

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/275155608>

# Squat one-repetition maximum profile of UPSI-MASUM athletes: Steps towards proper strength training prescription and monitoring

Conference Paper · May 2015

CITATIONS

0

READS

248

5 authors, including:



**Nur Ikhwan Mohamad**

Universiti Pendidikan Sultan Idris (UPSI)

48 PUBLICATIONS 283 CITATIONS

SEE PROFILE



**Lye Wei Wan**

Universiti Pendidikan Sultan Idris (UPSI)

1 PUBLICATION 0 CITATIONS

SEE PROFILE



**Raiza Sham Hamezah**

Universiti Pendidikan Sultan Idris (UPSI)

4 PUBLICATIONS 0 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



Stretching [View project](#)



Badminton [View project](#)

## **SQUAT ONE-REPETITION MAXIMUM PROFILE OF UPSI-MASUM ATHLETES: STEPS TOWARDS PROPER STRENGTH TRAINING PRESCRIPTION AND MONITORING**

**Nur Ikhwan Mohamad**

*Physical Conditioning Laboratory, Faculty of Sports Science & Coaching, Sultan Idris Education University  
nur.ikhwan@fsskj.upsi.edu.my*

**Nicholas Garaman Abas**

*Physical Conditioning Laboratory, Faculty of Sports Science & Coaching, Sultan Idris Education University  
xavierfreda@yahoo.com*

**Christopher Jawum**

*Physical Conditioning Laboratory, Faculty of Sports Science & Coaching, Sultan Idris Education University  
topfa89@gmail.com*

**Lye Wei Wan**

*Physical Conditioning Laboratory, Faculty of Sports Science & Coaching, Sultan Idris Education University  
lyeweiwan@ymail.com*

**Raiza Sham Hamezah**

*Physical Conditioning Laboratory, Faculty of Sports Science & Coaching, Sultan Idris Education University  
raiza.sham@yahoo.com*

### **ABSTRACT**

Main aim of this study is to assess lower-limb maximum strength capability of UPSI-MASUM athletes via the 1repetition maximum half-squat exercise. Ninety-two male and female from various sports (8 different sports) UPSI-MASUM athletes had voluntarily participated in this study. Results of this study indicated that overall average maximum load lifted is  $66.40 \pm 27.24$ kg. Separated based on gender, male athletes (n=40) average maximum load lifted is  $89.76 \pm 18.02$ kg, and female athletes (n=52)  $48.42 \pm 17.83$ kg. Comparison with typical average maximum load lifted by college level athletes in previous study indicated that UPSI-MASUM athletes' performance is much lower than it should be. It than can be concluded that UPSI-MASUM athletes still need to improve more in term of physical strength capability. Whatever current performance in their own respective sports can be concluded achieved without much contribution from proper level of muscular strength. It is than predicted that with proper strength and conditioning program UPSI-MASUM athletes can perform better in the future. In practical, it is also suggested that proper performance monitoring program should be in place, such as 1-RM test to assess performance increase or decrease from time to time.

### **KEYWORDS**

1-repetition maximum, muscular strength, varsity athletes, monitoring

## **1. INTRODUCTION**

Prescribing strength and conditioning program without taking into consideration on how the performance increment or decrement will be monitored during the process of the training, will only meant the end-result is more dependable on luck, rather than well-structured and planned program.

In prescribing a strength training program, many variables involved. Variables include number of sets, number of repetitions, load to be lifted, rest in between sets and time muscle under tension and many more (Kraemer & Ratamess, 2004; Silva, Oliveira, Fleck, Leon, & Farinatti, 2013). When prescribing a strength training program based on load that should be lifted, the amount of load is prescribe based on certain percentage out of maximum load able to be lifted by an individual (Mohamad, Cronin, & Nosaka, 2012). In order to know the maximum ability certain individual able to lift, a test need to be conducted. One of the widely used tests administered to determine maximum lifting capability is the one repetition maximum test or commonly known as 1-RM test (Desgorges, Berthelot, Dietrich, & Testa, 2010). There are several types of 1-RM protocol available, but the most commonly used in any research set-up related to strength training study are the 1-RM protocols as endorsed by the National Strength and Conditioning Association, USA (NSCA). NSCA provided two methods to assess 1-RM ability. One is by the prediction method; in which athletes or subject perform certain number of repetition with sub-maximal load, and based on that 1-RM ability will be predicted using mathematical formula (Morales & Sobonya, 1996; Reynolds, Gordon, & Robergs, 2006). Second to this, and most accurate, is the actual 1-RM test, in which athletes or subjects will attempt one repetition maximal lifting (Ritti-Dias, Avelar, Salvador, & Cyrino, 2011). Only loads that able to be lifted once (and the second attempt failed) will be counted as the 1-RM ability of the athletes.

With 1-RM ability known, strength coaches will be able to prescribe the amount of load need to be lifted in each training session accurately. The amount of load that should be lifted is typically based on the athlete's periodization phases. Strength training basically follows the periodization method as introduced by Tudor O. Bompa, where each phases have their own specific objectives, such as anatomical adaptation phase, hypertrophy phase, maximum strength phase and power phase (Bompa, 1996). For each phase, the suggested load that should be lifted is different (Campos, et al., 2002).

With this, one of the main task when a strength coach would like to prepare a strength training program is first to identify the 1-RM abilities of all athletes involved. And the first assessment will form the baseline for the performance monitoring program that will assist the training. For researchers, this monitoring program is also an excellent way of researching and assessing the reasons behind the success or failure of each training program (Hoff, 2005; Wisloff, Castagna, Helgerud, Jones, & Hoff, 2004). Therefore, it the purpose of this study to assess the 1-RM ability of Sultan Idris Education University (UPSI) athletes that underwent the centralized training for the Malaysian inter varsity competition 2013, so that basic profile can be established, training program can be prescribed and future performance increment or decrement can be monitored.

## **2. METHODS**

### **2.1 Experimental approach to the problem**

#### **2.1.1 Subjects**

Ninety-two male and female UPSI-MASUM athletes had voluntarily participated in this study. The subjects' mean age, height, body weight, body mass index and 1RM were  $22.03 \pm 4.10$  years old,  $1.62 \pm 0.07$  meter,  $61.30 \pm 15.23$  kg,  $23.43 \pm 4.15$  kg and  $66.40 \pm 27.24$ kg respectively. The subjects were fully informed of any risks and discomforts while performing this experiments prior their participation. Research was approved by Research Management and Innovation Centre (RMIC) of Sultan Idris Education University (UPSI) under the MASUM 2013 research project collaboration between the Faculty of Sports Science and Coaching with Sports Centre, UPSI.

### 2.1.2 Equipment

Squat exercise was performed inside the power cage (Body Solid, Transmark, Malaysia) with 20kg Olympic barbell (Body Solid OB Bar, Transmark, Malaysia) on the back of each participant. Lifting load for each participant was adjusted by adjusting the color coded weight plates (Body Solid, Transmark, Malaysia) used with the Olympic bar.

### 2.1.3 Procedures:

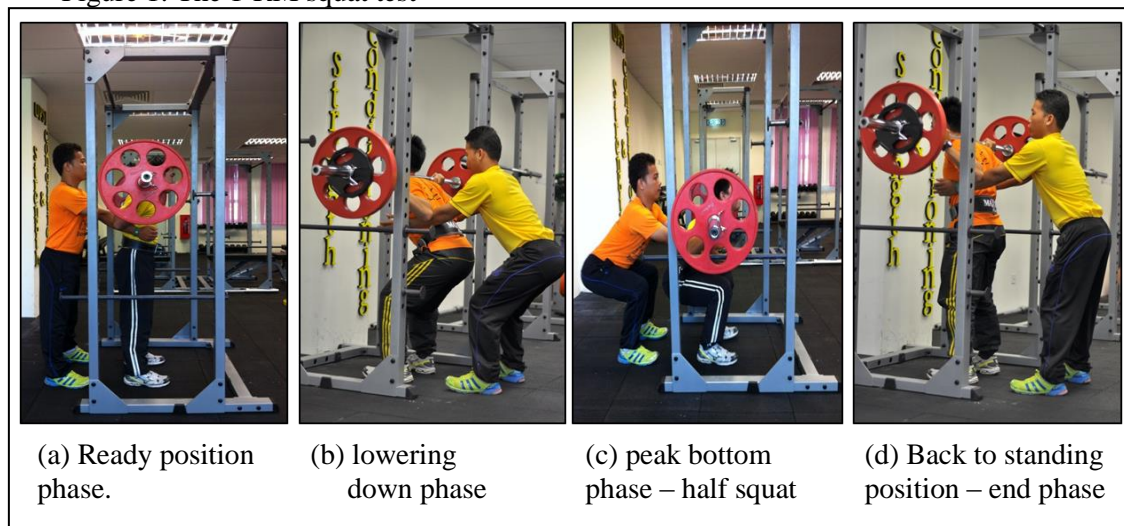
#### 2.1.3.1 Briefings and familiarization

Prior to the testing, subjects involved were given a briefing from the researcher on exercise and testing procedures involved. Briefings included exercise technique, exercise demonstration and explanation on 1-RM test protocol. Subjects were then given participation consent letter to be read and voluntarily signed once all doubt and questions arise has been answered. Subjects were reminded that they were allowed to quit the study at any time during any phase of the study without the need to give a reason for it.

#### 2.1.3.2 One Repetition maximum (1-RM) Testing Occasions

The 1-RM test begins with a standardized warm-up for 10 minutes, involving 5 minutes of ergometer cycling and 5 minutes of active stretching. The squat 1RM was assessed according to the protocol's recommended by National Strength and Conditioning Association (NSCA) (Baechle & Earle, 2008). Proper cooling down was performed at the end of the session.

Figure 1: The 1-RM squat test



#### 2.1.4 Data Analyses

The heaviest loads successfully lifted out of 5 trials allowed were recorded as the 1-repetition maximum ability of subject's involved. Loads lifted by all subjects were recorded in their testing output form. All data from the form later on transferred into an online format in Microsoft Excel sheet file (Microsoft Office Excel 2007, Microsoft, USA) for further analyses.

#### 2.1.5 Statistical Analyses

Software package for statistical analysis (SPSS version 16, IBM Corporation, USA) were used to performed statistical analyses on all variables of interest. Mean and standard deviations were used as measures of centrality and spread of data. The percent difference between two groups were calculated ( $\% \text{ Difference} = (1 - \text{Lowest Variable}/\text{Highest Variable}) \times 100$ ). Repetitive measures ANOVA were used to analyze within subjects contrast while paired sample T-Test were used to analyzed comparison between the chosen pairs. Alpha levels of 0.05 were used for statistical significance.

### 3. RESULTS

Combination of both gender produce average 1-repetition maximum ability of UPSI-MASUM athletes as only at  $66.40 \pm 27.24\text{kg}$  for the year of 2013 (Table 1). Divided into male and female categories, male recorded  $89.76 \pm 18.02\text{kg}$  1-RM lifting, with female only able to lift in average  $48.42 \pm 17.83$  for their 1-RM. As predicted, the female athletes was found significantly weaker the the male counterpart with a gap of 46.06% difference in average 1-RM lifted between the two populations. Whether in combination or divided by gender, the overall average load lifted was actually too low for a population of varsity athletes.

Table 1: Average load lifted in 1-RM test of UPSI-MASUM's athletes 2013based on gender

Grouping	Mean $\pm$ SD	% Difference	<i>p</i> Value
Combine male and female (kg)	$66.40 \pm 27.24$	n.a	n.a
Male only (kg) (n=40)	$89.76 \pm 18.02$	46.06	<b>0.001</b>
Female only (kg) (n=52)	$48.42 \pm 17.83$		

Table 2 indicated clearly average 1-RM lifted by athletes in accordance to the sports they participated. However, the average load lifted as indicated was actually quite bias, as some team had more number of athletes tested, while some had less (as low as 2 athletes in team such as tennis). But, the data provided in Table 2 did provided some insight on the level of maximum strength capabilities of UPSI-MASUM athletes based on type of sports. As the 1-RM test performed involved lower limb maximum strength (squat), not surprisingly the rugby team holds the highest average load lifted ( $91.40 \pm 11.58\text{kg}$ ), with the female tennis team recorded the lowest average load lifted of only  $36.00 \pm 9.64\text{kg}$ .

Table 2: Average load lifted in the 1-RM test based on athletes' type of sports

Grouping (male)	Mean $\pm$ SD	Grouping (female)	Mean $\pm$ SD
Handball (n=9)	78.43 $\pm$ 6.31	Handball (n=8)	74.75 $\pm$ 23.79
Softball (n=12)	107.9 $\pm$ 15.88	Softball (n=8)	36.63 $\pm$ 12.04
Rugby (n=10)	91.40 $\pm$ 11.58	Futsal (n=6)	49.17 $\pm$ 6.65
Petanque (n=7)	75.79 $\pm$ 14.42	Netball (n=6)	46.83 $\pm$ 14.51
Tennis (n=2)	72.50 $\pm$ 3.54	Hockey (n=8)	42.50 $\pm$ 8.45
		Taekwando (n=8)	50.63 $\pm$ 11.16
		Petanque (n=5)	39.60 $\pm$ 11.87
		Tennis (n=3)	36.00 $\pm$ 9.64

#### 4. DISCUSSIONS

Results have indicated average cumulative load lifted by male and female UPSI-MASUM athletes for the year of 2013. While the overall performance of UPSI-MASUM athletes had increased for the past few years based on number of medals won and the movement from top 20 to top 4 University in the past MASUM Games, it seems the physical potential of UPSI-MASUM athletes is still not properly explored and utilized. With current 1-RM performance as shown in this study, they still have a lot more potential in the sense that proper physical conditioning training can enhance their performance much further. For example a study on squat 1-RM of nineteen American collegiate football programs (NCAA Division I) indicated that their average total load lifted was  $185.2 \pm 35.7$  kg (Fry & Kraemer, 1991), far ahead of UPSI male counterpart from various sports that lifted only  $89.76 \pm 18.02$  kg. Imagine what the UPSI-MASUM athletes' on-field/in-court performance will be if they able to have above 100kgs of average load lifted. Previous study on effect of training have shown that maximal upper and lower body strength was increased by 6.5–11.5% after 2 years of training (consisting of numerous resistance, conditioning and skills training sessions every week) (Appleby, Newton, & Cormie, 2012). If for example UPSI-MASUM male athletes' under-go proper training, in 2 year's times their next 1-RM should be around 95.59 kg to 100.08 kg (average load lifted for all, some individual might increase more). This calculated prediction is just a simple prediction, which warrants further investigation and monitoring of the performance involved from time to time. The predicted outcomes will also not materialize if a proper structured training system is not in place.

Looking from sport's specific point of view, the rugby and softball team athletes especially, already shown that they have maximum strength level quite similar to other international level college athletes (Appleby, et al., 2012). However, other team average maximum load lifted was below normal level of college or university level athletes.

1-RM testing is just one out of so many tests available for performance monitoring. What is most important to be noted is that, the type of test chosen should be related to training program prescribed, so that monitoring process able to depict actual training and adaptation process. The 1-RM test for maximum strength among UPSI-MASUM athletes was chosen due to the use of similar exercise for their strength training program planned for the future.

In conclusion, this study provides the foundational basis for maximum muscular strength performance monitoring for UPSI-MASUM athletes. Continuous future assessment should be done for future comparisons and analyses.

## **5. PRACTICAL APPLICATIONS**

It will be the responsible of the athletes, coaches and management involved to prepare and implement a proper physical conditioning program for further improvement. Current assessment had shown that whatever the UPSI-MASUM team achieved so far, it was achieved with minimal contribution of physical strength and fitness. In order to provide proper monitoring program, assessment such as 1-RM test should be done from time to time, i.e., every 3 months etc.

## **ACKNOWLEDGEMENT**

This study was part of Sultan Idris Education University (UPSI) athlete's monitoring and research program implemented by Physical Conditioning Secretariat FSSKj and Sports Centre.

## **REFERENCES**

- Appleby, B., Newton, R. U., & Cormie, P. (2012). Changes in strength over a 2-year period in professional rugby union players. *The Journal of Strength & Conditioning Research*, 26(9), 2538-2546
- Baechle, T. R., & Earle, R. W. (2008). *Essentials of strength training and conditioning / National Strength and Conditioning Association* (3 ed.). Champaign, IL: Human Kinetics.
- Bompa, T. O. (1996). Variations of periodization of strength. *Strength & Conditioning Journal*, 18(3), 58-61.
- Campos, G. E., Luecke, T. J., Wendeln, H. K., Toma, K., Hagerman, F. C., Murray, T. F., et al. (2002). Muscular adaptations in response to three different resistance-training regimens: specificity of repetition maximum training zones. *European Journal of Applied Physiology*, 88(1-2), 50-60.
- Desgorges, F. D., Berthelot, G., Dietrich, G., & Testa, M. S. A. (2010). Local muscular endurance and prediction of 1 repetition maximum for bench in 4 athletic populations. *The Journal of Strength & Conditioning Research*, 24(2), 394-400
- Fry, A. C., & Kraemer, W. J. (1991). Physical performance characteristics of American collegiate football players. *The Journal of Strength & Conditioning Research*, 5(3), 126-138.
- Hoff, J. (2005). Training and testing physical capacities for elite soccer players. *Journal of Sports Sciences*, 23(6), 573-582.
- Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Medicine and science in sports and exercise*, 36(4), 674-688.
- Mohamad, N. I., Cronin, J. B., & Nosaka, K. K. (2012). Difference in kinematics and kinetics between high- and low-velocity resistance loading equated by volume: Implications for hypertrophy training. *The Journal of Strength & Conditioning Research*, 26(1), 269-275.
- Morales, J., & Sobonya, S. (1996). Use of submaximal repetition tests for predicting 1-RM strength in class athletes. *The Journal of Strength & Conditioning Research*, 10(3), 186-189.
- Reynolds, J. M., Gordon, T. J., & Robergs, R. A. (2006). Prediction of one repetition maximum strength from multiple repetition maximum testing and anthropometry. *The Journal of Strength & Conditioning Research*, 20(3), 584-592.
- Ritti-Dias, R. M., Avelar, A., Salvador, E. P. r., & Cyrino, E. S. (2011). Influence of previous experience on resistance training on reliability of one-repetition maximum test. *The Journal of Strength & Conditioning Research*, 25(5), 1418-1422

- Silva, N. d. L., Oliveira, R. B., Fleck, S. J., Leon, A. C. M. P., & Farinatti, P. (2013). Influence of strength training variables on strength gains in adults over 55 years-old: A meta-analysis of dose-response relationships. *Journal of Science and Medicine in Sport*, *Epub ahead of print*.
- Wisloff, U., Castagna, C., Helgerud, J., Jones, R., & Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *British Journal of Sports Medicine*, *38*(3), 285-288.