International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Study to Correlate Squat Jump Test & Wingate Cycle Ergometer Test to Assess Anaerobic Power in Young Adult – A Cross-Sectional Analytic Study

Dr. Raxit Kamlesh Voria[1], Dr. Pragna Gondaliya[2], Dr. Divya Sureshbhai Rathod[3]

[1]Assistant Professor, Smt. Shantagauri Rasiklal Shah (Rangwala) College of Physiotherapy, Hemchandracharya North Gujarat University, Kadi, Gujarat, India.
[2]P.G. Guide and Assistant Professor, MPT (Cardio-pulmonary conditions), Shree K.K. Sheth Physiotherapy College, Suarashtra University, Rajkot, India.
[3]Assistant Professor, Smt. Shantagauri Rasiklal Shah (Rangwala) College of Physiotherapy, Hemchandracharya North Gujarat University, Kadi, Gujarat, India.

ABSTRACT

BACKGROUND: Anaerobic energy is the important factor in day-to-day life. The squat jump is a variant of the vertical jump used to analyze the anaerobic power of the lower limb. The Wingate cycle test is considered the gold standard for the same. The need of the study is to check the correlation of power output of both.

METHOD: Total of 242 adults (female=112) with mean age of 21.5 ± 3.5 (SD) years from physiotherapy college & nearby areas were selected, and participants were included up till now. Peak anaerobic power was determined using Sayer's equations based on each subject's vertical jump height in centimeters (cm), body mass in kilograms (kg), and height in centimeters (cm). The participants performed the 30-second Wingate cycle ergometer test. Peak and mean anaerobic power (W) over the 30-seconds, were calculated by a computer program during the test.

RESULT: The data was analysed using SPSS software ver.26 which showed that data didn't followed normality, so Spearman rank test was used. The correlation was found to be strongly positive & statistically significant ($r = 0.82$, $p < 0.001$) of squat jump test & wingate test.

CONCLUSION: The squat jump strongly correlates with wingate cycle test. On the basis of the study a construct validity is also established for squat jump test. The squat jump test could be used for assessing the anaerobic power in young adult.

KEYWORDS: Anaerobic power, Squat jump test, Wingate cycle test, Peak power output, Sayer's Equation

INTRODUCTION

In the anaerobic system provides the energy during every kind physical activity. The essential energy

during every movement initiate with the anaerobic energy. Anaerobic energy system is the source of emergency-response system in the body. During an emergency, the response activate the majority of muscle groups are activated for the activities like sudden jump, stair climb & avoid obstacles etc. [1]

During normal development, the musculoskeletal system also progress which results into better anaerobic power generation during physical activities. [1] It is because of the children has underdeveloped glycolytic abilities when compared with adults. The muscle fiber increases up to 3.5 folds in girls & 4.5 folds in boys from childhood to adulthood. [2].

The Wingate cycle ergometer test (WCET) and squat jump test (SJT) have been commonly used tests to assess anaerobic power in athletes for the purpose of providing important information of anaerobic components of athletes energy system for various sports.[3,4]

The intensity and duration of all activities rely heavily on anaerobic metabolic pathways in the starting phase, namely the ATP-PC pathway and the glycolytic pathway. Previous researchers indicated that, during a 30-second Wingate Anaerobic Test, the energy contribution of the ATP-PC pathway is 28%, of the glycolytic pathway is 56%, and of the aerobic pathway is only 16%. Due to the specificity of the Wingate Cycle Ergometer Test for measuring components of anaerobic capacity, it would seem logical to use this test to measure anaerobic power. [5]

The SJT is widely used as filed tests for assessment of explosive strength of lower limbs in many sports. Such methods are frequently studied considering their confidence and validity in volleyball and football players. [3,6]

During a squat jump test, the aim of the performer is to attain maximum vertical displacement of the body's centre of mass (i.e. vertical height) in each consecutive jump over a period of time. Since the vertical displacement during a jump is mainly dependent on the muscular power output during the push-off phase from squat position, the measurement unit used to express Squat jump test output i.e. peak power expressed in Watt, this can be easily estimated with the formula described by Sayer's equation.[7,8]

Bosco et al. reported that the peak power output during the squat jump test is achieved during the first 15 seconds and then declines progressively until the end of the test. Additionally, the peak power output for the first 15 seconds period has been found to be highly correlated (r = 0.86) with fast twitch muscle fiber distribution (FT), while the power output during the successive 15 seconds periods demonstrated a lower correlation with FT (15-30s, r = 0.72). During a SJT, peak power output required to attain maximal jump height and complete a single test is reached between one and two seconds which suggests that only the adenosine triphosphate- phosphocreatine (ATP-PC) energy system is utilized.[3,9]

There are limited studies shows correlations of squat jump test with Wingate cycle ergometer test to measure anaerobic power in normal young adults. So, the need of study was to correlate squat jump test with Wingate cycle ergometer test as a method to assess anaerobic power in normal young adults.

METHODOLOGY

Ethical Approval: Was obtained from the Institutional Ethical Committee prior to the study.

Study design: A Cross-Sectional analytical study

Source of data: Physiotherapy colleagues & nearby by community area of Rajkot

Study duration: 6 months.

Sampling technique: Convenient sampling.

Sample size: n=242 (using power analysis) considering level of significance 5% and power of study 90%.

SELECTION CRITERIA:

INCLUSION CRITERIA	EXCLUSION CRITERIA
1. Subjects willing to participate. 2. Age group: 18 to 25 years. 3. Both males and females. 4. PAR-Q was taken	1. Subjects associated with any kind of weight loss programme. 2. Any recent orthopaedic surgery in lower limb within 1 year. 3. Subjects with cardiopulmonary, neurological and systemic illness. 4. Subjects undergoing any routine treatment protocol (medical & surgical).

PROCEDURE

In the study 250 subjects were recruited from the different areas of community with prior permission from school's respected Principals and chairman of the school with a permission letter. The subjects were screened for inclusion and exclusion criteria and among them 242 subjects met the criteria and were included in the study. The subjects were explained about the purpose of the study. If the subjects were willing to participate, their informed written consent was taken with proper explanation of details in it. Once the subjects gave their written consent, name, age, gender, height weight, PAR-Q & was filled in the assessment form. A proper history about their occupation, medical, drug, surgical and personal history was documented. Physical examination was done for each patient. Before the history and examination part the benefits, aims, objectives, and purpose of the study were clearly explained to the subjects. In examination, measurements like height, weight, standing height (with hand raised) were measured. Study duration was of 2 days for each participant.

Day 1:

Squat Jump Test (SJT):

- Prior to the vertical jump test, the athletes were led through an 8-10-minute warm-up. The participant's tip of middle finger was marked by therapist.
- Participants were asked to stand aside of the wall, keeping both feet remaining on the ground, reaches up as high as possible with one hand and marked the wall with the tips of the middle finger (P1).
- From a static position the athlete was asked to jumped as high as possible and mark the wall with the chalk on his finger (P2).
- The distance between P1 and P2 was measured and recorded by the therapist. The test was repeated 2 times.
- Best of three of recorded distances was considered and those values were used to assess the participant's performance by using Sayer's equation. [7]

Sayer's Equation:

Peak Power (W) = {60.7 × Jump Height (cm)} + {45.3 × Body Mass (kg)} – 2055 [7]

Day 2:

The Wingate cycle ergometer test (WCET):

- The Wingate cycle ergometer test was performed on a computerized Monarck Cycle ergometer (Monarck ergomedic 894E [tm]). The athletes were asked to perform a warm up for 10 minutes. To eliminate the possibility of fatigue after the warm up, a brief rest period followed by the warm-up

before testing was given.

- The seat height was adjusted in such a way that so that no more than 5oof flexion was possible when the leg was fully extended. The data for each subject were entered into the preinstalled Wingate Power software program.
- Prior to the initiation of the test, the pre-determined workload was placed in the ergometer's basket. The resistance was calculated as 7.50 % of the subject's body weight.
- Each subject pedalled the cycle without resistance before test begun for 2 minutes to building up to
- maximal revolution per minute to overcome the initial inertia of the ergometer. Once the required pedalling speed as calculated was reached, the resistance was added instantaneously by automatic dropping of the weight rack by the machine.
- Peak power and mean power were calculated and recorded in watts (W) using software power program.

Figure 1: Squat hold position in squat jump (one hand raised)

Figure 2 : Starting Position for squat jump (hip-knee forming 90-90)

Figure 3: Participant sitting on the Monarck cycle ergomedic 894E [tm]

FLOW OF THE STUDY

Ethical clearance was obtained from the institutional ethical committee prior to the study.

↓

Initial examination was done for 250 subjects in community.

↓

Subjects were screened for inclusion and exclusion criteria.

↓

242 subjects according to inclusion and exclusion criteria and willing to participate were included in the study.

↓

Proper explanation was given to the subjects and an informed consent form was obtained from them.

↓

Height, Weight & Standing height measurements were measured by the therapist.8-10 mins warm-up & then test were performed

↓

Squat jump & wingate cycle test was performed with 2 trails, the anaerobic power was calculated using Sayer's Equation. Best of two was considered

↓

The data of SJT & WCET of anaerobic power was analysed using SPSS v.26 software.

STATISTICAL ANALYSIS

Statistical analysis was done by using SPSS 26 version for windows software. Spearman's rho test was used to determine the degree of correlation between peak power of squat jump test and Wingate anaerobic test.

RESULTS

The current study was conducted to find out the correlation of squat jump test with wingate cycle ergometer test in adult participants. Total 242 subjects were included in this study who met inclusion criteria.

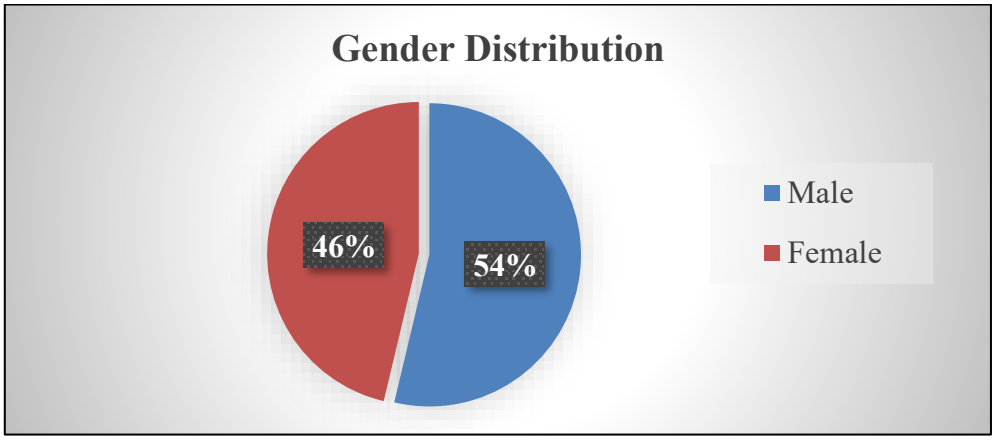
Data analysis was done using Statistical Package for Social Science Version 26 (SPSS V.26) and Microsoft Excel 2021. Normality of data was analysed with Kolmogorov-Smirnov test.

Table 1: Descriptive Statistics of Demographic Data

DEMOGRAPHIC DATA (N = 242)	MEAN ± SD
AGE (in years)	21.5 ± 3.5 years

Interpretation:

Table 1 shows Mean ± SD of Age in years of adult participants.



Graph 1: Gender Distribution

Interpretation:

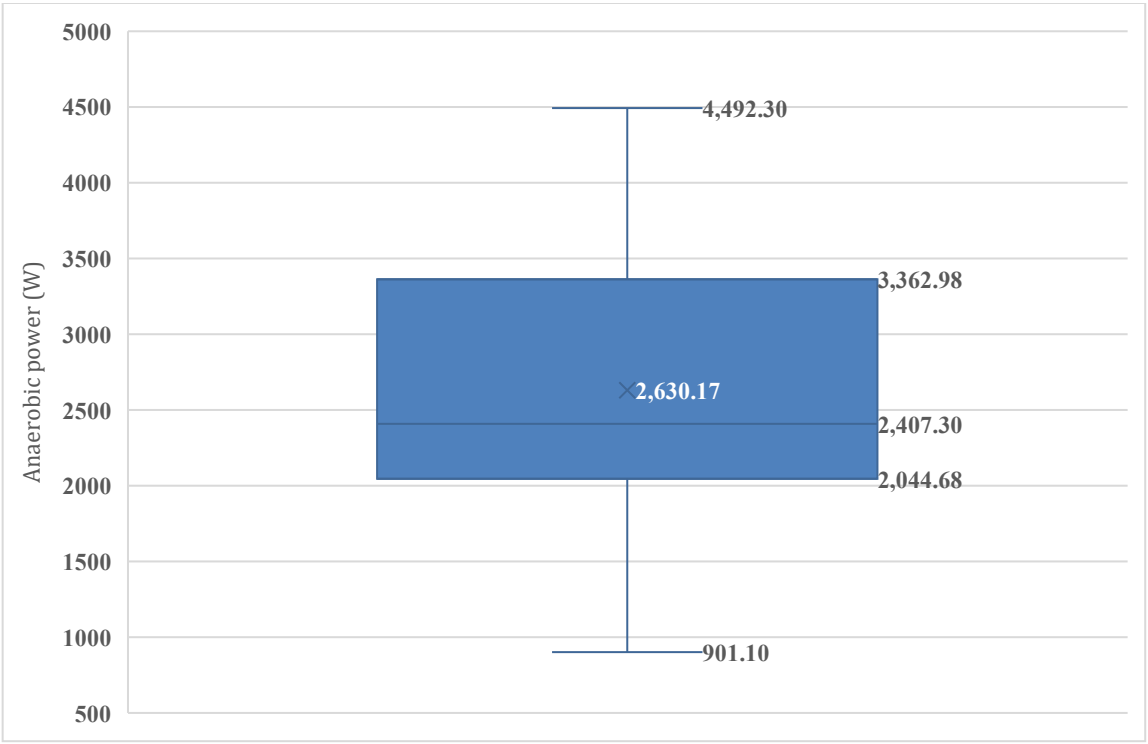
Graph 1 shows the gender distribution of 242 participants among which it includes 54% (130) males and 46% (112) females.

Table 2: MEAN ± SD of Peak power (W)

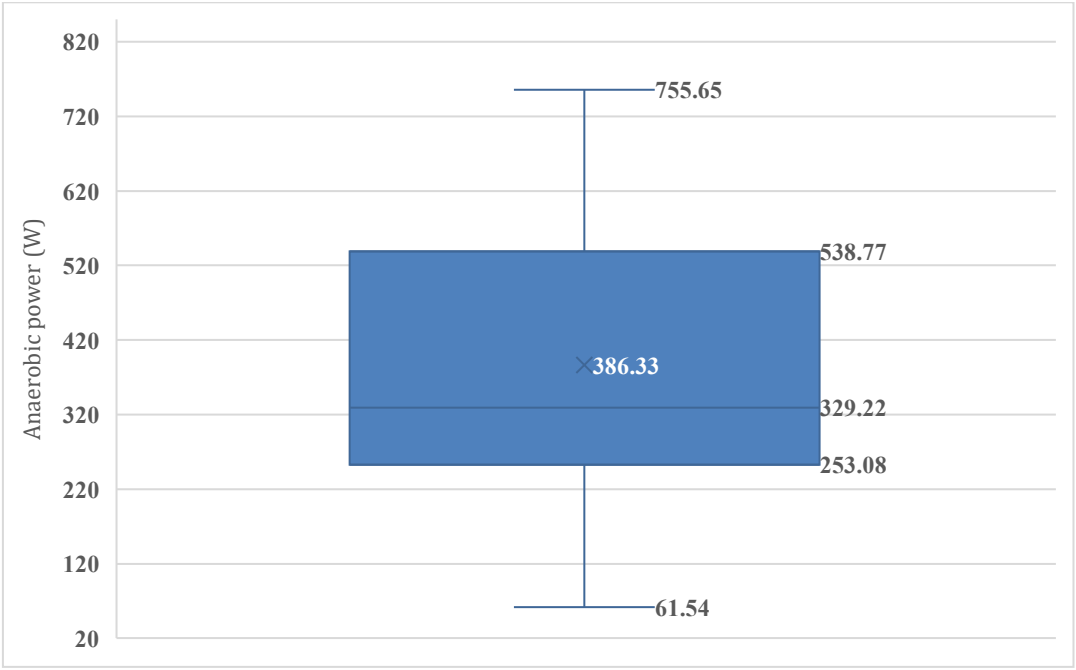
OUTCOME MEASURES	MEAN ± SD	Median (IQR)
SJT peak power (W)	2630.172 ± 909.94	2407.3 (1306.63)
WCET peak power (W)	386.33 ± 193.88	329.22 (279.78)

Interpretation:

The table no.2 shows the Mean ± SD & median with IQR of peak power of squat jump test & wingate test.



Graph 2: Box & whisker chart for squat jump test



Graph 3: Box & whisker chart of wingate cycle ergometer test

Interpretation:

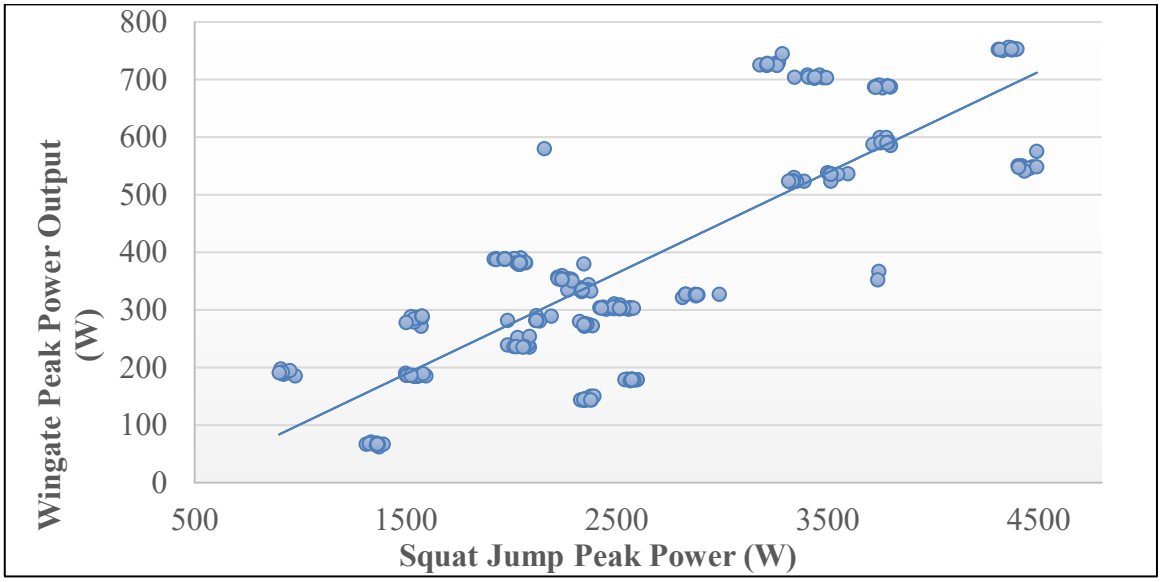
Graph 2 & 3 represent the box & whisker plot of squat jump test & wingate test.

Table 3: Correlation of peak power of squat jump test & wingate test in adult

Spearman's rho test	Squat jump peak power (W)	Wingate peak power (W)
SJT peak power (W)	1.000	0.821
WCET peak power (W)	0.821	1.000

Interpretation:

The table 3 shows that there is a very positive correlation of squat jump peak power & wingate peak power in adult person.



Graph 4: Scatter-plot showing correlation of squat jump & wingate test

DISCUSSION

The results showed that there is a strong correlation between squat jump test & wingate cycle ergometer test which is statistically significant (rho=0.821, $p \leq 0.05$) in adult, thereby supporting the experimental hypothesis. These findings demonstrate validity of squat jump test as a field test as a measure to assess anaerobic power in adult participants.

Squat Jump and Wingate cycle ergometer test power tests rely mostly on ATP/PC energy system contributions to produce/sustain maximum anaerobic power. Also, weight of the body had a considerable impact on performance on these two tests. The heavier subjects in the current study had higher anaerobic power outputs on both the Squat Jump and Wingate cycle ergometer tests. Previously, the squat jump and Wingate cycle ergometer tests have been administered to athletes and recreationally active individuals to assess anaerobic contributions, and are considered relatively valid and reliable as suggested in the literatures.[3]

The result of this study is similar to other studies done to asses the anaerobic power in both SJT and WCET. The maximum correlation obtained (r=0.821) in anaerobic power was greater that recently reported by **Parul Rakholiya et al**.[6]

In a study done by **Parul Rakholiya et al & Purvi Changela et al** found that there was a positive correlation (Population= football players, rho=0.220, $p<0.05$) (Population= basketball players, rho=0.759, $p<0.05$) between squat jump test and wingate cycle ergometer test in football players. The result accepted that the squat jump test is a valid field measure of anaerobic power instead of laboratory based test in sports players.[3,6]

The limitations of the study are some participants didn't seriously took the test and didn't gave their best outcome and also the sample size was less for participants of this age group. Hence its recommended in future studies to be done with a larger sample size, the gender comparison can be considered in future studies, also can be done in different age group populations (children, teenager etc).

CONCLUSION

The study concludes that, based on the analysis of 242 adult participants the alternative hypothesis (H^a) is accepted as there is a statistically significant correlation between SJT and WCET at the 0.05 level.

ACKNOWLEDGEMENT

The authors thank the participants sincerely for their enormous support and cooperation in our study. We thank our Principal, Senior faculties, Family, Friends and Institution for their guidance.

REFERENCES

1. Cahill BR, Misner JE, Boileau RA. The Clinical Importance of the Anaerobic Energy System and Its Assessment in Human Performance. Am J Sports Med 1997;25(6):863–72.
2. Van Praagh E. Development of Anaerobic Function during Childhood and Adolescence. Pediatr Exerc Sci 2000;12(2):150–73.
3. Changela PK, Bhatt S. The Correlational Study of the Vertical Jump Test and Wingate Cycle Test as a Method to Assess Anaerobic Power in High School Basketball Players.
4. Hoffman JR, Ratamess NA, Faigenbaum AD, Mangine GT, Kang J. Effects of Maximal Squat Exercise Testing on Vertical Jump Performance in American College Football Players. J Sports Sci Med 2007;6(1):149–50.

5. Coppin E, Heath EM, Bressel E, Wagner DR. Wingate Anaerobic Test Reference Values for Male Power Athletes. Int J Sports Physiol Perform 2012;7(3):232–6.
6. Rakholiya P, Gadesha A. A Study to Correlate the Vertical Jump Test and Wingate Cycle Test as a Method to Assess Anaerobic Power in Football Players. Indian J Public Health Res Dev 2020;11:538:544.
7. Sayers SP, Harackiewicz DV, Harman EA, Frykman PN, Rosenstein MT. Cross-validation of three jump power equations. Med Sci Sports Exerc 1999;31(4):572–7.
8. Theodorou A, Paradisis G, Panoutsakopoulos V, Smpokos E, Skordilis E, Cooke CB. Performance indices selection for assessing anaerobic power during a 30 second vertical jump test. J Sports Med Phys Fitness 2013;53(6):596–603.
9. Bosco C, Luhtanen P, Komi PV. A simple method for measurement of mechanical power in jumping. Eur J Appl Physiol 1983;50(2):273–82.