

Case Study Report

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Abstract

Background: The 1500m is a sprint is a test of both speed and endurance, requiring athletes to balance their energy systems and physical abilities for optimal performance (Jiménez-Reyes *et al.*, 2022). There are certain physiological requirements needed to optimise for maximum performance in this event.

Objective: This study aimed to identify the physiological demands of the 1500m event to effectively evaluate a 1500m subject's performance qualities using test scores, which were compared with university students as well as 1500m athletes found in other research studies to provide training recommendations to maximise performance.

Methods: The study focused on 1 subject's data for tests relevant to the physiological needs of the 1500m sprint. Convenience sampling was used, 11 trained male subjects participated in testing (26.4 ± 10.5 y) (80.3 ± 15.4 kg) (179.3 ± 9.5 cm), they were recruited as students of the university. The data of this participant was compared to those of the subjects' and some normative data gathered from research literature.

Results: The athlete scored z-scores equal to that of the university students. They scored almost equally to the 1500m athletes of normative data.

Discussion: The athlete scored generally favourably in all variables, however what may have been a strong quality when compared to university students was not as significant when compared to national and international level 1500m athletes, e.g. VO₂max.

Conclusion: The athlete's scores suggest they are physically optimal for the 1500m event, with minor adjustments to training advised.

Keywords: 1500m Sprint, Middle-distance, Aerobic, Anaerobic, Physiological Demands, Performance

Introduction

The 1500m is a sprint is a test of both speed and endurance, requiring athletes to balance their energy systems and physical abilities for optimal performance (Jiménez-Reyes *et al.*, 2022). There are certain physiological requirements needed to optimise for maximum performance in this event.

Endurance is pivotal in the 1500m sprint with athletes relying predominantly on their aerobic energy system for sustained performance (Duffield *et al.*, 2005). By utilising oxygen, this system provides the necessary energy for maintaining a steady pace throughout most of the race, ensuring continuous muscle contraction and ATP production. Studies highlight the strong correlation between aerobic capacity, measured by VO₂ max, and performance in middle-distance events like the 1500m (Balasekaran *et al.*, 2021).

While the aerobic energy system primarily sustains the athlete throughout the majority of the 1500m race, the event also demands significant contributions from anaerobic energy systems during critical moments (Duffield *et al.*, 2005). 1500m runners need the ability to sprint during the start's acceleration and final sprint to the finish line (Jiménez-Reyes *et al.*, 2022), anaerobic glycolysis provides the necessary ATP for these short explosive efforts

without the need for oxygen (Smith *et al.*, 2023). However, the consequence of using anaerobic glycolysis is the lactate accumulation which can lead to muscle fatigue and discomfort, significantly impacting performance towards the final sprint (Dunst *et al.*, 2023). Therefore, the capacity to produce power during lactate buffering is also essential for maximising performance in the 1500m sprint initial and final moments.

Possessing a sufficient underlying capacity for power and the ability to produce it maximally can set one apart in middle-distance events. Interestingly, Hallam *et al.* (2022) found that anaerobic capacity and maximum sprint speed were less prominent in sub-elite middle-distance athletes. However, Jiménez-Reyes *et al.* (2022) found anaerobic power and maximal sprint speed to be significantly correlated with success in the same events in elite athletes. This may suggest that training for power output and maximal sprint speed may contribute to improving an athlete's performance considerably.

As the 1500m sprint uses both energy systems, success in performance may need a mixture of both fast and slow-twitch muscle fibre types. Fast-twitch fibers, renowned for their capacity for rapid force generation, are crucial for executing accelerations and the final sprint. Conversely, slow-twitch fibers, distinguished by their endurance characteristics and resistance to fatigue, play a fundamental role in maintaining a consistent pace throughout the race. Although scarce, literature has mentioned the significance of fibre type distribution in middle-distance performance (Rade Stefanović, 2013; Stellingwerff *et al.*, 2019; Hallam *et al.* 2022). Consequently, incorporating training methods to elicit adaptations in both fast and slow muscle fibers may be worthwhile for those seeking to maximise performance in this event.

When optimising training, one should also consider improving mobility in optimising running mechanics and overall performance. Adequate mobility in joints and muscles allows for a full range of motion, potentially having a positive effect on stride length to cover more distance with each stride (Cerrillo-Sanchis *et al.*, 2024). Improved flexibility and joint mobility can reduce the risk of injury and enhance running economy by minimizing energy expenditure during each stride (Caplan *et al.*, 2009). Furthermore, sufficient mobility aids in maintaining good posture and alignment throughout the race, which is biomechanically efficient for maximizing force transfer and propulsion (Van Oeveren *et al.*, 2024). Therefore, assessing and training mobility in one's training routines will likely improve running mechanics and ultimately optimizing performance in the 1500m sprint.

The existing literature suggests that to improve overall performance in the 1500m event, the athlete should optimise their aerobic capacity most importantly, train the lactic acid system whilst still having a capacity to accelerate effectively at the end of the race. Therefore, they

should improve their maximal short distance sprint speed and lower-body power with frequent training sessions that include mobility focused exercises.

Methods

Research Design

The current study evaluated data collected from various fitness tests which 21 university students had completed on a weekly basis throughout the academic year of 2023-2024. The study focused on 1 subject's data for tests relevant to the physiological needs of the 1500m sprint. The data of this participant was compared to those of the subjects' and some normative data gathered from research literature. All data was kept confidential on a personal computer via password protected software, all participant identities were anonymous.

Participants

Convenience sampling was used, 11 trained male subjects participated in testing (26.4 ± 10.5 y) (80.3 ± 15.4 kg) (179.3 ± 9.5 cm), they were recruited as students of the university. Written consent was obtained at pre-screening and all procedures were approved by the university research ethics procedure. Participants completed a Physical Activity Readiness Questionnaire (PAR-Q) and were required to test blood pressure and complete a ACSM pre-exercise screening algorithm. Participants were of varied levels of fitness and training status, some being footballers, runners, triathletes, bodybuilders and some recreational. None of the participants indicated any medical or injury history that would expose them to risks relating to any testing. The subjects were instructed to abstain from intense exercise for 48 hours prior to participating in any of the tests, to avoid underlying fatigue that may affect results.

Wingate Protocol

The Wingate Test is a 30 second test assessing anaerobic power using a bicycle ergometer (Kent, 2001), and was developed at the Department of Sports Medicine and Research of the Wingate Institute for Physical Education and Sport in Israel in the 1970's (Castañeda-Babarro, 2021). Being a maximal 30 second sprint, it is considered a 'gold standard' among measuring anaerobic power, with the most common version involving only the legs. The test took place in a university laboratory with 2 members of first aid trained staff present, due to the risk of nausea or injury, the bicycle used was the Monark 894E to align with protocol (Castañeda-

Babarro, 2021). The protocol allowed each participant to do a 10-minute warm up, cycling at 90w and with two 4sec sprints afterward, to prepare physically. The bike's resistance was set at 7.5% of the participant's BW. Three members of first aid trained staff were present, due to the risk of nausea or injury. The participants were instructed to remain seated for the duration for the test. The seat was adjusted for each subject, allowing for just short of full extension of the knee at the downstroke of pedalling. Then the participant would perform the 30s cycling test, they were told to 'go maximal' and were verbally motivated by other participants. Following the test, the subject would perform a cool-down with an unloaded cycle of for 5-minutes for a gradual recovery. The 2 variables measured were Peak Power (w) and Average Power (w).

VO2max Test Protocol

The maximal oxygen uptake (VO2max) is widely accepted as the criterion measure of aerobic capacity. The test took place in a university exercise laboratory with 2 members of first aid trained staff present, due to the risk of nausea or injury. In the conducted VO2max test on a treadmill, resting heart rate were recorded before attaching a heart rate monitor and breathing apparatus, including a mouthpiece and nose clip, for the collection of respiratory gas exchange data. The treadmill was calibrated according to manufacturer guidelines (Technogym Excite+ Run 600 Unity), and a warm-up period of 5-10 minutes at a comfortable pace preceded the test. A ramp protocol was employed, gradually increasing treadmill speed or incline every 1-3 minutes until participants reached volitional exhaustion or predetermined stopping criteria were met. Heart rate, blood pressure, perceived exertion, and respiratory gas exchange were monitored throughout the test. Following completion, participants underwent a 3-5 minute cool-down period, walking at a slow pace on the treadmill. Data analysis included calculation of VO2max using the highest 30-second average of VO2 values obtained during the test, normalized to body weight for comparison across individuals. Equipment cleaning and maintenance were performed according to laboratory protocols (UWTSD Physiology Laboratory Student Guide), and all relevant data were documented in a standardized format for analysis.

Body Composition Protocol

In the conducted body fat measurement using skinfold callipers, the equipment was set up by calibrating the callipers according to manufacturer guidelines, and a clean, well-lit area was prepared for measurements. Participants were prepared by wearing minimal clothing to expose

the skinfold sites and removing any accessories that could interfere with measurements. Skinfold thickness was then measured at specific anatomical sites, including the triceps, biceps, subscapular, and suprailiac, using standardized techniques. Each measurement was taken in duplicate, and the average value was recorded to minimize error. The sum of skinfold measurements was calculated, and body fat percentage was estimated using established equations or conversion tables. Data were documented in a standardized format for analysis and interpretation.

30m Sprint Test Protocol

To measure max sprint speed, the 30-meter sprint test was conducted inside a university sports centre where the 30m zone was measured and marked using an Apollo 30m measuring tape. Light-gates (Brower TCi Timing System) were set up at the start and finish lines, aligned and calibrated for accurate timing. A gymnasium crash mat was fixed to the wall behind the finish line to minimise impact upon deceleration. Participants underwent a 10-minute warm-up routine consisting of 5 minutes dynamic stretching, followed by 5 minutes of drills and 4 submaximal sprints before assuming the start position. One participant would begin the sprint when ready as the timer triggered upon passing the first light-gate, the participant sprinted maximally through the 30-meter track, until triggering the second light gates to record their sprint time. Two trials were conducted with an adequate rest interval between to minimize fatigue and ensure reliable data collection.

Sit and Reach Protocol

To measure flexibility, each subject individually performed the Sit and Reach Test. The subject warmed up by riding a stationary cycle ergometer for 5 minutes at 90w and by doing dynamic stretching exercises for 5 minutes. The subject would sit down with shoes off with full extension at the knee and with the feet no more than 8 inches apart with the heels touching the box. For the test, the subject extended the arms straight forward with fingertips even and palms down and reach forward along the measuring scale, holding the position for 2 seconds. This score was recorded on a worksheet and repeated for a total of three trials, with the most distant point reached to the nearest cm. If extension in both arms was uneven or if flexion at the knee occurred, the test was repeated.

Statistical Analysis

The group's mean scores for Wingate peak power (w), Wingate average power (w), VO2max (ml/kg/min), Body Fat (%), 30m Sprint Time (s), and Sit and Reach (cm) were used for analysis. These university students' mean scores were compared with to calculate a Z-score for the 1500m athlete's data, mean scores of normative data from existing literature were analysed for comparison without calculating a Z-score.

Results

The mean anthropometric data for the participants is shown in Table 1.

Table 1. Subjects' Anthropometrics

Variable	Mean	Std. Deviation
Age (yrs)	28.1	11.2
Body Mass (kg)	82.1	16.9
Stature (cm)	179.6	10.7

The 1500m athlete's Z-scores for the physical qualities are illustrated in Figure 1.

Power Output

The athlete's WAnT relative Average Power output is relatively equal to the mean of the group. Relative Peak Power output in the WAnT was higher compared to the mean of the group (Figure 1). Their relative Average Power was lower than the average 1500m athlete, whilst their relative peak power was higher (Figure 2).

VO2max

The athlete's VO2max was significantly higher than the group's mean score, this being the largest margin of difference of all variables (Figure 1). Figure 2 shows the athlete's VO2max was of an equal standard to international level 1500m athletes.

Flexibility

The athlete performed scored better than the group on all variables besides Sit and Reach (cm), however this was a -0.3 difference (Figure 1). The athlete's score for sit and reach is slightly higher than the mean score of collegiate level 1500m athletes (Figure 2).

Body Fat

Body fat percentage was lower than relatively equal to that of the group, this not being a significant difference (Figure 1.) The athlete's body fat percentage is equal to that of the normative 1500m athlete (Figure 2).

Sprint Speed

The athlete's 30m Sprint Time was slightly lower than the group's, however this difference is not significant (Figure 1). 30m sprint speed was excluded as a variable in Figure 2, due to a lack of research studies.

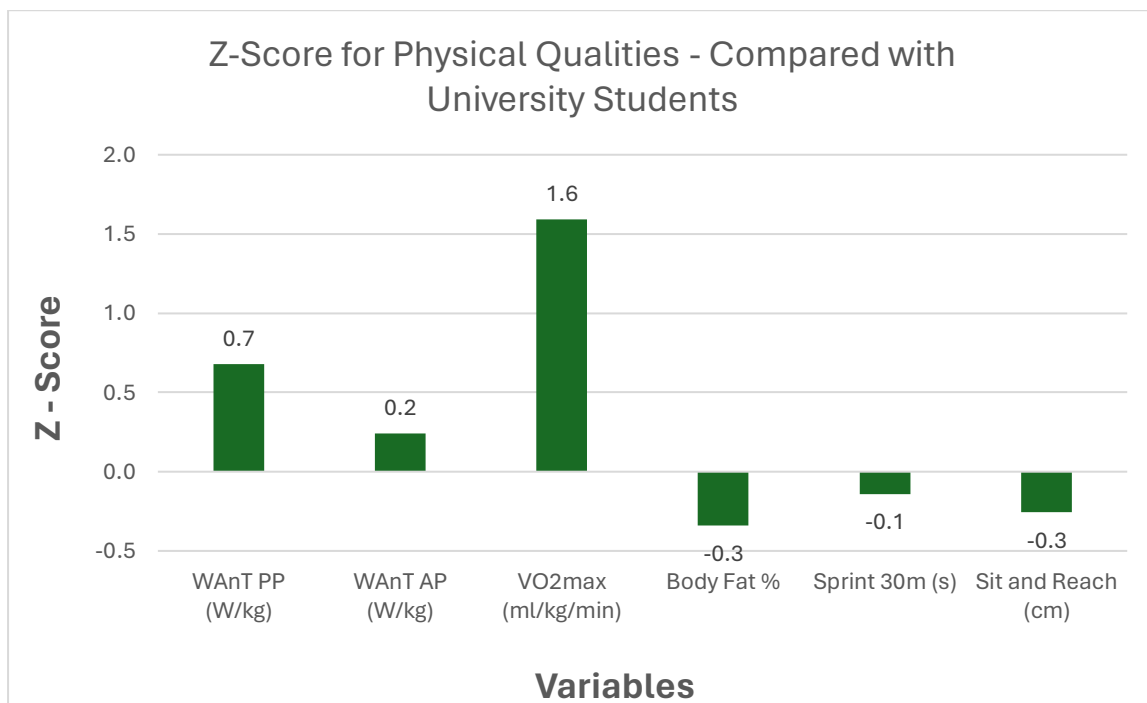


Figure 1. – Z-score for physical qualities when compared with the current study's subjects.

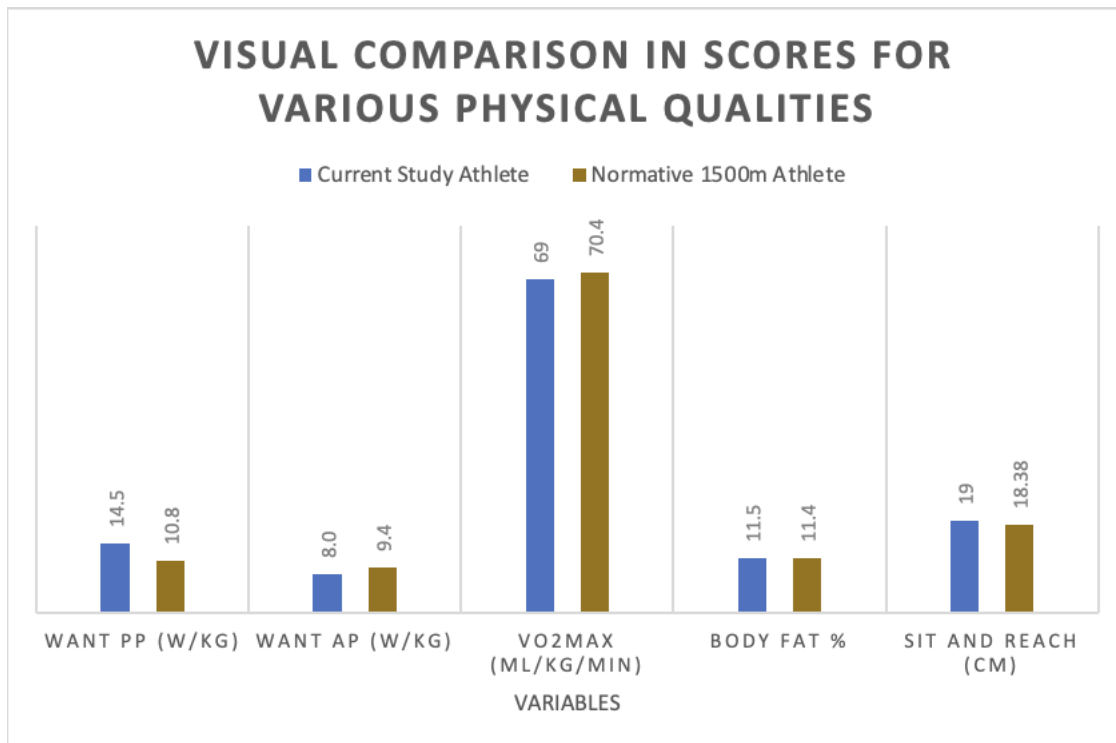


Figure 2. A visual illustration of the current study's athlete z scores compared with the mean score for 1500m athletes gathered from research studies.

Discussion

The current study found that when compared to well-trained male university students of various sports, the 1500m athlete scored positively in all variables notably the VO2max test. This suggests that their aerobic capacity is their strongest physical quality.

The athlete's relative power output is sufficient for the 1500m however they may improve how they distribute this power. The current study found the athlete had a peak and average power output equal to that of the university group (Figure 1), however when compared to international level 1500m runners (Legaz-Arrese *et al.*, 2011), the scores are significantly different (Figure 2). The athlete scored a much higher relative peak power than the runners however their relative average power was significantly lower than the standard set. This may contribute to their initial acceleration and final sprint, however they may benefit from focusing to improve their relative average power output as this is more relevant to the 1500m event, it being a predominantly endurance event (Duffield *et al.*, 2005).

The current study found the athlete to have an aerobic capacity sufficient for the 1500m event after VO2max assessment. Figure 1 shows the athlete scored significantly higher than the university group, however when compared to international 1500m-3000m athletes (Figure

2), they were within the mean score (67.7 - 70.4 ml.kg.min) (Blagrove, Howatson and Hayes, 2018). This suggests that their aerobic capacity, the most important aspect of the race is of sufficient standard for national and international level competing, Duffield *et al.*, 2005; Balasekaran *et al.*, 2021).

The athlete's body fat is likely optimal for the 1500m event. They had slightly less body fat when compared to the university athletes (Figure 1), additionally figure 2 shows almost no difference between the amount of body fat in the current study's athlete compared with Division 1 Collegiate 1500m athletes (Dengel *et al.*, 2020). This suggests the athlete need only to maintain their body fat percentage as it represents a good score for the 1500m event.

The athlete's initial sprint speed is sufficient for a general athlete of sub elite standard. The current study used the 30m sprint test to measure speed and scored slightly faster than the university students (Figure 1), however it was not possible to analyse their performance in relation to 1500m or other middle-distance runners due to a lack of research in the topic. This may suggest that they should keep aiming to improve sprint speed although occasionally.

The athlete's lower-body mobility is likely sufficient for the event. The current study compared their sit and reach score with the university athletes and found it to be almost equal (Figure 1). Likewise, when compared to normative data for collegiate 1500m runners, their results were almost equal (Figure 2). Therefore, training recommendations for the athlete would be to maintain their mobility practices and assess frequently to assure improvement.

Conclusion

This study aimed to identify the physiological demands of the 1500m event to effectively evaluate a 1500m subject's performance qualities using test scores, which were compared with university students as well as 1500m athletes found in other research studies to provide training recommendations to maximise performance.

The current study found that the athlete scored generally favourably in all variables, however what may have been strong quality when compared to university students was not as significant when compared to national and international level 1500m athletes, e.g. VO2max. Overall, its advised the athlete continue their current training practices however should focus on improving their average power output instead of peak power output to better specify training for the event.

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