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RESEARCH ARTICLE

Wingate anaerobic test reference value for lower limb of elite Indian men wrestlers

Rupak Kumar Singh[1], Anuj Kumar[2], Varad Vilas Apte[3], Amey Kolekar[4]

[1]Department of Physiology Armed Force Medical College, Pune, Maharashtra, India, [2]Sports Medicine Specialist, Department of Sports Science, Army Sports Institute, Pune, Maharashtra, India, [3]Biostatistician, Department of Sports Science, Army Sports Institute, Pune, Maharashtra, India, [4]Strength and Conditioning Specialist, Department of Sports Science, Army Sports Institute, Pune, Maharashtra, India

Correspondence to: Rupak Kumar Singh, E-mail: rupaksingh83@gmail.com

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ABSTRACT

Background: Wrestling as an Olympic sport was inducted in the modern Olympic Games from its very first edition. India has participated in Olympic Games for a long time. Anaerobic energy level is a deciding factor for adjudicating the final result in a wrestling match. Various studies found that the energy from the anaerobic metabolism sources can be more crucial than the aerobic power and capacity for success in wrestling. **Aims and Objectives:** The aim of this study was to develop reference values for the Wingate anaerobic test (WAnT) for peak power (PP), mean power (MP), and fatigue index (FI) in elite Indian wrestlers which can be used by coaches, trainers, or athletes as a reference of talent identification, conditioning, and enable more effective decisions to be made regarding training focus or rehabilitation status. **Materials and Methods:** A total of 76 highly trained elite Indian male wrestlers (age 23.3 ± 3.21 years, weight 73.19 ± 8.21 kg, height 170.12 ± 4.92 cm, and mean body fat % 12.59 ± 2.34) were volunteered for this study. All of them performed a 30s all out WAnT on cycle ergometer resisted at 0.075 kp/kg body mass (BM). **Results:** Mean values for PP and MP were 756.98 ± 107.19 and 555.17 ± 55.96, respectively. Mean relative PP and average power were 10.40 ± 1.48 and 7.61 ± 0.82. Mean FI was 49.84% ± 9.54%. Relative PP output >10.76, 9.69–10.76, and <9.69 W/kg was classified as high, medium, and low, respectively. Relative MP output >7.995, 7.33–7.995, and <7.33 W/kg was classified as high, medium, and low, respectively. **Conclusion:** Findings of this study emphasize the critical importance of developing Indian wrestlers' anaerobic power and capacity. The reference values were established in this study which can be used in different training and research programs to more accurately assess an athlete's level of anaerobic fitness and to monitor different changes resulting from anaerobic training.

KEY WORDS: Wrestling; Peak Power; Mean Power; Fatigue Index; Cycle Ergometer

INTRODUCTION

Wrestling as an Olympic sport was inducted in the modern Olympic Games from its very first edition. India has participated in Olympic Games for a long time, and wrestling has a unique spot among various Olympic disciplines in India. India has come a long way from just a participant to being a major contributor in the medal tally.[1] Modern-day wrestling involves competing in a demanding environment with repetitive actions which require very high-energy levels (e.g., attacks and counterattack) followed by alternate low-intensity submaximal work which comprises a brief pause.[2,3] A success in wrestling requires highly advanced capabilities of maximal strength, power, muscular endurance, anaerobic capabilities, speed, lactate tolerance and maximal aerobic

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power.[4] A wrestler requires higher physiological demands which are complex in nature.[2,3] To perform well during the competition, wrestlers are expected to physically dominate and clearly establish supremacy over an opponent.

Anaerobic energy level is a deciding factor for adjudicating the end result in a wrestling match.[2,5-7] The reason behind this is because the energy required for the crucial or final moments of the wrestling are mainly obtained from the anaerobic energy metabolism.[8] Horswill[2] and Yoon[3] reported that high-level anaerobic power and capacity are the utmost requirement of successful wrestlers. Mirzaei *et al*.[9] revealed that present international wrestling competition rules which include three rounds of 2 min with 30 s rest in-between have increased the requirement of higher anaerobic metabolism which also last for a longer period of time. They found that the energy obtained from the anaerobic metabolism can be more crucial than the aerobic power and capacity for success in wrestling. Bouts of wrestling need high-intensity actions, during which adenosine triphosphate (ATP) resynthesis for muscle contraction comes from anaerobic metabolism, due to which lactate production increases;[10] these results were also confirmed by measuring post-match blood lactate levels in wrestlers and boxers. Kraemer *et al*.[11] in their study on freestyle wrestlers were observed that after 5 min of competition, blood lactate concentrations increased up to 20 mmol/l.

In an anaerobic activity, energy coming by the utilization of anaerobic metabolism (oxygen is not utilized in this process). In general, these activities are of short length, that is, maximal effort goes up to 90 s, utilizing an effort till exhaustion.[10] Wingate anaerobic test (WAnT) has been widely used to evaluate the wrestlers' anaerobic capacities.[5,12-14] To perform WAnT, two most important energy sources are abundantly required. The first is the ATP-phosphocreatine (ATP-PCr) system, which lasts up to 10–15 s, during maximal effort,[10] and remainder of the maximum effort come from anaerobic glycolysis.[10] Therefore, WAnT is useful and gold standard to evaluate muscles' ability to work using both energy systems.

The certain parameters that WAnT assesses are lower body peak power (PP), average power, and drop of power, that is, fatigue index (FI).[15,16]In this test, participants have to cycle at maximal effort for 30 s against a fixed load that is around 7.5% of his or her body weight. The PP or in simple word the explosive power recorded is the maximum mechanical power produced by the participants during any 3–5 s interval of the test, ideally observed in the first 5 s. The anaerobic capacity, or average mean power (MP), is the total amount of work completed during the whole test duration. The lowest power output is an arithmetic mean of the lowest 5 s seen during the test; this is usually seen during the last few seconds of the test. Finally, FI is the percentage that expresses the decline compared to PP output. The capability to estimate these measurements precisely and specifically makes WAnT a valuable and gold standard test for coaches, athletes, and sports scientists.

Wrestling requires tremendous physical planning along with significant mental and emotional preparedness. One of the difficulties defined by the coaches, athletes, and sports researchers is to comprehend the physical and physiological elements to perform excellent in wrestling. In recent years, we find plenty of research done worldwide in sports physiology and other fields of sports science to identify the key performance indicators, in wrestling as well as other sports. However, there is a scarcity of research done on Indian wrestlers. According to our investigation and research until this study, there is no evidence of a computational compilation of data to compare normative values of the Wingate scores of Indian wrestlers. Therefore, the objective of this study was to develop reference values for the WAnT for PP, MP, and FI in elite Indian wrestlers. Anaerobic power data obtained by this study may be used by coaches, trainers, or athletes as a reference of talent identification, monitoring of training program, and strengthen them to make an effective decision regarding training or rehabilitation status.

MATERIALS AND METHODS

A cross-sectional study was conducted in a national level sports training institute in India in November 2019. Written informed consent was taken from the all the athletes participating in this study before testing and approval was obtained from the Institutional Ethics Committee.

Subjects: A total of 76 wrestlers aged between 20 years and 26 years were volunteered for this study. They were highly trained elite males' wrestlers. All wrestlers were tested during the pre-competitive phase of their training periodic cycle to ensure a high physical fitness and an optimal level of anaerobic performance.[17]

The inclusion criteria for this study were as follows:[18]
- Male sports person between ages of 18 and 30 years
- Minimum 4 years of high-level training experience and involved in the past 6 months of uninterrupted training
- Minimum national level participation.

The exclusion criteria for this study were as follows:[18]
- Hospital admission for more than 2 weeks in the past 3 months before start of the study due to any reasons
- Any acute injury/trauma/illness/unwillingness during the time of study.

The study was approved by the Institute's Ethical Committee. The consent forms were duly signed after mutual agreement between the researchers and the subjects.

To know the current state of medical status, activity, and training level, each participant completely filled two questionnaires designed accordingly. Based on these questionnaires and our exclusion and inclusion criteria, subjects were selected.

Body height and body mass measurement: Stadiometer was used to measure the height of the subjects (Cardinal Detecto, US). The subjects were instructed to give the height, barefoot, and with their head held in the Frankfort plane. Bodyweight was determined by a digital weighing scale (Omron digital weight scale, Kyoto, Japan) with subjects wearing only shorts.

Body composition: It was measured according to the guidelines proposed by the International Society for the Advancement of Kinanthropometry. Body fat% was estimated from an 8-site skinfold test (biceps, triceps, subscapular, suprailiac, supraspinal, abdominal, anterior thigh, and medial calf).

Testing Procedure

All the subjects were given an in-depth explanation about the study encompassing all the tests and research. The subjects comprehensively demonstrated the testing procedure for familiarization of the cycle ergometer. Each subject was encouraged to clear their doubts if any. The subjects were also interviewed by an investigator regarding the testing protocols. Subjects were randomly picked for testing.

Participants were advised to avoid intense exercise or any vigorous physical activity for 48 h before the testing. They were requested to continue their usual diet, remain euhydrated, and come for testing after 2 h post-consumption of light breakfast between 09:00 am and 12:00 pm.[8] To warrant this, an extensive dietary recall history was taken. The hydration status was determined by <1% (or 0.4 kg) variation in body weight recorded the previous day.

Monark cycle ergometer (894 E) with WAnT software was used to measure an absolute and relative (absolute power/body weight) PP, MP, and FI for the lower body.

Each participant completed a standard warm-up protocols and cycling for 5 min on the same cycle ergometer. The seat height of the cycle was so adjusted that during pedaling, the knee was flexed approximately 15 degrees in extended position.[19] Every participant was advised to pedal at a rate of 60–90 rpm against 1 kg resistance during the warm-up. Every participant was instructed to perform a "maximal effort" during the last 5 s of every minute of the warm-up, to imitate the actual test. Toe stirrups were used during entire period, that is, during both warm-up and actual test.

The resistance used for each participants during the testing was 7.5% of their own body weight,[12] and the determined resistance weight was placed in the basket.

At the beginning of the test, no resistance was applied, and participants were advised to maximize pedal speed approximately 3 s before initiation of the test to overcome the initial inertia of the flywheel. The test was initiated with the subject pedaling at maximal cadence against no load. The researcher's command of "Go" provides the auditory cue to participants. At the same time, the resistance basket was released and data collection started. The test is terminated after 30 s of all-out work. Following the test, a 5 min cool down period was given so they returned to approximately their pretest condition. The subjects were verbally encouraged throughout the test to maintain as a high pedaling rate and encouragement for all the players was the same.

Statistical Analysis

Statistical analysis was performed using RStudio Version 1.2. 5033. Statistical analysis included descriptive statistics with mean and standard deviation. Variables included for descriptive statistics were age, height, weight, PP, average power/MP, relative PP, relative average power, and FI.

Reference values were obtained using quantiles. Data points above 70 percentiles were classified as high. Those between 30 and 70th percentile were classified as medium and data points below 30 percentiles were classified as low for FI, PP, and MP.

RESULTS

The main objective of the study was to establish reference values for Indian male wrestlers.

A total of 76 Indian male wrestlers participated in the study. Their mean age was 23.3 ± 3.21 years, weight 73.19 ± 8.21 kg, height 170.12 ± 4.92 cm, and mean body fat % was 12.59 ± 2.34 [Table 1].

Reference values for PP, MP, and FI are presented in Table 2. Mean values for PP and MP were 756.98 ± 107.19 and 555.17 ± 55.96, respectively. Mean relative PP and average power were 10.40 ± 1.48 and 7.61 ± 0.82. Mean FI was 49.84% ± 9.54%.

Minimum and maximum values for PP and average power were (589.1, 1015) and (462.48, 733.43), respectively, whereas similar for relative PP and relative average power was (5.72, 14.85) and (3, 9.26), respectively.

DISCUSSION

Wrestling in India was always a popular sport since prehistoric times. It was popular as an exercise to stay physically fit in Indian subcontinent. Despite its ancient origins, wrestling failed to establish its supremacy in the sheer tally of medals at the Olympics for India compared to other countries. Globally, evidence suggests that modern-day wrestling utilizes anaerobic energy power as it's crucial element for success.[2,5,6,14]

Table 1: Descriptive statistics

Variables	Age	Height (cm)	Weight (kg)	PP (watts)	MP (watts)	Relative PP (w/kg)	Relative MP (w/kg)	Fat%	FI
Mean	23.34	170.11	73.19	756.98	555.17	10.40	7.61	12.58	49.84
SD	3.21	4.92	8.21	107.19	55.96	1.48	0.82	2.35	9.54

PP: Peak power, MP: Mean Power, FI: Fatigue index, SD: Standard deviation

Table 2: Reference value for peak power, mean power, and fatigue index, ***n***=76

Variables	PP (watts)	MP (watts)	Relative PP (w/kg)	Relative MP (w/kg)	FI
Low	<691.81	<523.47	<9.69	<7.33	<46.59
Medium	691.8–815.5	523.47–581.415	9.69–10.76	7.33–7.995	46.59–53.20
High	>815.50	>581.415	>10.76	>7.995	>53.20

PP: Peak power, MP: Mean power, FI: Fatigue index

Statistical results of this paper are closely related with different research articles published in different journals worldwide with smaller sample size. Studies investigating lower body power and FI from WAnT are summarized for elite senior male wrestlers [Table 3]. Table 3 reflects the PP, MP, and FI observed in current study and is compared with the values of previous studies. While comparing the reference values, it is necessary to observe the sample sizes of respective study. All studies were on elite senior wrestlers and testing procedures were the same, that is, on cycle ergometer for 30 s maximal effort. Hence, they all are comparable to the present study. Table 3 shows that the anaerobic powers, that is, relative PP (W/Kg) and relative MP (w/kg), of Indian national wrestlers are slightly lower than of wrestlers at the international level except one study.[20] PP is known as explosive power and it is a combination of strength and speed and the source of energy of these explosive powers is mainly the ATP-PCr system and little contribution from anaerobic glycolysis.[2,21] MP is anaerobic capacity of our body and depends mainly on anaerobic glycolysis and some amount on aerobic energy systems.[2,20,21] Reason of lower value of PP and MP of Indian wrestlers may be due to our training methodology which is not focused on developing these energy systems. Second possible reason may be the higher fat% of Indian wrestlers (12.58 ± 2.35). Ideally, a prospective wrestler is expected to have fat percent between 7 and 10% using proper nutritional plan and adequate endurance training. Top elite wrestlers usually have less than 10% body fat.[3] FI is the percentage fall in power output during testing. It is thought to represent the total potential to produce ATP through the immediate and short- term energy system.[21] Level of FI does not directly relate with an athlete's ability, but it can differentiate between two equally powerful athletes, that is, the athlete having low FI would perform better on the field.[22]Exceptionally very high value of FI is observed in Turkish national team wrestlers[23] may be due to higher PP and slightly higher weight.

Given the popularity and versatility of the WAnT all around the world's sports science laboratories, it is surprising that there is a limited work done related to the development of reference values for this test. Hence, the intent of this study was to develop reference values for anaerobic powers and FI for anaerobically well-trained elite male wrestlers for the WAnT. While doing this, athletes could perform WAnT and compare their results with other athletes on a scale from "low" to "high" [Table 2]. Coppin *et al*.[19]for male sportsperson of power sports, Zupan *et al*.[22]WAnT classifications for the NCAA Division IA athletes and Maud and Shultz[24] for physically active general population, have earlier attempted to develop reference values for the WAnT. However, no one has developed it, specifically for wrestlers. Although after comparing results of these studies with current study, the values of our study were slightly on the lower side.

Practical Applications

The aim of this study was to establish and set benchmark for Indian senior male elite wrestlers in lower body PP and anaerobic capacities from the WAnT. Although various studies have been carried out on wrestlers consisting WAnT, none have been established as a reference value for well-trained elite wrestlers. The data provided an anaerobic power status of elite Indian wrestlers to help coaches and athletes to judge their own value with international data. However, for a sport like wrestling where success can be dependent on numerous variables such as strategy and techniques, it is unfair to point out certain physiological parameters as performance predictors. The discretization proposed will allow coaches, sports scientists, and athletes to use these data as tools to assess anaerobic energy system status of the athlete and enable comparisons from a set of reliable benchmarks. Reference values from this study may also be used for monitoring progress of anaerobic training programs for male wrestlers and also during talent identification.

CONCLUSION

Anaerobic power and capacity are the most vital elements of peak performance. It also states a differentiating factor

Table 3: Wingate anaerobic test power comparisons for elite men wrestlers

Author	Year	Subject type	Peak power (w)	Relative PP (w/kg)	Mean power (w)	Relative MP (w/kg)	Fatigue index (FI)
Current study (*n*=76)	2019	23.3± 3.21 years in age, 73.19±8.21 kg in weight, elite Indian national wrestlers	756.98	10.40	555.17	7.61	49.84
Horswil *et al*.[2] (*n*=13)	1992	25.6±3.3 years in age 68.9±17.9 kg in weight, U. S. A. senior national wrestling team	-	10.9	-	9.4	-
Gacesa *et al*.[18] (*n*=17)	2009	20.64±3.36 years in age, 79.35±16.43 kg in weight, Serbian active athletes	765.53	9.76	516.11	6.63	-
Yoon *et al*.[3[(unpublished observations) (*n*=8)	2002	Korean national wrestlers	-	11.2	-	6.7	46.5
Kocak and Karli[19] (*n*=20)	2003	22–27 years in age, international level wrestlers	-	10.52	-	8.12	-
Hu¨bner-Wo´zniak *et al*.[20] (*n*=30)	2011	24.5±3.9 years in age, 84.4±13.2 kg in weight, Polish national team wrestlers	859	11.4	660	9.2	-`
Min Hu *et al*.[21] (*n*=14)	2011	22.9±3.4 years in age, 64.9±5.0 kg in weight professional national (China) wrestlers	817.5	12.6	534.5	8.2	-
Camcakal *et al*.[22] (*n*=20)	2014	21.6±2.5 years in age, 80.4±17.5 kg in weight elite Turkish national team wrestlers	1072.7	13.5	592.4	7.5	77.8

W: Watts, W/kg: Watts per kilogram, PP: Peak power, MP: Mean power FI: Fatigue index

in wrestlers, irrespective of their age, weight, and wrestling style. Even though various studies have been done before, very little research has been done over the surveillance of PP, MP, and FI in relation to program design and performance.

Findings of this study emphasize the significant importance of developing Indian wrestlers' anaerobic power and capacity. The reference values were established in this study for elite senior male Indian wrestlers. The current study can serve as a ballpark figure to utilize the normative data and implement the same to design different training methodologies and research programs. It may help to assess an athlete's level of anaerobic fitness and to monitor different changes resulting from training. The current study provides an insight into the necessity to warrant a further research on the global normative values on WAnT for PP, MP, and FI, especially in the anaerobic sports.

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