COMPARISON OF THE PHYSIOLOGICAL, PSYCHOLOGICAL & GENETIC TRAITS BETWEEN SPRINTERS & NON-ATHLETES

By

KATRINA WONG SUEN NEE

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LIST OF ABBREVIATIONS

VO_2Max	-	Maximal Oxygen Comsumption
bp	-	base pairs
°C	-	degree Celcius
PCR	-	Polymerase Chain Reaction
RFLP	-	Restriction Fragment Length Polymorphism
EDTA	-	Ethylenediaminetetraacetic acid
dH_2O	-	distilled water
ATP-PC	-	Adenosine Triphosphate Phosphocreatine
ATP-LA	-	Adenosine Triphosphate Lactic Acid
Df	-	Degree of freedom
p	-	probability
SD	-	Standard deviation

LIST OF PUBLICATIONS

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ABSTRACT

Comparison of the Physiological, Psychological and Genetic Traits Between Sprinters and Non-Athletes

Studies showed that genes are vital in explaining the differences in athletic performance as it is accountable to approximately 50% of the variability in physical performance while current findings in the relationship between genetics and sports seemed to be encouraging. ACTN3 genotypes may be vital in determining an athlete's potential in power sports. The aim of this study is to identify the similarities and differences between the physiological, psychological and genetic perspective of sprinters and non-athletes.

This is a cross-sectional research design. Nineteen participants were recruited and were randomized into two groups; sprint (n=10) and non-athletes (n=9). Each participant underwent 3 sessions of testing and evaluations for a duration of 3 weeks, with approximately one-week of wash-out period in between. Tests completed by the participants are the mental toughness (MT18) questionnaire, recovery-stress questionnaire for athletes, isokinetic dynamometer strength test, Wingate anaerobic test, body composition profiling, genotyping (using blood sample collection) and VO_2 max test. The participants' performance scores were recorded in each session.

Results showed no significant differences in body fat percentages (t = 1.886; df=17; p = 0.077) between sprinters and non-athletes. The results for the Wingate Anaerobic Test showed significant differences of mean power (t=4.811, df=17, p=0.001) and mean peak power (t=4.054, df= 11.515, p=0.002) between the two groups. However, there was no significant differences in comparing the mean fatigue index between the sprinters and the non-athletes (t=1.700, df= 17, p=0.107).

The mean flexibility of the non-athletes and sprinters are 27.3(6.46) and 38.8(7.80) respectively with results showing a positive significance in flexibility between the two groups (t=3.450, df= 17, p=0.003). A significance in the difference was also obtained between all the measures of the isokinetic strength test with an exception of the 60°/s Extension Average Power(W) (t=3.565, df= 17, p=0.002) and 60°/s Extension Average Power(W) test (t=1.957, df= 17, p=0.067). A significant result is also obtained in measuring the difference in the participant's maximal oxygen consumption (VO_2 Max) between the non-athletes and sprinters (t=2.970, df= 17, p=0.009).

The mental toughness between sprinters and non-athletes showed positive significance (p=0.023) whereas in the participants' stress-recovery state, the results showed no significance in all the subscales measured with an exception of sleep quality (t=2.204, df=17, p=0.042), disturbed breaks (t=2.147, df=17, p=0.046), and self-regulation (t=2.159, df=15.186, p=0.023) subscales.

In conclusion, there is a significant difference in the characteristics among physiological, psychological and genetic difference between the sprinters and non-athletes.

ABSTRAK

Perbandingan ciri-ciri fisiologi, psikologi dan genetik antara pelari pecut dan Bukan Atlet

Kajian menunjukkan bahawa gen memainkan peranan yang penting dalam mencari perbezaan dalam prestasi sukan kerana ia adalah bertanggungjawab untuk kira-kira 50% daripada perubahan dalam prestasi fizikal, manakala penemuan semasa dalam hubungan antara genetik dan sukan seolah-olah menggalakkan. Genotip ACTN3 mungkin memainkan peranan penting dalam menentukan potensi seseorang atlet dalam sukan kuasa. Tujuan kajian ini adalah untuk mengenal pasti persamaan dan perbezaan antara perspektif fisiologi, psikologi dan genetik pelari pecut dan bukan atlet.

Kajian ini merupakan suatu reka bentuk penyelidikan keratan rentas. Sembilan belas peserta telah diambil dan secara rambang kepada dua kumpulan; pelari pecut (n = 10) dan bukan atlet (n = 9). Setiap peserta telah menjalani 3 sesi ujian dan ujian penilaian selama 3 minggu, dengan kira-kira satu minggu tempoh berehat di antaranya. Ujian-ujian akan dilakukan oleh para peserta adalah seperti ketahanan mental (MT18) soal selidik, soal selidik pemulihan tekanan untuk atlet, isokinetik ujian kekuatan dinamometer, Wingate ujian anaerobik, profil komposisi badan, genotyping (menggunakan sampel koleksi darah) dan ujian VO2 max. Skor Para peserta telah direkodkan dalam setiap sesi.

Keputusan menunjukkan tiada perbezaan yang signifikan dalam peratusan lemak badan (t=1.886; df=17; p=0.077) antara pelari pecut dan bukan atlet. Keputusan bagi Wingate anaerobik Ujian menunjukkan perbezaan yang signifikan purata kuasa (t=4.811, df=17, p=0.001) dan purata kuasa puncak (t=4.054, df=11.515, p=0.002) di antara kedua-dua kumpulan. Walau bagaimanapun, tidak ada perbezaan yang signifikan dalam membandingkan indeks keletihan purata antara pelari pecut dan bukan atlet (t=1.700, df = 17, p=0.107). Purata fleksibiliti bukan atlet dan pelari pecut adalah 27.3 (6.46) dan 38.8 (7.80), masing-masing dengan keputusan yang menunjukkan makna yang positif dalam fleksibiliti antara kedua-dua kumpulan (t=3.450, df=17, p=0.003). Signifikan dalam perbezaan itu juga didapati antara semua langkah-langkah ujian kekuatan isokinetik dengan pengecualian daripada 60°/s Lanjutan Purata Kuasa (W) (t=3.565, df=17, p=0.002) dan 60 °/s Lanjutan Purata Kuasa (W) ujian (t=1.957, df = 17, p=0.067). Satu keputusan yang ketara juga diperolehi dalam mengukur perbezaan dalam penggunaan oksigen maksimum peserta (VO_2 Max) antara bukan atlet dan pelari pecut (t=2.970, df = 17, p=0.009).

Ketahanan mental antara pelari pecut dan bukan atlet menunjukkan kepentingan positif (p=0.023) manakala dalam tekanan pemulihan negara peserta, keputusan tidak menunjukkan sebarang kepentingan dalam semua sub skala diukur dengan pengecualian kualiti tidur (t=2.204, df=17, p=0.042), terganggu rehat (t=2.147, df=17, p=0.046), dan peraturan-diri (t=2.159, df=15.186, p=0.023) sub skala. Kesimpulannya, terdapat perbezaan yang signifikan di antara ciri-ciri fisiologi, psikologi dan genetik perbezaan antara pelari pecut dan bukan atlet.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Top athletes sprint the 100m events regularly in less than 10 seconds where generally, the race finishes with only one breath. In a 100m sprint, the anaerobic system contributes to 80% of the energy requirement with the remaining 20% contributed by the aerobic energy system. Henceforth, ATP-PCr system powers a sprinter for most of the race where all the energy production is derived from the anaerobic process without the presence of oxygen.

Physiologically, sprinting is to a large extent, depending on the coordination of both nerves and muscles and the ability of the central nervous system to overcome two forces, resistance and gravity. Generally, sprinting was frequently assumed to be of a rather simple skill, whereas in reality, it is a difficult task of efficiently blending various applied forces through the human system.

This application of forces yields maximum performance only when the particular strengths of the sprinter are properly balanced to coordinate the actions of the entire body. Physiologically, coordination, speed, strength, power, flexibility, and reaction time are 6 crucial attributes in sprinting. The ability to balance these attributes would determine the enhancement in sprint performances. Thus, it is not only vital to have high qualities in these attributes, but also the ability in balancing them harmoniously in achieving high performances.

It was suggested by Jones and colleagues that mental toughness is "having the natural or developed psychological edge that enables you to generally cope better than your opponents with the many demands (e.g., competition, training and lifestyle) that sport places on a performer and specifically be more consistent and better than your opponents in remaining determined, focused, confident and in control under pressure." (Jones, Hanton, & Connaughton, 2002)

In order to obtain high performances in sports, stressful high intensity training periods are necessary but numerous studies also clearly showed that systematic recovery periods in training processes are vital (Kellmann & W. Kallus, 1999). Generally, sprinters are constantly exposed to the psychologically stressing demands whereby such stressful environments would seem to be a norm among the athletes. Therefore, these athletes were assumed to have higher mental toughness and stress coping abilities. It is also suggested that a possible relationship between the recovery-stress state and performance in competition that should be further investigated on.

Genetics is the study of natural intrinsic causes of variation in living organisms (Mulvihill et. al, 2011). Recently, studies on the impact of genetic toward sports performance has been increasing as current findings on the relationship between genetics and sports seemed to be encouraging (Lippi, Longo, & Mafulli, 2010). The general hypothesis states that there is an inheritance component affecting physical and athletic fitness that is able to interact with environmental factors, particularly with training thus being necessary to understand the roles played by genes (Calo & Vona, 2008).

Calo and Vona (2008) mentioned that genes are vital in explaining the differences in athletic performance as it is accountable to approximately 50% of the variability in physical performance and training responses. Genetic testing in sport would enhance the identification of individuals with optimal physiology and morphology, greater capacity to respond or adapt to training and those with a lesser risk of injuries. Therefore, in this study, the relationship of ACTN3 gene polymorphisms and its effects in sprinting was investigated.

ACTN3 gene is being frequently investigated to sport performance, where this gene functions to encode α-actinin-3 which plays a vital role in the production of powerful contractions and are vital in binding and anchoring actin filaments (North & Beggs, 1996). A nonsense polymorphism within the ACTN3 gene results in substitution of an arginine (R) residue with a premature stop codon (X) present at amino-acid 577 (Eynon, et al., 2012).

1.2 RESEARCH OUTLINE

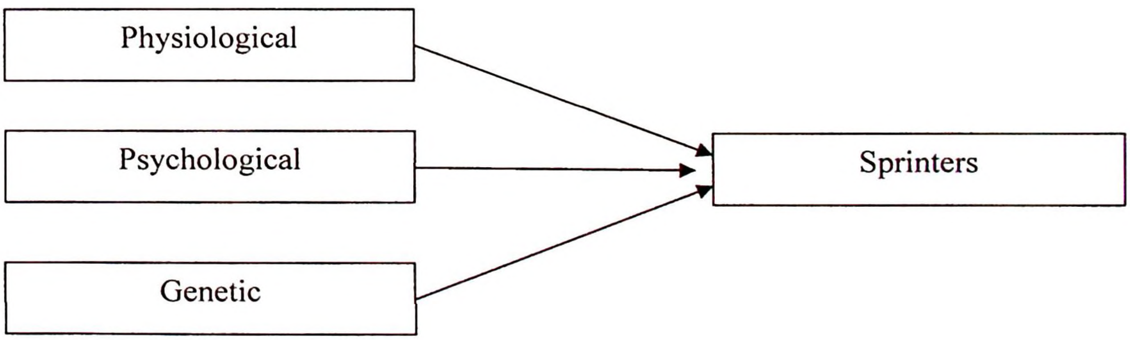

Figure 1.2 : Conceptual Framework

1.3 GENERAL OBJECTIVES

To examine the differences in characteristics between sprinters and non-athletes on physiological, psychological, and genetic trait factors.

1.3.1 SPECIFIC OBJECTIVES

1. To examine the differences in characteristics between sprinters and non-athletes on physiological factors
2. To examine the differences in characteristics between sprinters and non-athletes on psychological factors
3. To examine the differences in characteristics between sprinters and non-athletes on genetic trait factors

1.4 RATIONALE OF THE STUDY

Malaysia has yet to include genetic testing in the process of talent identification in sports among the young athletes. This study could potentially enhance the process of talent identification among the younger generations through genetic analysis, physiological measures, and psychological profiling. Assistance in determining and narrowing of the choices of sporting events during the specialization phase of an individual's sporting career is possible through this study.

The availability of genetic testing in sport would enable individuals to identify their optimal physiology, morphology and also the capacity to respond or to adapt to the training with a reduced risk of potential injuries (Lippi, Longo, & Mafulli, 2010). It is therefore important to understand the influence of genetics, is the main objective of this research that serves to understand the influence of genetics, physiological and psychological characteristics of sprinters.

Involvement in a particular sporting event begins with a decision to participate. This decision is habitually made with the consideration of an individual's potential in that sporting event hence any information that may contribute in providing a clearer probability in predicting one's potential is vital.

It is a common for young individuals to experience a phase of "trial and error" in multiple sports before focusing on one sport, with only a few succeeding in that search whereas the larger majority fails and eventually gives up. Talent identification at a younger age according to their natural genetic advantage, could provide the country with a means to a higher possibility that the continuation of outstanding elite athletes in the future is ensured.

1.5 HYPOTHESIS

HO1 : There is no significant physiological difference between sprinters and non-athletes

HA1 : There is a significant physiological difference between sprinters and non-athletes

HO2 : There is no significant psychological difference between sprinters and non-athletes

HA2 : There is a significant psychological difference between sprinters and non-athletes

HO3 : There is no significant genetic traits difference between sprinters and non-athletes

HA3 : There is a significant genetic traits difference between sprinters and non-athletes

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Running time are a function of reaction time, acceleration potential, maximum running velocity and the ability to maintain velocity as fatigue progresses are key determinants of sprint times (Ross, Leveritt, & Rick, 2001). Previous studies concluded that there are many factors contributing to an athlete's success in sprints, including physiological, morphological, and anatomical aspects (Beachle, 1994; Crowder, McKenna, & Plummer, 1992; Dintiman, Tellez, & Ward, 1997; Jarver, 1995).

2.2 GENERAL CHARACTERISTICS OF SPRINTERS

Sprint start and sprint running performance have been reported to be directly related to both force generation and anthropometric characteristics by Hoffman (1971) and Mero (1988). Body composition is associated with the amounts of various constituents in the body such as fat, muscle, bone, etc. (Watts, Coleman, & Nevill, 2012). Athletes who have attained the optimal physique are more likely to succeed than those who lack the general characteristics (Carter, 1984).

Body composition among athlete was widely used to prescribe desirable body weights in optimizing competitive performance, and in assessing the effects of training (Sinning, 1996). Since the 1960s, the interest in body composition has intensified where both the coaches and athletes recognizes that a certain physique is necessary in succeeding in a range of sports but also a certain ratio of muscle mass to fat mass (Ackland, Elliott, & Bloomfield, 2009).

Furthermore, body composition positively contributes to an individual's level of physical fitness for performance, especially in sports requiring one's body weight to be carried over a distance (Saha, 2012). An understanding of the physical demands of the sprint race is essential to prepare the athletes to excel and to identify the physiological and anthropometric characteristics that may lead to an advantage in performance (Watts, Coleman, & Nevill, 2012).

Due to the fact that additional body fat increases the body weight without contributing to its force production or energy producing capabilities, generally, a lower relative body fat is desirable for a successful competition performance in most sports (Midday, 2013). Besides that, it was discovered that athletes with lower body fat percentage had higher maximum oxygen uptake (VO_2 Max) (Heck, 1980) thus athletes with lower body fat percentage appeared to utilize oxygen most efficiently while excess body fat was reported to be detrimental to physical performance (Leelarthaepin, Chesworth, & Boleyn, 1983).

A study conducted by Abraham (2010) concludes that in comparison to other sport disciplines, track and field athletes have lower body fat percentage. In this study, it was also concluded that the lowest value of body fat percentages are present among sprinters which are reflected in the lower values of skin fold measurement in comparison to throwers.

2.3 PHYSIOLOGICAL CHARACTERISTICS OF SPRINTERS

The physiological systems of the body interact with each other to complete a variety of tasks. Both the aerobic and anaerobic capacities are vital in the performance in various games and sport (Gusain, 2013). The predominant use of one specific energy system in relation to distance specialization has been established among runners (Wilt, 1968). Events lasting 10 to 15seconds among sprinters has been estimated to have 98% of anaerobic contribution of the total energy expenditure (Fox & Mathews, 1974).

Aerobic capacity, as described by Gusain (2013) is the ability to mobilize energy for continuous performance of a specific movement for a prolonged period of time whereas anaerobic performance displays the ability to use the phosphogenic system and anaerobic capacity. Anaerobic performance is dependent on various factors (e.g., body composition, age, sex, muscle fiber composition, muscle cross-sectional area, strength and training) (Kin-Isler, Ariburun, A., Tandogan, & Ozkan, 2008).

Wingate tests performances have been shown to be highly reliant on energy release from both anaerobic and aerobic processes (Bar'Or, et al., 1978; Kavanagh & Jacobs, 1988; Medbo & Tabata, 1989). A study completed by Granier, Mercier, Mercier, Anselme & Prefaut (1995) states that during the Wingate test, the energy supplied depended on the competition specialty where indeed the energy supply of sprinters was predominantly provided by the anaerobic metabolism.

2.4 MUSCULAR STRENGTH

Muscle strength is a highly important factor in sprint running (Decluse, Van Leemputte, Wilems, Diels, Andries & Van Capponelle, 1994). According to Sale (1991) strength can be defined as the force or peak torque developed during a maximum voluntary contraction. "Torque" on the other hand as defined by Perrin (1993), is the force measured about a joint's axis of rotation while "peak torque" is the point in the range of motion tested at which the greatest torque is produced.

Several studies conducted in the past investigated mostly on the relationship between the strength of knee flexion, extension and sprint running (M.J.L, 1989; Cronin & Hansen, 2005; Bračič, Hadžič, Čoh, & Dervičevič, 2011). However, studies investigating the relationship between Isokinetic strength and sprint running time where sprint running time is registered in a competition is lacking (Misjuk, Rannama, & Edgar, 2013).

Various methods are available in measuring lower limb strength in both clinical and manual settings. In comparison to the easily accessible methods of manual testing, isokinetic testing offers the benefits of objective measurement though a controversy is present about which methods are the most clinically significant testing speed (Keasay, Bullock, & Keasys, 2000). However the use of isokinetic testing as a mean of measuring the dynamic muscle strength has increased significantly with the results of isokinetic measurements shown to be highly consistent (AL-Angari & AL-Hazzaa, 2004).

Isokinetic dynamometer is a contemporary isokinetic dynamometer with an electrically controlled servo-mechanism used in both clinical and research settings (Drouin, Valovich, Shultz, Gansneder, & Perrin, 2004). A constant velocity is engaged with accommodating resistance throughout a range of motion (ROM). An electric or hydraulic servo-controlled mechanism at a user-defined constant velocity is responsible in the resistance of isokinetic dynamometers. Thus objective measures of human muscle function on variables associated to torque, power and endurance can be acquired (Drouin, Valovich, Shultz, Gansneder, & Perrin, 2004).

It was proven by (Mann & Sprague, 1983) that both eccentric and concentric muscle actions of the knee extensors are vital in sprinting. (M.J.L, 1989) supported the theory when his study on elite sprinters showed significant correlation between 100m sprint times and peak torque of the concentrically contracting knee extensions and the plantar flexors acting eccentrically. Besides that, (M.J.L, 1989) also reported strong correlation between sprint performance, 100m personal best sprint time and concentric knee extension torque in elite sprinters

Eccentric muscle actions are vital during heel-strike as the vertical ground reaction forces in excess of three times the body mass are exerted meanwhile the concentric muscle actions are important in generating positive vertical forces later in the ground contact phase (Misjuk, Rannama, & Edgar, 2013). They further concluded that strength is a major contribution to sprint performance with the strength of the knee extensors at large velocities appeared to have the most influential role.

2.5 MENTAL TOUGHNESS

Mental toughness was defined as "an individual's propensity to manage the demands of environmental stressors, ranging from an absolute resilience to extreme vulnerability" (Fletcher, 2005). Mental toughness is also referred as the mental skills factor which are most frequently used as a significant contributor to sports performance enhancement (Gould, Dieffenbach, & Moffett, 2002)

Mental toughness is also regarded as the ability to handle pressure (Sargent & Shen, 1998) thus athletes who have consistent capability in handling pressure are often called "mentally tough" athletes (McKenzie et al., 2000; Hale & Collins, 2002). Besides that, a mentally tough athlete has the ability to perform to the full potential in a highly competitive situation, the ability to handle their emotional life effectively, and able to bring all the talent and skills to life consistently (Dyer, 2005; Lefkowits & McDuff, 2000; Landin & Herbert, 1997) which are positive attributes to achieve peak performances more consistently.

A qualitative study was conducted on mental toughness which identified twelve components of mental toughness comprising of motivation level, coping skills, confidence maintenance, cognitive skills, discipline and goal directedness, competitiveness, possession of prerequisite physical and mental requirements, team unity, preparation skills, psychological hardiness and ethics (Fourie & Potgieter, 2001).

2.6 RECOVERY-STRESS STATE

All athletes experience anxious thoughts which frequently occur in response to stress throughout one's career. Increased level of stress in competitions may lead to both physical and mental reactions in a manner that may hinder sport performance. Athletes may experience psychological disorders, such as stress, worry, anxiety as well as motivation and concentration disorders (Besiktas, 2015). Anxiety is one of the emotional states experienced by athletes before or during athletic competitions may hinder an athlete's performance (Besiktas,2015: Kar, 2008).

Physical arousal may be helpful at a certain level but when the body is in a tensed state, the coordinated movement required by athletic events becomes increasingly difficult. In the same context, a certain amount of worry may be helpful in performance as a positive stress but severe cognitive symptoms of anxiety can lead to a negative self-fulfilling prophecy (Kar, 2008).

Major sources of pre-competition anxiety includes fear of failure, thinking too much on people's opinion regarding performance, and lack of confidence (Douglas, Louis, Alison, & Edward, 2006). Douglas et al, (2006) also concludes that pre-competitive anxiety is dependent on skill level, experience and general level of arousal in daily activities.

Pre-competition anxiety was found to exert a powerful influence on an athlete's performance where the cognitive interpretation of an individual exerts an effect on performance (Krane, 1994). Besides that, athletes who are involved in individual sports are found to experience higher anxiety rates than those in team sports (Kar, 2008).

Recovery-stress state is defined as the extent to which an athlete is physically or mentally stressed, as well as whether an individual is capable of using individual strategies for recovery in which strategies are used (Kellman & Kallus, 2001). Kellman & Kallus (2001) hypothesized that the recovery-stress state may influence the results of competitions in sprinters. Unfortunately, not much investigation has been done regarding the recovery-stress state and its relationship to sport performance which requires speed and power, where psychological factors are relevant (Kalda, Jurimae, & Jurimae, 2004).

A close relationship has been reported between the recovery-stress state and performance in competition for the general stress-related and recovery-related areas, as well as for most single scales (Kellman & Kallus, 2001). Kellman & Kallus (2001) also found that as the competition results were negatively correlated with self-assessed fatigue, lower fatigue state were associated with better performances while emotional exhaustion scale was also negatively correlated with IAAF (International Association of Athletics Federations).

Recovery-Stress Questionnaire for Athletes (RESTQ-Sport) enables the systematic measurement of the recovery and stress of athletes (Kellman & Kallus, 2001; Kellmann & Kallus, 1999). RESTQ-Sport has been reported to be able to recognize changes in training volume and overreaching in sport participants (Kellman, Altenburg, Lormes, & Steinacker, 2001).

2.7 GENETICS IN SPRINTING

There is a high expectancy on the relationship between genetics and sports based on the current scientific evidence presented (Lippi, et. al., 2010). Physical exercise is a complex phenotype influenced by several environmental and genetic factors (McArthur & North, 2005). In accordance to that, investigation towards complex traits such as physical performance, using molecular biology techniques has been made possible (Calo & Vona, 2008).

In the past decade, numerous papers have been published showing evidence of variations in single genes may influence performance (Rankinen, et al., 2006). However, a single genetic polymorphism cannot be responsible for sport performances but it may modulate physical capacity (Dionne, et al., 1991). Previous studies hypothesized generally that ACTN3 genotypes may be vital in determining an athlete's potential in a sprint/power or an endurance sport (Calo & Vona, 2008) whereby genotypes have previously shown significant difference between sprinters and long distance runners.

The α-actinin encompasses a family of actin-binding proteins related to dystrophin which are vital in the binding and anchoring of actin filaments (North & Beggs, 1996; Mills, et al., 2001; Yang, et al., 2003). There are 2 genes which encode skeletal muscle α-actinin were discovered thus far in humans: the ACTN2 and ACTN3 proteins which localize at the Z disk, whilst ACTN1 and ACTN4 are not found in muscles. Interestingly, ACTN2 gene is found to be expressed in all fibers whereas ACTN3 is restricted to only fast myofibers (North & Beggs, 1996).

Various studies found 577R allele and the 577*RR genotype of the ACTN3 to be associated with power-oriented top-level athletic performance in a broad variety of ethnic groups

(Druzhevskaya, II, IV, & VA, 2008; Lucia, et al., 2007; Yang, et al., 2003). Some studies also suggests that carriers of the 577*XX genotype may possibly have an advantage in endurance-type activities (Niemi & Majamaa, 2005; Yang, et al., 2003).

A study conducted by (Yang, et al., 2003) suggests that the presence of α-actinin-3 has a beneficial effect on the skeletal muscle function in generating forceful contractions at high velocity thus providing an evolutionary advantage due to the increased sprint performance. Therefore, they also suggested that ACTN3 genotype may be one of the factors influencing normal variation in muscle function and, possibly, human performance.

A study conducted by (Calo & Vona, 2008) on Italian National male artistic gymnasts shows a positive relation between ACTN3*RR genotype and the development of muscular mass.ACTN3*XX genotype, on the other hand, is more significant in endurance athletes compared to power athletes (Eynon, et al., 2012). However, (Lucia, et al., 2006) concluded that ACTNE*XX genotype does not favor sprint performance and there is no significant difference found between endurance athletes and novices.

It was discovered that a genotype effect on female sprint athletes with higher than expected numbers of 577RX heterozygotes among sprint athletes. The lack of a similar effect in males proposes that ACTN3 genotype may affect athletic performances differently in males and females where the androgen hormone response to training is possible in a significant contribution to improvements in performance, so that the relative effect of α-actinin-3 on muscle power may be reduced. Besides that, all male Olympian power athletes were found to have at least one copy of the functional R allele of ACTN3 which suggests that "every variable counts" at the highest sports competition level (Yang, et al., 2003).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The study seeks to identify the physiological, psychological and genetic differences between sprinters and non-athletes. In addition, the researcher aimed to understand the relationship between the physiological, psychological, and genetic traits of the two groups.

3.2 STUDY DESIGN

This study employed a cross-sectional design study to identify and differentiate the physiological, psychological and genetic profiles of sprinters and non–athletes and to understand the relationship of these attributes concerning the respective groups.

3.3 RESEARCH LOCATION

This study is conducted in the Physiology Laboratory, Sports Science Unit, School of Medical Sciences, and Sports Science Laboratory, School of Health Sciences, Universiti Sains Malaysia.

3.4 PARTICIPANTS

This study recruited a total of N=19 male and female participants, which were assigned into 2 distinctive groups of sprinter (n=10) and non-athlete (n=9). Inclusion criteria for the sprinters are that they are current state/national level track and field athletes within the age of 15 to 23, with at least two years of competitive state level experience, and are currently injury-free. Inclusion criteria for the non-athletic sample are healthy, injury-free, not regularly engaged in sporting activities and have no previous record of participation in sprint events in the past two years.

3.5 SAMPLE SIZE CALCULATION

The sample size was calculated using G Power 3.1 software with the power of the study for objectives 1 and 2 were set at 80% confident interval, 5% significance level and 65% effect of size (Cohen, 1988). The calculated sample size was 9 participants in each group. Hence, a total of 18 participants were required. For objective 3, 80% confident interval, 5% of significance level was used to achieve a large effect size of 65% (Cohen, 1988). The calculated sample size was 8 participants in each group. Hence, a total of 18 participants were required. With a 10% of dropout rate, an addition of 1 participant was required. Thus, the final sample size calculated for this study is 20 participants. However, due to one participant dropped out from the study due to other commitments, the final sample size is 19 participants.

3.6 RESEARCH INSTRUMENTS

The instruments used in this study were polar heart rate monitor, treadmill, sit and reach box, weighing machine, Biodex™, bicycle Ergometer, and calipers. Each instrument will be briefly introduced in the subsection below.

3.6.1 Polar Heart Rate Monitor

The polar transmitter RS100 was used throughout the Submax and VO_2max test test to monitor the participant's heart rate. The electrode strap was made wet under running water. The connector was then attached to the strap with the strap adjusted to fit tightly but comfortably on the participant. The strap was tied around the chest, just below the chest muscles. The wet electrode area was checked to be firmly against the skin of the participant with the Polar logo of the connector was in a central and upright position.

Figure 3.1: Polar Heart Rate Monitor

3.6.2 Treadmill

The submax and VO_2max test, which involved running, was done on a Motorized treadmill. The acquired speed and gradient can be adjusted on the instrument. The running treadmill is also fixed with a monitor to record the time for exercise (min), running distance (km), heart rate (bpm) and running speed (km/h).

Figure 3.2: Motorized treadmill

3.6.3 Borg's Rate of Perceived Exertion (RPE)

Perceived exertion was measured using the Borg's RPE scale (Borg, 1982), which requires participants to rate on a 6-20 point category scale. The scale ranged from 6 (no exertion) to 20 (maximal exertion). The rating of perceived exertion was assessed every minute.

Borg Rating of Perceived Exertion

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 3.3: Borg's Rate of Perceived Exertion (RPE)

3.6.4 K4b2Gas Analyzer

Operating on battery power and is portable, t he K4b2 gas analyzer weighs approximately 1.5kg with the ability to transmit test data in real time to a PC base station, and storing the data in a memory stick as well. Oxygen uptake, the expired air, and the energy expenditure are measured, allows measurements of Oxygen production (VO_2), Carbon Dioxide production (VCO_2) and respiratory exchange ratio (R).

Figure 3.4 : K4b2 Gas Analyzer

3.6.5 Biodex™ System 3

Strength assessment can be done using the isokinetic dynamometer Biodex™ machine, which provides computerized-controlled resistance. The modes available are concentric, eccentric and isometric according to the variable resistance set. Popular isokinetic velocities are $60°\cdot s^{-1}$, $90°\cdot s^{-1}$, and $180°\cdot s^{-1}$; often referred to as slow, medium and fast speeds respectively.

Figure 3.5: Biodex™

3.6.6 LODE Bicycle Ergometer and ergometer workload programmer

Peak anaerobic power, mean anaerobic power, total work and fatigue index can be determined with the Wingate Anaerobic Test using a bicycle Ergometer. The resistance load can be adjusted to a pre-determined level and the Lode Ergometer can be programmed to last for approximately 0-45 seconds.

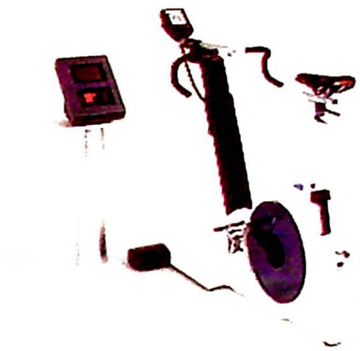

Figure 3.6: LODE Bicycle Ergometer

3.6.7 Harpenden Skinfold Calipers

The caliper (model: Harpenden) applies a standard pinch pressure and provides an easily read measure of the width (mm) of the pinch. Scales are within the range of 0.2mm and 1.0mm.

Figure 3.7: Harpenden Skinfold Caliper

3.6.8 Lufkin Executive Thinline Measuring Tape

Precise site of various skinfolds are located by using a tape measure (model- Lufkin executive thinline measuring tape). A body marker is also used to mark the site of the skinfold on the subject measured.

Figure 3.8: Lufkin Executive Thinline Measuring Tape

3.6.9 Sit and Reach Box

Sit and reach box are used to measure the back and leg flexibility of a participant. The measurements are read in centimeters and inches.

Figure 3.9: Sit and Reach Box

3.6.10 Stadiometer (SECA)

The stadiometer has a hinged lever on the wall-mounted stadiometer (model- SECA), separated from the weighing scale. The height and weight of a participant can be measured using this equipment. The scales used are in centimeters (cm) and kilograms (kg).

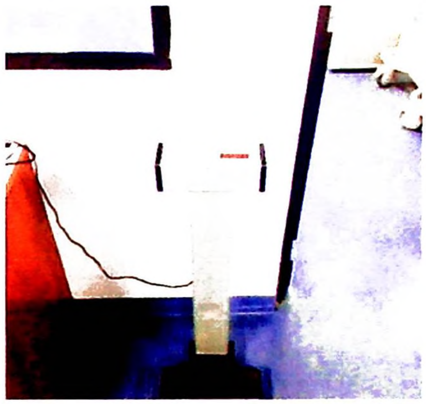

Figure 3.10: SECA stadiometer

3.6.11 Mental Toughness Questionnaire (MT18)

The MT18 questionnaire contains 18 items on the 4 sub-scales measuring different elements of performance related characteristics (Challenge, Control, Commitment and Confidence) (Clough, Earle, & Sewell, 2002). The responses valued from 1 (strongly disagree) to 5 (strongly agree). Construct validity has also been established from the longer version of MT48, which relates to a number of other constructs, including optimism ($r=0.48$, $p<0.01$), self-image ($r=0.42$, $p<0.05$), life satisfaction ($r=0.56$, $p<0.01$), self-efficacy ($r=0.68$, $p<0.01$) and stability ($r=0.57$, $p<0.01$) (Clough, Earle, & Sewell, 2002)

3.6.12 Recovery-Stress Questionnaire for Sports (RESTQ-52 Sport)

The RESTQ-52 Sport questionnaire contains 48 items under 19 subscales. The RESTQ-Sport is based on 12 non-specific and 7 additional sport-specific scales (Kellman & Kallus, 2001). The scales are General Stress, Emotional Stress, Social Stress, Conflicts/Pressure, Fatigue, Lack of Energy, Physical Complaints, Success, Social Recovery, General Well-Being, Sleep Quality, Disturbed Breaks, Burnout/Emotional Exhaustion, Fitness/Injury, Fitness/Being in Shape, Burnout/Personal Accomplishment, Self-Efficacy and Self-Regulation. Responses are provided on a 6-value scale anchored by 0 (never) to 6 (always). The internal consistencies and reliability of the RESTQ-Sport have previously been reported with Cronbach's alpha (0.67-0.88) and the test-retest reliability (r=0.51-0.81) (Kellman & Kallus, 2001).

3.7 RESEARCH PROCEDURES

The protocols and procedures for this study was approved by the Human Research Ethical Committee of Universiti Sains Malaysia (USM) and were conducted in accordance with ethics guideline outlined by the Helsinki Declaration. Presently, permission to recruit study populations was obtained from the principle of Sekolah Kebangsaan Menengah Putera, Kelantan. Details of the present study were explained to the coach and participants before the testing was conducted. Participation in this study is voluntary and a written consent was obtained from each individual prior to commencement of the testing. Participants were allowed to withdraw at any point of the study.