

Exercise Physiology (BMSS5001) Assignment 2

Olive'on Joslyn
Health Nutrition and Lifestyle
Geraint Forster

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The Physiological Profile of a 100m sprint enthusiast

Introduction

Exercise physiology is essential to the human body since it helps athletes and exercise enthusiasts maintain optimal function while increasing performance. The participant expressed her interest in becoming a 100m female sprint athlete. In sports, there are physiological demands that athletes must meet to excel at their full potential. For instance, the 100m sprint is one of track and field's most exciting and challenging events. Achieving excellence in sprinting requires a distinct combination of qualities, such as speed, power, agility, and specific physiological traits needed for success. According to Benardot (2020, p.307), A sprint necessitates the quickest obtainable speed over a short, specified distance. According to Barbieri et al. (2017), Athletic sprinters have a body composition characterised by a low body fat percentage and a high muscle mass. This assists in reducing body weight and fat and increasing the power-to-weight ratio, both of which are vital for producing explosive motions. Regarding sprinting, the skeletal and muscular systems play a crucial role. This is because a sprinter, especially an elite one, tends to have a high concentration of fast-twitch muscle fibres (Trappe et al., 2015). The fast twitch muscle fibres support fast, abrupt movements, hence why there are likely to be more sprinters. Since the movement of a sprinter is short and requires power and agility, energy is needed. Mero, Komi and Gregor (1992) state that the energy utilised in sprinting is called adenosine triphosphate; this is being supplied by energy systems such as adenosine phosphocreatine and glycolysis to provide the adenosine triphosphate to the muscles (Di Prampero, Botter and Osgnach, 2014). High phosphocreatine concentration will reduce muscle fatigue, improving performance; this is why athletes and exercisers take creatine supplements (Butts, Jacobs and Silvis, 2017). The maximum capacity of an individual's body to transport and use oxygen in motor muscles is called Vo2 max, also known as maximal oxygen absorption (Habibi et al., 2014). Vo2 max is more essential in long-distance runners than sprinters, but it is still relevant to determine an athlete's overall health. Furthermore, sprinting necessitates precise muscle contraction, timing, and movement patterns. The nervous system is essential for coordinating motor neuron activation, recruiting muscle fibres, and synchronising muscle contractions (Ross, Leveritt and Riek, 2001). Rapid brain signalling is vital for carrying out explosive motions, maintaining balance, and coordinating complexities of stride mechanics. In addition, Hunter et al. (2017) imply that stride length and frequency are characteristics to consider when maximising speed. Also, mental focus and reaction are important because any delayed reflexes or stops in sprinting can result in reduced speed time and place other than first (Li et al., 2022). In reality, if athletes advance faster than 100ms into the race, they will be disqualified (International Association of Athletics Federations, 2009). Sprinters must have the flexibility and joint mobility to achieve ideal stride length and range of motion. A flexible musculoskeletal system facilitates force transfer and lowers the chance of injury. Maintaining and enhancing flexibility requires an adequate warm-up, stretching, and mobility training. This case study report aims to assess the physiological profile of a 100m sprint enthusiast; the results will be compared to exercise physiology students.

Method:

A female sprint enthusiast was tested using various testing protocols, which are physiological indicators related to running the 100 m sprint race. The results were recorded in a spreadsheet and compared using a Z-score fitness profile, to be expressed in standard deviations, which indicates how far an individual's score is above or below the mean (Andrade, 2021). The participant completed a written consent form and a PARQ questionnaire.

Testing protocols

Anthropometrics

The participant's height was measured in centimetres (cm) using Seca stadiometer 213 (Seca, Hamburg, Germany) and body weight (kg) using Seca Weighing Scale 85 (Seca, Hamburg, Germany), with shoes removed.

Grip strength

The hand length on the Takei hand grip dynamometer (Habdirect, Southam, UK) was adjusted to the participant's hand size (Housh et al., 2016). The participant held the hand grip dynamometer in their right hand with the palms down, elbow at a 90-degree angle and squeezed it. The force value (kg) was recorded on a worksheet. The test was done twice for both hands, and the highest strength values were added together and recorded.

Sit and reach the test.

The individual started with a brief jog, followed by static stretches, and then sat down with their legs extended at the 23cm mark at the sit and reach box (Habdirect, Southam, UK). The participant reached forward along the scale with arms extended and fingertips even. This was repeated for three trials, with the reached point recorded each time. The most distant point reached was recorded on the worksheet to the nearest cm. If the fingertips were uneven or flexion at the knee occurred, the test was to be repeated. The test must be redone if the fingertips are not aligned, or there is any bending at the knee.

Vertical platform jump

The vertical jump was measured using the force platform FP8 2003 test (Hur, Kokkola, Finland). The participant was instructed to do a countermovement jump, stand on the platform, hands on hips, squat and jump at the sound of a beep. The jump height was recorded in centimetres (cm).

30m sprint

Brower Timing system (South Fort Street, Draper, USA) were set up at 20m and 30m along a curved line. At the starting point, the participant was instructed to take off when ready.

VO2 max

The participant warmed up for 4 minutes at a low intensity; after the warm-up, the participant adjusted the Watt bike pro cycle ergometer (Wattbike, Nottingham, UK). The test began at low power and increased gradually until the participant reached volitional exhaustion. The mouthpiece (Hans Rudolph, Kansas, USA) and nose clip were placed on the participant before air collection. A 100-litre Douglas bag (Hans Rudolph, Kansas, USA) was used to collect the expired air at the final load.

Wingate anaerobic power test (WAnt)

The participant warmed up for 5 minutes to increase heart rate. The participant's body weight and height were measured. The details were entered into the Monark Ergomedic bike 894E (Monark, Vansbro, Sweden) anaerobic test software. The seat was adjusted, and the participant's leg had a slight bend. The weight was lifted with the blue cord, and the participant cycled at max power for the 30s at 60 rpm after clicking the start button. The total peak power was recorded.

Keiser leg press

The participant was instructed to sit on the Keiser leg press A300 machine (Keiser, Fresno, USA), position feet shoulder-width apart, and push through heels to align knees over toes. Extend legs almost straight, and lower weight carefully. Perform as many reps as the weight increase. The power was recorded.

Reaction time test

On the wall, nine pods were linked to the BlazePod app (Blazepod, Twickenham, UK). The participant was directed to touch any pods to start and then tap the pod that randomly lights up. The participant followed the instructions, and after one minute, the timer beeped, and the results were recorded.

Results

Table No. 1 – shows the variable measured and the group's mean and standard deviation vs the participant's data scores.

Variables	Mean and standard deviation	Participant's data
Body mass (kg)	71 ± 16.3	53.8
Stature (cm)	164 ± 10.1	151
Age	30± 11	21
Grip test (kg)	34.37 ± 4.56	20.1
Keiser leg press	548.43± 146.50	550
Force platform jump (cm)	26.43 ± 9.40	36.59
30m sprint (s)	5.7 ± 0.48	4.75
WAntpp (w)	605.14 ± 153.54	458
Vo2 max (ml/kg/min)	31.27 ± 5.76	29.3
Reaction time	44.28± 3.25	52
Sit and reach (cm)	30.42 ± 7.85	30

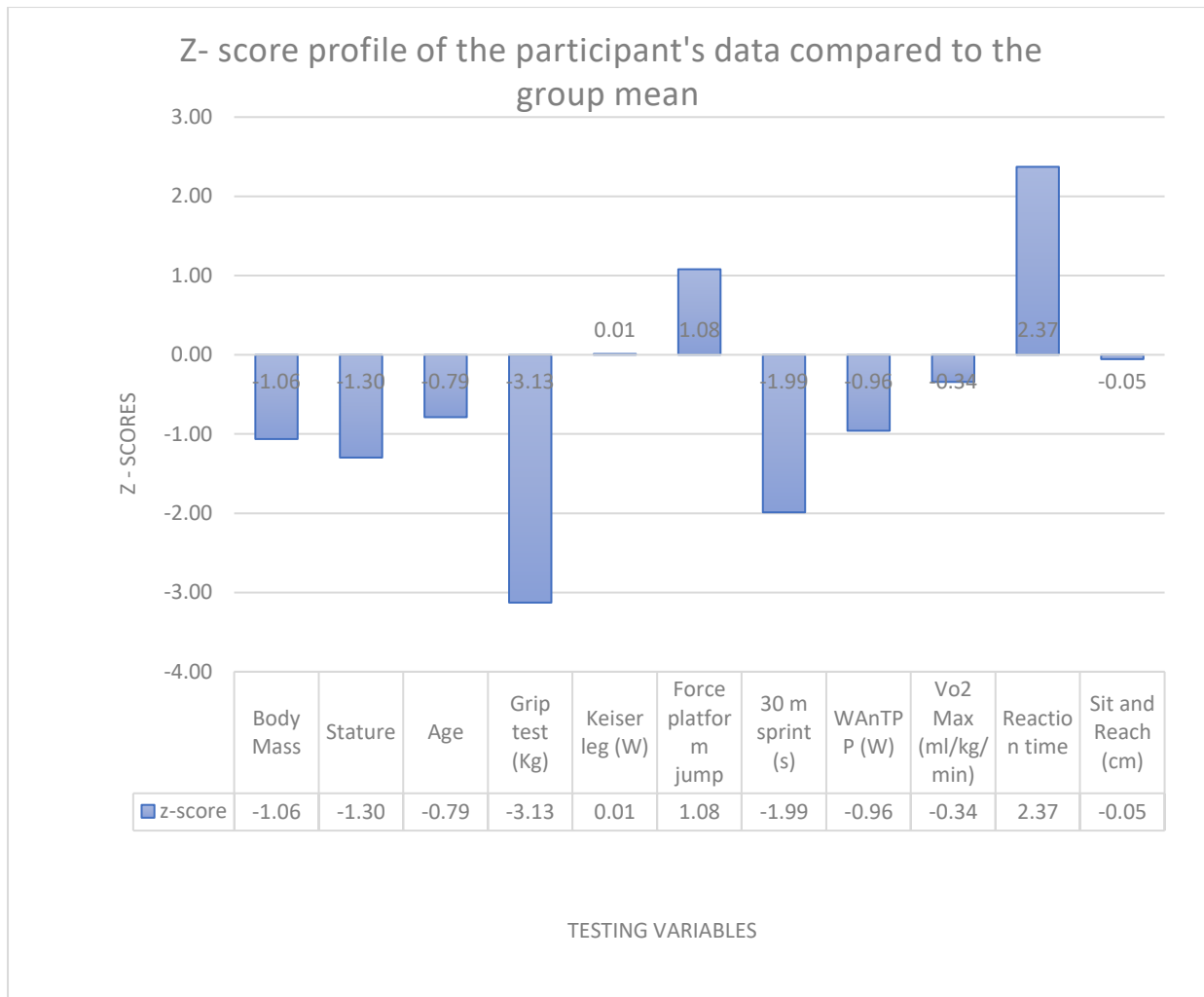


Figure No.1 - showing the z scores profile of the participant's data compared to the overall group.

The sit and reach test results for the participant displayed a negative z-score of 0.5, indicating a score below the average. The participant exhibited a positive z-score of 2.37 for their reaction time, suggesting that their reaction time was higher than the average. Regarding the Vo2 max, the participant had a negative z score of -0.34; compared to the mean score of all the participants, the participant's score was less. The Wingate anaerobic total peak power was below the mean score and had a z score of -0.96. In sprinting, having a faster time is the goal. The individual's negative z score of -1.99 for the 30-meter sprint, in this case, is considered positive and was 1.99 away from the standard deviation. The participant's force platform test was 1.08, with a positive z-score indicating a 1.0 standard deviation above the mean. The participant had a positive Z score of 0.01; this means that the participant's score was close to the mean score. The participant's grip test had a negative z score of -3.13, indicating that it is further away from the mean score and is 3.13 standard deviation away. The participant's age had a negative z score of -0.79, away from the mean score, and the body stature had a negative z score of -1.30 since the participant's height was less than the mean. The participant's body mass was -1.06, a negative z score compared to the group's standard.

Discussion

Anthropometric data for sprinting helps understand body composition. The participant's weight-to-height ratio is average, but building muscle mass can increase power and strength for generating more force. Abe et al. (2019) study found that reducing fat mass may have a greater impact on sprint performance than increasing muscle mass. A skinfold test can then determine the participant's body fat percentage. Regarding height, the participant is short, so working on stride frequency would be more beneficial since the stride length would be a disadvantage if competing with relatively taller females (Mattes, Wolff and Alizadeh, 2021).

Flexibility is an essential physiological dynamic because injuries are reduced, and stride length may increase with flexibility. The individual's sit and reach test score was 30 cm, which is considered fair for a female aged 20-29 based on normative data (Liguori, 2018). Wan et al. (2017) findings suggest that hamstring muscles with greater flexibility may have reduced muscle strains for a particular exercise, such as sprinting, and that flexibility may be a risk factor for a hamstring injury.

In a 100m race, timing and acceleration play a crucial role in achieving success, and the start and acceleration must be executed flawlessly to ensure victory. According to (Zhang, Lin and Zhang, 2021), top athletes have fast reaction times. The participant scored a positive z score away from the mean, and the participant scored 52 after tapping the blaze pods in a minute, indicating that she reacted to the stimulus in approximately 1.15s. Doing more reaction exercises can help enhance performance, although the client's reaction to the stimulus is good.

Sports events require different types of energy, and a 100m sprint relies primarily on anaerobic energy due to its short and explosive nature, requiring a significant amount of ATP without oxygen. However, it is still essential to consider Vo2 max, as studies show that changes in creatine content are linked to changes in tissue oxygen consumption. (Saks et al., 2000). Vo2 max is higher in long-distance runners than in sprinters (Wiriawan, Pd and Kes, 2020). According to a study conducted by De Aguiar et al. (2015), the sprinters had a mean of 51.5 +/- 2 ml kg min for the sprinters. Do Nascimento Salvador et al. (2016) conducted a study, and the average Vo2 max for sprinters was 57.9 +/- 2 ml kg min. Based on the cardiopulmonary exercise testing percentile chart from Axtell et al.(2018), the participant's Vo2 max is considered poor, which means it needs to be improved not only sports-related but overall general health. To improve Vo2 max, the participant should partake in sprint interval training. (Boullosa et al., 2022) imply that sprint interval training enhanced vo2 max and anaerobic performances.

The Wingate anaerobic power test determined the participant's total peak power, and it was below the average peak power of the group. According to the (Zagatto, Beck and Gobatto, 2009) research, 751.04 was the mean of athletes. In addition, Legaz-Arrese et al. (2011) conducted research, and they found that International Amateur Athletic Federation (IAAF) female athletes had a mean of 606 (w). Anaerobic capacity can be increased by specialised training that includes high-intensity intervals and sprints at maximum effort. This type of exercise improves the body's tolerance and buffering of lactic acid, enabling athletes to perform at higher intensities for a more significant amount of time.

The participant's force platform vertical jump test exceeded the group's mean. According to Haugen et al. (2020), athletes that participate in power and strength sports, such as sprinting, should have high values of a counter-movement jump. Jump squat training would help improve vertical jump. Marián et al. (2016) state that in 8 weeks, improvements were made in measures like countermovement leap, squat jump, maximum isometric squat force, and sprint time.

Although the participant's 30-meter sprint time is faster than the group's, it is still average (4.75 seconds) compared to female athletes. (Davis et al., 2000, p.125). Resistance sprint training is an effective way to increase speed, particularly during sprint training. Young, Benton and Pryor (2001) imply that weight sled training, weighted vest sprints and inclined sprints are exercises used to improve short speed and maximise speed. Cronin et al. (2008) found that sled towing and weighted vest training improve performance in the acceleration phase of the race.

Grip test

Based on the percentile rank standards by Montoye and Lamphiear (1977), the participant did not reach the required percentile rank. The participant should work on improving strength since it is a weakness. This can be achieved by partaking in upper body strength training by doing chest presses and weightlifting. Thomas and Burns (2016) found that High-Frequency Training (three sets, three times a week) and Low-Frequency Training (nine sets, once a week) chest press and weight training included both improved strength and lean mass.

Keiser leg press

The participant's leg power could benefit from improvement. Exercises like leg presses and squats can help increase strength and muscle mass. According to a study by Wirth et al. (2016), both of these exercises are effective in boosting strength, with squats being particularly effective. Eccentric exercises rapidly absorb force, which improves the stretch reflex ability and create more fast twitch muscle fibre while improving both force production and decreasing the risk of injury (Harris-Love, Gollie and Keogh, 2021).

Conclusion

To become a 100m sprint athlete, the client must concentrate on improving their entire performance. While their reaction time, 30m sprint time, Keiser leg press score, and vertical jump score were all great Z-scores, they needed to improve their flexibility, VO2 max, Wingate test, and grip test to compete with the finest sprint athletes in the world. The client can improve their performance by integrating plyometric exercise, resistance training, weightlifting, and eccentric exercises.

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Figure 1.2 shows the participant and group's raw data.