Effects of Weight Categories Variation on Relative Muscular Strength of Squat Powerlifting

Prof. Dr. Ahmed Abdulgani Taha. **Lecturer: Azad Shafik Shamsuldin**

الملخص

دراسة مقارنة لتاثير اختلاف الفئات الوزنية في القوة النسبية لدى لاعبي الرفعات القوة البدنية في رفعة القرفصاء

تعد القوة العضلية احد المكونات الاساسية لرياضة القوة البدنية اذ ترتبط اية رفعة في هذه الرياضة بمقدار القوة التي ينتجها المشارك وان هذا المقدار يحدد نتيجة المشارك في المنافسة. ومن جهة اخرى، يلقى اختلاف الفئات الوزنية في هذه الرياضة تاثيرا مختلفا على انتاج اقصى قوة يمكن ان ينتجها الرياضي نسبة الى وزن جسمه. لذا هدفت الدراسة الحالية الى التعرف على تاثير اختلاف الفئات الوزنية في القوة النسبية لدى لاعبي الرفعات القوة البدنية في رفعة القرفصاء. تم اختيار العينة من مجتمع المشاركين في بطولات محافظات العراق في رياضة القوة البدنية. وتضمن الاختبار اداء رفعة القرفصاء بشكل قانوني وحساب القوة النسبية المنتجة من هذه الرفعة نسبة الى وزن المشارك. تم بعدها تصنيف القوة النسبية تبعا للفئة الوزنية للمشاركين. تم بعدها معالجة البيانات احصائيا باستخدام الوصف الاحصائي وتحليل التباين، ومعامل ارتباط بيرسون. واظهرت النتائج ان الفئات الوزنية الاقل تتمتع بقوة نسبية اكبر من الفئات الوزنية الاعلى. وعزا الباحثان هذا الفرق الى طبيعة الفئات الوزنية الكبيرة التي تخزن كتلة شحوم اكبر من النسبة المثالية لها والتي يمكن ملاحظتها في الاوزان الخفيفة. واوصت الدراسة بما يتناسب ونتائج الدراسة.

Abstract

Muscular strength is the basic component of the Olympic powerlifting sport since the athlete attempting a maximum weight single lift of a barbell loaded with weight plates. On the other hand, the variation of the weight categories in this sport play different effects upon the maximum muscular strength could be produced by the powerlifter. So, this study aimed at being acquainted with the effects of weight categories (Classes) variation on relative muscular strength of squat powerlifting. The sample was selected from the participants in the competition of Iraq's states in the sport of powerlifting. The procedure included an official test of a squat powerlifting. The relative strength (RS) was calculated and classified according to the weight category of the participants. The data were proceed statistically by utilizing the descriptive statistics, ANOVA, and Pearson correlations. The results revealed that the less weight categories had greater RS than the higher categories. The result could be attributed to the essence of the higher categories which their participants have fat masses larger than typical ones observed with the lighter categories. According to finding of the study, certain Recommendations were adopted.

Introduction

Powerlifting is a strength sport that consists of three attempts at maximal weight on three lifts: squat, bench press, and deadlift. As in the sport of Olympic weightlifting, it involves the athlete attempting a maximum weight single lift of a barbell loaded with weight plates. Powerlifters are divided into weight classes so that the higher ones lift heavier weights. The powerlifter wins his or her weight class with the highest total of the three lifts. Such as this rule determines the best powerlifter of a competition but ignores percentages of body mass which affect each lift independently since "the three lifts of powerlifting are not closely related biomechanically"(Mayhew *et al.*, 1993).

It is obvious that there is a relationship size and strength, but this relationship not linear. In addition, the ability of muscles to generate strength depends directly upon their peak cross-sectional area. So, a muscle could be doubles in its size, but not in its peak cross-sectional area or even could be reach to this. Human skeletal muscle could generates between 16 and 30 Newtons as a maximum of force per square centimeter of muscle cross-sectional area (McArdle and Katch, 2009). So if body mass of the powerlifters doubles according to ascending of weight, their strength would not double.

There are other than anthropometric factors contribute to strength such as the neural control, cross sectional area, and fiber type (Haines *et al.*, 2011), rate at which the muscle fibers recruit and the order in which they recruit. All these factors could be altered by training. However, the anthropometric measurements and body mass at specific weight class have a little solutions with which to be dealt.

Many powerlifters especially taller ones drop their ratio of lifts to body mass when they reduce their body mass to compete at lower weight class. This procedure affect negatively on strength. According to the variation in body mass among weight classes of powerlifting, the absolute weight lifted in one repetition maximum squat lift does not necessarily represent the strength per se.

Despite these thoughts common among powerlifters and their coach, little research has been applied to acquaint with the effects anthropometric measurements on performance of powerlifting. Pointing out the degree to which anthropometric measurements are related to strength performance may help coach of powerlifting to select players with more specific anthropometric measurements proper to enhance their chances for competitive performance.

The objective of this study was to determine the effects of weight categories variation on relative muscular strength of squat powerlifting in addition to certain relationships between certain anthropometric measurements and strength performance in function of one-repetition maximum (1RM) squat lift among senior male powerlifters in classes of 66,73,83,93, and 105 Kg. A 1RM squat lift is defined as "the heaviest resistance that can be lifted for one complete repetition and is used to determine a person's lower body maximal strength" (Nuzzo *et al.*, 2008).

Methods

Eighty-two senior male powerlifters (age 26.89 ± 2.92 years) volunteered to be participants in this study. All of the participants had been competed throughout the year in powerlifting competitions at level of Iraqi states. Pilot study was conducted on three participants whom anthropometric measurements were assessed prior to the test of 1RM squat lift to assess muscular strength values. Each measurement techniques had been assessed precisely and in proper manner to ensure consistency. Measurements included standing height (Hgt), body mass (BM), body mass index (BMI), and strength relative to body mass (RS). Standing height was determined using a wall stadiometer. BM was determined using a scale which was calibrated for accuracy. BMI was calculated by taking a participant's weight and dividing by his height squared utilizing formula of BMI = Weight in Kg ÷ Height in metres$^{\wedge 2}$. The higher the figure the more overweight a participant is. The normal acceptable range of BMI is 20.1 to 25.0 for men. The only exceptions are athletes especially weightlifters, powerlifters, and body builders, whose extra muscle may tip their BMI over the normal range. RS was determined taking a participant's 1RM squat lift and dividing by his weight utilizing formula of SR= 1RM squat in Kg ÷ weight in Kg. Once each participant was classified into a specific weight class, reducing a weight was not allowed. Table 1 details the RS measurements and table 2 details the Hgt of the sample.

Table 1. RS measurements of the sample.

Weight class	N	Mean	Std. Deviation
66	14	2.26	0.09
73	18	2.39	0.08
83	20	2.21	0.10
93	18	2.04	0.08
105	12	2.07	0.11
Total	82	2.20	0.16

Note. RS= relative strength, N= size of sample, Std=standard.

Table 2. Hgt measurements of the sample.

Weight class	N	Mean	Std. Deviation
66.00	14	163.50	2.65
73.00	18	169.94	3.06
83.00	20	173.80	3.00
93.00	18	173.61	2.33
105.00	12	176.17	2.59
Total	82	171.50	4.94

Note. Hgt= Height in centimeters, N= size of sample, Std=standard.

Having a proper warm up according to their pre-determined abilities, all participants performed the (1RM) squat lift during the morning session. Each participants was given three trails to achieve his 1RM. The squat lift “starts with the lifter standing erect and the bar loaded with weights resting on the lifter's shoulders. At the referee's command the lift begins. The lifter creates a break in the hips, bends his knees and drops into a squatting position with the hip crease (the top surface of the leg at the hip crease) below the top of the knee. The lifter then returns to an erect position. At the referee's command the bar is returned to the rack and the lift is completed” (Wikipedia, no date). All participants wore a lifting belt during the lift. Descriptive statistics, one way ANOVA, and Pearson correlations among all variables were utilized to process data statistically.

Results

Table 3 details the correlation coefficients (r) and their probabilities among variables of BM, RS and BMI for total weight classes.

Table 3. Correlation coefficients (r) and their probabilities among variables of BM, RS and BMI for total weight classes

	BM kg	BMI (kg/m2)
BMI (kg/m2)	0.953 0.001	
RS	-0.685 0.001	-0.703 0.001

Note: Cell Contents are Pearson correlation in the first row and P-Value in the second row, BM= body mass, BMI= body mass index, RS=relative strength.

The relationship between BM and BMI was highly significant and has a positive direction. The relationship between BMI and RS was highly significant and has a negative direction. Expressing RS to BMI increased the r value correlation from -0.685 to -0.703

Table 4 indicates that there were significant differences in SR among weight classes of participants utilizing one way ANOVA among classes. Table 5 details these differences by utilizing Post Hocs of Duncan.

Table 4. One way ANOVA of SR among classes

	Sum of Squares	df	Mean Square	F	p.
Between Groups	1.348	4	0.337	38.497	0.001
Within Groups	0.674	77	0.009		
Total	2.022	81			

Note. SR= relative strength, df=degree of freedom, F=Fisher statistic, p=probability.

Table 5. Post Hocs of Duncan for RS among classes

	Weight class	N	Subset for alpha = 0.05		
			1	2	3
Duncan	93	18	2.04		
	105	12	2.07		
	83	20		2.21	
	66	14		2.26	
	73	18			2.39
	Sig.		0.411	0.149	1.000

Note. The arithmetic mean of every cell in a separate column differs significantly from those in other columns. Two arithmetic means in a separate column do not differ significantly each other. N= size of sample

The best significantly RS was for the sake of the 73 kg class. The second best significantly RS was for the sake of the 66 kg class which was better than 105 and 93 kg classes. The third best significantly RS was for the sake of the 83 kg class which was better than 105 and 93 kg classes. The last RS was for the 105 and 93 kg classes which they had significant priority each other.

Table 6 indicates that there were significant differences in Hgt among weight classes of participants utilizing one way ANOVA among classes. Table 7 details these differences by utilizing Post Hocs of Duncan.

Table 6. One way ANOVA of Hgt among classes

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1386.911	4	346.728	45.437	0.001
Within Groups	587.589	77	7.631		
Total	1974.500	81			

Note. Hgt= height in centimeters, df=degree of freedom, F=Fisher statistic, p=probability.

Table 7. Post Hocs of Duncan for Hgt among classes

	Weight class	N	Subset for alpha = 0.05			
			1	2	3	4
Duncan	66.00	14	163.50			
	73.00	18		169.94		
	93.00	18			173.61	
	83.00	20			173.80	
	105.00	12				176.17
	Sig.		1.000	1.000	.848	1.000

Note. The arithmetic mean of every cell in a separate column differs significantly from those in other columns. Two arithmetic means in a separate column do not differ significantly each other. N= size of sample

The best significantly height was for the sake of the 105 kg class. The second best significantly height was for the sake of the 83 and 93 kg classes equally. The third best significantly height was for the sake of the 73 kg class. The last height was for the 66 kg class.

Discussion

The high and positive relationship between BM and BMI as an anthropometric indicator of the body fat was observed ($r = 0.\ 0.953$, $p \leq 0.001$). This high relationship suggests that body fat is positively related to maximum strength trail and greater body fat is associated positively with greater strength. In addition, the positivity of this relation influence on this relationship (Watson and DJ, 1977; Mayhew *et al.*, 1993; Mayhew, Piper and Ware, 1993a, 1993b). In spite of contributing the BM greatly and obviously to amount of weight lifted by the participants of this study in squat lift, removing the effect of BM by utilizing the RS reversed the findings.

When RS of squat lift was expressed by BMI as an anthropometric indicator of the body fat, the correlation was reversed to become negative and significant (-0.703, p≤

0.001). This negative relation indicates that the smaller powerlifters had greater RS trail, and this agreed with the findings suggested by Mayhew et al 1993 and Mayhew et al 1993b on high school males and college football players respectively (Mayhew, Piper and Ware, 1993b).

However, the significance of relation between RS with BMI as an anthropometric indicator of the body fat in this study does not agreed with findings of Mayhew *et al* 1993 found a negative but weak correlations between body fat and strength performances of bench press and dead lift the other Olympic powerlifts (Mayhew, Piper and Ware, 1993b). This contraction may be contributed to the test method, means of expressing strength performance, variability in the subject sample, and level of training among individuals. All these may reflect the significance in which the of body fat effect on strength performance. McLeod *et al* 1983 have measured RS performance from pull-up and dip work output and suggested that body fat was negatively related to strength performance, but not to absolute strength from a grip strength test (McLeod, Hunter and Etchison, 1983).

In relation to height of participants, the significant differences among categories suggests also that height can affect how much weight could be lift relative to BM so that shorter powerlifters are better squat lifters and this coincided with Mayhew *et al* (Mayhew, Piper and Ware, 1993a).

The body is a system of levers. So, the longer the lever, the less mechanical advantage the body will have. In relation to squat lift, there are two arm levers. The first lever arm is the horizontal distance from the bar to the hip. The second one is the distance between the bar and the hip along the bag. Hence, the taller participant has much longer range of motion to travel the distance from standing to rock bottom position which leads to less mechanical advantage.

In addition, powerlifter or even tall people generally fit into the Ectomorph body type which has taller average than other types. Ectomorph usually has no heavily muscles. On the other hand, Mesomorph is shorter usually and has better leverage and carry more muscle. So, body type could genetically influence the athletic potential.

Conclusions

The greater the BM the greater the Fat included and this helps to lift more weights. But in specific weigh category of squat lift, powerlifter needs as much as possible of his weight to be muscle. So, the fatter powerlifter may be out lifted by more muscular opponent in a same weigh category of squat lift.

Recommendations

In squat lift, the taller powerlifter is recommended to compete in higher weight classes to achieve competitive lift. This could be held reversely for the shorter powerlifter who could manage his weight loss 24 hours before the competition.

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