ANTHROPOMETRIC AND PHYSICAL FITNESS PROFILES OF KELANTANESE INTELLECTUALLY DISABLED POPULATION

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ANTHROPOMETRIC AND PHYSICAL FITNESS PROFILES OF KELANTANESE INTELLECTUALLY DISABLED POPULATION

by

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CBR	Community-Based Rehabilitation
ID	Intellectual Disabled/Disability
PDK	Pemulihan Dalam Komuniti
USM	Universiti Sains Malaysia

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PROFIL ANTROPOMETRIK DAN KECERGASAN FIZIKAL POPULASI ORANG KURANG UPAYA INTELEK KELANTAN

ABSTRAK

Orang kurang upaya intelektual ditakrifkan sebagai individu yang mempunyai perkembangan mental yang tidak sempurna atau terbantut. Golongan dewasa yang kurang upaya intelektual lazimnya dilaporkan mempunyai berat badan yang berlebihan dan obes serta menunjukkan tahap kecergasan fizikal yang rendah disebabkan gaya hidup yang tidak aktif. Matlamat kajian ini adalah untuk mengenal pasti nilai ukuran antropometrik dan profil kecergasan fizikal golongan dewasa yang kurang upaya intelektual di Kelantan. Kajian ini juga menilai korelasi pengukuran antropometrik dan komposisi badan mengikut prestasi kecergasan fizikal yang dipilih yang dinilai berdasarkan ujian lontaran bola segar, lompat jauh berdiri, imbangan statik, ketangkasan 505 dan lari pecut 20 meter. Kedua, kajian ini juga bertujuan meramal pemboleh ubah terbaik yang boleh memberi sumbangan signifikan terhadap prestasi kecergasan fizikal dari segi kekuatan eksplosif, keseimbangan, ketangkasan dan kelajuan. Bateri ujian kecergasan dalam kajian ini telah diadaptasi daripada manual pengukuran Inspire i-Talent yang telah dihasilkan oleh Institut Sukan Negara. Seramai 124 orang dewasa yang kurang upaya intelektual di Kelantan, iaitu 70 lelaki dan 54 perempuan telah direkrut dalam kajian ini. Komponen antropometrik (ketinggian berdiri, ketinggian duduk dan panjang depa) diukur dengan menggunakan stadiometer dan pita pengukur, manakala komposisi badan seperti berat badan, jisim bebas lemak, peratusan lemak, dan index jisim badan (BMI) telah direkod menggunakan *Bioelectrical Impedance Analysis (BIA).* Orang dewasa yang kurang upaya intelektual dalam kajian ini dianggap mempunyai berat badan yang berlebihan.

Nilai BMI yang lebih tinggi didapati pada golongan wanita (26.4 ± 6.6 kg/m2) berbanding lelaki (22.7 ± 5.8kg/m2). Tambahan pula, tahap kecergasan fizikal orang dewasa yang kurang upaya intelektual dalam kajian ini secara umumnya dianggap berada pada tahap yang rendah, namun peserta lelaki menunjukkan prestasi yang lebih baik berbanding perempuan kecuali dalam ujian ketangkasan 505. Korelasi Pearson mendedahkan bahawa parameter antropometrik menunjukkan nilai korelasi yang signifikan dengan keseimbangan, kekuatan eksplosif bahagian bawah dan atas badan, ketangkasan, dan kelajuan. Namun begitu, analisis regresi secara berperingkat menunjukkan bahawa ujian ketangkasan 505 (R= 0.859, R2= 0.738, F= 6.136, p= 0.015) boleh diramalkan dengan lari pecut 20 meter, lompat jauh berdiri dan nilai ketinggian duduk. Selain itu, ujian ketangkasan 505 dan ketinggian duduk didapati menjadi peramal yang kukuh bagi lari pecut 20 meter (R= 0.839, R2= 0.705, F= 9.259, p=0.003). Sebaliknya, pemboleh ubah kekuatan eksplosif bahagian bawah badan (R= 0.864, R2= 0.747, F= 34,947, p<0.05) boleh dijangka daripada lontaran bola segar, peratusan lemak dan nilai ujian ketangkasan 505. Lain daripada itu, kekuatan eksplosif bahagian atas badan (R= 0.863, R2= 0.745, F= 4.223, p= 0.042) boleh diramal berdasarkan nilai lompat jauh berdiri, berat badan, jantina, imbangan statik dan panjang depa. Akhir sekali, lompat jauh berdiri dan ujian ketangkasan 505 boleh menjadi peramal utama bagi imbangan statik (R= 0.597, R2= 0.356, F= 6,586, p= 0.011). Hasil daripada analisis regresi ini, terdapat beberapa persamaan regresi telah dibina untuk meramalkan ketangkasan, kelajuan, kekuatan eksplosif bahagian bawah dan bahagian atas badan, dan keseimbangan dalam kalangan individu kurang intelektual. Oleh itu, intervensi senaman perlu dilaksanakan untuk meningkatkan tahap kecergasan fizikal umum dan mengurus berat badan mereka untuk mengurangkan

kadar berat badan yang berlebihan dan obesiti dalam kalangan individu kurang upaya intelek.

ANTHROPOMETRIC AND PHYSICAL FITNESS PROFILES OF KELANTANESE INTELLECTUALLY DISABLED POPULATION

ABSTRACT

Intellectual disability (ID) is defined by the person that has a presence of incomplete or arrested mental development. Adults with ID typically reported to be overweight and obese and demonstrate poor level in physical fitness due to inactive lifestyle. The aim of this study is to identify the anthropometric measurement and physical fitness profile in adults with ID in Kelantan. This study also assessed the correlation of anthropometric and body composition on selected physical fitness performance assessed by medicine ball throw, standing long jump, static balance, 505 agility, and 20-m sprint test. Secondly, to predict the best predictors that can significantly contribute to physical fitness performance in term of explosive strength, balance, agility and speed. The fitness test batteries in this study were adapted from Inspire i-talent manual which developed by National Institute of Malaysia. A total of 124 adults with ID in Kelantan, 70 males and 54 females were recruited in this study. Anthropometric components (standing height, sitting height and arm span) were measured by using stadiometer and measuring tape while body composition such as body weight, fat free mass, fat percentage and body mass index (BMI) were recorded by using Bioelectrical Impedance Analysis (BIA). Adults with ID in this study are considered to be overweight. The higher BMI value was found in females (26.4 ± 6.6 kg/m^2) than in males (22.7 ± 5.8kg/m^2). In addition, physical fitness level in adult with ID in this study is considered to be generally poor, male participants performed better than female except in 505 agility test. Pearson correlation revealed that anthropometric parameters showed significant correlation with balance, lower and upper body power,

agility, and speed Nevertheless, stepwise regression analysis revealed that agility test (R= 0.859, R^2= 0.738, F= 6.136, p= 0.015) can be predicted by 20-meter sprint, standing long jump, and sitting height values. Besides, 505 agility test and sitting height were found to be strong predictor of 20-meter sprint (R= 0.839, R^2= 0.705, F= 9.259, p=0.003). On the other hand, lower limb explosive strength variable (R= 0.864, R^2= 0.747, F= 34,947, p<0.05) can be anticipated from medicine ball throw, fat percentage and 505 agility test values. In addition, for upper body explosive strength (R= 0.863, R^2= 0.745, F= 4.223, p= 0.042) it can be forecasted from standing long jump, body weight, gender, static balance, and arm span values. Lastly, standing long jump and 505 agility test could be main predictor of static balance (R= 0.597, R^2= 0.356, F= 6,586, p= 0.011). From these regression analysis findings, a few regression equations have been developed to predict agility, speed, explosive strength in both lower and upper body, and balance among intellectually disabled persons. Therefore, exercise intervention should be implemented to improve their general physical fitness level and to manage their weight to lower the rate of being overweight and obesity among intellectually disabled people.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Intellectual disability (ID) is the most prevalent of all developmental disabilities. An ID is characterized by significant limitations in both cognitive functions and adaptive behaviour that cover conceptual, social, and practical skills (NICHCY, 2012). According to the tenth revision of the WHO (World Health Organization), ID is a disorder defined by the presence of incomplete or arrested mental development. It is principally characterized by the deterioration of concrete functions at each stage of development that contribute to the overall level of intelligence, such as cognitive, language, motor and socialization functions. In this anomaly, adaptation to the environment is always affected. Scores for intellectual development levels are determined based on all the available information, including clinical signs, adaptive behaviour in the cultural medium of the individual and psychometric findings (National Academies of Sciences et al., 2015).

In comparison to their typically developed peers, ID people are more likely to be obese, less likely to be physically active and twice as likely to develop several chronic diseases, such as diabetes and respiratory problems (Barwick et al., 2012). Emerson and Hatton (2013) indicated the importance of ID people to participate in sports because of the predisposed risks to several health problems, for example, cardiovascular disease, diabetes, liver problems and hypertension.

Physical fitness testing is important to various kinds of populations, especially in ID people, it is crucial to monitor and assess their physical fitness level regularly as it can provide us with information on the overall physical fitness level. Physical fitness is well-known to be related to health and functioning. Previous studies have found that

the ID population demonstrate unhealthy ageing compared to their non-disabled peers (de Winter et al., 2012; Schoufour et al., 2014). Assessing their physical fitness allowed us to monitor and understand any age-related decline in physical functioning (Blair, 2003; Lee et al., 2011; Schoufour et al., 2014). However, measuring physical fitness in the ID population comes with few challenges due to the physical and cognitive abilities of individuals with ID (Lahtinen et al., 2007). For instance, the execution of a test is not always in accordance with the test procedures considering the limited physical and cognitive ability of people with ID. Therefore, this limitation will affect the test result such as resulting in dropout or invalid test results (T. I. M. Hilgenkamp et al., 2013).

It has been well-documented in previous studies on able-bodied that anthropometry has a significant impact on different physical fitness performances (Kirk, 2016). Anthropometry parameters (standing height) were revealed to be significantly correlated with physical performance in a previous study (Cherif et al., 2022). Moreover, anthropometry parameters have been demonstrated to be an important factor that could predict an individual sports or physical potential, particularly in specific performance or skills that require unique physical demands (Norton & Olds, 2001).

In terms of physical performance, one should have a good body composition, body mass index (BMI) and fitness level to optimise their physical fitness performance. According to Barandun et al. (2012), sprint time was found to be associated with the average running speed and the percentage of body fat. According to Damayanti and Adriani (2021), the sprint time was found to be associated with body fat percentage. It was found that the increases in body weight will result in increases in fat reserves in adipose cells and muscle glycogen (Murbawani & Gizi, 2017). It has

been suggested that reducing body fat percentage will improve physical condition, hence resulting in improvement in sports performance. Additionally, in terms of muscle activities, the increase in muscle mass will cause muscle contraction to be more efficient (Putranto et al., 2015). The impact of body fat percentage on running performance becomes important when it reaches a certain limit value; a certain value of body fat (13%-17%) seems to be advantageous for fast race time in a runner (Knechtle et al., 2010). Moreover, the range between body fat for male and female are different. It is recommended that male runners' body fat ranges from 5% to 11% and female runners body fat ranges from 10 % to 15%. These differences are due to women, whether runners or not, needing extra body fat for the reproductive hormones to function properly (MacKenzie, 2007). Hillman (2020) found that the optimal BMI for male was between 19 to 20 whereas the ideal BMI for female was 18.5. Fat mass and fat-free mass were found to be widely reported in previous studies. However, it was revealed that generalized whole body measurements (BMI) are not always an important marker to predict individual potential in physical performance (Tsukahara et al., 2020).

Inspired i-Talent is a guideline manual that was established to measure fitness levels among the disabled population in Malaysia. The manual was developed by the National Institute of Malaysia. The Inspired i-Talent test battery is a set of 9 physical fitness tests consisting of strength, balance, agility and speed. The manual has been used widely in Malaysia to measure and identify sports talent among people with disabilities. Hence the manual establishment encourages and promotes the participation of people with disabilities in physical and sports activities. However, to the best of our knowledge, there is no study adapting the Inspired i-Talent manual as a fitness guideline. Therefore, the current study aims to investigate/ gain insight into

the health-related fitness level of people with ID based on the Inspired i-Talent manual guidelines.

1.2 Problem Statements

To date, to our knowledge, there is no published data, study or research that has been conducted to assess the contribution of anthropometric characteristics, body composition, BMI and health-related physical fitness among the ID population in Malaysia. There is also a lack of insight on the mechanism of anthropometric, body composition and BMI contribution to physical fitness of people with ID in Malaysia. There were limited past studies regarding fitness profiling had been conducted in ID population. However, there were a few physical fitness profiling studies that had been conducted in another region notably in ID population; (1) Mohammadi et al. (2021) conducted a physical fitness and body composition profiling in young people with mild ID among Iranian population and another study by (2) Cuesta-Vargas, Paz-Lourido and Rodriguez (2011) conducted a physical fitness profiling study in the population of adult athletes with ID. The present study sought to explore/address the gap in the literature by investigating the status of health-related components in the ID population in Malaysia.

1.3 Significance of the Study

The present study will produce comprehensive fitness data among ID individuals, which can be used by educators, sports scientists and coaches for selecting ID individuals to participate in sports. Also, the results of this study will provide recommendations to educators working with disabled people focusing on physical performance. This present study also could enhance the ability and open more

opportunities for disabled people to be involved in physical activities. Implementation of a systematic approach during the mass measuring programme will encourage sports practitioners to strengthen their coaching abilities and skills in helping to systematically measure physical fitness in the ID population.

1.4 Research Questions

1) What is the physical fitness level of ID individuals in Kelantan?
2) What is the correlation between anthropometric characteristics and physiological parameters (selected physical fitness test), among ID individuals and to what extent do those factors predict upper-lower limb explosive strength, balance, agility, and speed?
3) What are the factors that can significantly contribute to the sports performance of upper-lower limb explosive strength, balance, agility and speed?

1.5 Objectives of the Study

General objective:

The general objective of the present study is to determine th physical fitness level of the ID population in Kelantan based on the Inspired i-Talent manual.

Specific objectives:

1) To produce a physical fitness profile among intellectually disabled persons in Kelantan
2) To determine the correlation of anthropometry characteristics and selected health fitness batteries (medicine ball throw test, standing long jump, static balance test, 505 agility test and 20-m sprint test).

3) To predict the best factor that can significantly contribute to the sports performance of upper-lower limb explosive strength, balance, agility and speed.

1.6 Study Hypothesis

HO_1: There are no relationship exists between anthropometry characteristics with selected health fitness performances (medicine ball throw, standing long jump, static balance, 505 agility and 20-m sprint).

HA_1: There are significant relationship exists between anthropometry characteristics with selected health fitness performances (medicine ball throw, standing long jump, static balance, 505 agility and 20-m sprint).

HO_2: There are no factors that can significantly predict the upper-lower limb explosive strength, balance, agility and speed.

HA_2: There are factors that can significantly predict the upper-lower limb explosive strength, balance, agility and speed.

CHAPTER 2

LITERATURE REVIEW

2.1 Physical Fitness Status among Intellectually Disabled Population

Physical fitness refers to the ability of individual body systems to work together efficiently to allow you to be healthy and perform activities of daily living (Charles B. Corbin et al., 2014). Body composition, cardiovascular endurance, flexibility, muscular endurance and muscular explosive strength are the components that can define a person's health-related fitness (Chanias et al., 1998). Good physical fitness is essential for overall health and a person's well-being, it is important to develop physical fitness to improve daily functioning (e.g., walking, running, jumping, lifting, and carrying objects). However, there was multiple evidence reported that individuals with ID demonstrated a poor level of physical fitness. Scholars have highlighted that the physical fitness of individuals with ID demonstrated poor fitness levels on their standard fitness tests, particularly on measures of cardiovascular endurance, body composition, muscular endurance, strength and motor coordination (Carmeli et al., 2008; Chanias et al., 1998; Frey et al., 2008; Graham & Reid, 2000; Spinks et al., 2007). It is important to note that individuals with ID have been reported to have lower levels or poor physical fitness across all stages of their lives (Golubović et al., 2012; Pitetti & Boneh, 1995; Skowronski et al., 2009; Van De Vliet et al., 2006). It was documented that individuals with ID demonstrated a lower level of cardiovascular fitness which begins at an early age and deteriorates with age (Oppewal et al., 2013). Previous studies have compared the physical fitness of the ID population to the general population, these studies found that individuals with ID tend to perform poorly on physical fitness tests (Reid et al., 1985; Yanardag et al., 2013). This finding is in line with the previous studies, whereby individuals with ID exhibited much lower

levels of performance on cardiovascular fitness tests compared to individuals without disability (Guerra et al., 2003; Kittredge et al., 1994). Additionally, similar results were obtained by Van de Vliet et al., 2006, where the physical fitness level of elite athletes with ID was, at best equal to, or lower than their sporting peers without ID.

Factors that contributed towards the poor performance on the physical fitness tests could be: (1) sedentary lifestyle (Bickum, 1995; Graham & Reid, 2000; Lotan et al., 2004; Pitetti & Boneh, 1995); (2) lack of motivation during testing (Graham & Reid, 2000; Halle et al., 1999); (3) limitations and impediment in motor development (Frey & Chow, 2006; Hartman et al., 2010; Seidl et al., 1987; Vuijk et al., 2010; Westendorp et al., 2011); (4) limited mental ability and short attention span (Vuijk et al., 2010); (5) physical characteristics such as short stature; (6) infrequent opportunities to practice test items; and (7) the tendency of stoppage during test when uncomfortable (Graham & Reid, 2000).

In addition, previous evidence pointed out that physical activity was related to health-related parameters, such as the ability to maintain balance, muscle strength and quality of life in the ID population (Bartlo & Klein, 2011; Chanias et al., 1998; Heller et al., 2011). This evidence suggests that an increase in physical activity and regular exercise can improve the level of physical fitness, overall health, and well-being in individuals with ID. The importance of physical fitness as a concept has been established, however, measuring physical fitness in individuals with ID comes with multiple challenges (Lahtinen et al., 2007). Moreover, the instruction and execution during measuring physical fitness are not always accordant with the physical and cognitive abilities of the individuals with ID, resulting in dropout and invalid test results (T. I. M. Hilgenkamp et al., 2013). Therefore, it is important when measuring

physical fitness to consider the limitations in their physical and cognitive abilities since they vary from one another.

Table 2.1 Physical Fitness Status among Intellectually Disabled Population

Author	Physical fitness component	Findings
Carmeli et al., 2008; Chanias et al., 1998; Frey et al., 2008; Graham & Reid, 2000; Lahatinen et al., 2007; Rimer 1992; Van de Vliet et al., 2006; Gillespie 2003; Spinks et al., 2007; Mac Donncha et al., 1999	Cardiovascular endurance, body composition, muscular endurance, strength and motor coordination.	• Scholars have highlighted that the physical fitness of individuals with ID demonstrated poor fitness levels on their standard fitness tests, particularly on measures of cardiovascular endurance, body composition, muscular endurance, strength and motor.
Pitetti & Boneh, 1995; Skowronski et al., 2009; Van de Vliet et al., 2006; Golubovic et al., 2012	Physical fitness	• Individuals with ID have been reported to have lower levels or poor physical fitness across all stages of their lives.
Oppewal et al., 2013).	Cardiovascular	• Individuals with ID demonstrated a lower level of cardiovascular fitness which begins at an early age and deteriorates with age.
Reid et al., 1985; Yanadarg et al., 2013	Physical fitness tests	• Previous studies have compared the physical fitness of the ID population to the general population, these studies found that individuals with ID tend to perform poorly on physical fitness tests.
Guerra et al., 2003; Kittredge et al., 1994; Pitetti & Tan, 1991	Cardiovascular	• This finding is in line with the previous studies, whereby individuals with ID exhibited much lower levels of performance on cardiovascular fitness tests compared to individuals without disability.

Table 2.1 Continued

Van de Vliet et al., 2006,	Physical fitness	• Additionally, similar results were obtained by where the physical fitness level of elite athletes with ID was, at best equal to, or lower than their sporting peers without ID.
(1) (Graham & Reid, 2000; Bickum, 1995; Lotan et al., 2004; Pitetti & Boneh, 1995); (2) (Graham & Reid, 2000; Halle et a., 1999); (3) (Frey & Chow, 2006; Hartman et al., 2010; Seidl et al., 1987; Vuijk et al., 2010; Westerndorp et al., 2011); (4) (Vuijk et al., 2010); (5) (6) (7) (Graham & Reid, 2000)	Factors contributed towards the poor performance	• Factors that contributed towards the poor performance on the physical fitness tests could be: (1) sedentary lifestyle; (2) lack of motivation during testing; (3) limitations and impediment in motor development; (4) limited mental ability and short attention span; (5) physical characteristics such as short stature; (6) infrequent opportunities to practice test items; and (7) the tendency of stoppage during test when uncomfortable.
Hilgenkamp et al., 2013		• The instructions and execution during measuring physical fitness were not always accordance with the physical and cognitive abilities of the individuals with ID, resulted in dropouts and invalid test results.

2.1.1 Body Mass Index and Body Composition among Intellectually Disabled Population

Individuals with ID demonstrated a higher prevalence of being overweight and obese when compared to the general population (Cherif et al., 2022; Rimmer & Yamaki, 2006; Spinks et al., 2007). Few studies have investigated the body mass index (BMI) status of the ID population (children and youth) based on geographical region,

gender and age, the authors reported a significantly higher BMI compared to their typically developing peers (Lloyd et al., 2012). Moreover, several scholars investigated the rate of obesity among individuals with ID, and the authors found a higher rate of obesity in the ID population, with a further increase during adulthood (Chanias et al., 1998; Fernhall, 1993; Graham & Reid, 2000). Also, the previous scholars found a higher BMI value was prevalent in female compared to male (Lahtinen et al., 2007), therefore the prevalence of being overweight and obese was typically found in female than male (Temple et al., 2014).

The term "body composition" refers to the various components of an individual's body, which include the body fat, muscles, skeletal system, and other tissues. Besides, body composition is an important determinant that defines individual overall health and physical fitness (Chanias et al., 1998), as a person who carries excessive body fat can increase the risks of developing chronic health problems. Also, it is crucial to understand the body composition of individuals with ID, to identify and address the health risks among this population. Moreover, it is important to note that body composition is an essential component for daily functioning in adults with ID (T. I. M. Hilgenkamp et al., 2010). What is more, body composition factors which are mainly linked to fatty mass can affect both physical and physiological performance (Maciejczyk et al., 2014) and, therefore could interfere with the daily functioning of individuals with ID. As a matter of fact, multiple evidence have addressed the poor fitness level related to measures of body composition demonstrated in individuals with ID (Chanias et al., 1998; Franciosi, Baldari, et al., 2010; Graham & Reid, 2000; Van De Vliet et al., 2006). Previous scholars have suggested that there were greater increases in terms of body mass and body fat percentage in individuals with ID (Graham & Reid, 2000). Indeed, the greater increases in these variables were reported

to be associated with obesity which has been linked to increased risks of developing chronic health problems (e.g., cardiovascular disease (Rojas & Rodríguez, 2020), diabetes, hypertension, ischemic stroke, and cancers) (Emerging Risk Factors Collaboration et al., 2011; Mozaffarian et al., 2015). In fact, it is important to consider that the body composition of individuals with ID may be different from their typical developing peers (without ID), which indicates that individuals with ID may have atypical fat distribution or greater fat mass, because of underlying syndromes or comorbid conditions (Humphries et al., 2009).

Table 2.2 Body Mass Index and Body Composition among Intellectually Disabled Population

Author	Physical fitness component	Findings
Spinks et al., 2007; Rimmer & Yamaki, 2006; Cherif et al., 2022	BMI	• Individuals with ID demonstrated a higher prevalence of being overweight and obese when compared to the general population.
Lloyd et al., 2012	BMI	• The body mass index (BMI) status of the ID population (children and youth) based on geographical region, gender and age were reported to be significantly higher when compared to their typically developing peers.
Chanias et al., 1998; Fernhall, 1993; Graham & Reid, 2000).	BMI	• Found a higher rate of obesity in the ID population, with a further increase during adulthood.
Lahtinen et al., 2007	BMI	• The higher BMI value was prevalent in female compared to male.
Temple et al., 2014	BMI	• Reported the prevalence of being overweight and obese was typically found in female than male.
Hilgenkamp et al., 2010).	Body composition	• Body composition is an essential component for daily functioning in adults with ID.

Table 2.2 Continued

Maciejczyk et al., 2014	Body composition	• The body composition factors which are mainly linked to fatty mass can affect both physical and physiological performance.
Chanias et al., 1998, Graham and Reid, 2000; Van de Vliet et al., 2006; Franciosi et al., 2010	Body composition	• Poor fitness level related to measures of body composition demonstrated in individuals with ID.
Graham & Reid, 2000	Body composition	• Suggested that there were greater increases in terms of body mass and body fat percentage in individuals with ID.
(1) Rojas & Rodrigues, 2019, (2), (3), (4) and (5) Mozaffarian et al., 2015; Wormser et al., 2011	Body composition	• The greater increases in these variables (body mass & body fat) were reported to be associated with obesity which has been linked to increased risks of developing chronic health problems (e.g., (1) cardiovascular disease, (2) diabetes, (3) hypertension, (4) ischemic stroke, and (5) cancers).
Humphries et al., 2009	Body composition	• The body composition of individuals with ID may be different from their typical developing peers (without ID), indicates that individuals with ID may have atypical fat distribution or greater fat mass, because of underlying syndromes or comorbid conditions.

2.1.2 Muscular Strength among Intellectually Disabled Population

Muscle strength refers to the ability of a group of muscles to exert force against resistance or obstacle. Muscle strength is an important component in physical fitness as it is necessary for developing functional skills (Cowley et al., 2010; Rimmer, 2000) and allows us to perform daily activities with ease and efficiency in daily functioning. Besides, muscular explosive strength is also an important component of health-related

fitness, which refers to the ability to exert maximal force in a short duration. Muscular explosive strength is essential in generating an explosive force which typically required in our daily functioning, such as jumping, sprinting, throwing, pushing and rapid directional movement changes.

In the case of the ID population, it has been widely highlighted by previous scholars associated with poor levels in performance of muscular strength and explosive strength among individuals with ID (Burns, 2015; Guidetti et al., 2010; Mohammadi et al., 2021; Van De Vliet et al., 2006). In the same way, where the performance of muscular strength and explosive strength of individuals with ID was compared to their typically developing peers, it was evident that the performance of individuals with ID was still comparable, indicating that they demonstrated poor muscular strength and explosive strength compared to their peers (Onyewadume, 2006; Pitetti & Fernhall, 2004; Zhang et al., 2009).

The previous evidence by Karinharju (2005) also suggested that good muscular performance is important in generating effective movements in individuals with ID. This finding agrees with Orssatto et al. (2020), where the authors suggested that both muscular strength and explosive strength was important factor linked to functional capacity.

In another study conducted on individuals with ID and their normal peers, the previous evidence suggests that poor physical fitness especially in muscle strength and power was still significant when compared to their normal peers' performance (Onyewadume, 2006; Pitetti et al., 2002; Pitetti & Fernhall, 2004; Zhang et al., 2009).

The finding above demonstrated the importance of developing and improving in terms of muscular performance in individuals with ID, as a strong muscle allows them to perform daily tasks and participate or engage in various sports and recreational

activities therefore it can promote the increase of physical activity and improve the quality of life among this population.

Table 2.3 Explosive strength among Intellectually Disabled Population

Author	Findings
Guidetti et al., 2010; Van de Vliet et al., 2006; Burns et al., 2015; Mohammadi et al., 2021	• In the case of the ID population, it has been widely highlighted by previous scholars associated with poor levels in performance of muscular. strength and explosive strength among individuals with ID.
Zhang et al., 2009; Pitetti & Yarmer, 2000; Pitetti & Fernhall, 2004; Onyewadume, 2006	• The performance of muscular strength and explosive strength of individuals with ID were compared to their typically developing peers, it was evident that the performance of individuals with ID were still comparable, indicating that they demonstrated poor muscular strength and explosive strength compared to their peers.
Karinharju, 2005	• Suggested that good muscular performance is important in generating effective movements in individuals with ID.
Orssatto et al., 2020	• Suggested that both muscular strength and explosive strength was important factor linked to functional capacity.
Zhang et al., 2009; Pitetti & Yarmer, 2000; Pitetti & Fernhall, 2004; Onyewadume, 2006	• Poor physical fitness especially in muscle strength and power was significant when compared to their normal peer's physical performance.

2.1.3 Balance among Intellectually Disabled Population

Balance refers to the ability to maintain one's stability and control the body movements in both static and dynamic circumstances. Balance is an important component of physical fitness, and it is essential for the development of functional skills (Cowley et al., 2010; Rimmer, 2000), due to its importance in providing stability

and coordination. This statement is in agreement with Malina et al. (2004), where the ability to coordinate movements was linked with the ability to maintain balance.

Individuals with ID are often reported to experience difficulties that can affect their ability to maintain their balance and mobility. This was evident in previous scholars, where individuals with ID were reported to demonstrate difficulty in maintaining their balance and executing motor skills (Cleaver et al., 2009; Gorla et al., 2003; McKinlay et al., 1987). The difficulty in executing motor skills such as difficulty maintaining their balance, running, jumping, hopping, throwing and rapid changes of movements are typically associated with the ID population, which can interrupt their daily functioning and quality of life (Cleaver et al., 2009; Gorla et al., 2003; McKinlay et al., 1987). This has been demonstrated in previous findings, where the difficulties in executing motor skills were due to underlying cognitive issues (e.g., difficulty in processing information) which can possibly affect their ability to maintain their balance (Oppewal et al., 2013). Indeed, the difficulty in processing information and the lack of motor coordination contribute to the poor performance in their ability to maintain balance, as these difficulties are notably concerning in the ID population, where they are at a greater risk of exposing themselves to the risks of falling and injuries (Carmeli et al., 2008; Cox et al., 2010). Therefore, it is important to increase the level of physical activity in the ID population, as the previous finding found that physical activity can positively affect the ability to maintain balance for individuals with ID (Bartlo & Klein, 2011; Chanias et al., 1998; Heller et al., 2011).

Table 2.4 Balance among Intellectually Disabled Population

Author	Findings
Gorla et al., 2003; McKinlay et al., 1985; Cleaver et al., 2009	• Individuals with ID were reported experiencing difficulty in maintaining their balance and executing motor skills.

Table 2.4 Continued

Gorla et al., 2003; Mckinlay et al., 1987; Diamond, 2000	• Difficulty in executing motor skills such as difficulty maintaining their balance, running, jumping, hopping, throwing and rapid changes of movements are typically associated with the ID population, which can interrupt their daily functioning and quality of life.
Oppewal et al., 2013	• The difficulty in executing motor skills were due to underlying cognitive issues (e.g., difficulty in processing information) which can possibly affect their ability to maintain their balance.
Carmeli et al., 2008; Cox et al., 2010	• The difficulty in processing information and the lack of motor coordination contribute to the poor performance in their ability to maintain balance, as these difficulties are notably concerning in the ID population.
Bartlo & Klein, 2011; Chanias et al., 1998; Heller et al., 2011	• Increasing the level of physical activity can positively affect the ability to maintain balance for individuals with ID.

2.1.4 Agility Performance among Intellectually Disabled Population

Agility refers to the ability of an individual to move or change direction quickly and effectively, where this action requires a combination of ability in both physical and cognitive skills (e.g., perceptual and decision making) (Chelladurai, 1976; Ellis et al., 2000; P. Chelladurai & M. S. Yuhasz, 1977; Sheppard et al., 2006; Sheppard & Young, 2006; W. B. Young et al., 2001, 2002; W. Young & Farrow, 2006). For instance, agility typically involves a set of coordinated and rapid movements when altering the directions in physical performance such as running, jumping, balancing, throwing and in daily activities (Gorla et al., 2003; McKinlay et al., 1987). In the case of individuals with ID, it was documented in previous scholars where the authors pointed the poor agility among this population, it was also suggested that the possible explanation was due to the difficulty in executing coordinated movements (Bertini,

2005; Carmeli et al., 2008; Graham & Reid, 2000), lack of perceptual ability, and delay mental development (Gawlik & Zwierzchowska, 2004). Also, it has been demonstrated in previous evidence, where the study was conducted in the athletes population with ID, demonstrating that the agility performance in individuals with ID is relatively lower than their non-disabled peers (Franciosi, Baldari, et al., 2010). Similarly, in previous evidence conducted on male students with ID (age 11-20 years), the authors highlighted the lower performance was pronounced in strength and agility (Jeoung, 2018). It is important to consider that individuals with ID have various IQ levels depending on their impairment severity, IQ level was evident to be an important factor in physical performance, previous authors suggested that IQ level was associated with physical performance in individuals with ID, demonstrating that individuals with higher IQ level allow them to perform better in fitness test compared to those with lower IQ level (Bartík & Bolach, 2015; Mohammadi et al., 2021). Specifically, game intelligence which refers to the ability to process information and quick decision making in complex and dynamic circumstances is typically underdeveloped which is possible to clarify the poor physical performance in this population (Burns, 2015).

Indeed, it is important to improve the agility performance in individuals with ID as this can significantly affect and interrupt their daily functioning hence impeding their involvement in physical activity, it was emphasised in previous scholars suggested that increasing the level of physical activity can impact the agility performance in ID population (Bartlo & Klein, 2011; Jeng et al., 2017). On top of that, previous evidence suggested that the 10 weeks of aerobic exercise significantly improved the agility timing in children with ID (Angba, 2020).

Table 2.5 Agility Performance among Intellectually Disabled Population

Author	Findings
(1) (Graham & Reid, 2000, Bertini, 2005; Carmeli et al., 2008), (2), (3) (Gawlik & Zwiezchaowska, 2004	• In the case of individuals with ID, it was documented in previous scholars where the authors pointed the poor agility among this population, it was also suggested that the possible explanation was due to the difficulty in executing (1) coordinated movement, (2) lack of perceptual ability, and (3) delay mental development.
Franciosi et al., 2010	• This study was conducted in the athletes population with ID, demonstrating that the agility performance in individuals with ID is relatively lower than their non-disabled peers.
Jeoung, 2018	• This study was conducted on male students with ID (age 11-20 years), the authors highlighted the lower performance was pronounced in strength and agility.
Bartik & Bolach, 2015 ; Mohammadi et al., 2021	• Reported that individuals with a higher IQ level allowed them to perform better in fitness test compared to their peers with lower IQ level.
Burns, 2015	• Specifically, game intelligence which refers to the ability to process information and quick decision making in complex and dynamic circumstances is typically underdeveloped which is possible to clarify the poor physical performance in this population.

2.1.5 Speed Performance among Intellectually Disabled Population

Speed refers to the ability of an individual to perform and complete a task in a short amount of time, such as sprinting which requires speed to cover a given distance in a short duration. Sprinting requires explosive force and a high-intensity burst of physical efforts which primarily depends on power production. Individuals with ID demonstrated vary in cognitive abilities that mainly can affect their physical

performance in sprinting. In one finding by Andrews et al. (2009), it was been highlighted that there were obvious differences in velocity and acceleration demonstrating that a reduction in both parameters was pronounced in athletes with ID compared to athletes without ID. Moreover, Andrews et al. (2009) also highlighted the reduced performance in velocity and acceleration was associated with anthropometric factors which resulted in a shorter stride length and slower acceleration, this was plausible due to the differences in height where the athletes with ID were on average 4 cm shorter than their peers. Interestingly, another evidence suggested that the differences in IQ level can significantly affect their physical performance (i.e., hand movement speed, 25-m speed), where the authors found that IQ level was associated with hand movement and 25-m speed suggesting that individuals with low IQ demonstrated a lower physical fitness level than those who had high IQ (Mohammadi et al., 2021). It also implies that anthropometric factors (height) and speed of limb play a major role in optimizing sprinting performance (Kunz & Kaufmann, 1981).

Other evidence also suggested that sprinting performance (60-m sprint) in athletes with ID was associated with the ability to coordinate their movements, on the other hand, the degree of intellectual disability was also highlighted as an important factor as the lower degree of ID resulted in higher achievements in motor coordination (Franciosi et al., 2010). As previously mentioned, the lack of coordinated movements (Bertini, 2005; Carmeli et al., 2008; Graham & Reid, 2000) was pronounced in individuals with ID, it was possible due to the delay in mental development (Gawlik & Zwierzchowska, 2004) which possible to explain the sprinting performance in ID population.

Indeed, it is important to improve speed in our daily functioning, as previous scholars emphasised that physical activity had a positive impact on improving speed (Bartlo & Klein, 2011; Jeng et al., 2017), hence possible to encourage the participation of the ID population in sports and recreational activities which could result in positive social well-being (Castagno, 2001; Özer et al., 2012).

Table 2.6 Speed Performance among Intellectually Disabled Population

Author	Findings
Andrews et al., 2009	• It was highlighted that there were obvious differences in velocity and acceleration demonstrating that a reduction in both parameters was pronounced in athletes with ID compared to athletes without ID. • The reduced performance in velocity and acceleration was associated with anthropometric factors which resulted in a shorter stride length and slower acceleration, this was plausible due to the differences in height where the athletes with ID were on average 4 cm shorter than their peers.
Mohammadi et al., 2021	• Suggested that the differences in IQ level can significantly affect their physical performance (i.e., hand movement speed, 25-m speed), where the authors found that IQ level was associated with hand movement and 25-m speed suggesting that individuals with low IQ demonstrated a lower physical fitness level than those who had high IQ.
Franciosi et al., 2010	• Sprinting performance (60-m sprint) in athletes with ID was associated with the ability to coordinate their movements, on the other hand, the degree of intellectual disability was also highlighted as an important factor as the lower degree of ID resulted in higher achievements in motor coordination.
Bartlo & Klein, 2011; Jeng et al., 2017	• Physical activity had a positive impact on improving speed in ID population.
Castagno, 2001; Özer et al., 2012	• Encourage the participation of the ID population in sports and recreational activities which could result in positive social well-being.

2.2 Factors Affecting Individual's Physical Fitness Performance

2.2.1 Factors Affecting Individual's Explosive Strength Performance

Muscle strength refers to the ability of a muscle group to generate force against an external resistance or obstacle. Muscle strength is an important component of physical fitness which is essential for the physical functioning of daily living. Muscle strength can be affected by vary of factors, such as in anthropometric measurement and physical fitness status. In regard to anthropometric factors, an individual's muscular explosive strength can be affected by the length of standing height, standing height is important to explosive strength in both the upper and lower body. The increased length of standing height was highlighted to be essential in improving explosive strength in the upper body, indicating that taller individuals are capable of generating greater explosive force in the upper body (Albaladejo-Saura et al., 2022). Correspondingly in explosive strength in the lower body, standing height can positively affect the force production in the lower body (Kushkestani et al., 2021). The taller individual generally exhibits a certain quality in structural variables, such as having a longer limb such as a longer sitting height and arm span which provide them leverage in executing physical activity.

A longer sitting height indicates a longer torso length, besides standing height, sitting height also plays an important role in determining an individual's explosive strength in both the upper and the lower body. A longer sitting height was associated with increases in explosive strength in the upper body, which implies the degree of sitting height was associated with the degree of ball release point in a medicine ball throw test (Albaladejo-Saura et al., 2022; M. Hammami et al., 2019; Kutlay et al., 2020). The degree of ball release point was the fundamental aspect that indicates the height of the ball being released from the hands, which was evident to significantly

influence the ball trajectory and travel distance during the test (Beckham et al., 2019; Sato et al., 2018). Similar to explosive strength in the lower body, the length of sitting height was an important aspect to consider in assessing the muscular explosive strength in the lower body (Mirzaei et al., 2011). As previously mentioned, a longer sitting height is linked to a longer length in standing height, and these physical attributes provide them leverage in generating more force during the take-off in the standing long jump (Fattahi et al., 2012; Patel, 2010).

Concerning arm span, the length of the arm span was one of the relevant factors that significantly affected the performance of muscular explosive strength of both the upper and lower body. A longer length of arm span contributes to the increase in force production of muscular explosive strength. Indeed, individuals with a longer arm span were capable of generating more force in the medicine ball throw test, while the level of strength performance in individuals with a shorter arm span was comparable (Albaladejo-Saura et al., 2022; Kutlay et al., 2020). Also, a longer arm span was evident to enhance the performance of muscular explosive strength in the upper body, which demonstrated in producing greater throwing velocity (Martínez-De-haro et al., 2022; Ortega-Becerra & Pareja-Blanco, 2020; Skoufas et al., 2003). A similar association was found between arm span and muscular explosive strength in the lower body, a longer arm span was demonstrated to provide a mechanical advantage during the takeoff, which resulted in more force production during the arm swing as the body was propelled forward (Mirzaei et al., 2011). The length of the arm span was strongly associated with height at all ages, demonstrating that as the person grows taller the length of their arm span will increase, which indicates the bones in their limbs elongate accordingly (Tuquet et al., 2020). Indeed, structural variables such as bone structure were highlighted to be associated with biomechanical parameters of strength

execution, hence this variable provides an appropriate environment for an individual's muscle development (Holway & Garavaglia, 2009), as the increases in muscle mass were evident positively impact the production of explosive force in the targeted muscle group.

Besides structural variables, it is important to consider an individual's body weight as a factor when assessing the performance of muscular explosive strength. Body weight was well documented as an important aspect to focus on in enhancing muscular performance, which has been demonstrated that increases in body weight were associated with enhanced explosive strength in the upper body (Albaladejo-Saura et al., 2022; Carter-Thuillier et al., 2019; M. Hammami et al., 2019; Hermassi et al., 2021; Kutlay et al., 2020; Mirzaei et al., 2011). It is important to note that, the increases in body weight were related to the increases in absolute muscle mass, illustrating that a higher absolute muscle mass resulted in greater burst or explosive force production in specific muscle groups (Kyriazis et al., 2010). However, it is important to consider that male and female have distinctive muscle morphological characteristics, such as different muscle thickness, muscle pinnation angle and fascicle length (Bartolomei et al., 2021; Blazevich & Sharp, 2005). Also, male typically have a higher body mass (Kyriazis et al, 2010), whilst female tend to have a higher proportion of body fat (Ćopić et al., 2014), which can result in differences in power output in the upper body (Bartolomei et al., 2021). It was well documented by previous scholars, where it has been suggested that the higher rate of body fat has a negative effect on the production of explosive force in the lower body (Ćopić et al., 2014; Yıldırım & Özdemir, 2010). In the case of body fat, the higher rate in body fat percentages was evident to result in lower anaerobic power and delayed the rate of force development therefore indicating a negative impact on the production of explosive force in the lower body (Maciejczyk