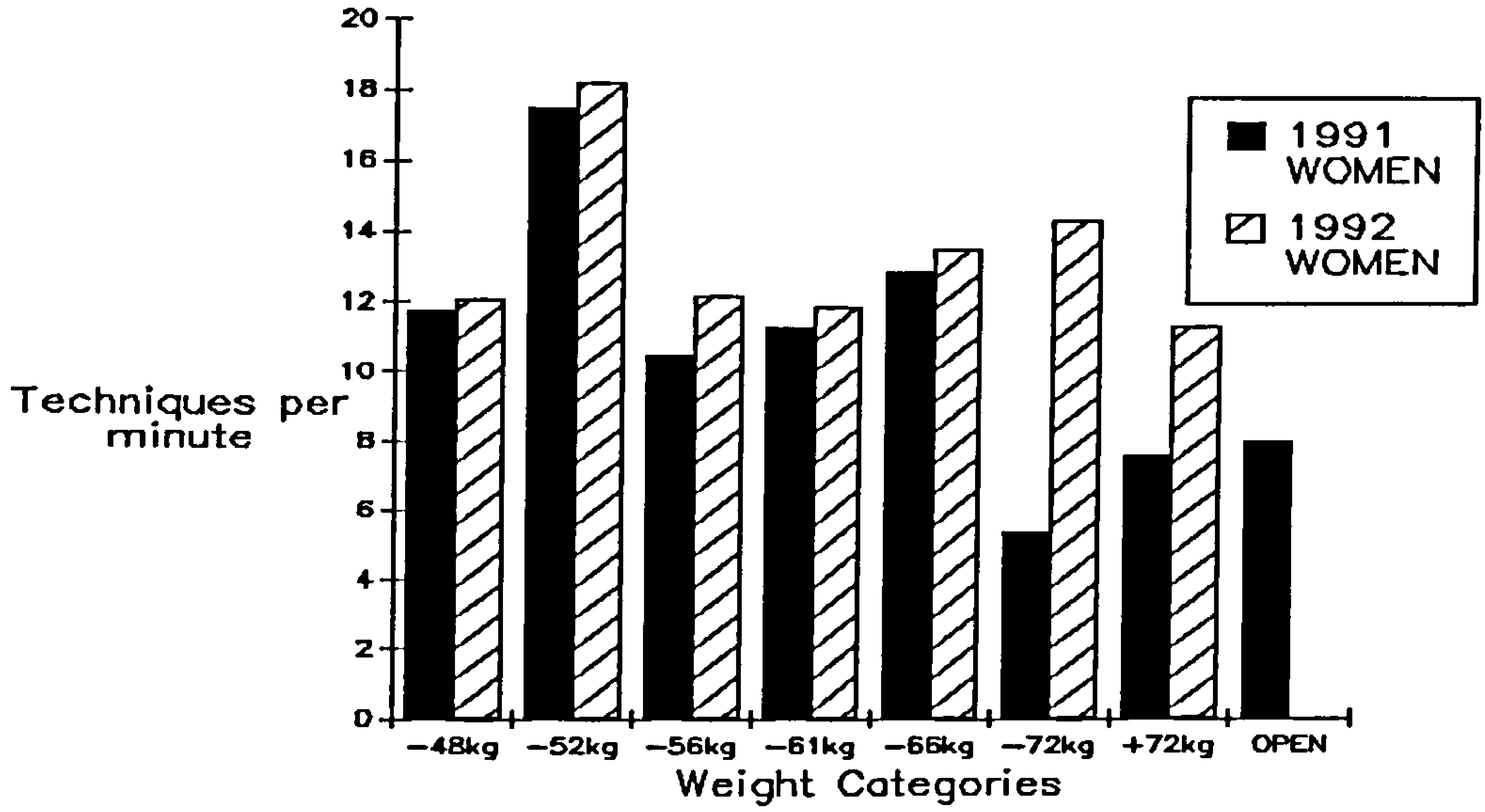


Figure 8.8 The number of techniques used per minute by the female finalists of all weight categories

Table 8.23 shows the number of techniques used per minute by the male finalists in the 1991 World Championships and 1992 Olympic Games. Figure 8.9 shows a similar display of the comparison of the number of techniques used per minutes between the finals of the 1991 World championships and the finals of the 1992 Olympic Games for male competitors. The number of techniques used in the final of the 1992 Olympic Games seemed to be greater than in the final of the 1991 World Championships in all categories, except the -86kg and +95kg which were both decided by Ippon, however this is not statistically significant (T=0.87, P>0.1). The +95kg weight category in the 1992 Olympic Games final had the same finalists as the Open weight category in the 1991 World Championships final. In no other weight category were the finalists the same in 1991 and 1992. The number of techniques used per minute were decreased in the +95kg weight category of 1992 compared with the 1991 Open weight category.

Table 8.23 The number of techniques used per minute for male finalists in 1991 and 1992

	1991	1992
-60kg	6.7	13.9
-65kg	8.8	11.8
-71kg	3.4	8.8
-78kg	6.7	6.9
-86kg	15.0	9.8
-95kg	4.6	5.5
+95kg	5.7	3.9
Open	7.3	
Mean	7.3	8.7
S.D	3.5	3.5

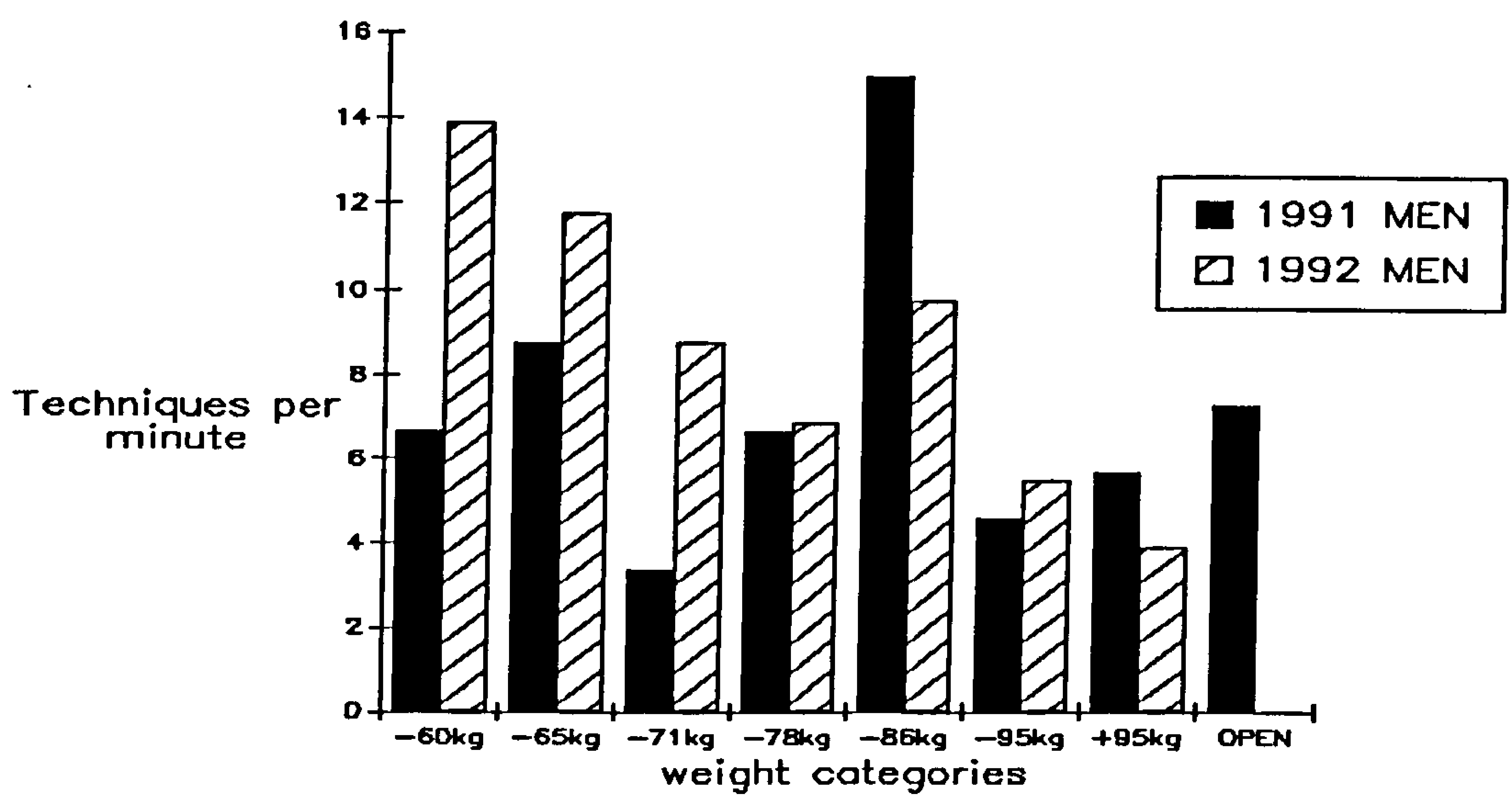


Figure 8.9 The number of techniques used per minute by the male finalists of all weight categories

8.4.4 Time spent in groundwork

Table 8.24 shows the time spent in groundwork, expressed as a percentage of the total contest time, during the finals of each weight category in the 1991 World Championships and the 1992 Olympic Games for female competitors. The time spent in groundwork in 1991 is not significantly different to time spent in groundwork in the 1992 competition ($T=0.66$, $P>0.1$). The variation of percentage time spent in groundwork with weight category is displayed in Figure 8.10 for female competitors in 1991 and Figure 8.22 for female competitors in 1992. In the 1991 World Championship finals, more than half of the contest time was spent on groundwork in the -66kg and +72kg categories. In the 1992 Olympic Games finals, the categories that spent more than half of the contest time in groundwork were the -52kg, -61kg and +72kg weight categories. In fact, the finals of the -66kg category in the 1991 World Championships and the +72kg category in the Olympic Games, were decided by scores obtained from groundwork techniques. In contrast, the shortest time duration that was spent in groundwork was in the -48kg finals in both 1991 and 1992. There was a significant correlation between time spent in groundwork and weight category in the 1991 World Championships finals ($r=0.82$, $P<0.014$), although this correlation is not so clear in the 1992 Olympic games female finalists ($r=0.41$, $P<0.198$).

Table 8.24 Time percentage spent on groundwork for female competitors

%	WOMEN'91	WOMEN'92
-48kg	18 %	6 %
-52kg	23 %	53 %
-56kg	27 %	39 %
-61kg	36 %	62 %
-66kg	51 %	18 %
-72kg	36 %	35 %
+72kg	50 %	67 %
Open	44 %	*
mean	35.6%	40 %
S.D	+12.3	+22.5

Table 8.25 shows the time spent in groundwork, expressed as a percentage of the total contest time, during the final of each weight category in the 1991 World Championships and the 1992 Olympic Games for male competitors. The variation of percentage time spent in groundwork with weight category is displayed in Figure 8.12 for male competitors in 1991 and Figure 8.13 for male competitors in 1992.

The time spent in groundwork in the finals of the 1991 World championships seemed to be greater than in the finals of the 1992 Olympic Games, however, this was not statistically significant (T=1.79, P>0.1). In the 1991 World Championships, contests were decided by a score obtained during groundwork. In contrast, in the 1992 Olympic Games finals, there was no contest which was won by groundwork technique. No contest had more than 45% of the time spent in groundwork during 1991. This figure dropped to 34% in the 1992 Olympic Games. The shortest groundwork time was in the Open category (6%) of the 1991 World Championship finals, and in the -78kg category (3%) in the 1992 Olympic Games finals. In addition, less than 10% of the contest time was spent on groundwork in the -60kg and -86kg categories in 1992. There was no significant correlation between the time spent in groundwork and weight category in both the 1991 World Championships finals (r=0.01, P>0.25) and the 1992 Olympic Games (r=0, P>0.25) finals for the male competitors.

Table 8.25 Time percentage spent on groundwork for male competitors

%	MEN '91	MEN '92
-60kg	31 %	5 %
-65kg	15 %	34 %
-71kg	23 %	31 %
-78kg	34 %	3 %
-86kg	21 %	9 %
-95kg	45 %	12 %
+95kg	34 %	14 %
Open	6 %	*
mean	26.1%	15.4%
S.D	+12.4	+12.3

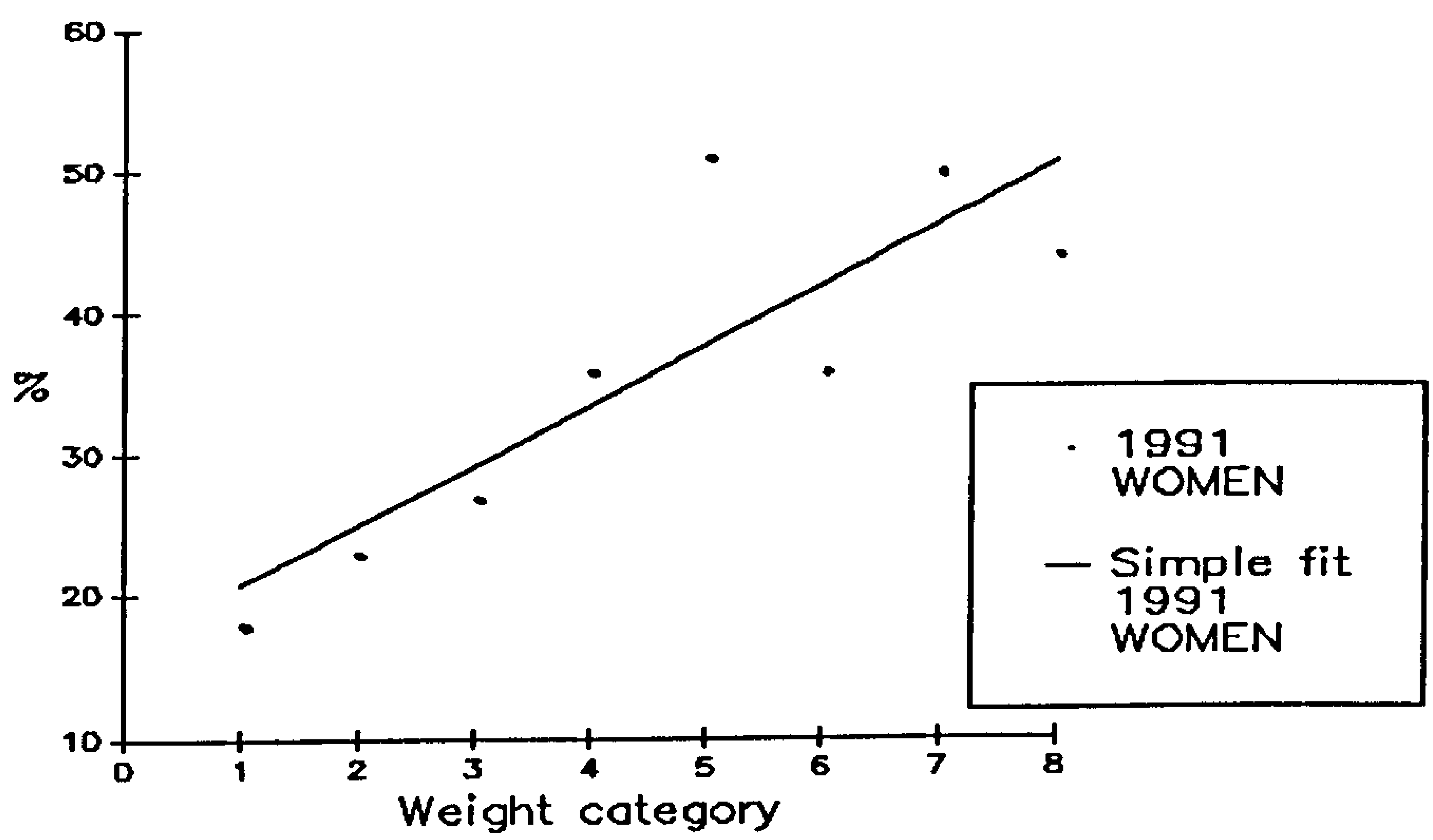


Figure 8.10 The variation of percentage time of contest spent in groundwork with weight category for female competitors in 1991

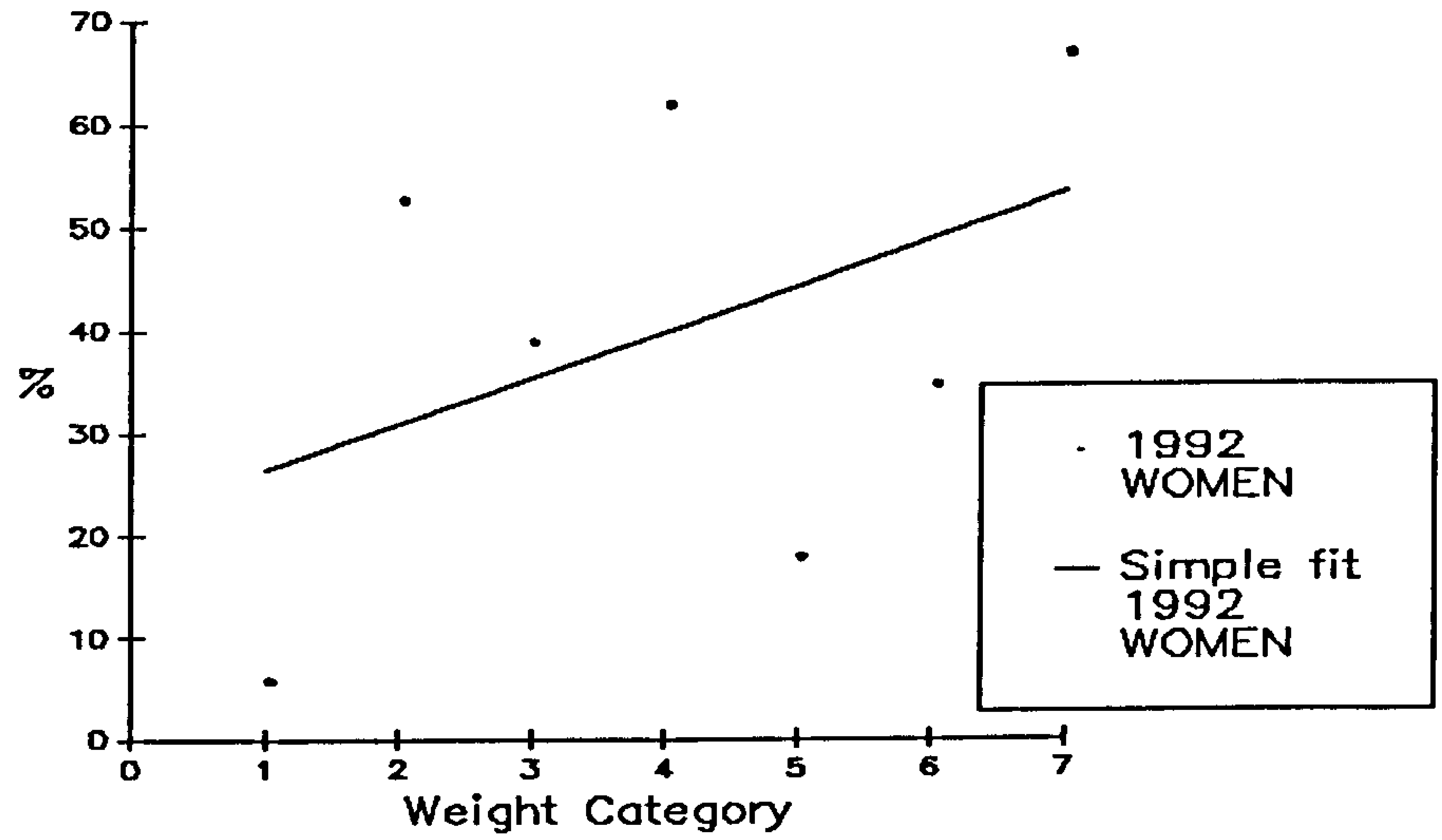


Figure 8.11 The variation of percentage time of contest spent in groundwork with weight category for female competitors in 1992

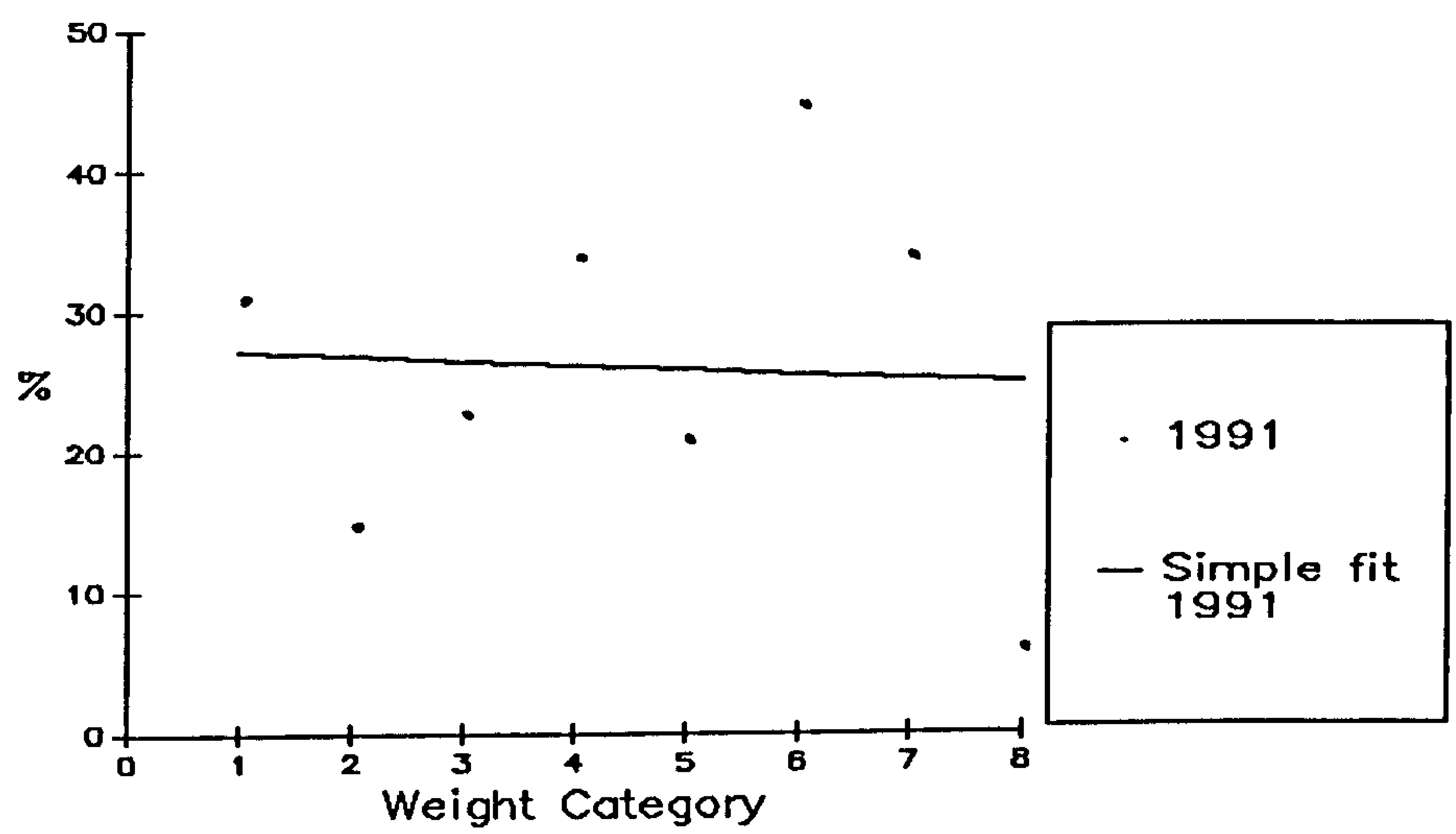


Figure 8.12 The variation of percentage time of contest spent in groundwork with weight category for male competitors in 1991

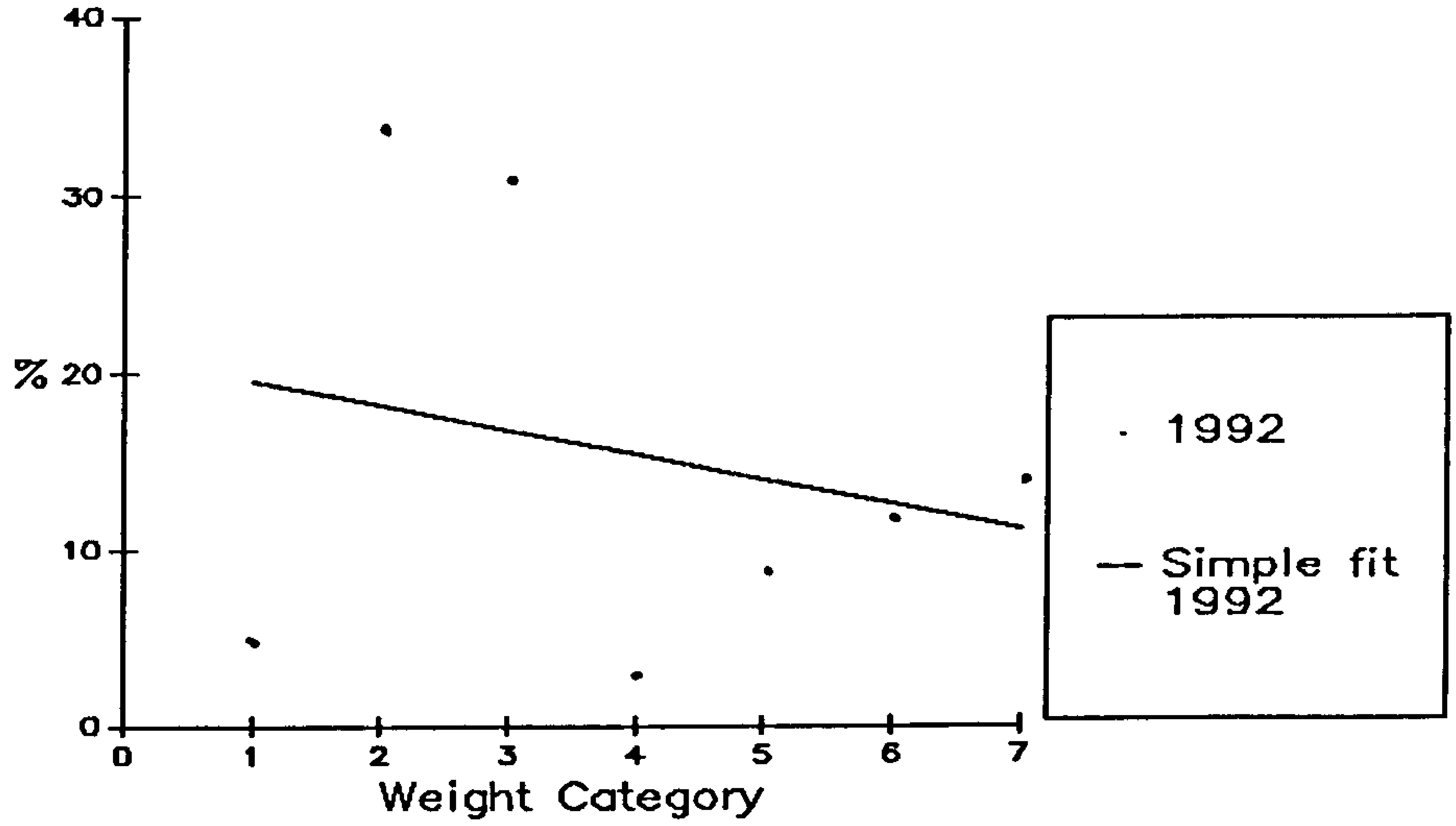


Figure 8.13 The variation of percentage time of contest spent in groundwork with weight category for male competitors in 1992

8.5 RESULT OF THE 1991 AND 1992 FINALS AND THE RESULTS OBTAINED BY THE CHAMPION FOR EACH ROUND

8.5.1 Result of the 1991 and 1992 finals for female competitors

This section documents some pertinent statistics related to the finals of the 1991 World Championships and the Olympic Games. First the score that decided the contest is given and then the total time of the contest, followed by time spent in groundwork. The time spent recovering during Matte and the number of times Matte was called is given on the next line. This information allowed an average time of activity (designated as average work time) and an average time for recovery (designated as rest time) for the entire contest to be calculated. The figure below indicates the concept used in this analysis for a hypothetical contest in which Matte was called four times.

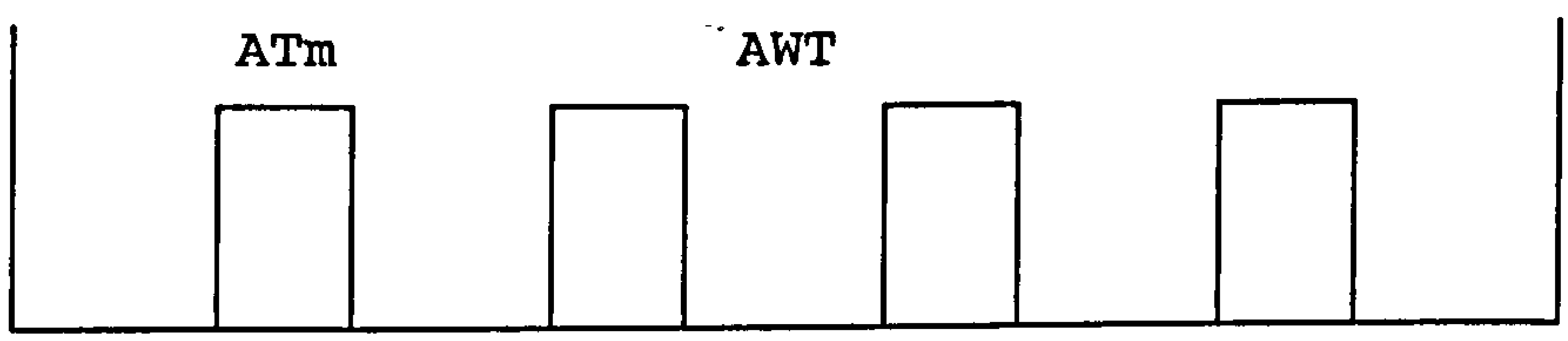


Figure 8.14 The concept of activity and recovery time for a hypothetical contest

If the number of times Matte is called is N and the average time for each Matte is ATm then total Matte time is TTm and given by

$$TTm = N \times ATm$$

Hence average rest time = TTm / N

Total time for activity is the total time of the contest T minus TTm. Hence average work time (AWT) separated by recovery is

$$AWT = (T - TTm) / (N + 1)$$

The work to rest ratio is

$$AWT / TTm$$

WOMEN	1991	1992
-48kg	C.Nowak (FRA) vs K.Briggs (GBR)	C.Nowak (FRA) vs R.Tamura (JPN)
Decided by	Kinsa	Koka (KAD)
Total Time	4:59	5:22
G.W Time	0:42	0:16
Matte	0:54/4	1:20/11
Average Work Time	49.0	20.2
Average Rest Time	13.5	7.3
Work to Rest Ratio	3.6:1	2.8:1
-52kg	A.Giungi (ITA) vs S.Rendle (GBR)	A.Munoz (ESP) vs N.Mizoguchi (JPN)
Decided by	Kinsa	Yuko (KSG)
Total Time	6:13	6:32
G.W Time	0:55	2:08
Matte	1:54/16	2:34/14
Average Work Time	15.2	15.9
Average Rest Time	7.1	11.0
Work to Rest Ratio	2.1:1	1.4:1
-56kg	M.Blasco (ESP) vs N.Flagotheier (BEL)	M.Blasco (ESP) vs N.Fairbrother (GBR)
Decided by	Waza-Ari (UM)	Yuko (KSG)
Total Time	5:21	6:03
G.W Time	1:05	1:33
Matte	1:10/8	1:57/8
Average Work Time	27.9	27.3
Average Rest Time	8.8	14.6
Work to Rest Ratio	3.2:1	1.9:1
-61kg	F.Eickhoff (FRG) vs D.Bell (GBR)	C.Fleury (FRA) vs Y.Arad (ISR)
Decided by	Awase-waza(UNA & KYS)	Koka (KAD)
Total Time	3:26	5:22
G.W Time	0:58	0:16
Matte	0:48/6	1:20/11
Average Work Time	22.6	20.2
Average Rest Time	8.0	14.6
Work to Rest Ratio	2.8:1	1.4:1

-66kg

	E.Pierantozzi (ITA) vs O.Revjiminez (CUB)	O.Revjiminez (FRA) vs E.Pierantozzi (ITA)
Decided by	Ippon (KYS)	Waza-Ari (UM)
Total Time	6:10 (4:26)	5:13
G.W Time	2:16	0:44
Matte	1:39/4	1:11/7
Average Work Time	54.2	30.3
Average Rest Time	24.8	10.1
Work to Rest Ratio	2.3:1	3.0:1

-72kg

	M.Kim (KOR) vs Y.Tanabe (JPN)	M.Kim (KOR) vs Y.Tanabe (JPN)
Decided by	Koka (UM)	Kinsa
Total Time	6:13	5:49
G.W Time	1:26	1:25
Matte	2:20/5	1:37/8
Average Work Time	38.8	28.0
Average Rest Time	28.0	12.1
Work to Rest Ratio	1.4:1	2.3:1

+72kg

	J.Y.Moon (KOR) vs Y.Zhang (CHN)	X.Zhuang (CHN) vs E.Rodriguez (CUB)
Decided by	Yuko (SN)	Ippon (KSH)
Total Time	5:19	4:02
G.W Time	2:01	1:48
Matte	1:17/9	1:33/5
Average Work Time	24.2	24.8
Average Rest Time	8.5	18.6
Work to Rest Ratio	2.8:1	1.3:1

OPEN

	X.Zhuang (KOR) vs Y.Zhang (CHN)
Decided by	Waza-Ari (KUG)
Total Time	5:41
G.W Time	1:45
Matte	1:03/11
Average Work Time	23.2
Average Rest Time	5.7
Work to Rest Ratio	4.1:1

The mean of average work time in the 1991 World Championships for female finals is 31.9 (S.D ± 13.9) seconds and the mean of average work time in the Olympic Games is 23.8 (S.D ± 5.2) seconds. For females, the average work time in the 1991 World Championships finals had longer time duration compared with the 1992 Olympic Games finals ($T=2.0$, $P<0.025$). The mean of average rest time in the 1991 World Championships is 13.1 (S.D ± 8.6) seconds and the mean of average rest time in the Olympic Games is 12.6 (S.D ± 3.7) seconds. There is no statistical difference between them ($T=0.37$, $P>0.1$). As far as the ratio of work and rest is concerned, the average in the finals of the 1991 Championships is 2.7 : 1 (S.D ± 0.9) and the average of the 1992 Games is 2.0 : 1 (S.D ± 0.7). It seems the average ratio in the 1991 finals is higher than the 1992 finals although this difference is not statistically significant ($T=1.56$, $P>0.05$).

Figure 8.15, 8.16 and 8.17 show the average work time, the average rest time and the average work and rest ratio respectively in each weight category for the female finals. The average time of activity from all contests is 28.0 seconds with an upper limit of 54.2 seconds and a lower limit of 15.2 seconds. The average recovery time for all contests is 12.8 seconds with an upper limit of 28.0 seconds and a lower limit of 5.7 seconds. These data give an average work to rest ratio for all contests of 2.4 : 1 with an upper limit of 4.0 : 1 and a lower limit of 1.3 : 1.

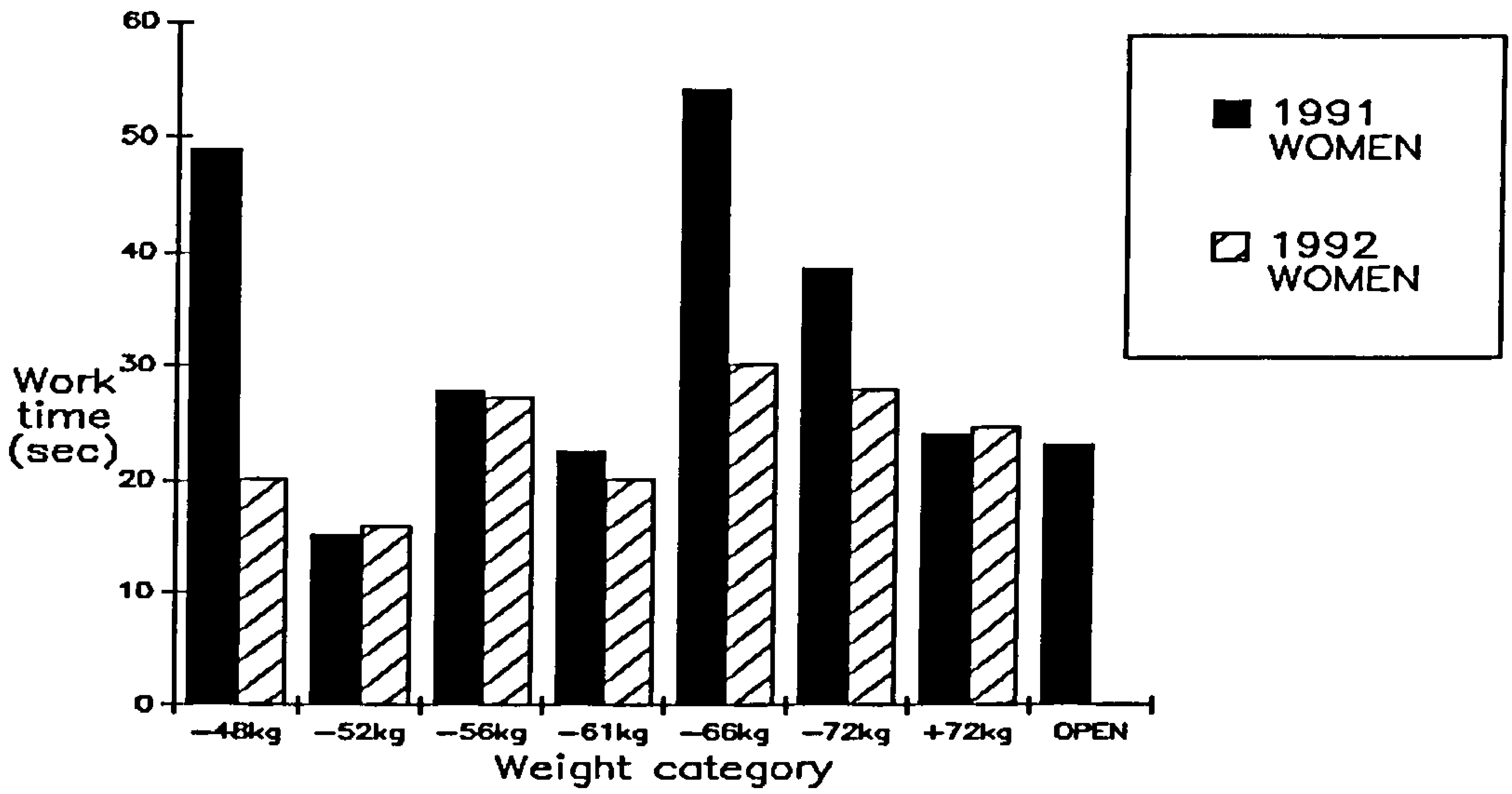


Figure 8.15 The average time of activity for female competitors

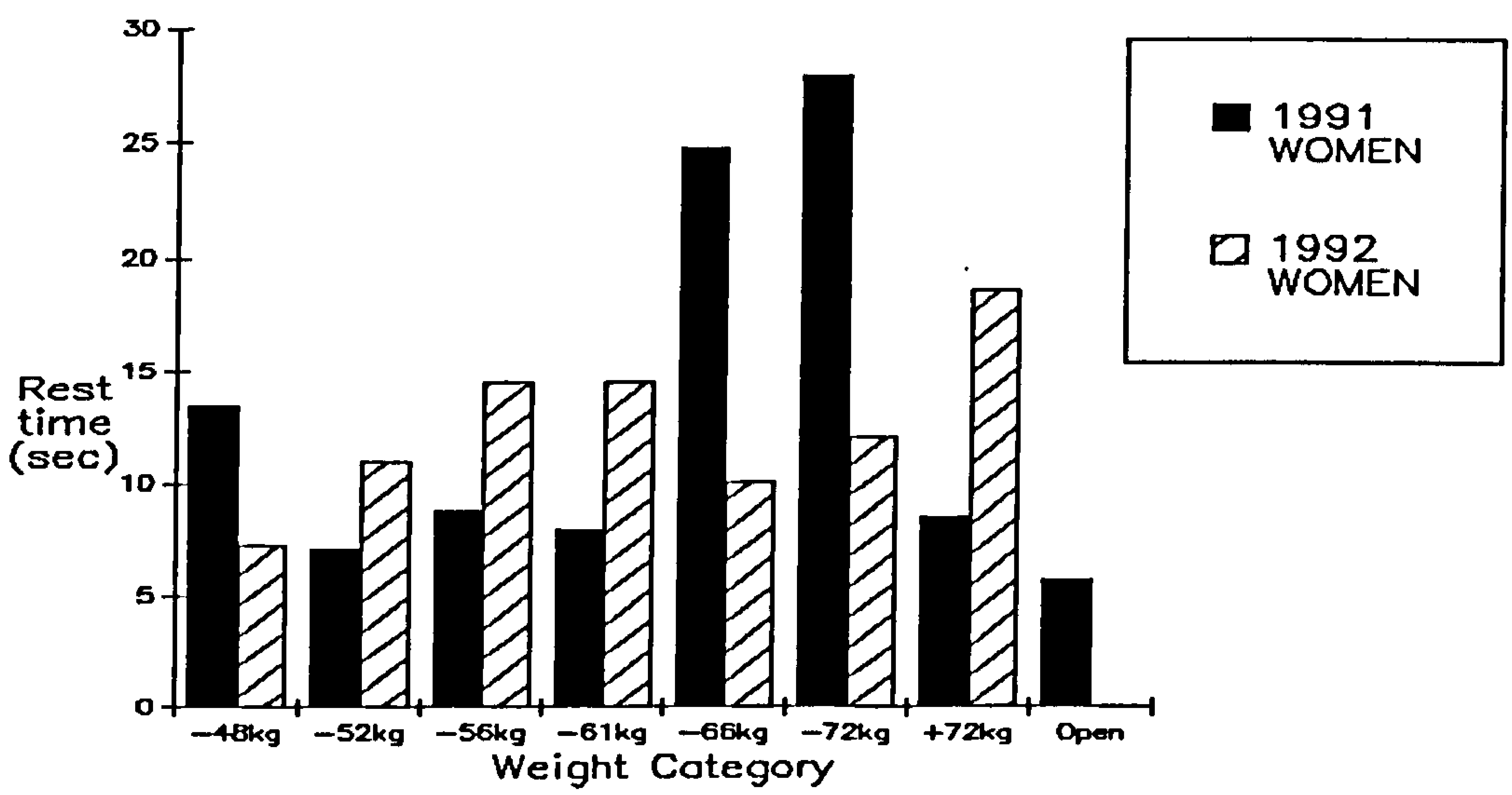


Figure 8.16 The average time of recovery for female competitors

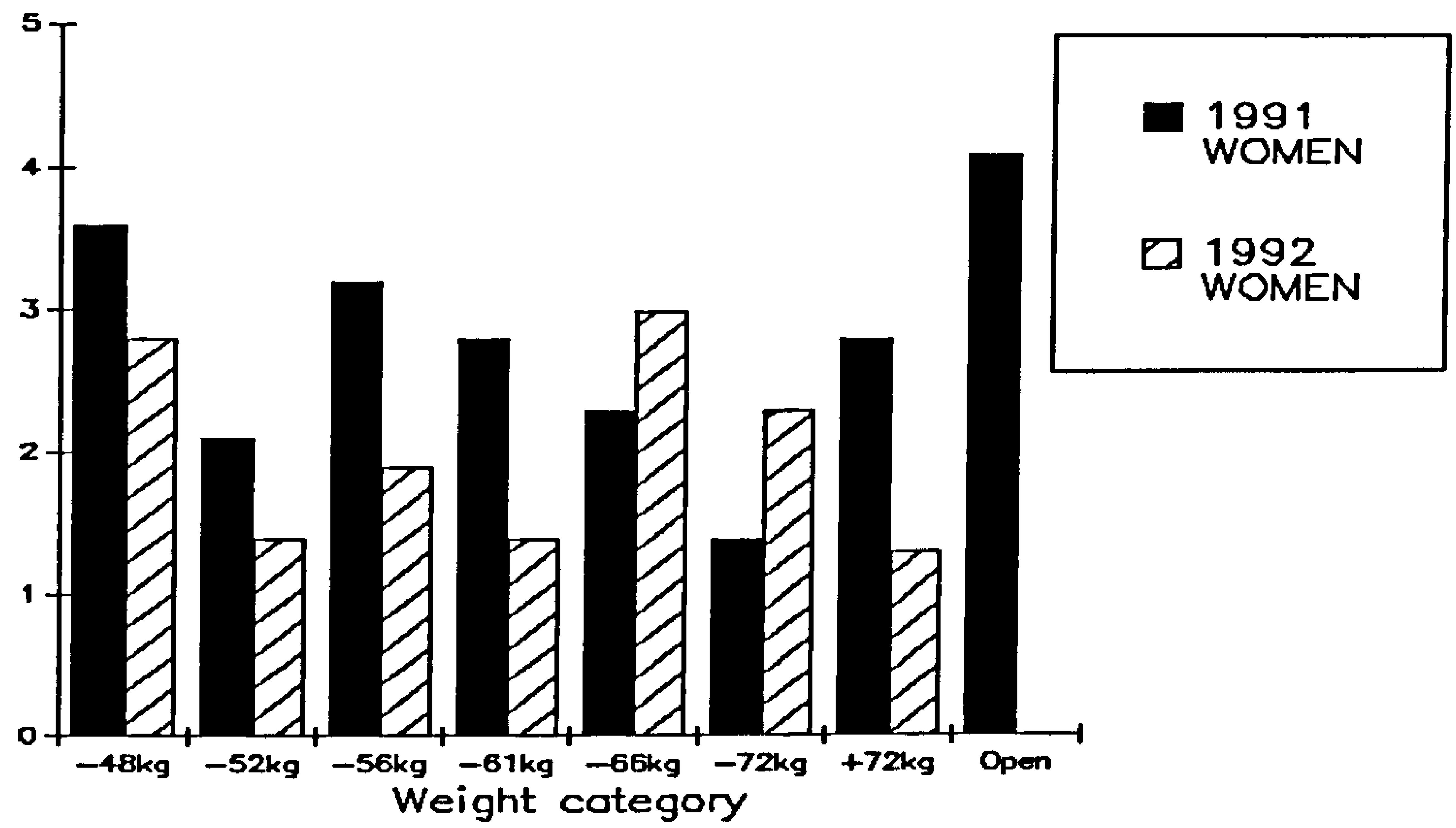


Figure 8.17 The ratio of average activity to recovery time for female competitors

MEN	1991	1992
-60kg	T.Koshino (JPN) vs H.Yoon (KOR)	N.Gousseinov (EUN) vs H.Yoon (KOR)
Decided by	Kinsa	Koka (STA)
Total Time	7:06	8:34
G.W Time	1:34	0:41
Matte	1:46/11	3:25/24
Average Work Time	26.7	12.4
Average Rest Time	9.6	8.5
Work to Rest Ratio	2.8:1	1.5:1
-65kg	U.Quellmalz (FRG) vs M.Okuma (JPN)	R.Sampaio (BRA) vs J.Csak (HUN)
Decided by	Chui	Waza-Ari (OSG)
Total Time	7:48	7:46
G.W Time	0:46	0:36
Matte	2:44/7	2:47/12
Average Work Time	38.0	23.0
Average Rest Time	23.4	13.9
Work to Rest Ratio	1.6:1	1.7:1
-71kg	T.Koga (JPN) vs J.Ruiz (ESP)	T.Koga (JPN) vs B.Hajtos (HUN)
Decided by	Yuko (SKG)	Kinsa
Total Time	9:11	7:11
G.W Time	1:08	0:28
Matte	3:58/12	2:01/16
Average Work Time	24.1	18.2
Average Rest Time	19.8	7.6
Work to Rest Ratio	1.2:1	2.4:1
-78kg	D.Lascau (FRG) vs J.Laats (BEL)	H.Yoshida (JPN) vs J.N.Morris (USA)
Decided by	Yuko (KUG)	Koka (KAD)
Total Time	7:04	5:51 (3:53)
G.W Time	1:42	0:07
Matte	2:15/13	2:18/10
Average Work Time	20.6	19.6
Average Rest Time	10.4	13.8
Work to Rest Ratio	2.0:1	1.4:1

-86kg	H.Okada (JPN) vs J.Wanag (USA)	W.Legien (POL) vs P.Tayot (FRA)
Decided by	Ippon (KUG)	Yuko (UM)
Total Time	1:12 (0:56)	7:55
G.W Time	0:12	1:32
Matte	0:14/2	2:50/12
Average Work Time	19.3	23.5
Average Rest Time	7.0	14.2
Work to Rest Ratio	2.8:1	1.7:1

-95kg	S.Traineau (FRA) vs P.Nastula (POL)	H.Kovacs (HUN) vs R.Stevens (JPN)
Decided by	Ippon (JG)	Yuko (UM)
Total Time	6:32 (4:18)	6:52
G.W Time	1:55	1:43
Matte	2:22/10	1:55/8
Average Work Time	22.7	33.0
Average Rest Time	14.2	14.4
Work to Rest Ratio	3.8:1	2.3:1

+95kg	S.Kosorotov (URS) vs G.Moreno (CUB)	D.Khakhaleichvili (EUN) vs N.Ogawa (JPN)
Decided by	Ippon (JG)	Awase-Waza(TKG & KSG)
Total Time	4:39 (3:45)	1:23 (1:04)
G.W Time	1:17	0:03
Matte	1:04/7	0:25/2
Average Work Time	26.9	19.3
Average Rest Time	9.1	12.5
Work to Rest Ratio	3.0:1	1.5:1

OPEN	N.Ogawa (JPN) vs D.Khakhaleichvili (URS)
Decided by	Ippon (TO)
Total Time	3:53 (2:32)
G.W Time	0:12
Matte	1:28/8
Average Work Time	16.1
Average Rest Time	11.0
Work to Rest Ratio	1.5:1

The mean of average work time in the 1991 World Championships for male finals is 24.3 (S.D ± 6.6) seconds and the mean of average work time in the Olympic Games is 21.3 (S.D ± 6.3) seconds. There is no statistical difference between these competitions ($T=1.19$, $P>0.1$). The mean of average rest time in the 1991 World Championships is 13.1 (S.D ± 5.7) seconds and the mean of average rest time in the Olympic Games is 12.1 (S.D ± 2.9) seconds. Again, there is no statistical difference between them ($T=0.46$, $P>0.1$). In the ratio of work and rest, the average in the men's finals of the 1991 Championships is 2.1 : 1 (S.D ± 0.7) and the average of the 1992 is 1.8 : 1 (S.D ± 0.4). There is no statistical difference in the ratio work and rest between the two championships ($T=0.9$, $P>0.1$).
Figure 8.18, 8.19 and 8.20 show the average work time, the average rest time and the average work and rest ratio respectively in each weight category for the male finals. The average time of activity from all contests is 22.9 seconds with an upper limit of 38.0 seconds and a lower limit of 12.4 seconds. The average time for recovery from all contests is 12.6 seconds with an upper limit of 23.4 seconds and a lower limit of 7.0 seconds. These data give an average work to rest ratio for all contests of 1.9 : 1 with an upper limit of 3.8 : 1 and a lower limit of 1.2 : 1.

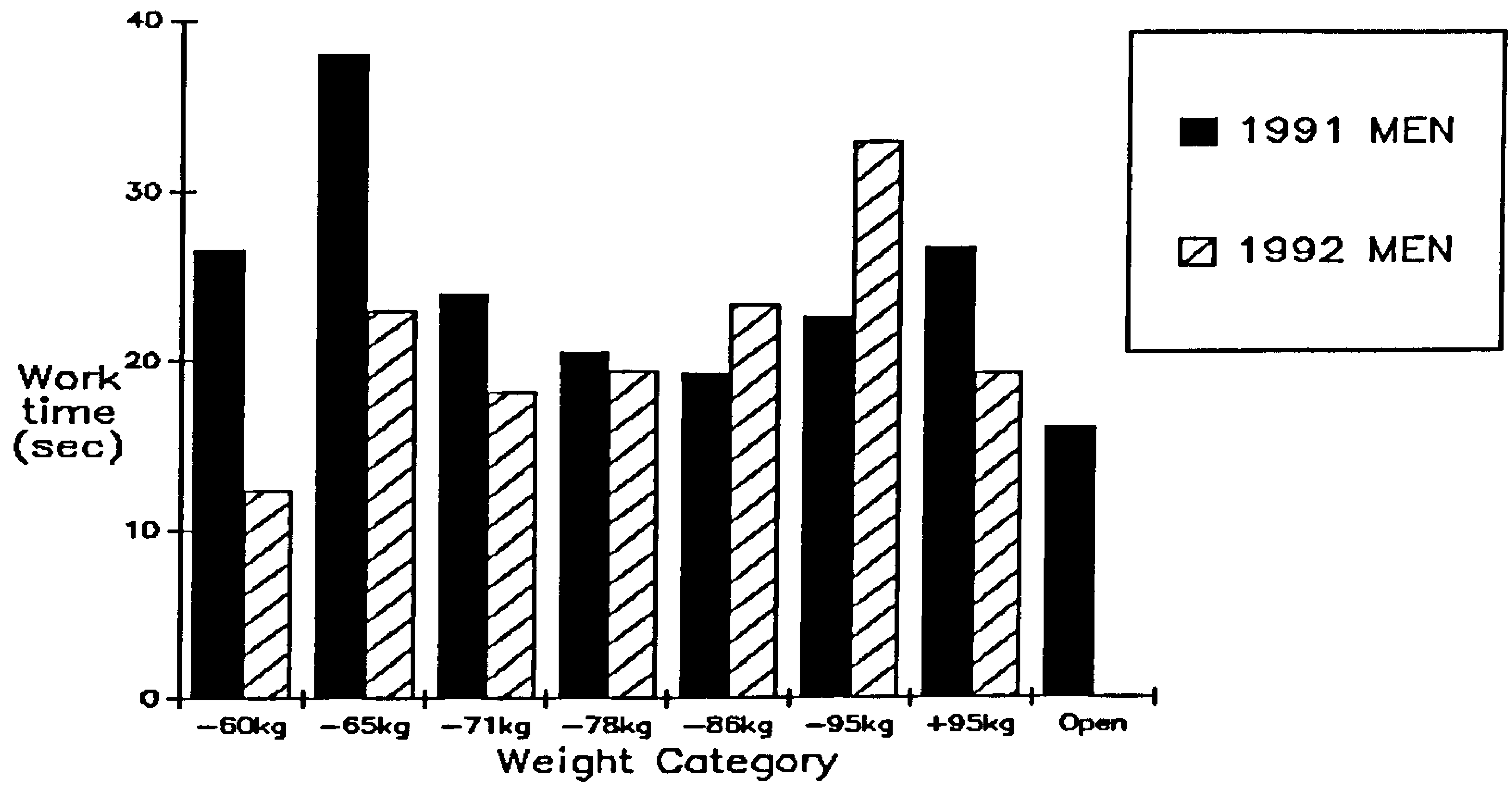


Figure 8.18 The average time of activity for male competitors

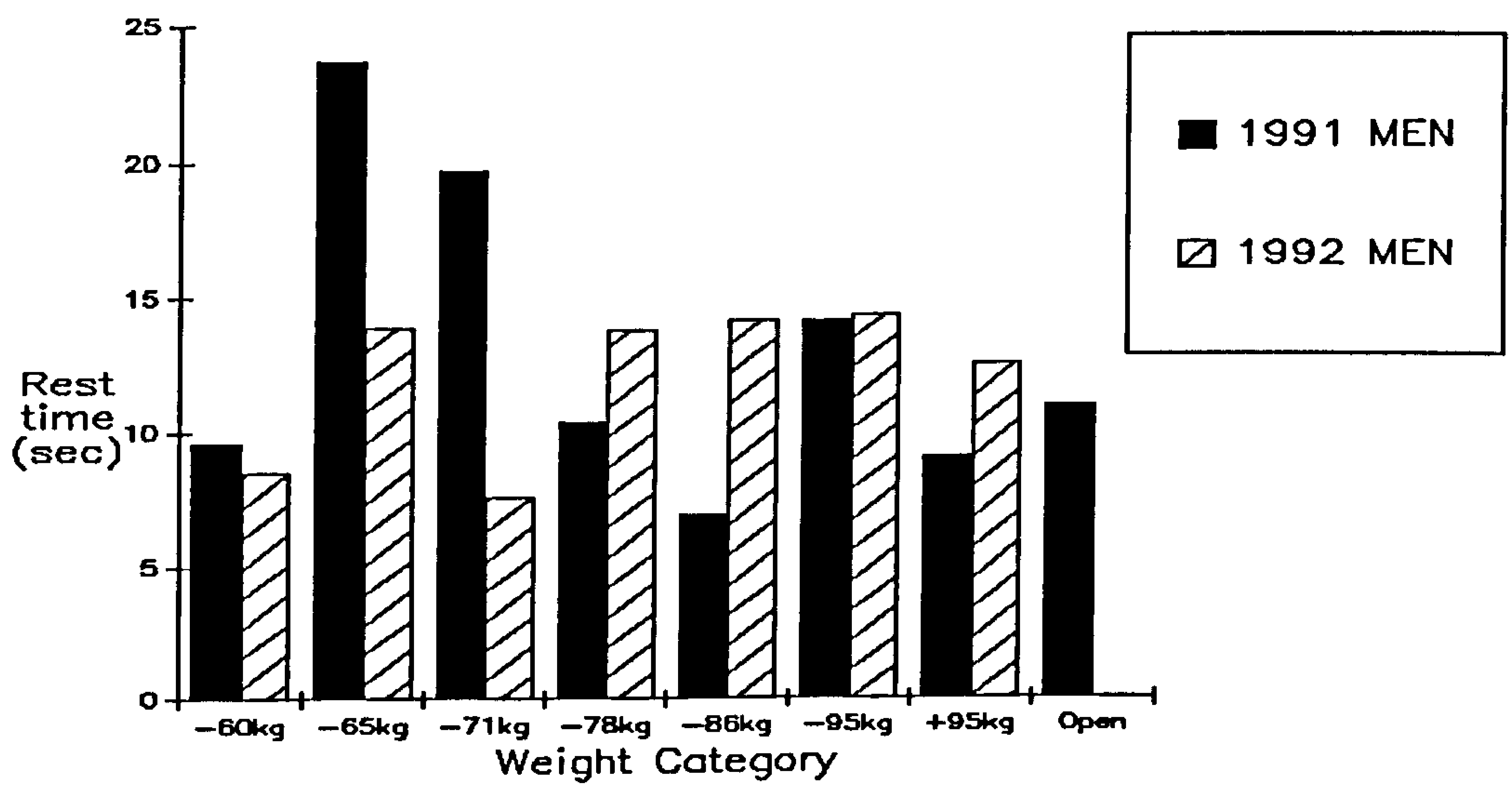


Figure 8.19 The average time of recovery for male competitors

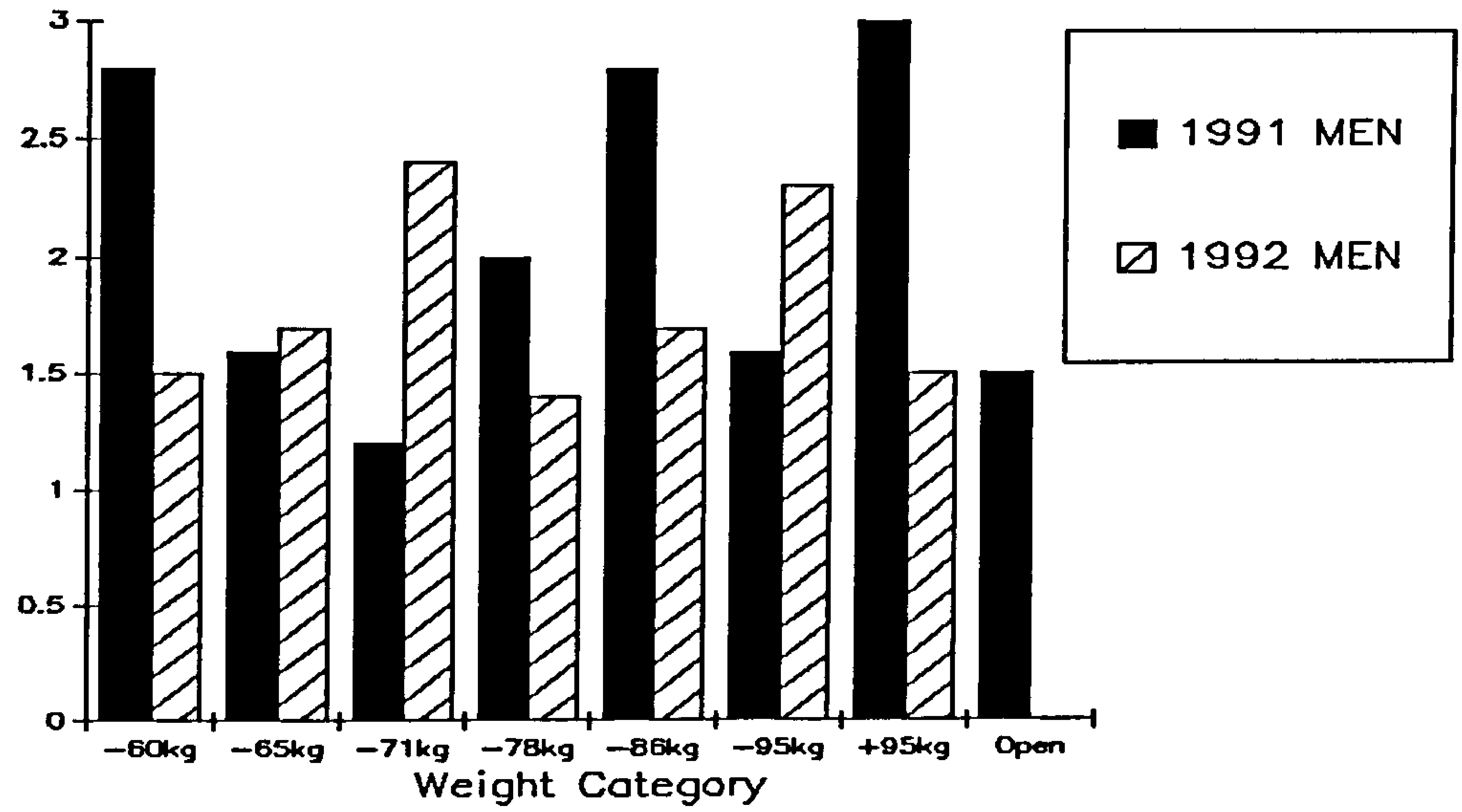


Figure 8.20 The ratio of average activity to recovery time for male competitors

8.6 COMPARISON OF THE RESULTS OBTAINED BY THE CHAMPIONS

In Chapter 6, the female champions at the 1991 World Championships in the weight categories -56kg, -61kg, -66kg and Open were classified as a hyperdominant group. The -48kg, -52kg -72kg and +72kg weight categories were grouped into a hypodominant group.

From the hyperdominant group of female champions in the 1991 World Championships, the champions in the -56kg and Open weight categories also won a gold medal at the 1992 Olympic Games. The champion in the -66kg finished with a silver medal in the Olympic Games. Of this group only the -61kg weight category champion did not obtain a medal. In the hypodominant group, the champions in the -48kg and -72kg weight categories also won a gold medal at the 1992 Olympic Games. The -52kg and +72kg weight category champions lost in earlier rounds. It is of some interest that in the 1992 Olympic Games, the results of the finals could not be classified in two separate groups such as a hyperdominant or a hypodominant group. Only the -72kg weight category champion at the Olympic Games won 3 contests out of 4 rounds by Ippon. This champion was also the champion in the 1991 World Championships -72kg category and belonged to the hyperdominant group.

A similar pattern emerged for the male competitors. In the 1991 World Championships for male competitors, the -95kg, +95kg and Open weight categories could be classified as a hyperdominant group. The -60kg and -65kg weight categories could be considered as a hypodominant group. In the hyperdominant group of male champions in the 1991 World Championships, only the champion in the Open weight category obtained a gold medal at the 1992 Olympic Games, but this was in the +95kg weight category. The champion in the -95kg lost in the third round and the champion in the +95kg did not compete at the 1992 Olympic Games. In the hypodominant group, the champion in the -60kg and -65kg weight categories both won a bronze medal at the 1992 Olympic Games. It was difficult to classify the -71kg and +78kg weight categories. Nevertheless, the -71kg champion in 1991 also won at the 1992 Olympic Games. He was the only male champion who won both the 1991 World Championships and the 1992 Olympic Games in the same weight category. The champion of the -78kg weight category in 1991 lost before achieving the medal position at the 1992 Olympic Games. However the -78kg Olympic champion was a bronze medallist in the 1991 World Championships.

8.7 DISCUSSION AND CONCLUSION

The International Judo Federation consists of 5 Continental Unions, from Europe, Pan America, Africa, Asia and Oceania. The number of countries which belong to each Union is not the same. The European and Pan American Judo Unions consist of 40 countries while a smaller number of countries belong to the other three Unions. The Oceanic Judo Union is the smallest with only 15 countries (see Figure 8.1). This means that the number of competitors from each Union taking part in the 1991 World Championships and the 1992 Olympic Games was different. Of the 465 competitors participating in the World Championships there were more competitors from the European Union than the aggregate number from the other four Unions (see Figure 8.2 and 8.3). Although the number of competitors from Europe dropped slightly in the Olympic Games, without a significant decrease from the other Unions, there was still a considerable bias towards European Judo Players in both competitions. Of the 438 competitors at the Olympic Games, 80 female contestants and 120 male contestants were from Europe.

Hence, although the sample size of elite performers drawn from the International Judo pool did not change appreciably from 1991 to 1992 and the frequency distributions were similar (apart from a significant influx of male African competitors in 1992) the statistical results of this thesis must be biased towords the European style of Judo and the techniques that are most appropriate for the anthropometric characteristics of the European contestant. Nevertheless the fact that the venue was the same in 1991 and 1992, and there was only one year between the two competitions should minimise the sources of variation associated with the geographical location of the competition and the maturity or ageing of the competitors.

The two samples surveyed and compared in this Chapter are drawn from one end of the population pool of Judo players. It can be assumed that all contestants at both competitions were elite performers. There was also an overlap in the distribution of competitors because 90 of the female competitors and 120 of the male competitors who competed in the 1992 Olympic Games had also competed in the 1991 World Championships (see tables 8.1 and 8.2). The number of returning competitors appeared to be relatively evenly distributed throughout the weight categories.

Within these sample distributions it can be assumed that the medallists would be found in the upper tail of the spectrum of Judo ability. Since 54% of females and 44% of males at the Olympic Games also competed at the World Championships then it might be expected that a significant proportion of medallists at the World Championships would become medallists in the Olympic Games, if 12 months is insufficient time for the influx of a cohort of new talent to make its mark on International Judo. The results of this thesis confirm this supposition. Fifty percent of the female medallists in 1991 became medallists in 1992. Since 19% of the medallists in 1991 did not compete in 1992, only 31% of the World Championships female medallists were not successful (if obtaining a medal can be deemed as a success) a year later. A similar picture emerges for the male medallists. Forty-one percent of the male medallists in 1991 became medallists in 1992. Since 19% of the medallists in 1991 did not compete in 1992, only 40% of the World Championships male medallists were not successful a year later. These statistics suggest a common group of competitors in the two championships with efflux from 1991 replaced by an influx in 1992 that was dominated by the same subgroup of female and male contestants. For this reason it seems appropriate to assume that the two samples of Judo players had similar abilities in 1991 and 1992.

Following from the deduction above it might be expected that the scoring patterns derived from standing techniques in 1991 and 1992 would be the same. This was indeed the case for the two samples of all competitors at the two championships and when the contestants were partitioned by gender. However when the competitors were partitioned into medallists and non-medallists as well as gender, all the subgroups displayed the same scoring patterns in 1991 and 1992 except for the male non-medallists. It would appear that in 1992 more Ippon and less Yuko and Koka were scored than expected from the observed data, while in 1991 less Ippon and more Yuko and Koka were scored than expected. These differences may reflect the judges' perception of the scores rather than the abilities of the competitors. Data concerning the referee and judges have not been introduced in this thesis, but the ability of these officials is another obvious source of variation.

The scoring patterns associated with groundwork techniques were unaltered from 1991 and 1992. At this level of Judo competition it would appear that the chances of escaping from a groundwork technique, that is initiated successfully, are exceedingly small. Holding techniques nearly always lead to Ippon once they are started.

The most successful standing techniques of Uchi-Mata (UM) for the women and Seoi-Nage (SN) for the men in 1991 still remained the most successful techniques in 1992. The high success rate of UM (it was the second most successful technique for men as well) may reflect the bias towards a high percentage of European competitors with longer arms and legs (for increased leverage) compared with contestants in some of the other Judo Unions.

The number of techniques used per minute by the female contestants was significantly higher in 1992 than 1991, but this observation did not apply to the male contestants. Why these differences should occur is not immediately apparent.

The time spent in groundwork by female contestants was substantial both in the 1991 World Championships and the 1992 Olympic Games, but not significantly different from one year to the next. There is statistical evidence that time spent in groundwork is correlated to the weight category for female contestant. The greater the weight of the competitor the more time is spent in groundwork. It would appear that the heavier female competitors prefer to do more of their fighting on the ground than their lighter colleagues.

The same remarks do not apply to male Judo competitors. There was no significant difference in time spent in groundwork between 1991 and 1992. At both competitions, there is a reduction compared with the female competitors. In addition there seems to be no correlation between time spent in groundwork and weight category. This suggests that male Judo competitors, unlike their female counterparts, prefer to do most of their fighting using standing techniques throughout the entire range of weight categories.

Perhaps the most important statistic arising from these comparative chapters are those related to the activity and recovery times during the Judo contest. These data give some hints about designing appropriate conditioning programmes. It is clear that Judo is a high activity sport utilising skeletal muscle throughout the entire body. There are periods of recovery, however, throughout the contest. When Matte is called the contestants disengage from combat and recovery from the fighting activity takes place. The data presented in this chapter suggest that the average time of activity for the female finalists (for whom it might be expected that differences in Judo ability are minimal) is around 28 seconds, ranging from 54 to 15 seconds, while the average recovery time was about 13 seconds with a range from 28 to 6 seconds. These data give an average activity to recovery ratio of 2.4 : 1, which can be as low as 1.3 : 1 or as high as 4.0 : 1. Such statistics suggest that for female Judo competitors a suitable conditioning programme that might be used, to complement the normal Judo practice, would consist of a high activity whole body exercise (such as associated with a rowing ergometer) which lasted for 30 seconds followed by 15 seconds recovery for a period of approximately 4 minute (8 repetitions of 45 seconds in 1 set). Complete recovery would by required before the next set of 8 repetitions was attempted.

The average time of activity for female finalists during the 1991 World Championships was significantly higher than in the 1992 Olympic Games, but there was no significant difference in the average time of recovery. Although the ratio of activity to recovery in 1992 was lower than in 1991 this difference was not statistically significant and the data from all the finals support the conclusions reached above.

Similar descriptive statistics apply to the male finalists of 1991 and 1992. However, the average time of activity is about 23 seconds with an upper limit of 38 seconds and lower limit of about 12 seconds. This is a slightly lower activity time average compared to these associated with the female finalists, whereas the average time of recovery is almost the same, at 13 seconds, as that obtained for the female finalists. It would appear that, during competition on average, the male competitors have a slightly higher activity time with the same time for recovery than the female competitors, but in general the pattern has to be maintained for one minute longer (for 5 minutes rather than 4 minutes). Also it is possible that the intensity of activity is higher for male competitors than their female competitors. However, the data presented here do not address this problem.

There was no statistical difference between the average activity and recovery time or the ratio of activity to recovery produced during the 1991 World Championships and the 1992 Olympic Games by the male finalists at these championships.

These data indicate the duration and frequency of appropriate conditioning programmes for Judo players, but do not identify the intensity. This problem will addressed in subsequent chapters (Chapters 9 and 10).

Finally, by following each champion through every round in the competition, the female champions were subdivided into two separate groups for the World Championships, a hyperdominant group and hypodominant group. Of the hyperdominant group identified in 1991 only one contestant did not reach the final in 1992. Even in the hypodominant group two of the champions returned to claim a gold medal one year later. A similar pattern emerged for the male championships. These observations reinforce the concept, introduced previously, of World Championships and Olympic Games dominated by an elite group of performers.

8.8 SUMMARY

* Continental Unions	: There were more competitors from the European Union than the aggregate number from the other four Unions in the both championships.
* Returning competitors	: 90 out of 166 female competitors and 120 out of 272 male competitors who competed in the 1992 Olympic Games had also competed in the 1991 World Championships.
* Partitioning into medallists	: 50% of the female medallists in 1991 became medallists in 1992. 41% of the male medallists in 1991 became medallists in 1992. These statistics suggest a common group of competitors in the two championships with efflux from 1991 replaced by an influx in 1992 that was dominated by the same subgroup of female and male contestants.
* Scoring pattern	: All the subgroups displayed the same scoring patterns from standing technique in 1991 and 1992 except the male non-medallists. The scoring patterns associated with groundwork techniques were unaltered from 1991 and 1992.
* Standing techniques	: UM and SN were the two most successful techniques for both female and male competitors.
* Number of techniques used per minute	: The number of techniques used per minute by female contestants was slightly higher in 1992 than 1991, but this observation did not apply to the male contestants.
* Time spent in groundwork	: There was no statistically significant difference in the time spent in groundwork between two

championships for the female finalists. There is statistical evidence that the heavier weight female competitors spent more time in groundwork than the lighter weight competitors. There was no statistically significant difference in time spent in groundwork between 1991 and 1992 for the male finalists. There seems to be no correlation between time spent in groundwork and weight category for male finalists.

* Relationship of the activity and recovery times during the contests : The average time of activity for the female finals is about 28 seconds, while the average recovery time was about 13 seconds. These data give contests average activity to recovery ratio of 2.4:1. The average time of activity for female finals during the 1991 World Championships was significantly higher than in the 1992 Olympic Games, but there was no significant difference in the time of recovery and the ratio of activity to recovery. The average time of activity for the male finals is around 23 second. The average recovery time was about 13 seconds. These data give a an average activity to recovery ratio of 1.9:1. There is no statistical difference between the average activity and recovery time or the ratio of activity to recovery produced during the 1991 World Championships and the 1992 Olympic Games by the male finalists at these championships.

* The results obtained by the champion	: Of the hyperdominant group identified in 1991 only one contestant did not reach the final in 1992 for both genders.

CHAPTER 9

INVESTIGATION OF BLOOD LACTIC ACID CONCENTRATION DURING REST AND EXERCISE : COMPARISON OF DIFFERENT SAMPLE SITES

9.1 INTRODUCTION

The statistical evidence presented in the earlier chapters suggests that Judo is a sport in which periods of whole body activity are separated by intervals of recovery. The duration of activity for male competitors is 5 minutes. The time interval is reduced to 4 minutes for female competitors. The activity time is not continuous. On average, based on the data obtained from Barcelona in the 1991 World Championships and the 1992 Olympic Games the duration of the contest is separated into approximately 12 activity periods with a duration of approximately 25 seconds each. The periods of activity are separated, on average, by recovery periods of approximately 15 seconds duration. However, these observations give no information about the intensity of the exercise.

Objective measures of exercise intensity have been made using heart rate, blood lactate concentration and rate of oxygen uptake or utilisation. Subjective measures rely on rating of perceived exertion. Direct measurement of expired gases during Judo practise or competition would be virtually impossible. Recent advances in telemetry have made heart rate monitoring during the practice of Judo a practical possibility and the results of such a study will be discussed in the next chapter (Chapter 10).

Blood lactate concentration has been linked to aerobic capacity and the definition of optimal training intensity for endurance events[30]. Recently this parameter has been used by Japanese research workers to study exercise intensity in Judo competition. However, the site of sampling has not been standardised. Yamamoto[31][32] took blood from the ear-lobe before and after Judo competition, whereas Terao[33] obtained blood from the fingertip for assessment. There is some evidence in the scientific literature that the way blood is collected for lactate concentration measurement and the site from which it is sampled can influence the result obtained. For example, during cycle ergometry significant differences in arterial and venous blood lactate concentrations have been observed during submaximal graded exercise and in recovery[34]. In contrast, differences in arterial and venous blood lactate concentrations were not obtained during incremental treadmill exercise[35][36]. Neither of these methods of obtaining blood would be appropriate in Judo.

An indwelling catheter, whether in the vein or the artery, would be unrealistic during Judo competition. Hence, if blood lactate concentration is to be used as a possible measure of exercise intensity then the only feasible alternative is a finger or ear-lobe sample obtained by puncturing the skin at these sites. This procedure also raises some problems because it has been reported that lactate samples obtained from the ear-lobe were significantly lower than samples which were obtained from both the fingertip and the toe[37].

In addition, sweat has a very high concentration of lactic acid in the order of 30 mmol/l and if care is not taken in sampling this can alter the results. For these reasons this chapter investigates the blood lactate concentrations obtained from lancet pricks in the ear-lobe and fingertip during rest and during an incremental cycle ergometer test to exhaustion. In addition, the lactate concentration in the sweat produced during the exercise was recorded.

9.2 MATERIALS AND METHODS

Experiment 1 : Comparison of blood lactate concentration sampled at different sites at rest

*** Subjects used**

19 volunteers (female 5, male 14) participated in this study. The mean age of these subjects was 27.0 (S.D ± 8.8) years for females and 27.4 (S.D ± 3.9) years for males.

*** Sampling site**

The sampling sites were the two ear-lobes (left and right) and two finger tips (left and right index finger). Blood was always obtained in the same order. First the left and right finger and then the left and right earlobes.

*** Sampling Procedure**

The same operator took all samples. Gloves were worn by the operator collecting the blood samples throughout the procedure. The finger was wiped to remove any sweat, and then pierced using an Autoclix lancet system. Each procedure required the use of a sterile needle. The first drop of blood was always removed from the fingers and ears. The blood was collected in a small bottle containing crystals of the anticoagulant heparin and preservative fluoride oxylate.

*** Measurement of blood lactate concentration**

Blood lactate levels were measured using a Yellow Springs Instrument Model 23L Lactate Analyzer (Yellow Springs, Ohio, 45387, U.S.A). Before each test of a specific batch, the equipment was calibrated using a standard 5 mmol/l solution. The samples were analysed as soon as possible after the test and in each case not later than 24 hours after collection. The samples were kept at room temperature until measurement. A previous study[38] had shown that storage in this way does not affect the lactate levels recorded.

Experiment 2 : Comparison of blood lactate concentration sampled at different sites during exercise

*** Subjects used**

Five male volunteers participated in this study. Table 9.1 shows the age and activity of these subjects.

Table 9.1 The age and activity of subjects

	Age	Activity
Subject A	26y	Squash
Subject B	28y	Squash
Subject C	22y	Judo
Subject D	26y	Judo
Subject E	52y	Runner

*** Test protocol**

Before the test started, each subject was informed of the requirements of the study and familiarised with the experimental procedures and test equipment. Each subject signed a consent form based on the format suggested by the American College of Sports Medicine.

Each subject was instructed to continue exercising until exhausted. The subjects were asked to cycle at 50 - 60 revolution per minute (rpm) during an incremental power test on a friction-braked Bodyguard Ergometer. A power output of 50 watts for 5 minute was selected for warm up. In most subjects this power output produced a steady H.R of 120 - 130 beat/minute (bpm). The initial power output in the incremental test was 50 watts. This output was maintained for 2 minutes. The power output was increased in increments of 50 watts until 200 watts was reached and in increments of 25 watts thereafter until exhaustion. All subjects were given verbal encouragement throughout the test. The ergometer was calibrated according to the manufacturer's instructions before each test.

*** Time of sampling**

Blood samples were taken, at rest before warm up, at rest after warm up, every 2 minutes during exercise and also during recovery, with intervals of 1 minute, 3 minutes and 5 minutes after the exercise had ceased.

Sweat samples were taken from the face, using the same type of sampling bottle as blood samples. Once the subject was seen to be sweating, sweat samples were taken at the same time as subsequent blood samples were taken.

*** Sampling site**

The process of sampling was virtually the same as for experiment 1. However, four different samples (below) were taken by four different operators at the same time.

1: a blood sample from the right ear-lobe.
2: a blood sample from the right wiped index finger.
3: a blood sample from the left index finger (not wiped before sampling).
4: a sweat sample from the face.

*** Measurement of blood lactate concentration and sweat lactate concentration**

The measurement of blood lactate concentration and sweat lactate concentration was the same as the measurement of blood lactate concentration in experiment 1.

*** Statistical evaluation**

Differences between the blood lactate concentrations sampled from different sites for the same individual were assessed by means of a Student's t-test for paired data. For this study statistical significance was assumed at the 5% level.

9.3 RESULTS

Results of Experiment 1

The result of taking blood samples from right and left ears and fingers during rest are shown Figures 9.1, 9.2 and 9.3.

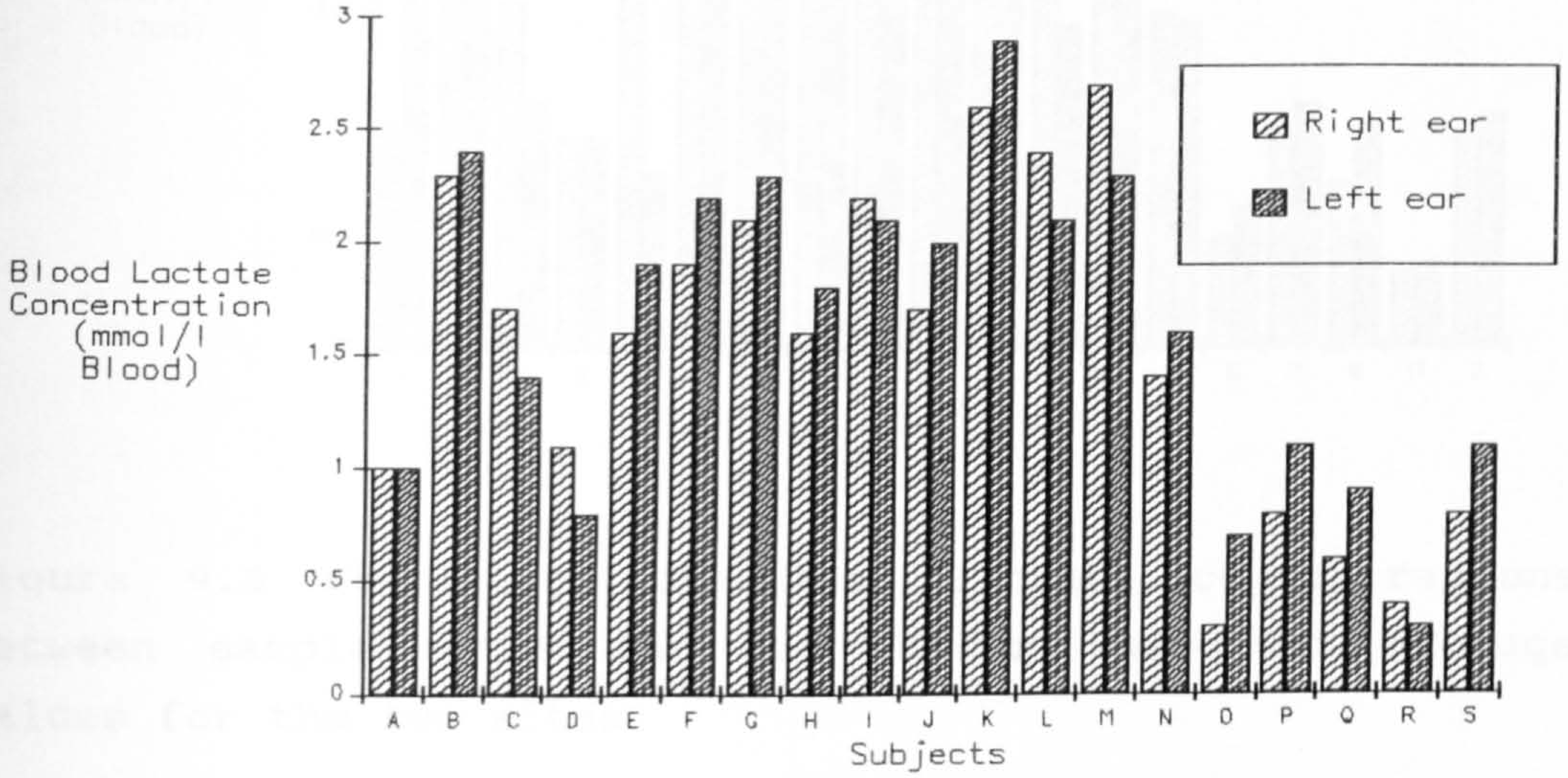


Figure 9.1 Comparison of blood lactate concentrations between sample sites Right Ear and Left Ear

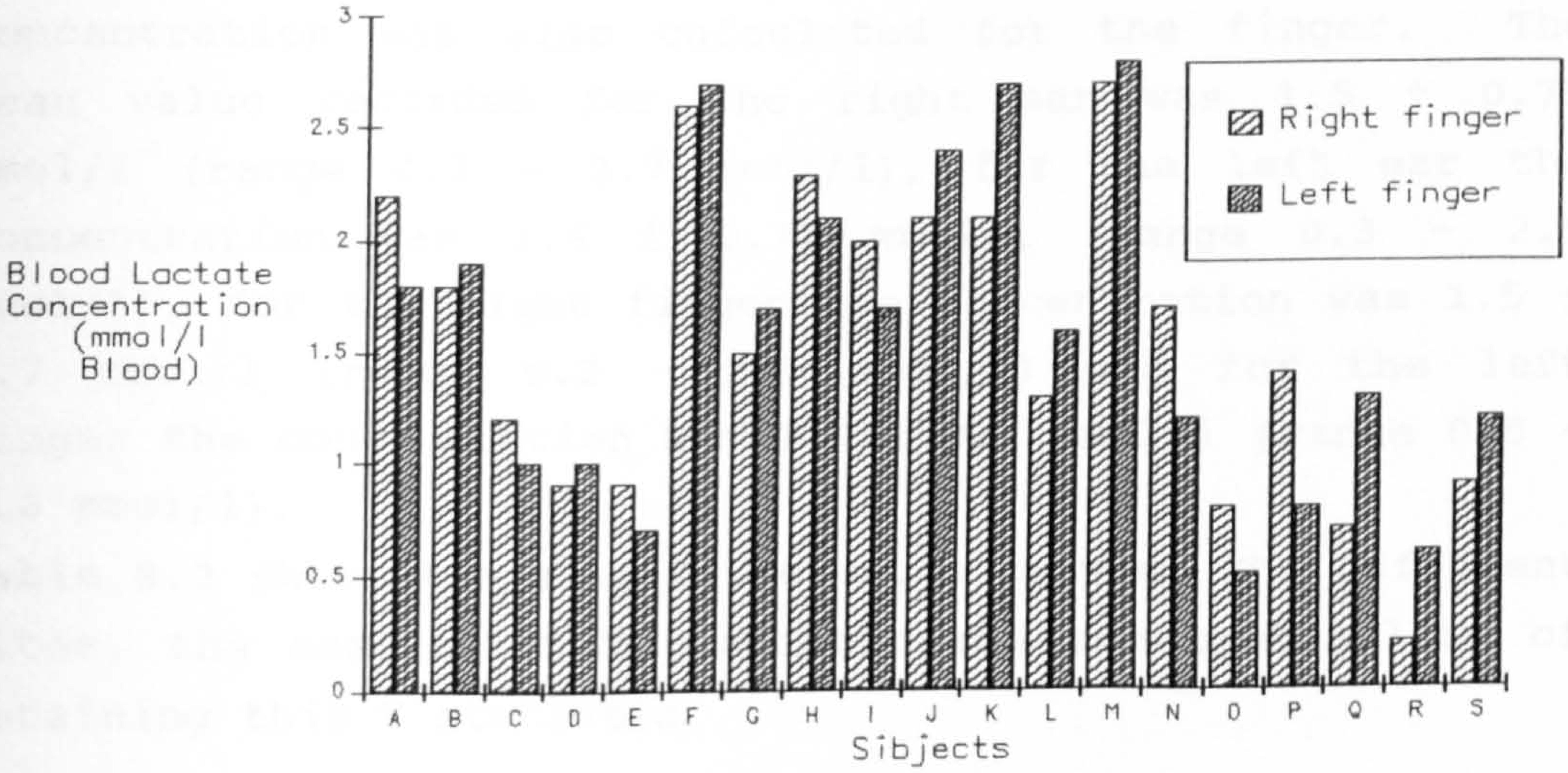


Figure 9.2 Comparison of blood lactate concentrations between sample sites Right Finger and Left Finger

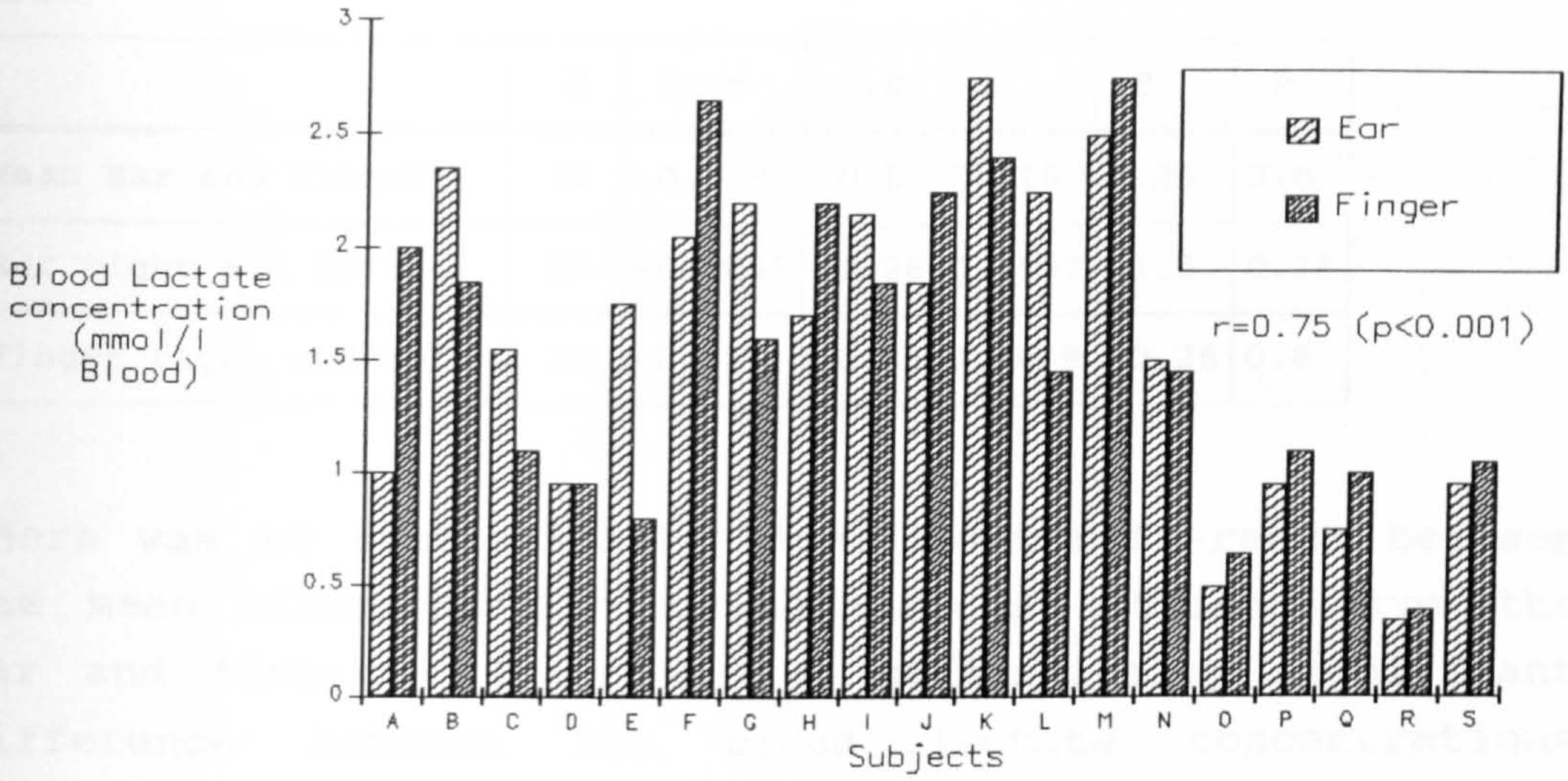


Figure 9.3 Comparison of blood lactate concentrations between sample sites Ear and Finger based on average values for the two sites

The blood lactate concentrations from the left and right ear were averaged to give a mean blood lactate concentration for the ear. A mean blood lactate concentration was also calculated for the finger. The mean value recorded for the right ear was 1.5 ± 0.75 mmol/l (range 0.3 - 2.7 mmol/l), for the left ear the concentration was 1.6 ± 0.71 mmol/l (range 0.3 - 2.9 mmol/l), for the right finger the concentration was 1.5 ± 0.7 mmol/l (range 0.2 - 2.7 mmol/l) and for the left finger the concentration was 1.6 ± 0.7 mmol/l (range 0.5 - 2.8 mmol/l).

Table 9.2 shows the mean differences between the different sites, the associated T statistic and the probability of obtaining this T statistic.

Table 9.2 Comparison of lactate value between each sample site

	N	Mean	S.D	SE	T	P
Mean Ear and Finger	19	0.029	0.5	0.115	0.25	0.8
Ear right and Left	19	-0.0895	0.26	0.0597	-1.5	0.15
Finger right and Left	19	-0.0211	0.36	0.0819	-0.26	0.8

There was no statistically significant difference between the mean blood lactate concentrations obtained from the ear and finger. There was no statistically significant difference between the blood lactate concentrations obtained from the left and right side for either the ear or the finger.

Result of Experiment 2

In all cases as the power output increased there was a gradual increase in blood lactate concentration sampled from both the ear-lobe and fingertip. After cessation of the exercise, during recovery, the blood lactate concentration decreased. There was no evidence of a further increase in blood lactate concentration beyond that achieved during exercise at any stage in the recovery period for any subject. Figures 9.4 and 9.5 show typical curves of blood lactate concentration at the different sites for two of the subjects. The lactate concentrations in the sweat sampled from the forehead of the subject at selected times is shown for comparison.

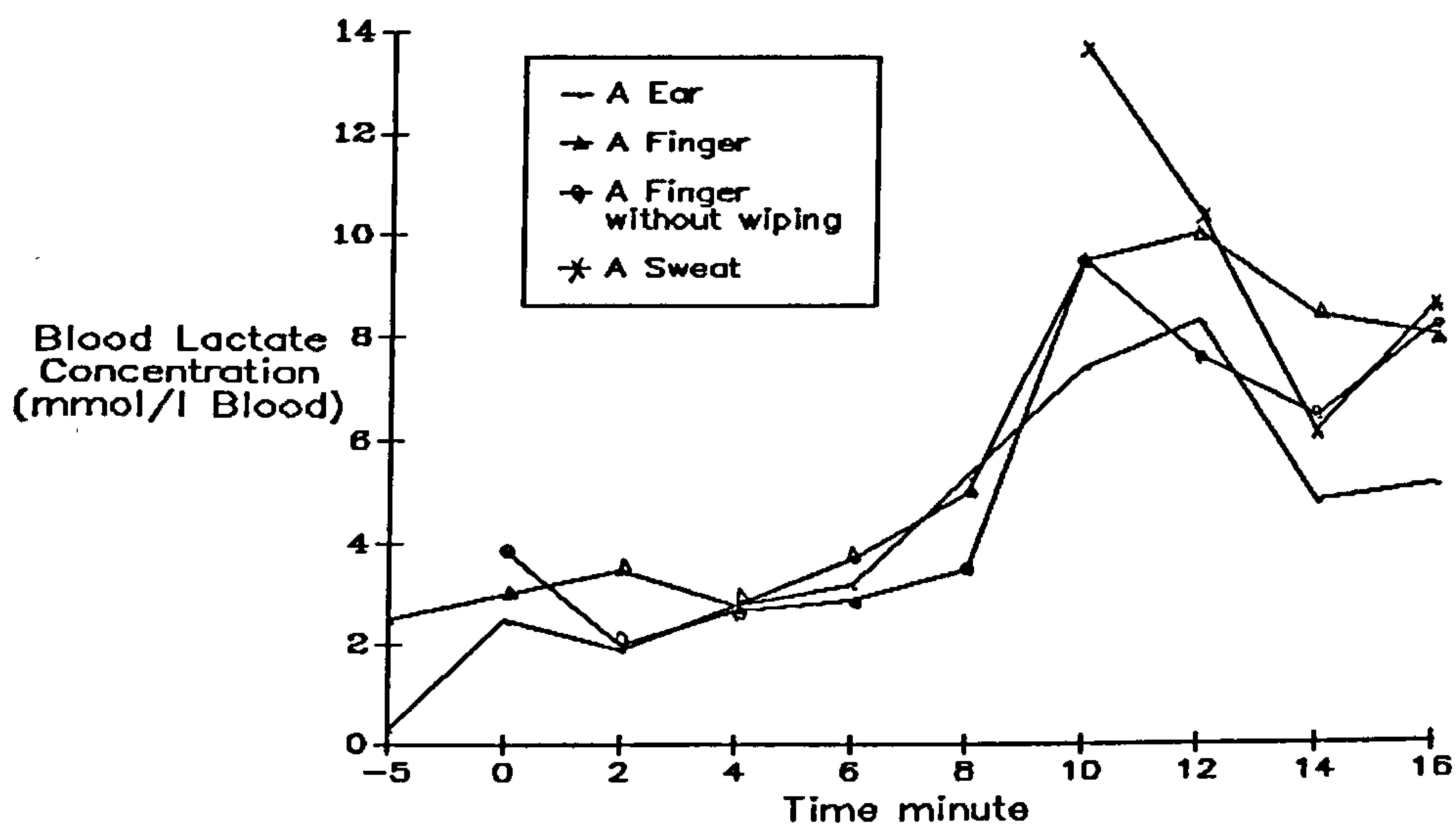


Figure 9.4 Blood Lactate Concentration Subject A

Figure 9.4 shows the blood lactate concentration response to the increasing exercise intensity for a Judo player, whereas Figure 9.5 shows the same response for an endurance trained distance runner.

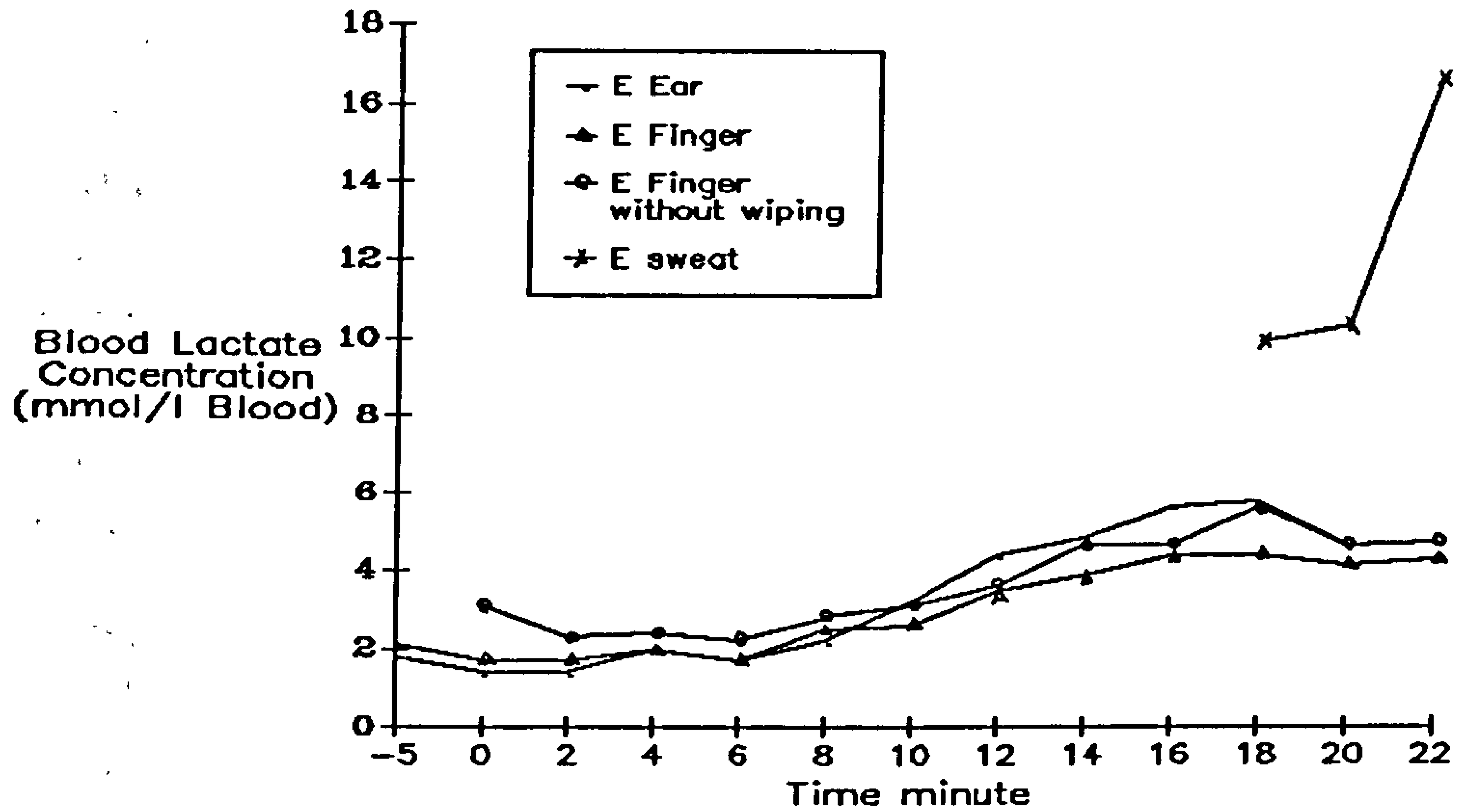


Figure 9.5 Blood Lactate Concentration Subject E

For each subject the points which defined the two curves of blood lactate concentration were assessed for any differences and the Student T test for paired data was used to evaluate the statistical significance of the data. Table 9.3 gives a synopsis of this evaluation.

Table 9.3 Comparison of the differences between the blood lactate concentrations obtained from the ear-lobe and fingertip during the incremental power test. (N signifies the number of points).

	N	Mean	S.D	SE mean	T	P
Subject A	10	1.06	1.24	0.39	2.70	0.024
Subject B	7	1.77	1.71	0.64	2.75	0.033
Subject C	6	0.77	0.7	0.29	2.68	0.044
Subject D	12	0.35	1.68	0.48	0.72	0.48
Subject E	13	-0.39	0.63	0.18	-2.2	0.048

Blood lactate concentrations in samples obtained from the ear-lobe were significantly lower than those found in fingertip samples for subjects A, B and C. There was no statistically significant difference in the concentration curves obtained from the two different sites for subject D. For subject E the blood lactate concentrations in the samples obtained from the ear-lobe were higher than those obtained from the finger. Table 9.4 shows the effect of wiping the fingertip before sampling and the possible contamination by sweat during exercise.

Table 9.4 Comparison of the differences between the blood lactate concentrations obtained from fingertip and fingertip without wiping during the incremental power test.

	N	Mean	S.D	SE mean	T	P
Subject A	9	0.60	1.55	0.52	1.16	0.28
Subject B	7	2.76	2.09	0.79	3.05	0.013
Subject C	6	1.83	1.57	0.64	2.87	0.035
Subject D	11	2.32	1.68	0.51	4.57	0.001
Subject E	12	0.16	0.73	0.21	0.75	0.47

For subject A and E there was no statistically significant difference between the results obtained from the fingertip without wiping the sweat away compared with the wiped finger, whereas subject B, C and E showed statistically significant differences between the blood lactate concentrations under these two conditions. The average lactate concentration in sweat calculated from measurement taken from all subjects (N=26) was 13 ± 5.2 mmol/l sweat (mean ± S.D) with a range of 6.1 mmol/l up to 22.2 mmol/l sweat. This was significantly higher than the lactate concentrations found in the blood at the same time points.

9.3 DISCUSSION AND CONCLUSIONS

Experiment 1

There was no statistically significant difference in blood lactate concentration when sampled from ear-lobe and fingertip at rest. Also there was no statistically significant difference between the blood lactate concentrations obtained from the left and right side for either the ear or the finger.

Although it is appropriate to compare such experiments with similar experiments reported in the literature, research on the comparisons of different lactate concentrations between different sites (fingertip and ear-lobe) does not seem to have been undertaken when subjects are at rest.

During rest and light exercise, blood lactate levels are in a steady state. At rest, the quantity of lactic acid produced by the body cells and the quantity of lactic acid which is removed by the cells is the same. During exercise active skeletal muscle becomes the predominant producer of lactic acid. The blood lactate concentration is the difference between release rate into, and removal rate from the blood. The concentration of lactic acid is not high during low levels of exercise, because the rates of production and clearance of lactic acid are balanced. As the intensity of the exercise increases the rate of production exceeds the removal rate and the lactate concentration rises. The levels of lactic acid during rest will be approximately the same in all parts of the body. The volume of blood is well mixed at rest. Therefore, it does not matter which site the operator chooses, the same blood lactate concentration will be obtained.

Experiment 2

The blood lactate concentration of all subjects, A, B, C, D and E, was measured in response to increasing mechanical power output. Subjects A, B and C showed lower blood lactate concentrations in the ear-lobe than the fingertip. Subject D showed the same concentrations in both ear-lobe and fingertip, and subject E showed higher concentrations in the ear-lobe than in the fingertip.

As lactate concentration in sweat is significantly higher than blood, two other experiments were conducted. One when the lactate was obtained without wiping sweat from the finger, and one when lactate was obtained from sweat.

Three out of five subjects produced lactate samples from the ear-lobe which had significantly lower concentrations than samples which were obtained from the fingertip. A similar result was obtained by Heller et al[37].

Blood lactate levels can be influenced by inhomogeneous blood flow, the distance travelled by the lactate from the site of production to the site of sampling as well as lactate elimination, by muscles and organs such as the heart, inactive skeletal muscles, liver and kidneys. In addition, some lactate produced by fibres in active muscles may be utilised as fuel by other fibres in the same active muscle.

For the reasons above, it is possible that differences in blood lactate levels may occur when blood is obtained from fingertip and ear-lobe. There was a tendency for the higher lactate concentrations to be associated with greater differences between the fingertip and ear-lobe. This suggests that the concept of a well mixed blood compartment becomes more inappropriate the greater the mechanical power output of the subject. A bicycle ergometer was used to conduct these tests. Throughout the procedure, it was necessary for all subjects to grip the handlebars. When the power output increased and the physical effort was greater, the subject often attempted to grip the handlebars tighter. In this case there may be some isometric contraction of the muscles in the forearms as well as a reduction of blood flow to the fingers from increased pressure. It is very difficult to control this aspect of the experiment, especially when the subjects are trying hard. This variability in gripping may have led to the different lactate concentration responses to exercise seen in the five subjects.

During the test, only Subject E showed a lower lactate concentration in blood sampled from the fingertip compared with the ear-lobe. In addition, the special characteristics of subject E must be taken into consideration. He was the oldest subject and a good veteran endurance runner. The power output he achieved was the highest for all the subjects. The endurance capacity was reflected in the lactate concentration obtained during the test.

The maximum blood lactate concentration from subject E's finger was less than half that obtained from the other 4 subjects. Also, lactate samples from the finger which was not wiped, showed the same levels as the wiped finger, suggesting little contamination by sweat on the fingers. The samples from subject E's ear showed the same magnitude as two of the other subjects. Nevertheless the lactate concentration in the sweat, obtained from the face of subject E was the third highest in the 5 subjects. On considering these results, it seems necessary to undertake a further substantial study in order to produce a clear picture. It can be concluded however that fingertip and ear-lobe samples can produce different comparative lactate concentrations.

The samples of lactic acid taken from the fingertip without wiping, resulted in a zigzag blood lactate slope. This showed the influence of contamination by sweat. Sweat is composed of mainly water (99%) with some salt, antibodies, traces of metabolic wastes (urea, uric acid, ammonia), Vitamin C and lactic acid. The lactate concentration in the sweat in this study varied from 6.1 mmol/l to 22.2 mmol/l. These values were much higher than found in the blood. Fluctuation within this range will occur depending on the genetic heredity and dietary characteristics of a subject[39]. The major role of sweating is to assist in maintaining normal body temperature. In other words, sweating is necessary during exercise. It is therefore important that when lactic acid concentration is measured in the blood, that no possible contamination by sweat is allowed.

In order to obtain blood lactate results which can be compared with blood lactate obtained in other sports the sampling site should be standardised, but this is not always possible, especially when the athlete is gripping an implement, as in canoeing or rowing, and moving the hand.

In the case of Judo, the ideal sites to obtain blood lactate samples are either the ear-lobe or fingertip. Both of these sites are accessible after, but not during the competition. The extraction of blood from such sites does not directly interfere with the player's performance. However, as Judo is a gripping sport, excessive extraction of blood from the fingertip could make the fingers sore and reduce the gripping performance. This may be exacerbated by the plaster and tape placed over the sample site to prevent bleeding after extraction of the blood. Without protection blood may be transferred to an opponent with a concomitant increase in the probability of cross contamination.

The ear as a site of sampling is less attractive in this respect. It is difficult to attach to the ear-lobe a permanent cover which will prevent blood being passed from one player to another. As a consequence the ethical issues of blood sampling during Judo practice will have to be considered carefully, if blood lactate concentrations are to be used as assessment of exercise intensity.

9.5 SUMMARY

* There was no statistically significant difference in blood lactate concentration when sampled from ear-lobe and fingertip at rest.
* There was also no statistically significant difference between the blood lactate concentrations obtained from the left and right side for either the ear or the finger.
* Three out of five subjects produced lactate samples from the ear-lobe which had significantly lower concentrations than samples which were obtained from the fingertip. Only one out of five subjects produced lactate samples from the ear-lobe which had significantly higher concentrations than samples which were obtained from the fingertip.
  It can be concluded that fingertip and ear-lobe samples can produce different comparative lactate concentrations during exercise.
* The samples of lactic acid taken from the fingertip without wiping, resulted in a zigzag blood lactate slope. This showed the influence of contamination by sweat. It is therefore important that when lactic acid concentration is measured in the blood, that no possible contamination by sweat is allowed.
* In the case of Judo, the ideal site to obtain blood lactate samples are either the ear-lobe and fingertip. Both of these sites are accessible after, but not during the competition. The extraction of blood from such sites does not directly interfere with the players performance. However, because of the possibility of cross contamination, the ethical issues of blood sampling during Judo practice will have to be considered carefully.

CHAPTER 10

PHYSIOLOGICAL ASPECTS OF JUDO

10.1 INTRODUCTION

The earlier chapters in this thesis have used statistical and video analysis to identify the fundamental characteristics of Judo competition at the highest level. In particular the results have highlighted Judo as a sport of intense activity separated by periods of recovery. Since a competitive bout lasts for 5 minutes for males and 4 minutes for females it must be accepted that a significant endurance component exists in Judo. At this stage it is important to distinguish between 'continuous' endurance events like running, cycling or swimming and 'intermittent' endurance events like Judo, soccer, hockey and basketball. Judo is a whole body 'intermittent' endurance event. The intensity of exercise during practice and competition should be reflected in the cardiorespiratory response of the body and the concomitant metabolic response of the active skeletal muscles.

One variable that can be used to identify the cardiorespiratory response is heart rate. However, there are major difficulties involved in acquiring authentic heart rate data, even during Judo practice. Nevertheless Kaneko[40] had suggested that the average heart rate of competitors during Judo Randori practice is 183 beats/minute (bpm). In addition, Yanagisawa[41] has indicated that the average heart rate during mock Judo matches was 178 bpm. Yanagisawa measured heart rate by fixing the heart rate receiver onto the rugby cap. Kaneko also incorporated a similar method during his measurements of heart rates.

Measurement of lactate (the salt of lactic acid) concentration in the blood has found favour in recent years as a measure of endurance capacity. As explained in Chapter 9, this concentration can only identify the balance between lactate appearance and removal rate from the blood lactate compartment. Deductions about the anaerobic metabolic activity of the skeletal muscles from this measurement will, of necessity, contain a significant element of speculation. Nevertheless it has been used pragmatically in endurance sports like swimming and running to establish levels of exercise intensity that optimise endurance conditioning programmes(42)(43)(44). Some evidence of attempts to establish the levels of blood lactate concentration seen after Judo competition have appeared in the scientific literature. For example, Yamamoto(32) has suggested that Judo players who fought for the full length of a Judo contest had lactate concentrations of approximately 7.5 mmol/l blood after the competition, whereas Cavazani(45) reported average lactate concentrations of 11.5 mmol/l after competition. Even higher values of lactate concentration (14 mmol/l) were measured by Terao(33) during a Judo tournament. These data are supported by a single measurement obtained in a pilot study for this thesis at the 1991 European Championships. A blood lactate concentration of 8.1 mmol/l was found in a British competitor after the second round of these championships.

Recognising the sparsity of authentic data on the intensity of exercise during Judo practice and competition this Chapter addresses four issues.

1, Measurement of blood lactate concentration during Judo training.
2, Measurement of heart rate during Randori practice.
3, Measurement of blood lactate concentration after competition.
4, Measurement of heart rate and blood lactate concentration during a rowing ergometer conditioning programme designed to simulate the activity and recovery time during Judo competition.

10.2 MATERIALS AND METHODS

An explanation of terminology

A Judo practice session can generally be divided into the following 4 segments.

1) Warm-up : Stretching and light movement.

2) Uchikomi : Repetitive practice of a certain throw. This develops an understanding of the throw, speed of entry and balance.

3) Yakusoku : The throwing of a partner without resistance. This develops the feeling of an actually completed throw.

4) Randori : 4-1 Free standing practice
4-2 Free Groundwork practice

In most cases when 'Randori' is mentioned, this usually relates to standing rather than groundwork practice. Yakusoku practice is beneficial for beginners and for players who are preparing for forthcoming competitions. Repetitive throwing without resistance, acclimatizes the body to the throwing action. Although such training sessions may vary slightly within the competitive seasons, features 1,2 and 4 are usually incorporated within most training session. The two main practice regimes for the first two experiments in this chapter were as below :

Example 1

1, Warm-up (10 ~ 15 min)
2, Uchikomi (10 ~ 15 min)
3, Randori of standing technique (40 ~ 60 min)
4, Randori of groundwork technique (20 ~ 45 min)

Example 2

1, Warm-up (10 ~ 15 min)
2, Randori of groundwork technique (20 ~ 45 min)
3, Uchikomi (10 ~ 15 min)
4, Randori of standing technique (40 ~ 60 min)

Experiment 1 : Measurement of blood lactate concentration during Judo practice

*** Subjects used**

Ten elite Judo players (2 British and 8 Japanese Judo Players) volunteered for the measurement of blood lactate concentration during Randori practice (free practice). These subjects included a 1991 World championship silver medallist and a 1993 World Champion. The subjects were taken from different weight categories. One subject fought in the -60kg weight category, 4 came from the -65kg category, 4 from the -71kg category and 1 from the -78kg category. The mean age of these subjects was 22.1 ± 2.96 years, the mean height was 170.9 ± 3.9 cm and the mean body mass was 70.8 ± 5.19 kg.

In groundwork practice, 4 elite Judo players (1 British and 3 Japanese) were used. These subjects were chosen from the -60kg, -65kg, -71kg and -78kg weight categories respectively. The mean age of this group was 22.3 ± 3.2 years, the mean height was 171.3 ± 3.3 cm and the mean weight was 70.8 ± 7.63 kg.

*** Sampling site**

Each subject was informed that a blood sample would be taken between every Randori practice from the middle or index finger of his Tsurite (the right hand of right grip player and the left hand of left grip player). The number of times blood samples were taken depended upon the length of the practice session. For example, ideally if there were 4 practices 4 blood samples should be taken.

*** Sampling Procedure**

The same operator took all samples. Gloves were worn by the operator collecting the blood samples throughout the procedure. The finger was wiped to remove any sweat, and then pierced using an Autoclix lancet system. Each procedure required the use of a sterile needle. The first drop of blood was always removed from the finger. The blood was collected in a small bottle containing crystals of the anticoagulant heparin and preservative fluoride oxylate. Immediately after sampling had taken place white tape was applied to the sampled site. The purpose of the tape was to stop the bleeding without hindering the player during practice.

*** Measurement of blood lactate concentration**

Blood lactate levels were measured using a Yellow Springs Instrument Model 23L Lactate Analyzer (Yellow Springs, Ohio, 45387, U.S.A). Before each test of a specific batch, the equipment was calibrated using a standard 5 mmol/l solution.

The samples were analysed as soon as possible after the test and in each case not later than 24 hours after collection. The samples were kept at room temperature until measurement. A previous study(38) had shown that storage in this way does not affect the lactate levels recorded.

Experiment 2 : Measurement of heart rate during Randori practice

1, Pilot studies : Basis of the investigation

First it is important to describe the difficulties experienced when performing tests of this nature. The wearing of hard/foreign objects during a Judo competition is prohibited, therefore the measurment of heart rate by a heart rate monitor during a Judo competition is impossible. For this reason, in earlier research(41) pulse rates have been checked with the fingers directly after a fight. The checking of the pulse rate in this way may be inaccurate and only gives information about heart rate at the end of the contest. In the first pilot studies, it was found that during groundwork practice, it was difficult to fix a heart rate monitor as there is a lot of close contact between both players. Although there was less contact between both players during Randori practice, the positioning of the monitor on the body presented difficulties. First, certain throws seemed to shock the monitor. Second the monitor appeared to obstruct the players' movement. There were instances when during Randori practice the heart rate monitor stopped or the belt became undone, causing the loss of a reading. In the next pilot study the receiver was strapped to the chest and held in place by wrapping a cotton cloth around the torso of the player. The receiver was placed on the top of the head where it was held in place by a piece of cloth or a rugby cap. In some cases the receiver was attached to the belt of the player. The cotton sash is normally used when a player has injured his lower back, giving it support, therefore it can be assumed that a player with such a cotton sash wrapped around his chest will experience some difficulty in movement. The ideal situation was to have the receiver in an area where it can not be grasped and is not a hinderence to the subject. The use of a skin tight costume such as those worn by tri-athletes or female swimmers seemed to be the most practical way in which to affix the receiver to the subject's body. Initially in order to protect the receiver from the shocks of certain throws, a towel was used. However, this still felt awkward, eventually the receiver was covered by a sponge which was cut in such a way as to fit the shape of the receiver. The receiver and sponge was then held in place by the tri-athlete suit.

As Judo players do not wear anything on their heads during practice, the wrapping of a cotton sash in a turban like manner in order to contain the receiver, can feel somewhat strange and awkward for the subject. Also, as many Judo throws involve the use of the belt, fixing the receiver to the belt can sometimes lead to it being knocked and thus influencing the heart rate readings.

In the final method that was used the transmitter was placed on the centre of subject's chest just below the pectoral muscle. The receiver was positioned in the

right/left (right handed player = right hand, left handed player = left hand) side of the chest band instead of the wrist and covered with a piece of sponge as shown in Figure 10.1.B.
One subject, former British Student Champion (height 175.5cm, weight 71kg) was used in two pilot trial tests. During the Randori session a successful record of the heart rate was taken.

2, Main study

*** Subjects used**

All subjects who had their blood lactate concentration measured were used to measure heart rate at the same Judo practice session. However, information on the heart rates of only eight of the ten subjects were obtained because of technical difficulties. The subjects were separated into 4 from the -65kg weight category, 3 from the -71kg category and 1 from the -78kg category. The mean age of these 8 subjects was 21.6 ± 3.02 years, with a mean height of 171.6 ± 3.09 cm and a mean weight of 71.6 ± 5.14 kg.

*** Measurement of Heart Rate**

Heart Rate was measured with a Polar Electro PE 3000 Sport Tester Monitor (Polar Electro OY, Kempele, Finland). Heart Rate reading was recorded every five seconds. The recorded heart rate data was downloaded to computer via a Sport Tester (Polar Electro OY) computer interface unit and analysed using custom made software supplied by the manufacturer. Figure 10.1 shows how the Heart Rate monitor was fixed on the Subjects.

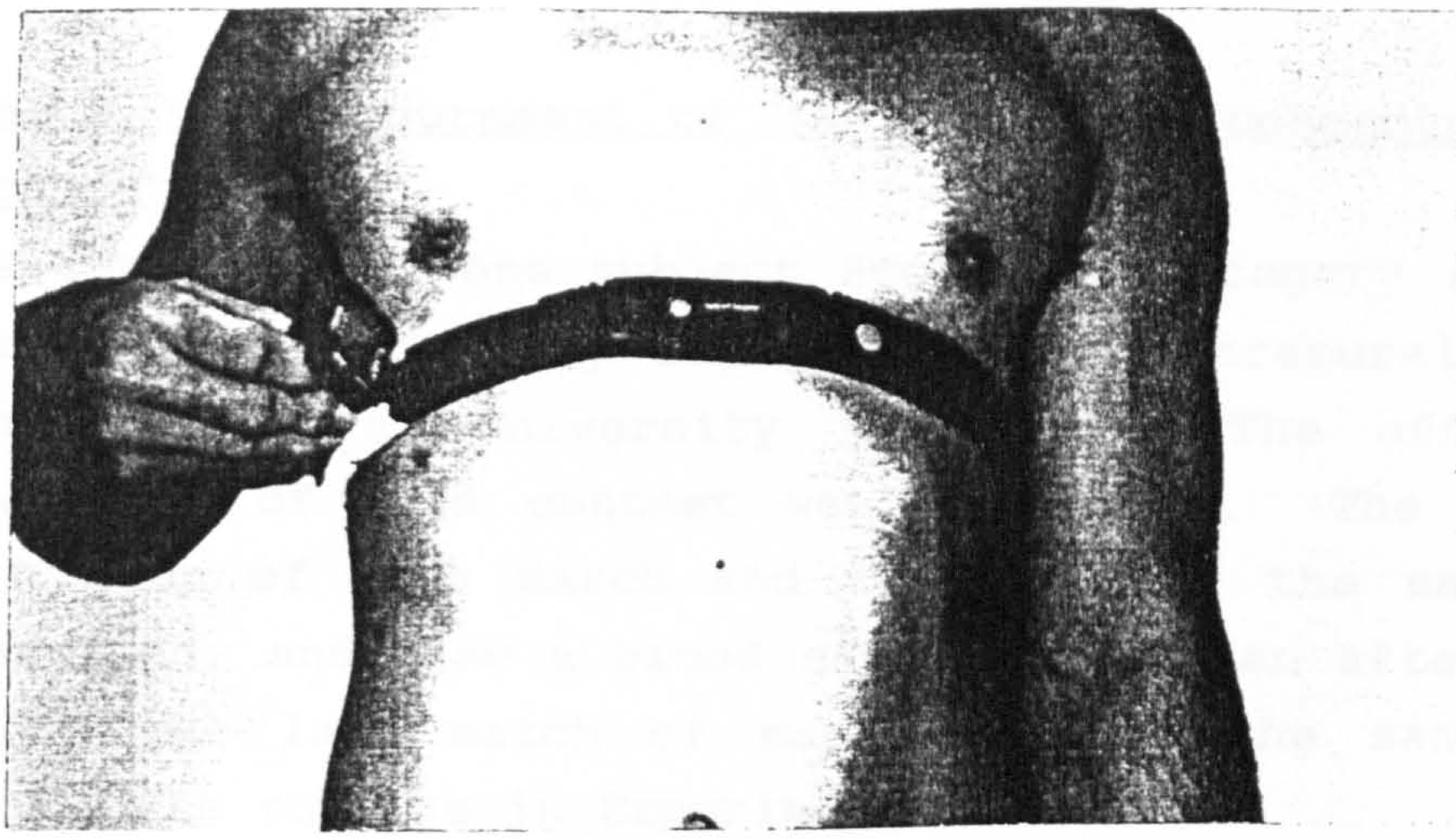


Figure 10.1.A Placement of the transmitter around the subject's chest and positioning of receiver on belt.

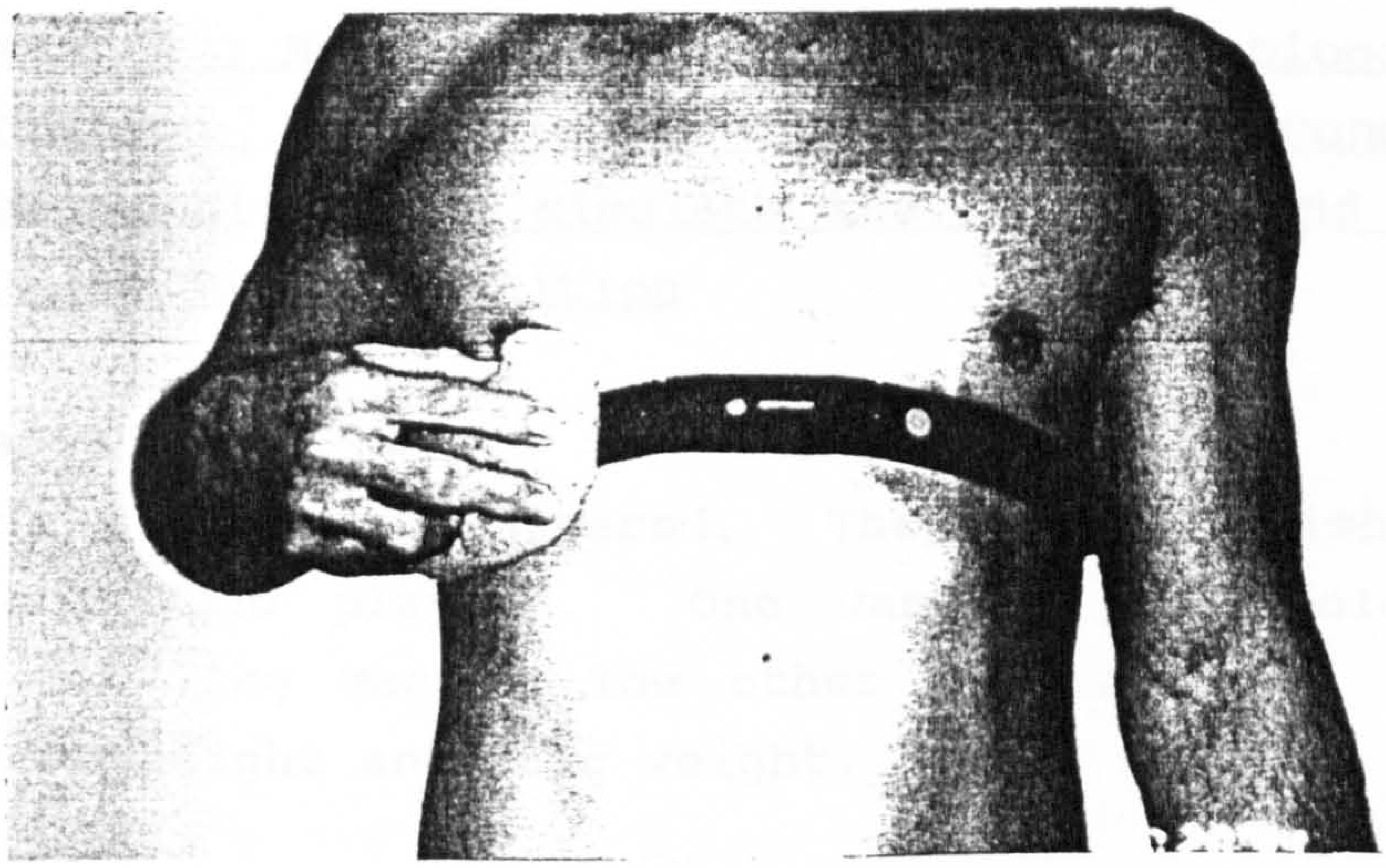


Figure 10.1.B The receiver, covered by sponge, attached to the belt.

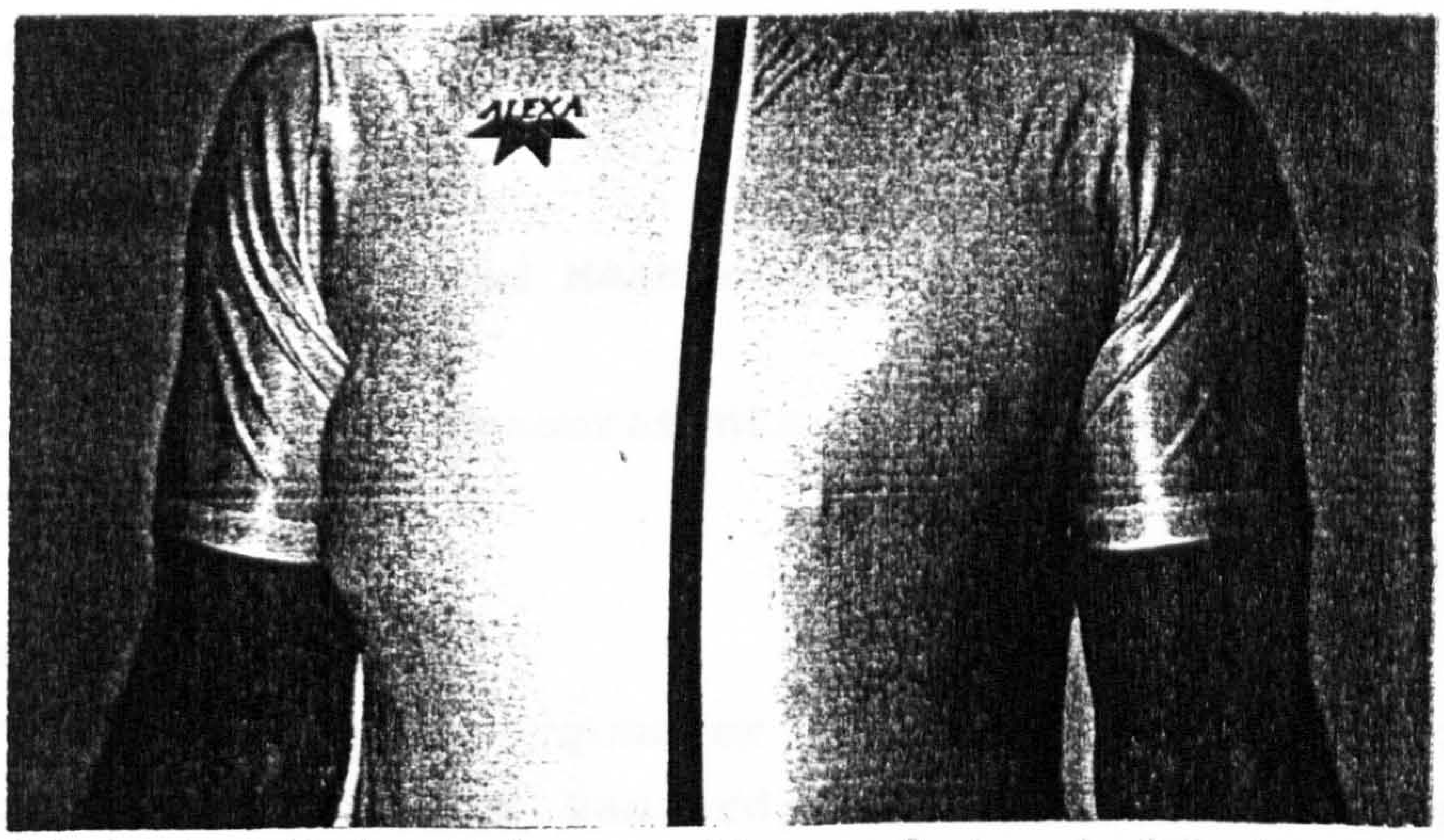


Figure 10.1.C Tri-athlon suit used to hold heart rate monitor in place.

Experiment 3 : Measurement of blood lactate concentration after competition

For the competition, one subject from each category (total 7 subjects) was chosen by lottery in the intramural Judo tournament of Tokai University in Japan. The official time duration of this contest was 5 minutes. The total time duration of each match and time between the matches were recorded, and also a blood sample was taken after the finish of the last match of each subject, the sampling method was the same as in Experiment 1.

Experiment 4 : Measurement of heart rate and blood lactate concentration during a rowing ergometer conditioning programme designed to simulate the activity and recovery time during Judo competition

*** Subjects used**

Two Judo players volunteered. They were British student top class Judo players. One was 29 years old, 176cm height and 71kg mass. The other subject was 27 years old, 178cm height and 88kg weight.

*** Sampling site**

The male subjects were informed that a blood sample would be taken after the rowing session from their right hand index finger.

*** Sampling procedure and Measurement of blood lactate concentration**

These procedures and measurements were the same as in Experiment 1.

*** Ergometer**

The Concept II rowing ergometer (Concept II, Morrisville, Vermont-Concept II, Old Basford, Nottingham) was used in this experiment. This ergometer has a microprocessor driven LCD display of stroke output in Watts per stroke, an average power output throughout the exercise and the stroke rate. The ergometer was calibrated according to the instructions of the manufacturer.

*** The exercise**

This exercise protocol was based on the results of Chapter 8. The average time of activity for the male finalists in the 1991 World championships and 1992 Olympic Games was 23 seconds. The average recovery time was 13 seconds. Therefore the exercise protocol that was chosen was 12 sets of 25 seconds high intensity activity with 15 seconds recovery. A warm-up power output of between 150 ~ 200 watts for 2 minutes was selected. Figure 10.2 shows this exercise protocol. The average power output during each 25 seconds period was recorded.

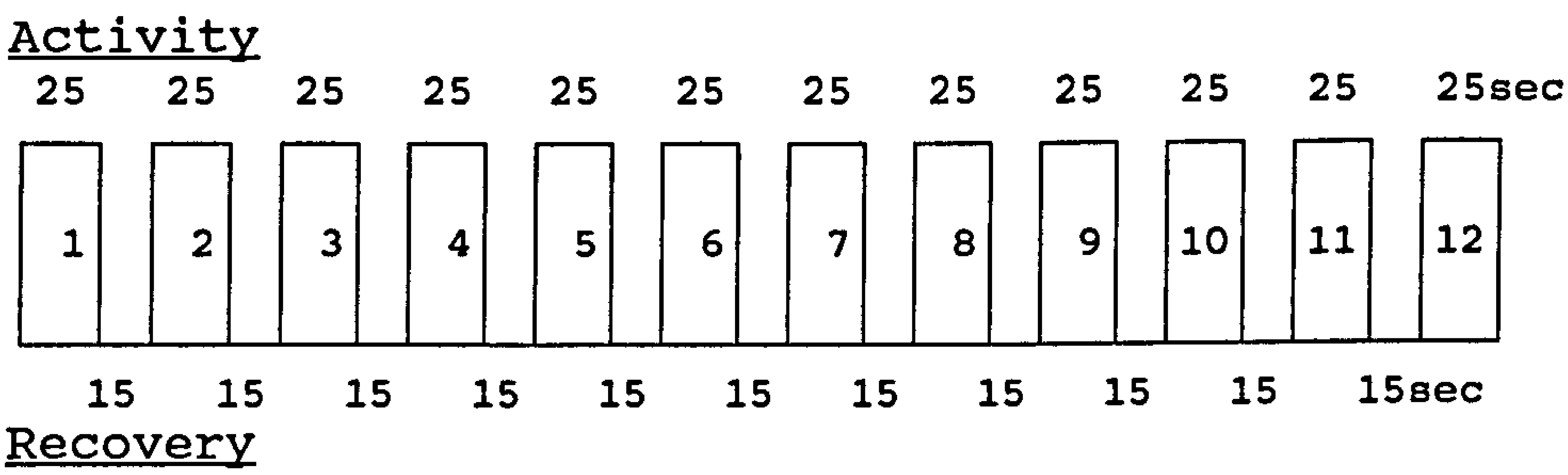


Figure 10.2 The test protocol of the rowing ergometer.

10.3 RESULTS

Experiment 1 : Measurement of blood lactate concentration during Judo practice

(a) Randori Practice

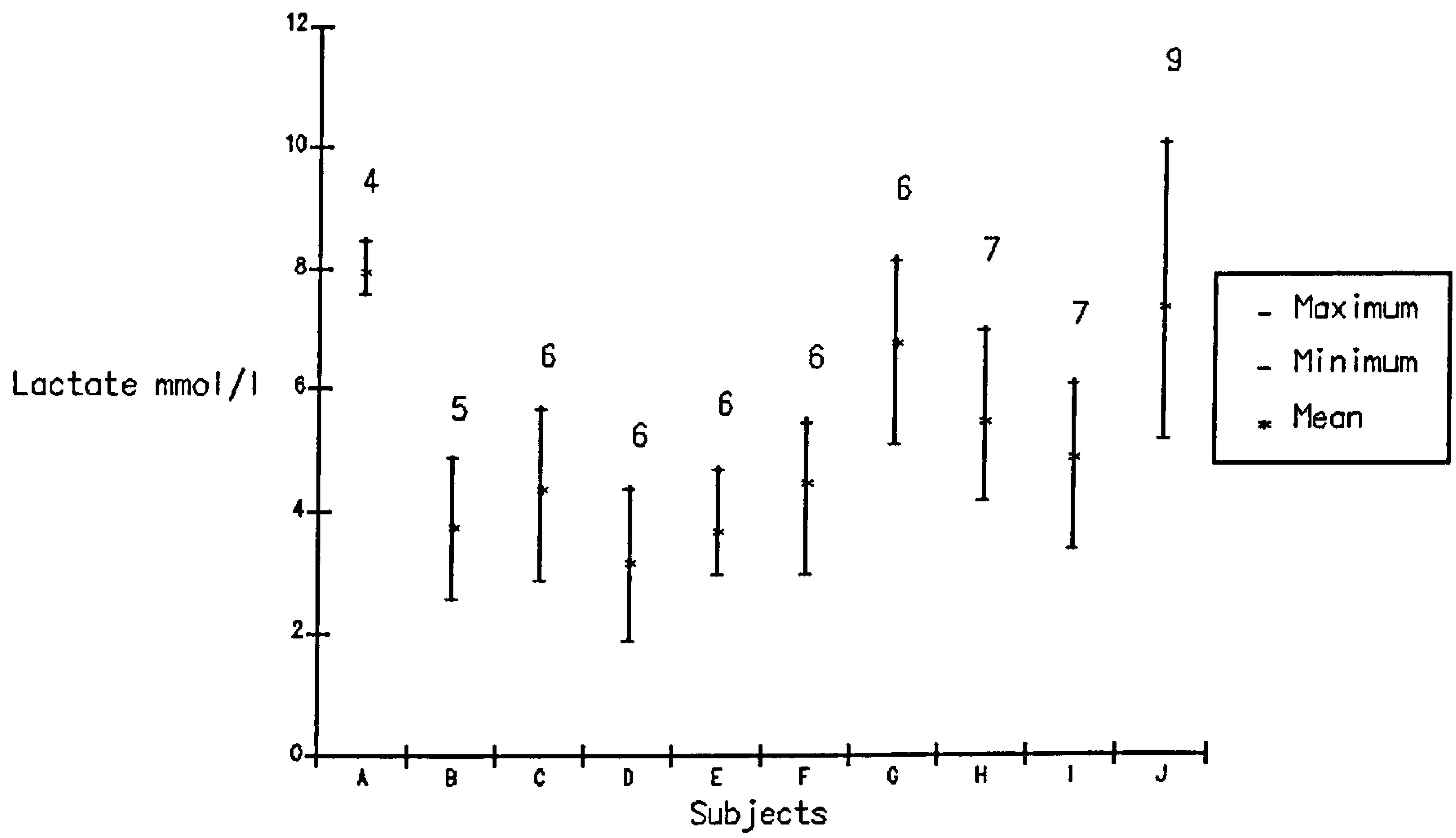


Figure 10.3 The blood lactate concentrations during Randori. The number of Randori practice sessions is shown at the head of each column.

The result of blood lactate concentrations measured during Randori is shown in Figure 10.3. The mean of the average blood lactate concentrations from all the practice sessions was 5.2 ± 1.66 mmol/l (range 3.2 ~ 8.0 mmol/l). For the maximum blood lactate concentration the mean value was 6.5 ± 1.89 mmol/l (range 4.4 ~ 10.1 mmol/l) and for the minimum blood lactate concentration the mean value was 3.9 ± 1.68 mmol/l (range 1.9 ~ 7.6 mmol/l).

(b) Groundwork Practice

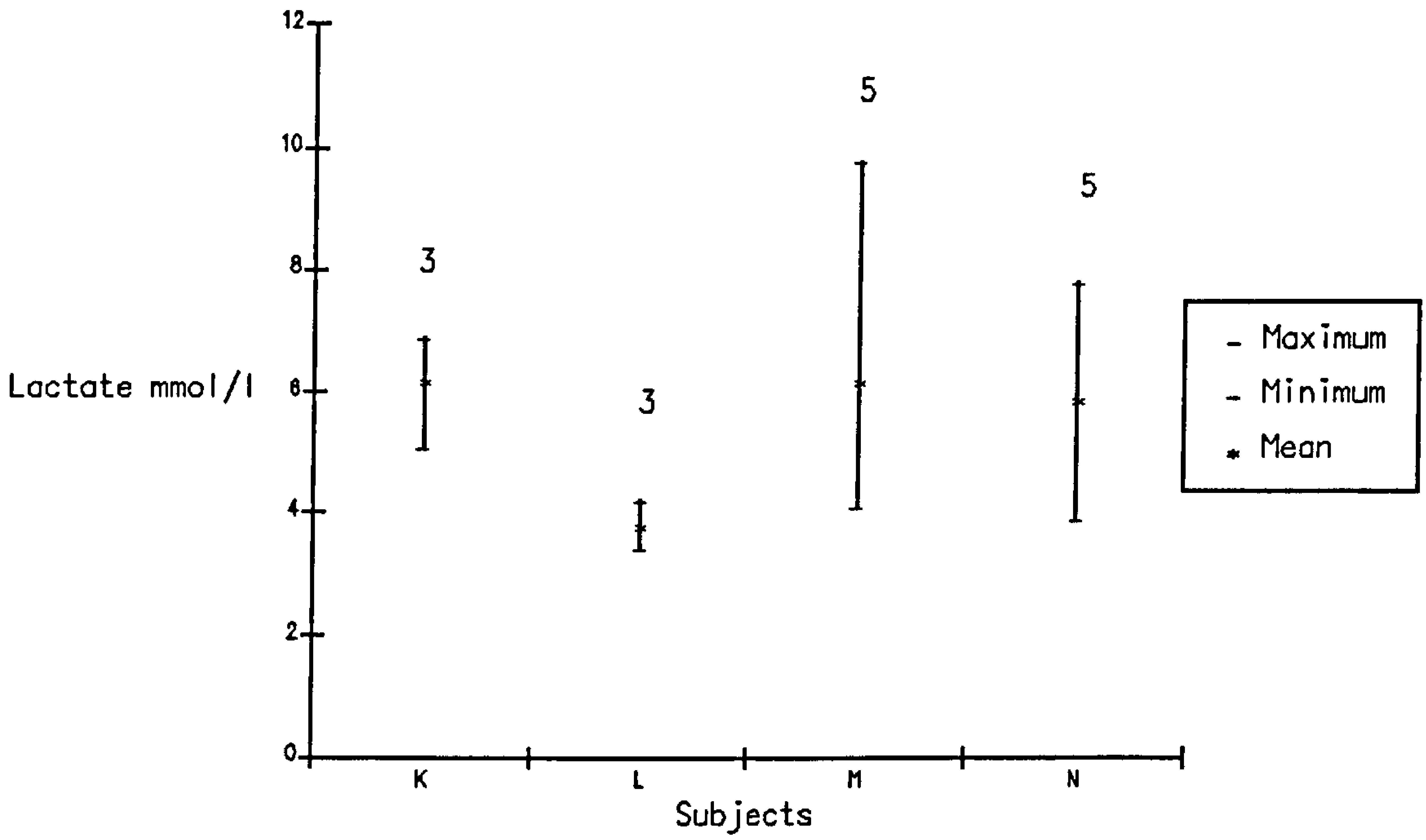


Figure 10.4 The blood lactate concentrations during Groundwork practice. The number of Randori practice sessions is shown at the head of each column.

Figure 10.4 shows the result of the blood lactate concentrations measured during groundwork practice. The mean value of the average blood lactate concentrations from all the practice sessions was 5.5 ± 1.2 mmol/l (range 3.8 ~ 6.2 mmol/l). For the maximum blood lactate concentrations the mean value was 7.2 ± 2.32 mmol/l (range 4.2 ~ 9.8 mmol/l) and for the minimum blood lactate concentration this mean value was 4.1 ± 0.71 mmol/l(range 3.4 ~ 5.1 mmol/l).

Experiment 2 : Measurement of heart rate during Randori practice

Table 10.1 The heart rate and blood lactate concentrations during Randori practice

Subject	Begin bpm (%) (%)	Recovery min	End bpm	Mean bpm	Max bpm	Time min	La mmol/l
A	103(53)		177	164	178	4:15	8.1
C	127(64)		147	130	153	6:00	4.6
	130 (98)	3:20	153	158	180	6:00	4.4
	113 (112)	6:00	188	166	188	6:00	4.9
	118 (108)	7:00	152	155	173	6:00	3.7
D	104(52)		163	160	179	6:00	3.8
	113 (92)	2:00	174	152	174	4:45	
	143 (72)	0:45	175	166	181	5:30	3.3
	114 (91)	1:45	172	162	180	4:45	
	163 (64)	0:45	187	175	188	5:00	4.4
	120 (87)	1:45	164	150	168	4:45	
	138 (75)	1:00	177	164	179	5:00	3.0
	124 (84)	3:15	133	157	173	6:00	
	133 (78)	0:45	150	150	161	3:15	2.6
	97 (107)	9:15	145	143	168	4:30	
	111 (94)	0:45	140	147	167	5:00	1.9
E	99(51)		159	147	164	6:00	3.6
	93 (106)	2:00	161	148	173	4:30	
	140 (71)	0:45	165	157	165	2:30	4.2
F	113(57)		142	156	179	4:00	4.7
	136 (83)	1:30	178	165	186	5:00	4.6
H	139(70)		172	158	172	5:00	6.3
	138 (101)	1:50	160	166	173	3:40	4.2
	145 (96)	1:30	171	171	179	3:50	7.0
	139 (100)	2:40	176	167	176	3:10	5.6
	121 (115)	5:10	175	158	175	5:00	6.2
	141 (99)	1:00	173	167	176	4:50	4.6
	136 (102)	2:10	157	159	167	3:20	4.4
I	119(60)		144	136	154	3:00	3.5
	105 (113)	5:30	148	147	157	4:10	3.4
	97 (123)	1:30	152	146	164	4:40	4.7
	111 (107)	1:50	159	153	165	3:20	5.3
	111 (107)	2:00	168	153	168	3:30	5.4
	116 (103)	2:00	160	160	168	3:40	6.1
	113 (105)	3:00	165	148	165	2:00	6.1
	160 (74)	1:40	165	165	173	4:00	5.3
J	110(55)		166	158	168	5:00	7.1
	145 (76)	1:20	174	167	174	3:10	6.0
	140 (79)	2:00	183	179	188	3:30	9.9
	149 (74)	1:40	184	176	184	3:50	10.1
	153 (72)	1:20	177	173	181	4:20	8.3
	130 (85)	5:50	165	158	168	5:10	5.2
	143 (77)	1:10	181	167	183	4:30	7.4
	148 (74)	1:00	172	162	173	4:10	6.3
	142 (77)	1:20	172	169	178	4:20	6.3
Mean	126.3(57.8) (91.4)	2:26	164.9	157.8	173	4:27	5.3
S.D	18.04(6.58) (15.51)	1:59	13.39	6.63	8.59	1:00	1.83

Table 10.1 shows the result of heart rate during Randori practice. All subjects had continuous Randori practice

with only a small amount of rest which occured when sampling blood or changing partners. Forty-five Randori practices were recorded from 8 Judo players. The average Randori practice time duration was 4:27 ± 1:00 min (range 2:30 ~ 6:00). The average heart rate at the beginning of the practice period was 126 ± 18 bpm (range 93 ~ 163 bpm). The number inside the bracket shown in bold on the first line was the percentage of maximum heart rate (based on 220 - age) at the beginning of Randori practice. This average percentage was 57.8 ± 6.58% (range 51 ~ 70%). The number inside the bracket in the second column of the begin column was the percentage of the recovery based on the heart rate at the beginning of Randori practice. A heart rate after recovery which was equal to the heart rate at the beginning of the practice would be a recovery of 100%. If the recovery heart rate dropped below the heart rate at the beginning of the practice a recovery of over 100% was recorded, whereas a recovery heart rate greater than that at the beginning of the practice gave a recovery of less than 100%. The average of recovery percentage was 91.4 ± 15.5% (range 64 ~ 127%). The average of recovery time was 2:26 ± 1:59 minute (range 0:45 ~ 9:15 minute). The average heart rate at the end of each Randori practice was 165 ± 13 bpm (range 133 ~ 188 bpm). The average of the mean heart rates calculated for each Randori practice was 158 ± 7 bpm (range 149 ~ 167 bpm). The average maximum heart rate of each Randori practice was 173 ± 9 bpm (range 153 ~ 188 bpm).
Figure 10.5 shows a typical heart rate recording during a practice session and the blood lactate concentration measured at the end of each Randori practice is shown above the heart rate curve. Figure 10.6 shows typical heart rate recording during a single Randori practice (R:Randori, U:Uchikomi, W:Warm-up, r:Rest).

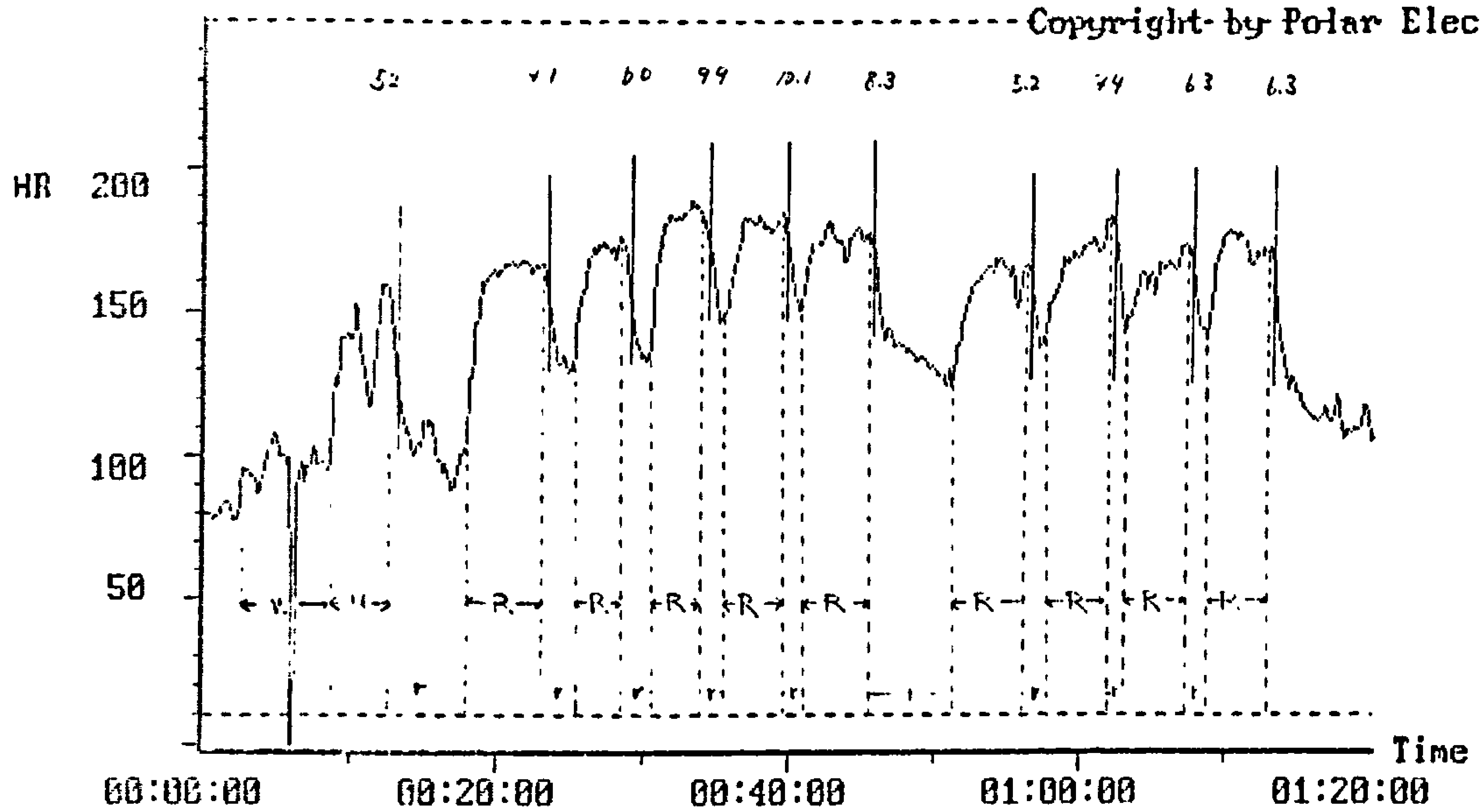


Figure 10.5 The typical heart rate recording during Judo practice session

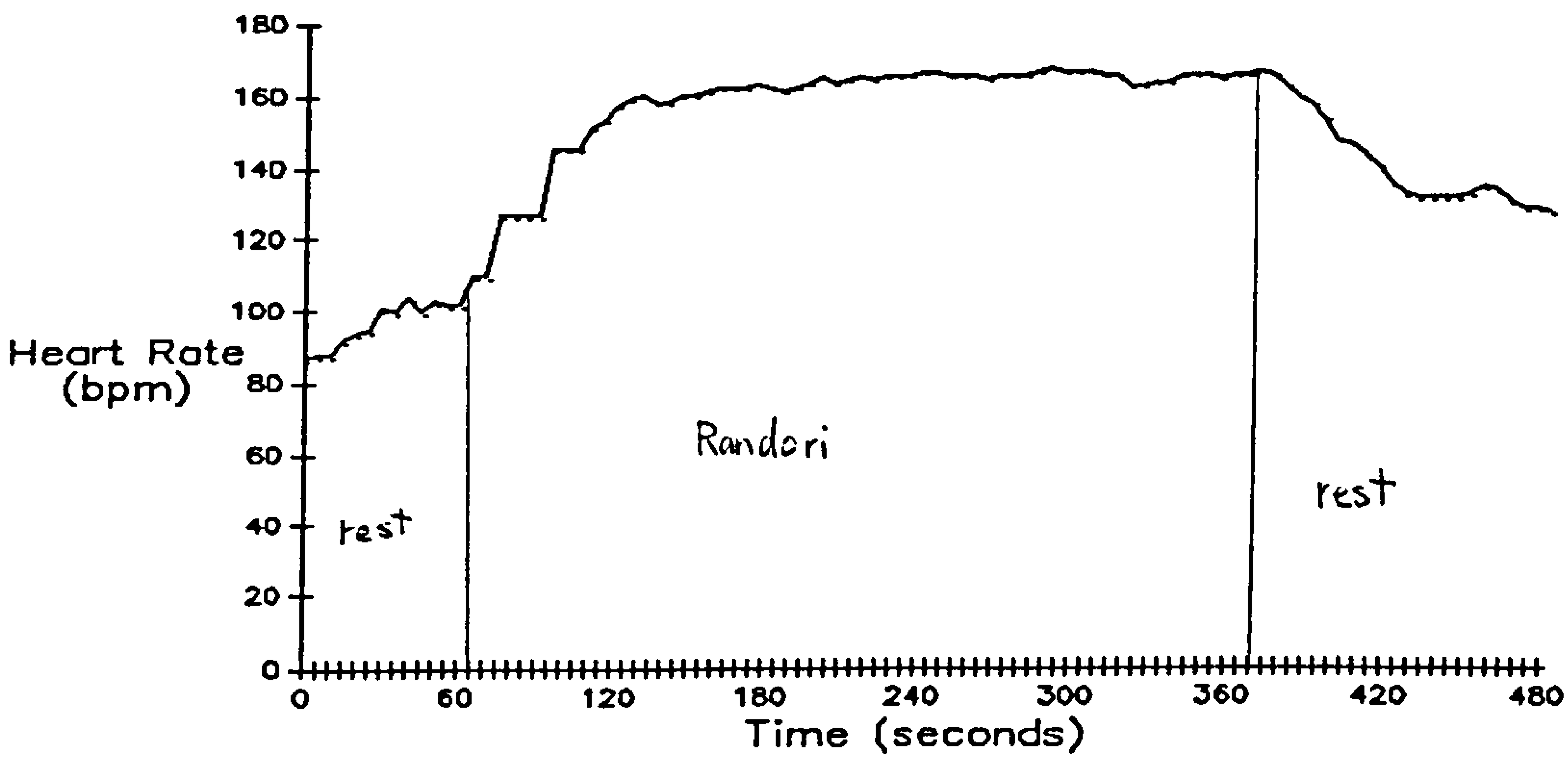


Figure 10.6 The typical heart rate recording during Judo a single Randori practice

Experiment 3 : Measurement of blood lactate concentration after competition

Table 10.2 The blood lactate concentrations after the competition.

Category	Round	Total Time	Interval Time	Lactate	Details
-60kg	1st 2nd 3rd 4th	6:13 10:15 6:50 1:15	 18:55 17:10 20:00	 3.1	win by Kinsa win by Yuko win by Kinsa win by Ippon
-65kg	1st 2nd	5:30 2:25	 23:35	 4.5	win by Kinsa win by Ippon
-71kg	1st 2nd	3:17 11:57	 49:17	 8.3	win by Ippon win by Yuko
-78kg	1st 2nd 3rd	7:53 6:22 5:55	 42:22 1:03:05	 6.6	win by Kinsa lost by Koka win by Kinsa
-86kg	1st 2nd 3rd	6:30 7:05 6:52	 21:25 26:29	 6.3	win by Yuko win by Kinsa win by WazaAri
-95kg	1st 2nd	7:15 6:48	 1:11:19	 6.2	win by Kinsa win by Koka
+95kg	1st 2nd	6:10 1:55	 1:13:00	 3.7	win by Chui win by Ippon

Table 10.2 shows the details of each contest and the blood lactate concentrations after the end of the tournament. The average blood lactate concentration was 5.5 ± 1.8 mmol/l (range 3.1 ~ 8.1). In the -60kg, -65kg and +95kg weight categories, the last match was not of full time duration, because it was decided by Ippon. The mean time duration of the competition for these Judo players was 1:48 ± 40.4 seconds, and the mean lactate value was 3.8 ± 0.7 mmol/l. In the -71kg, -78kg, -86kg and -95kg weight categories, the last match was of full time duration. The mean lactate values for these competitors was 6.9 ± 0.98 mmol/l (range 6.2 ~ 8.3 mmol/l). The mean time duration of these contests was 7:53 ± 2:45 minute. The average

time interval between each contest was 38:47 ± 22:00 minute (minimum 18:55, maximum 1:13:00).

There was a statistically significant correlation between lactate level and time duration of the last contest (r = 0.97, P > 0.05). Figure 10.7 shows the correlation between blood lactate concentration and time duration.

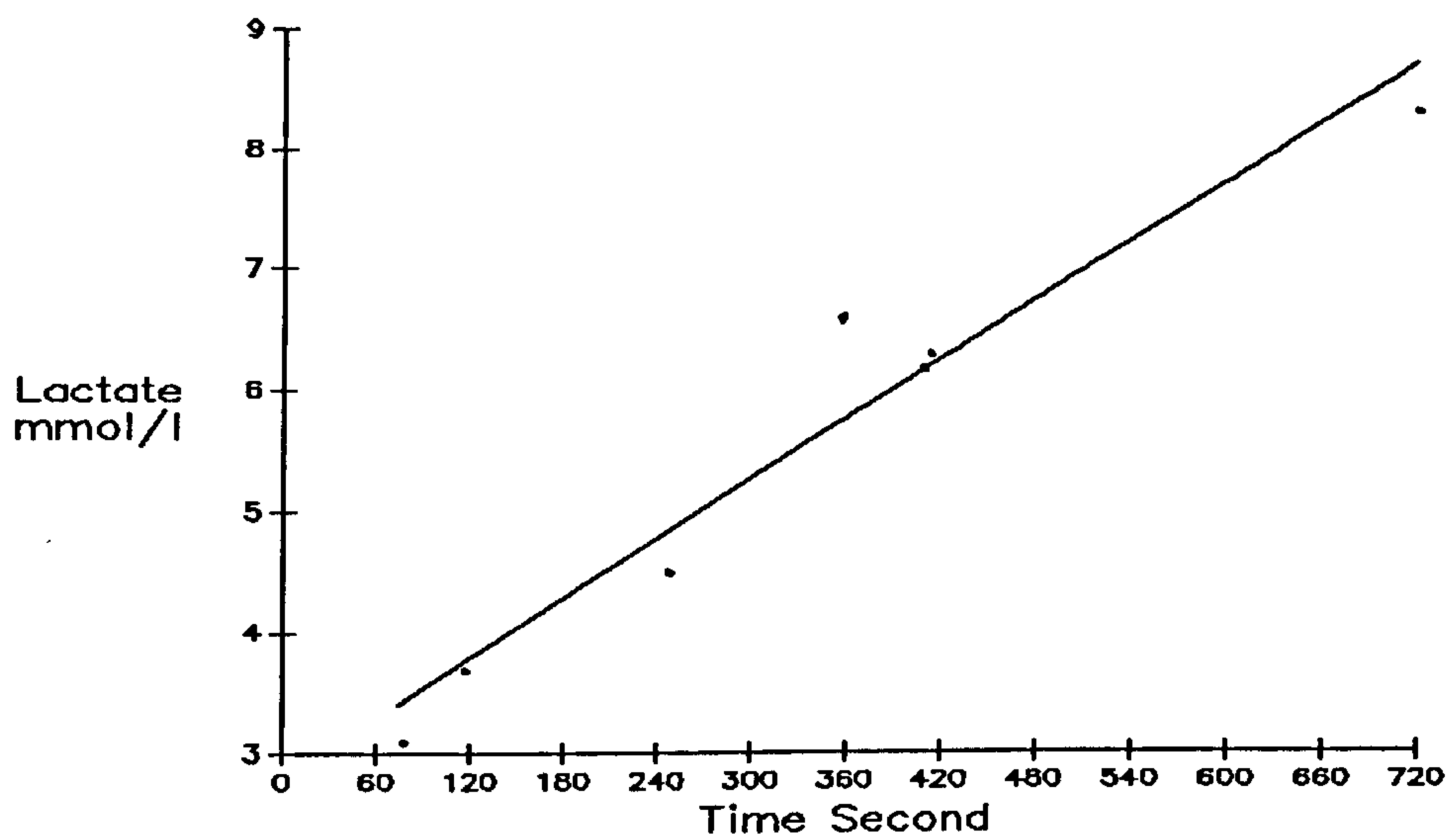


Figure 10.7 The correlation between blood lactate concentration and time duration of the last contest.

Experiment 4 : Measurement of heart rate and blood lactate concentration during a rowing ergometer conditioning programme designed to simulate the activity and recovery time during Judo competition

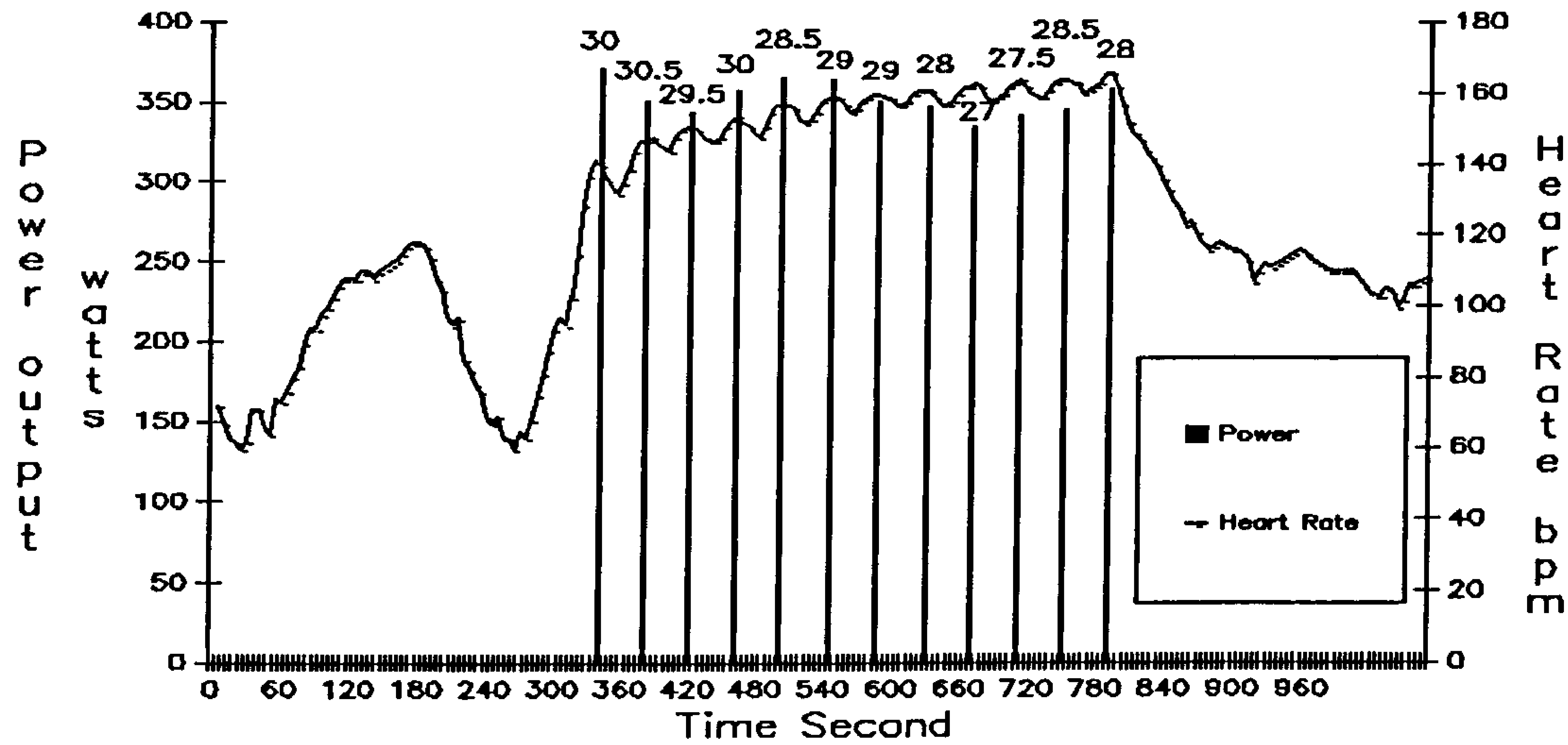


Figure 10.8 The heart rate curve and power output during rowing exercise in Subject A.
The number of strokes per minute is shown at the head of each column.

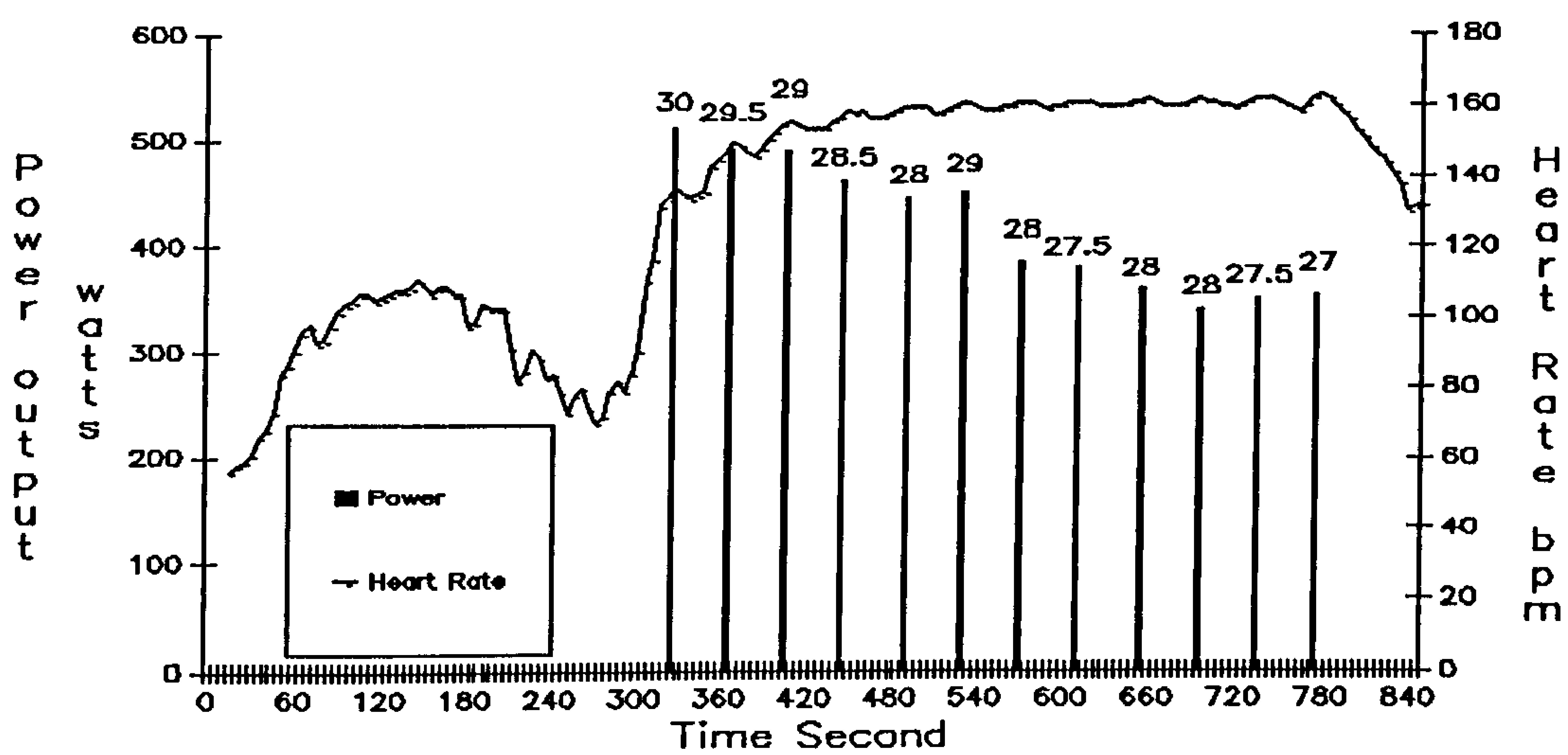


Figure 10.9 The heart rate curve and power output during rowing exercise in Subject B.
The number of strokes per minute is shown at the head of each column.

The result of heart rate and power output during the rowing exercise are shown Figure 10.8 and Figure 10.9. In Subject A, the average heart rate during exercise is 150 ± 17 bpm (maximum 166, minimum 60), the average power output is 352.7 ± 10.6 watts (maximum 371 watts at 1st set, minimum 335 watts at 9th set) and the average stroke rate is 28.8 ± 1.1 times per minute. In Subject B, the average heart rate during exercise is 152 ± 18.5 bpm (maximum 163, minimum 70), the average power output is 419.8 ± 63.5 watts (maximum 514 watts at 1st set, minimum 341.2 watts at 10th set) and the average stroke rate is 28.3 ± 0.9 times per minute.

The results of blood lactate concentration are 1.9 mmol/l for Subject A and 2.9 mmol/l for Subject B at rest, and 10.3 mmol/l for Subject A and 10.4 mmol/l for Subject B after the exercise.

10.4 DISCUSSION AND CONCLUSION

There are two factors associated with skeletal muscle that are important for Judo. They are instantaneous power and significant endurance. Although competition times are 5 minutes for men and 4 minutes for women, the actual fighting time may vary from a few seconds to as long as ten minutes, when one includes the recovery intervals after the call of Matte.

From experiment 1, the mean of the average blood lactate concentrations measured after each Randori practice session was 5.2 mmol/l (range 3.9 ~ 8.0 mmol/l). This value was lower than those reported in earlier studies(31)(33)(45). Even when the blood lactate concentration of the earlier studies were compared with the maximum blood lactate concentrations obtained during Randori practice, the values of earlier research are slightly higher than the average maximum value of 6.5 mmol/l (range 4.4 ~ 10.1 mmol/l) obtained after Randori practice. However, this earlier research reported the blood lactate concentration in competitors after the Judo contest(31)(33)(45). It has been said that one learns more in one contest fight than in a single day's practice, therefore it is possible that perhaps unconsciously, a greater amount of effort is used during a contest than during practice.

In groundwork practice, the mean blood lactate concentration was 5.5 mmol/l (range 3.8 ~ 6.2 mmol/l). Yamamoto (1991) suggested that the blood lactate concentration obtained after a contest which was decided by groundwork technique was higher than the blood lactate concentration after a contest which was decided by standing technique (Standing technique : 3.5 mmol/l, Groundwork technique : 5 mmol/l). However in this study, the blood lactate concentrations obtained during groundwork practice were similar to those blood lactate concentrations obtained during Randori practice. A probable explanation of the similarities in the blood lactate concentrations of both Randori practice and groundwork practice is that, during groundwork practice, a player who is holding his opponent may be able to relax more quickly when he realizes that his hold is secure. However, in a competition, if a player is holding down his opponent then in most cases he will use the complete 30 seconds in which to stop his opponent escaping. The sustained isometric contraction during this 30 seconds manoeuvre is likely to lead to a significant production of lactic acid from the active muscles.

Interestingly, the range of lactate values during Randori practice seems to be wider than the range obtained during groundwork practice. The lowest value is 1.9 mmol/l and the highest value is 10.1 mmol/l for Randori practice, and the lowest value is 3.4 mmol/l and the highest value is 9.8 mmol/l for groundwork practice. It is possible that this is, in part, due to the influence of the time duration of practice, but also perhaps more importantly it is the opponent and the intensity of the practice that will influence these results the most.

From experiment 2, it is very difficult to obtain heart rate during Judo practice. For a combat sport such as Judo the fixing of transmitter and monitor to the subjects during practice is very difficult as knocking and brushing between both players can cause interference and sometimes damage to the recording equipment. Also, the use of such equipment can lead to some awkwardness during practice, thus increasing the risk of injury. This can be seen as one of the main reasons why such research has yet to become common amongst such sports as Judo. It appears this that thesis is one of the few occasions in which heart rate measurements have been obtained throughout the Judo practice with blood lactate concentration being obtained concurrently.

The first Randori practice and the Randori practice which was just after a long recovery period seemed to have a lower heart rate curve compared with others. However, the data which showed the highest peaks varied depending on the individual subjects. Although the peaks showed a slightly higher difference after the first practice, the following peaks remained fairly constant. This means that it is possible to think that these subjects have superior recovery abilities. Moreover, it is necessary to study not only the subject, but also the opponent and his influence on the subject. The average of the mean heart rate was 158 bpm (range 130 ~ 179 bpm). This value is approximately 80% of the age related maximum heart rate. The average maximum heart rate was 173 bpm (range 153 ~ 188 bpm). This value is approximately 87% of the age related maximum heart rate. These results are much lower than those reported previously(40)(41). In this study, most of the subjects are national or world class Judo players. It is possible that the player of higher skill or ability has a lower intensity of exercise, as measured by heart rate, during Randori practice. Although the Randori practice was continuous for all subjects, there were significant intervals of recovery which on average was 2:26 minutes (range 0:45 ~ 9:15 minutes). It can be assumed that the recovery time will lead to a lower average heart rate during Randori practice than in competition. In fact, the average recovery percentage was 91.4% compared with the heart rate at the beginning of the first Randori practice. This means that, on average, each recovery period did return the heart rate to a level which was only slightly higher than that heart rate recorded at the start of the practice.

During the Randori practice, the maximum exercise intensity was on average about 87% of the maximum heart rate. No data exist for maximum heart rate during competition, but it may be assumed that the maximum exercise intensity is higher than that reached during practice, especially when there is very little difference in the player's ability and skill. The results indicate that it is important to be conscious of the level of exertion that is required in competition. As a consequence the ambitious competitor should be encouraged to extend him/herself during Judo practice. For example, for more intensity, training with a heavier opponent. For top class players finding a similar calibre of opponent to practice with every day can be difficult. Therefore supplementing their Judo practice with other forms of training is vital.

From experiment 3, the average blood lactate concentration after the competition was 5.5 mmol/l (range 3.1 ~ 8.1 mmol/l), but 3 out of 7 categories were decided by Ippon in the last match. The average blood lactate concentration of these categories was 3.8 mmol/l. The last matches in the other 4 categories went to full time duration. The average blood lactate concentration was approximately 7 mmol/l, which is much higher than the value of the shorter time duration matches. This result is very similar to the result of Yamamoto's (7.4 mmol/l) previous research[31]. In addition the same tendency can be suggested that there was a statistically significant correlation between lactate level and time duration. However, the value of blood lactate concentration was not as high as was suggested by Cavazani[45] and Terao[33]. There are two main reasons for this, one is that all subjects had between two and four matches in the competition used in this study. This means that there were less matches when compared with a big Judo tournament. Another reason is that the time period for recovery was long enough for the lactate concentration to return to base line values before the next match (average 38:47 minute). In this study, the blood sample was taken at the end of competition, this single measurement reflects only the last match in the competition. Therefore it is not really a true measurement of the overall intensity throughout the competition. Jacobs[46] has suggested that more than 20 minutes rest is necessary for total recovery to take place before another exercise bout is attempted.

When blood lactate values after the matches and the blood lactate values during Judo practice were compared, the average values were similar. However, the average blood lactate value after the matches that ran their full duration was higher than the lactate value taken during Judo practice. Statistical analysis could be attempted but the sample sizes are small and so the results could suffer from substantial sampling variation. Nevertheless there does seem to be a trend. Again it is suggested that the intensity of exercise during a match is higher than the intensity of exercise during practice. This conclusion should be viewed against the observation that the full time duration of the match seems in some cases to be longer than the practice time duration.

In experiment 4, the rowing involves the whole of the body, just like Judo, that is why this form of exercise was chosen. The heart rate and blood lactate concentration were measured during a rowing ergometer conditioning programme which was based on the typical Judo full time match. The average heart rate was about 150 bpm in both subjects with maximum heart rates of 163 and 166 bpm respectively. This value is just slightly lower than the heart rates values observed during Judo practice. This difference is likely to be associated with the different type of exercise. Judo involves a more isometric muscle contraction when compared with rowing. Rowing exercise uses a more rhythmic form of muscle recruitment, while with Judo, there is a more irregular pattern of muscle recruitment. For example, in Judo there is a time when the players are gripping each other in order to stop the opponent's movement and or waiting for an opening for a technique. Figure 10.10 shows the typical heart rate curve during exercise and during Randori practice.

The values of blood lactate concentration were 10.3 and 10.4 mmol/l after the rowing exercise. These values are higher than the blood lactate concentrations observed after the Judo practice and Judo matches which were measured in a previous experiment. However, former studies[33][45] have suggested that the blood lactate concentration is more than 10 mmol/l after the Judo competition. The subjects indicated that the fatigue they feel after the rowing experiment was similar to the fatigue that is felt after Judo matches. This suggests that the main energy pathway of the rowing is provided by anaerobic glycolysis. This energy pathway is also thought to be a significant component in the production of adenosine triphosphate (ATP) during Judo practice and competition.

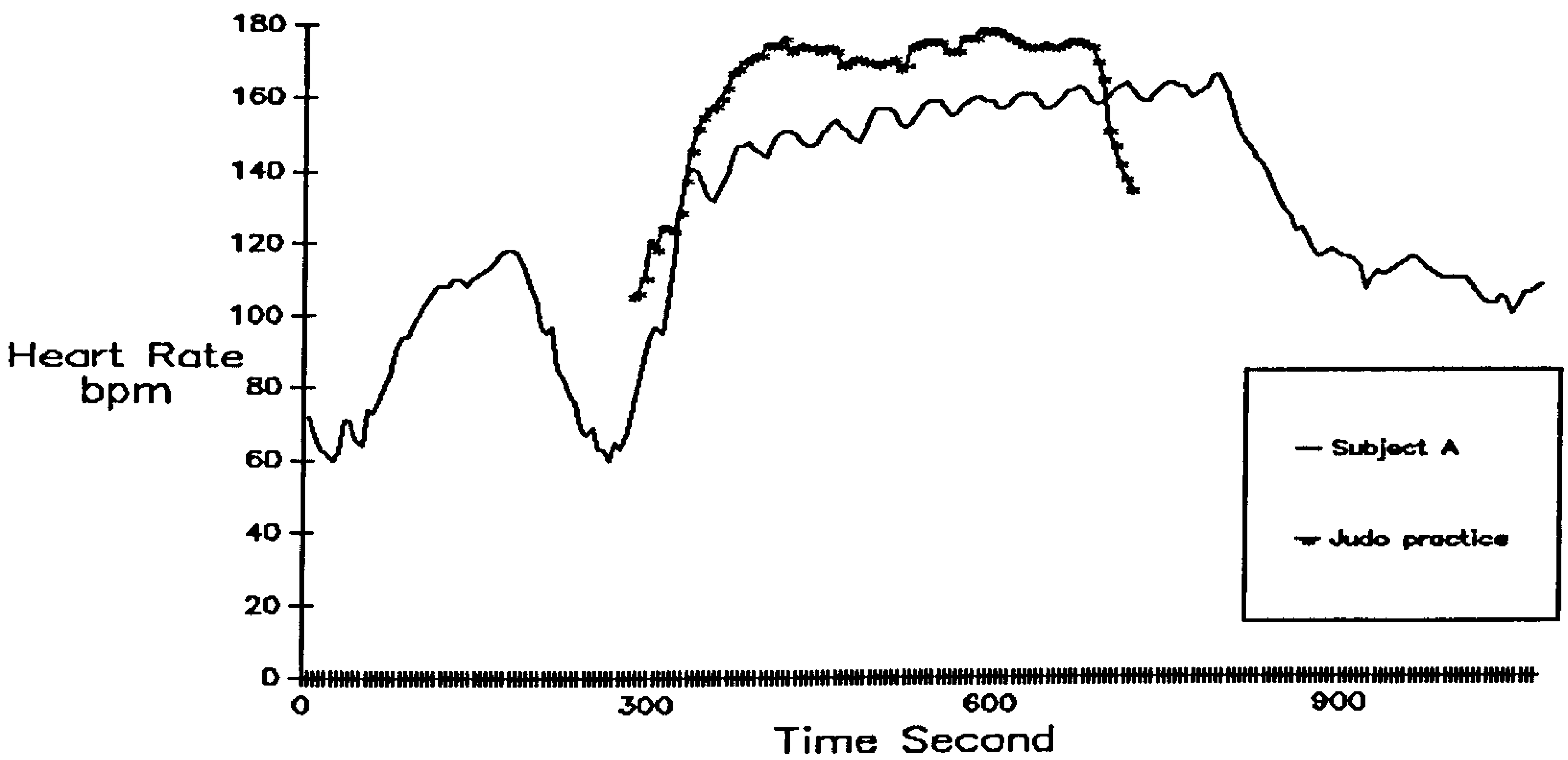


Figure 10.10 The typical heart rate curve during exercise and during Randori practice.

In conclusion, it is difficult for a Judo player to train for a Judo competition with just Judo training, because the exercise intensity of a Judo competition seems to be higher than Judo practice. This is especially true in the case of a Judo player whose skill and ability is high, and as a result finds it difficult to practice with players of equal calibre. In these circumstances, the player must adapt his practice in such a way as to simulate as closely as possible competitive Judo during practice. The work presented in this chapter suggests that top class Judo competitors could supplement their Judo practice with high intensity training such as the interval programme for the rowing ergometer that has been outlined in this thesis.

10.5 SUMMARY

* The mean of the average blood lactate concentrations was 5 mmol/l (range 3.9 ~ 8.0 mmol/l) after each Randori practice.
* The mean of the average maximum blood lactate concentrations was 6.5 mmol/l (range 4.4 ~ 10.1 mmol/l) after Randori practice.
* The blood lactate concentration was 5.5 mmol/l (range 3.8 ~ 6.2 mmol/l) after groundwork practice.
* It seemed that the opponent and the intensity of the practice influences the results the most.
* The average of the mean heart rate was 158 bpm (range 130 ~ 179 bpm) during Randori practice.
* The average maximum heart rate was 173 bpm (range 153 ~ 188 bpm) during Randori practice.

Judo competition

* The average blood lactate concentration after the competition was 5.5 mmol/l (range 3.1 ~ 8.1 mmol/l).
* The average blood lactate concentration of the categories which were decided by Ippon in the last match was 3.8 mmol/l (range 3.1 ~ 4.5 mmol/l).
* The average blood lactate concentration of the categories which were full time duration in the last match was 6.9 mmol/l (range 6.2 ~ 8.3 mmol/l).
* There was a statistically significant correlation between lactate level and time duration of the last match.
* It seemed that the intensity of exercise during a match was higher than the intensity of exercise during practice.
* The ambitious competitor should be encouraged to extend him/herself during Judo practice. For example, training with a heavier opponent might increase the required stimulus whilst supplementing their Judo practice with other forms of training will be useful such as rowing exercise.

Rowing exercise

* The average heart rate was about 150 bpm.
* The maximum heart rates of the two subjects were 163 and 166 bpm.
* At the end of the exercise the blood lactate concentrations were 10.3 and 10.4 mmol/l.
* The bulk of the energy required for rowing is provided by anaerobic glycolysis. This energy pathway is also thought to be a significant contributor in the production of adenosine triphosphate (ATP) during Judo practice and competition.

CHAPTER 11

SYNTHESIS OF THESIS AND RECOMMENDATIONS FOR FUTURE WORK

This thesis is an account of Judo based on the emergence of the sport from martial arts, the statistical analysis of competition at the very highest level, and physiological monitoring during practice and competition. It is intended that the integrated whole should be more than the sum of the individual parts.

The brief history of the sport in the early chapters was included to show the reader how Judo developed from the style of fighting employed by the knights (BUSHI) in Japan during the middle ages. In this sense, Judo is different to those sports that have evolved from recreational games. Also the Judo suit is not just a garment that identifies the allegiance of the competitor. It is an essential, but subtle, piece of equipment for the sport of Judo. These aspects, along with the evolution of the rules for competition, have ushered Judo into the 1990s.

To address factors associated with modern Judo the statistical and motion analysis of competitors participating in two major world class championships was performed. It was anticipated that the statistical analysis would reveal features such as differences in scoring patterns for medallists and non-medallists or between male and female competitors. Surprisingly, however, very little difference was observed in scoring patterns for a variety of partitioning strategies. However, there was marked difference in the scoring patterns produced from standing and groundwork techniques. The groundwork technique almost always produced Ippon, whereas the standing technique allowed for the subjective judgement of the referees to influence the scoring pattern. The most successful techniques in these competitions were the standing techniques of Uchi-Mata and Seoi-Nage. Hence these standing techniques were analysed by using video recordings of the finals at each weight category in the two championships. From the analyses appropriate strength and power conditioning programs could be constructed.

The video recordings revealed another interesting fact. The average activity to recovery ratio in competition was about 2:1, with the activity, often of an intense nature spanning a time of approximately 25 seconds. This pattern was repeated for 5 minutes and 4 minutes respectively during male and female competitions.

Armed with this information a natural progression of investigation for the thesis led an assessment of the to physiological demands of Judo during competition. Heart rate was used as a comparative cardiorespiratory index, while blood lactate concentration gave a metabolic index of exercise intensity.

These parameters were used pragmatically rather than trying to understand the fundamental physiology and biochemistry that led to the results. It appeared that Judo practice (RANDORI) was not as intensive as the actual Judo competition. For this reason a whole body conditioning programme, based on the observed activity to recovery ratio which occurred in competition, was constructed for a rowing ergometer. This pilot study of the acute response to the exercise programme reported in this thesis appeared to produce an effective physiological and biochemical response, pushing the athlete beyond those levels seen in RANDORI, and similar to those observed during competition.

Future work should be centred on developing both the strength and endurance conditioning programmes and subjecting two matched groups of Judo players of equal status to a controlled trial over a well defined training period. In this way any immediate gains in strength, power and endurance from the suggested programme could be assessed.

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