

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Introduction	15	
2. Method	20	
3. Results	20	
4. Discussion and Conclusion	35	
5. Presentation and Referencing	10	

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

University of Wales Trinity Saint David

BSc. Health, Nutrition and Lifestyle

BMSS5001 – Exercise Physiology

Assignment 2 (Case study report)

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Introduction

Sprinting has been described as one of “the most dynamic and vigorous running techniques” (Burkett, 2019). The 400m flat event has been deemed as a “prolonged sprint” (Thompson, 2017) and is sometimes called a “killer event” (Quercetani, 2005). This race is one of speed and power. Maximum sprint speed capability, speed endurance, and high lactic acid threshold to sustain speed are essential in one's triumph in this race (Ramadan, 2014). Technique and flexibility also play an important role in an individual's performance at this event. The 400m is mostly anaerobic in nature; however, the degree of contribution of the aerobic system has been under debate (Ramadan, 2014). Hanon et al. (2010) stated that the contribution of the anaerobic system is generally approximately 65% in 400m runners and even 75% in elite athletes. This variation can be due to differences in athletes' fitness (Ghosh, 2004).

For the first 6-10 seconds of maximal effort, the sprinter will mainly use the ATP-CP system. As more energy is needed when acceleration occurs, CP stored in muscles begins to deplete (Smith, Plowman and Ormsbee, 2022). The lactic acid system then predominantly takes over the production of ATP by rebuilding ADP from breaking down glucose. The lack of oxygen in this energy system allows pyruvic acids to form which is then converted into lactic acid that accumulates and contributes to muscle fatigue and movement efficiency if the aerobic system is not able to provide adequate oxygen to the muscles (Rønnestad and Mujika, 2013). Type II or fast-twitch fiber muscles are mainly recruited by sprinters and this energy system (Thompson, 2017). Type IIa (fast-twitch oxidative) is often preferred with the endurance aspect of a 400m sprint in mind (Kenney, Wilmore and Costill, 2022).

Kenney and company explained that type IIa muscles are both explosive and fatigue less compared to what is seen with type IIb muscles. However, this is also opinionated among different professionals. The major muscles involved in sprinting are the hip flexors, gluteus, quadriceps, and hamstrings. It is important that these muscles be able to provide relative strength and ratio differences between the hamstring and quadriceps should be taken into consideration. It is shown that persons with a higher hamstring-to-quadriceps ratio are more economical when running (Sundby and Gorelick, 2014). Parisi (2021) has also suggested that strengthening the fascia system can also improve strength and elasticity whilst reducing injury

risk. Other factors contributing to success at a 400m event include low body fat % (Abe et al, 2020), flexibility (Sundby and Gorelick, 2014), and tendon stiffness that increases contact force with the ground and velocity (Douglas et al, 2020).

This case study will look at a female student from a group of exercise physiology students and where she presently stands to compete as a 400m sprinter when compared to her classmates and well-trained athletes. She will be referred to as Participant B.

Method

Participant B would like to know how she stands physiologically amongst the class to be a 400m runner and what it would take to meet the required demands. To do this, primary research was conducted to assess the demands of the sprint event. The findings were then discussed with Participant B and the test to be conducted explained to allow informed consent. She was tested on three separate days. After the Par-q (Housh et al. 2016) was conducted to ensure that Participant B was okay to get involved in the tests required along with an informed consent form (Housh et al. 2016) her anthropometric data was taken along with her blood pressure using an automated BP monitor (Jungingen, Germany) (Housh et al. 2016). On the first day, strength, muscle endurance, and power. Respectively and in order of testing were as below:

Strength

A Takei hand grip dynamometer (Habdirect, Southam, UK) was used as outlined by Housh et al. (2016). For each arm, the palm was facing up and the elbows at a 90-degree angle; the dynamometer was squeezed for 3secs and the value was recorded. The test was then repeated two more times at 2 minutes intervals. The highest score for each arm was then added together.

The participant was asked to warm up for 5 minutes.

Muscle endurance

A 1-minute sit-up test of muscular endurance (Housh et al. 2016) was conducted utilizing a digital stop clock. From a lying position with the heel 18 inches from the buttocks and fingers

behind the ear, the subject was asked to make as many sit-ups with elbows to the alternating knee for 1 minute.

Power

Participant B's leg power was tested by a Keiser A300 leg press (Keiser, Fresno, USA). Sitting with both feet against the footplate at a 90-degree angle a series of leg presses was completed to failure. The subject was asked to push as fast and evenly as possible to full knee extension. They started with a low resistance which gradually builds based on their previous result until maximum resistance was reached.

On the second day of testing, blood pressure testing was repeated and the following test was conducted in the sequence listed below.

Speed

After a 5-minute warm-up, Participant B's speed was tested over a 30m distance utilizing light gates. The point of start was from a standing position. The subject started with their most comfortable leg on their count and the best of 3 attempts taken.

Flexibility

After allowing Participant B to recoup after 2 minutes, a sit and reach flexibility test was conducted (Housh et al. 2016). With their leg fully extended against the scale, Participant B was asked to reach forward as far as possible on 3 occasions with one hand on the other and the furthest of the scores recorded.

Allowing their legs to relax for about 1 minute, the hip flexibility was then tested. The subject was asked to lie on the floor and extend her leg with her knees fully locked and raise them as far as possible towards her head. The degree of flexion was then measured with a dynamometer one leg at a time.

The data was then entered into an Excel file and compared to the female participants in the group utilizing a z-score report. Participant B's data was also then compared to that of normative data and well-trained athletes where possible to make recommendations.

Anaerobic power output on final day

A Wingate test (INBAR et al. 1996) was performed on a Monark ergomedic 894E (Monark, Vansbro, Sweden), the subject was asked to cycle as fast as possible for 30secs in a seated position. Before the session, BP was taken and subject asked to warm up for 5 minutes.

Results

Participant B's anthropometric information along with her results from all testing variables can be found below in *Table 1*. Participant B has no known medical history, or sporting past and has a low physical activity level at the time of consultation.

Table 1: Testing variable results for Participant B

Anthropometric data		Fitness		Flexibility	
Age (Years)	26	WAnTPP (W)	616	Sit and Reach	33
Stature (cm)	177.3	WAnTAP (W)	404	Hip flex with goniometer:	
Body Mass (kg)	72.6	WAnTPD (%)	71	Right leg ($\square$)	89
		VO2 Max (ml/kg/min)	31.9	Left Leg ($^{\circ}$)	116
Speed		Strength		EE (Kcal/day)	2444.6
30m Sprint	5.46	Grip Strength (Kg)	36.6		
Endurance		Power			
Sit-ups (n)	21	Keiser Leg Press (W)	604.5		

A 20-degree angle difference was found between Participant B's right and left leg during the hip flexibility test. However, no significant difference was found in the power exertion on each leg after conducting the Keiser leg press test. Using normative data for female athletes extracted from Zupan et al. (2009) **Appendix A**, Participant B's peak power is below average.

In *Figure 1*, it can be seen what Participant B's score are like compared to her female classmates.

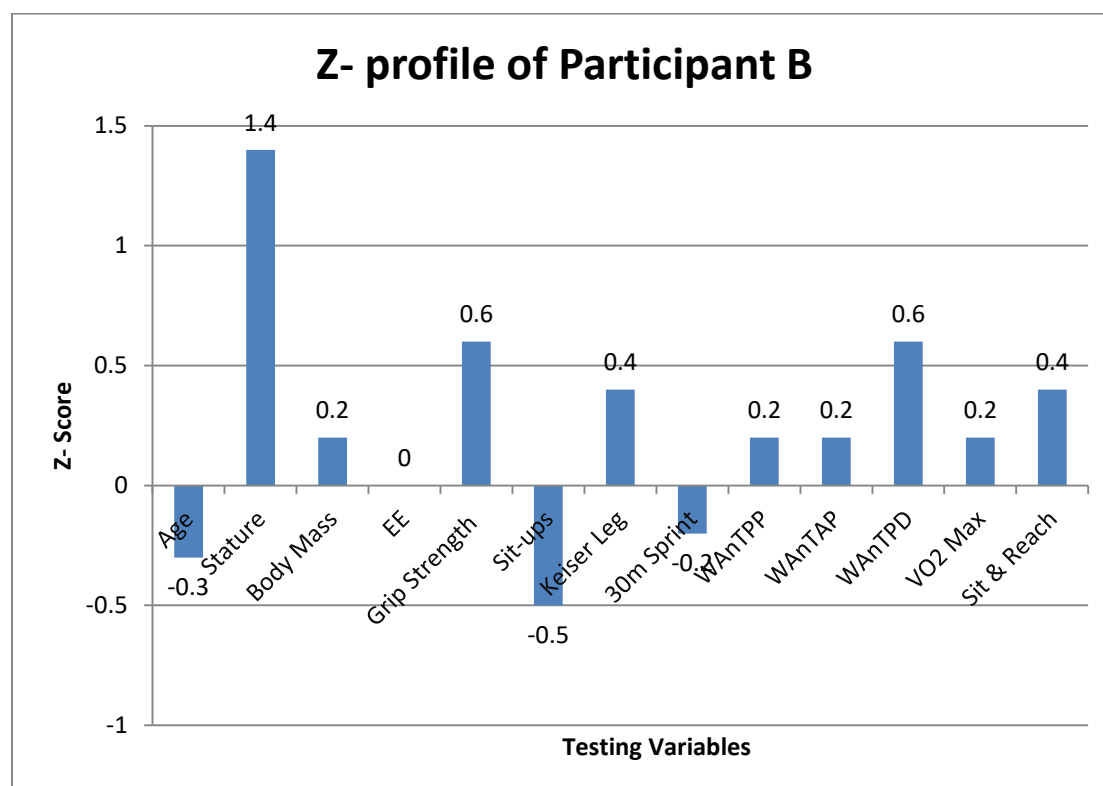


Figure 1. Z- profile of Participant B compared to her female classmates

Participant B appears to be amongst the tallest of the group being compared. Her energy expenditure is reported to be around the mean of the group $z=0$. Overall Participant B's scores are relatively close to the mean of the group given that her maximum $z=0.6$ and minimum $z=-0.5$. Even though she is close to the mean, she performs below the mean in sit-ups $z=-0.5$ and the 30m sprint $z=-0.2$. Participant B's strongest point when compared to this group is her strength.

Based on the normative data shown in **Appendix B** for the sit and reach test, Participant B is considered 90% more flexible than others of her gender and age.

Also comparing Participant B's sit-up test score against normative tables **Appendix C** indicates that her core endurance is below average for her age and gender.

Discussion and Conclusion

Compared to her female classmates, Participant B is close to the mean scores for the tested variables from body mass to speed, endurance, and flexibility. Despite this, she would not be classified as fit in many areas when compared to the normative data. Her overall fitness needs to be improved, however, for the sport of a 400m sprint; the areas of focus will be on power, speed, and anaerobic capacity. To develop endurance and improve performance it is important to build the core that was identified to be a point of weakness.

Participant B scored under average in the 1-minute sit-up test which can be a possible flag for developing lower back pain. However, her good range of movement is a good sign. Improvement in core strength can increase speed. While sprinting, the core helps to stabilize the body, facilitate movement and prevent injuries through force transfer. As someone inactive, working on the core is essential to effectively use force and power. Clark, Lucett and Sutton (2014) suggest stabilizing exercises such as planks and bridges may be used. Strengthening core exercises such as reverse crunches may be incorporated. Building the core improves concentric strength (force production) and eccentric strength (force reduction). Core power exercises such as rotation chest pass, soccer throw, and front medicine ball oblique throw can aid in the ability of an individual to generate more force quickly.

Despite no significant difference being seen in the power output between both legs during the Keiser Leg press, before specific training is carried out Participant B should be tested for difference in leg strength between both legs. Yeung, Suen and Yeung (2009) along with Davidson and McLean (2016) have expressed the need to assess the hamstring-to-quadriceps strength ratio as an imbalance here also causes injury. Hewett et al. (1999) mentioned that

females are more likely to have knee injuries. Rosene, Fogarty, and Mahaffey (2001) along with O'Sullivan, Presler and Tanaka (2022) later attributed to females being more quad-dominant. Exercises that can be used to enhance power and aid in strengthening the hamstring include plyometrics. It is known to improve the stretch and shortening cycle that is said to improve the running economy (Sundby and Gorelick, 2014).

Due to the percentage drop from peak to average Watts during the Wingate test, it can be speculated that Participant B possibly has a higher makeup of fast-twitch fibers which is good for sprinting. To improve her anaerobic capacity, she will need to do exercises that rely heavily on fast-twitch muscle fibers over short intervals and intense efforts that are above her lactate threshold. This includes high-intensity intervals and maximal sprints which allow the body to go to a state where it is producing the maximum energy it can through glycolysis. Over time, this type of exercise will allow the body to adapt or tolerate the lactate acid which in turns allows it to perform at that intensity for longer. Okudaira et al. (2019) suggest that sprint intervals with longer recovery time for less-trained athletes are ideal for anaerobic adaptations.

Reduced body fat % by at least 5% can help to improve performance by reducing the work needed to drive the body forward (Abe et al., 2020). From a biological standpoint due to her height and long legs that may permit longer strides. Plevnik et al. (2013) found that females of the same height and leg length finished their 400m test in 1s less than their male counterparts.

When compared to her classmates, Participant B stands a chance of completing a 400m sprint at the same time as the others considering most of her tested scores are close to the mean. Her scores indicate that she is unfit when compared to normative data but that is expected from a person who is not regularly active. The first step will be to stabilize, build and strengthen her core that will facilitate the building of muscle power and increase anaerobic capacity. These areas work together for overall performance improvements.

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APPENDICES

Appendix A

Categories	Peak power (W)	Peak Power (W/kg ⁻¹)	Anaerobic capacity (W)	Anaerobic capacity (W/kg ⁻¹)
Elite	>730	>11.07	>541	>8.22
Excellent	686-730	10.58-11.07	510-541	7.86-8.22
Above average	642-685	10.08-10.57	478-509	7.51-7.85
Average	554-641	9.10-10.07	414-477	6.81-7.50
Below average	510-553	8.60-9.09	382-413	6.45-6.80
Fair	467-509	8.11-8.59	351-381	6.10-6.44
Poor	<467	<8.11	<351	<6.10

Appendix B

Percentile Ranks and Normative Data for the Traditional Sit-and-Reach Test (cm)

AGE (y)		20-29		30-39		40-49		50-59		60-69	
Sex		M	F	M	F	M	F	M	F	M	F
Percentile rank	90	39	40	37	39	34	37	35	37	32	34
	80	35	37	34	36	31	33	29	34	27	31
	70	33	35	31	34	27	32	26	32	23	28
	60	30	33	29	32	25	30	24	29	21	27
	50	28	31	26	30	22	28	22	27	19	25
	40	26	29	24	28	20	26	19	26	15	23
	30	23	26	21	25	17	23	15	23	13	21
	20	20	23	18	22	13	21	12	20	11	20
	10	15	19	14	18	9	16	9	16	8	15

May be used for the traditional, backsaver, and V-sit tests. If values fall between the percentile ranks, interpolate the data. For example, if a male subject is 21 years old and achieves a result of 37 cm, then his percentile rank is 85.

Source: *Canadian Physical Activity, Fitness & Lifestyle Approach: CSEP-Health & Fitness Program's Appraisal and Counselling Strategy*, 3rd edition, © 2003. Reprinted with permission from the Canadian Society for Exercise

Appendix C

Female norms for the 1-Minute Sit-Up Test (number of correctly performed sit-ups).^{2,3} **TABLE 26.2**

Classification	Age (years)					
	16-25	26-35	36-45	46-55	56-65	66+
Excellent	55-44	54-40	50-34	42-28	38-25	36-24
Good	41-37	37-33	30-27	25-22	21-18	22-18
Above average	36-33	32-29	26-24	21-18	17-13	16-14
Average	32-29	28-25	22-20	17-14	12-10	13-11
Below average	28-25	24-21	18-16	13-10	9-7	10-6
Poor	24-20	20-16	14-10	9-6	6-4	4-2
Very poor	17-4	12-1	6-1	4-0	2-0	1-0

Appendix D

TABLE 23.2 Percentile ranks for sum of grip strengths (kg, right plus left) for females.

Percentile rank	Age (yrs)																
	10	11	12	13	14	15	16	17	18	19	20-24	25-29	30-34	35-39	40-44	45-49	50-59
90	30	37	44	49	65	60	58	61	59	63	61	67	65	66	64	64	57
80	25	33	40	44	50	54	53	54	55	59	57	62	60	59	58	57	52
70	22	30	36	41	48	49	49	50	52	54	53	57	57	55	54	53	48
60	20	27	33	38	44	45	48	47	49	50	50	53	53	53	51	52	45
50	18	25	31	36	41	43	43	44	46	48	48	49	49	51	49	49	43
40	17	23	28	34	39	41	41	42	43	46	45	48	47	49	47	47	40
30	15	20	26	32	36	38	39	39	39	42	42	46	44	46	43	44	38
20	14	17	22	30	32	36	36	36	36	39	38	43	41	43	40	40	34
10	10	12	18	26	27	31	33	31	31	36	34	37	36	36	36	34	30