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The influence of compressive gear on maximal load lifted in competitive powerlifting

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ABSTRACT: The competition in powerlifting has been divided into two divisions, with gear equipment (EQ) and without gear equipment (RAW). When competing in the EQ division, additional supportive gear can be worn by the athletes, while in the RAW division such gear is not allowed. The aim of the study was to compare the results of the RAW and EQ powerlifting divisions based on the results of world championships and current world records. One-hundred and twenty powerlifters (63 men, 57 women) were included to the analysis. Post hoc analysis for the results of men's world championships indicated significantly higher results of the barbell squat (SQ; $p < 0.001$; ES = 1.31), bench press (BP; $p < 0.001$; ES = 1.27) and deadlift (DL; $p < 0.001$; ES = 0.37) for EQ compared to the RAW division. Post hoc analysis for the results of women's world championships indicated significantly higher results of the SQ ($p < 0.001$; ES = 1.31), BP ($p < 0.001$; ES = 1.13) and DL ($p < 0.001$; ES = 0.71) for the EQ compared to the RAW division. Post hoc analysis for men's world record indicated significantly higher results in the SQ ($p < 0.001$; ES = 1.32) and BP ($p < 0.001$; ES = 1.24) for the EQ compared to the RAW division. Furthermore, there were no significant differences in the results of world records in the DL ($p = 0.901$; ES = 0.26) between the EQ and RAW divisions. Post hoc analysis for women's world records indicated significantly higher results in the SQ ($p < 0.001$; ES = 1.22) and BP ($p < 0.001$; ES = 1.99) for the EQ compared to RAW division. The main finding of the study was that supportive gear increases maximal load lifted during powerlifting competition.

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INTRODUCTION

Powerlifting is one of the sport disciplines in which maximal muscle strength determines results and success. Particular powerlifting lifts are often accepted as reliable measures of strength. The powerlifter competes in three specific disciplines: barbell squat (SQ), bench press (BP) and deadlift (DL), each designed to measure different areas of maximal strength. With the founding of the International Powerlifting Federation (IPF) in November, 1972, the first official IPF World Championships were held in 1973 in Harrisburg, PA, USA. Powerlifters, men and women from the age of 14 and upwards compete in given age groups and weight categories. Weight categories begin with 43 kg for women and end in the men's over 120 kg category (unlimited). The IPF is a leading global powerlifting federation but there are also many other powerlifting federations in the world.

Since 2013, the competition in powerlifting has been divided into two powerlifting divisions, with gear equipment (EQ) and without gear equipment (RAW). When competing in the EQ division hi-tech supportive gear can be used, while in the RAW division such gear is not allowed. Initially, hi-tech supportive gear was used for protection against injury, however, later it was used to improve results in maximal load lifts. EQ powerlifting progressed from knee wraps, which were essentially tensor bandages, to diverse knee wraps, squat and deadlift suits, and bench press shirts. The material of this support gear is elastic and resilient and has a braking effect on movement during the eccentric phase. This means that the fabric will stretch to a given point (limit), where a lot of elastic energy is created. The fabric then quickly and demandingly attempts to return to its original form, thus creating the 'pop', or increased momentum, at the end ranges of the SQ and BP [1]. Generally the gear is a passive element, but during movement (especially in the eccentric contraction), the strain of the material of which the gear is made may provide additional elastic energy which assists the athlete during the eccentric phase, giving a "rebound" effect during the concentric phase of the lift increasing the maximum lifted load and power output [2–7]. With tighter and more restrictive gear, the pressure and resistance of material increases and, if tolerated by the lifter, a greater load can potentially be lifted. The more experienced, technically proficient, and confident an athlete is with equipment, the more potential there is to surpass that guideline. The hi-tech supportive gear is adapted to both the disciplines and the somatic traits of the lifter. During the SQ the athlete uses the suit and knee wraps and some athlete also use erector shirts. For the BP athletes use a bench press shirt as well as wrist wraps, while for the DL suits are worn and some athlete also use the erector shirt and knee wraps. In case of shirts, suits and knees wraps there are several leading producers, such as Titan Support Systems and Inzer Advanced Designs, two of the major powerlifting equipment suppliers in the world. Depending on the powerlifting federation, some also allow for the use of multi-ply shirts, suits and longer knee wraps.

Despite the use of powerlifting gear during EQ competition by each athlete, there is no scientific data about the ergogenic effects of gear on results of the SQ, BP and DL compared to no-gear performance. Considering that powerlifters are among the strongest athletes in the world, and often the subject of scientific research [8–11], it seems fully justified to investigate whether and how much powerlifting gear increases the maximal load lifted during the SQ, BP, and DL. Due to the lack of scientific data concerning the acute effects of powerlifting gear on maximal strength, the aim of the present study was to analyze and compare the results of the RAW and EQ powerlifting divisions based on the results of world championships and current world records. It was hypothesized that the results of EQ competition are significantly higher than those reached in RAW competitions.

MATERIALS AND METHODS

Study design

The study was based on a comparison of world powerlifting championship results from 2013 to 2019 and current world records between the EQ and RAW divisions. The world championship results in the EQ and RAW divisions were compared in accordance with the following inclusion criteria: 1) only results from IPF federation, 2) only athletes that participated in the RAW and EQ competitions in the same calendar year, 3) only best attempts from the SQ, BP, and DL. The comparison of world records between EQ and RAW divisions were made based on the current data form the IPF federation (10; last update: 18 Apr 2020).

Participants

One-hundred and twenty powerlifters (63 men, 57 women), with male athletes from 52 kg to +120 kg and female athletes from 47 kg to + 84 kg weight categories were included in the analysis. To assess differences between results of world championships between the EQ and RAW divisions results were taken into account in the same calendar year from 2013 to 2019. Only results from the same year were compared. To assess differences between world records for the EQ and RAW divisions we used data from www.powerlifting.sport [12]

Procedure

Data were taken from the official IPF website [12], and were related to the results of the World Championships from 2013 to 2019 and current IPF federation world records (last update: April 18). The data were divided independently to men and women lifters [13] and independently into results of the SQ, BP, and DL.

Statistical analysis

All statistical analyses were performed using Statistica 9.1. Results are presented as means with standard deviations. The Shapiro-Wilk, Levene and Mauchly´s tests were used in order to verify the normality, homogeneity and sphericity of the sample data variances, respectively. Differences between the EQ and RAW divisions were examined independently for women and men, using repeated measures two-way ANOVA 2 × 3 (division × disciplines). The statistical significance was set at $p < 0.05$. In the event of a significant main effect, post hoc comparisons were conducted using the Tukey's post hoc test. Percent changes and 95% confidence intervals were also calculated. Effect sizes (Cohen's *d*) were reported where appropriate. Parametric effect sizes were defined as: large ($d > 0.8$); moderate (*d* between 0.8 and 0.5); small (*d* between 0.49 and 0.20) and trivial ($d < 0.2$) [14].

RESULTS

Comparison of world championship results between EQ and RAW divisions

The repeated measures ANOVA between EQ and RAW divisions revealed statistically significant interaction effect in the SQ, BP and DL, both in women ($p < 0.001$) and men ($p < 0.001$). A statistically significant main effect was also revealed for divisions, both in women ($p < 0.001$) and men ($p < 0.001$).

TABLE 1. A comparison of world championships results between the EQ and RAW powerlifting divisions for men.

Divisions	Squat [kg] (95%CI)	Bench Press [kg] (95%CI)	Deadlift [kg] (95%CI)	*p* for interaction
EQ	313 ± 56 (299 to 326)	221 ± 50 (208 to 233)	291 ± 42 (281 to 301)	0.001*
RAW	247 ± 44 (236 to 258)	169 ± 29 (162 to 176)	276 ± 39 (267 to 286)	
Effect size	1.31	1.27	0.37	
p for main effect	0.001*	0.001*	0.001*	

All data are presented as mean ± standard deviation; CI: confidence interval; EQ – powerlifting divisions with gear equipment; RAW – powerlifting divisions without gear equipment; *statistically significant differences p < 0.05.

TABLE 2. A comparison of world championships results between the EQ and RAW powerlifting divisions for women.

Divisions	Squat [kg]	Bench Press [kg]	Deadlift [kg]	*p* for interaction
EQ	225 ± 42 (214 to 237)	134 ± 36 (124 to 144)	198 ± 23 (192 to 204)	0.001*
RAW	170 ± 42 (159 to 182)	100 ± 23 (94 to 107)	182 ± 22 (176 to 188)	
Effect size	1.31	1.13	0.71	
p for main effect	0.001*	0.001*	0.001*	

Note: All data are presented as mean ± standard deviation; CI: confidence interval; EQ – powerlifting divisions with gear equipment; RAW – powerlifting divisions without gear equipment; *statistically significant differences $p < 0.05$.

TABLE 3. A comparison of world records between the EQ and RAW powerlifting divisions in male athletes.

Divisions	Squat [kg]	Bench Press [kg]	Deadlift [kg]	*p* for interaction
EQ	394 ± 66 (338 to 449)	299 ± 73 (238 to 361)	357 ± 49 (316 to 397)	0.003*
RAW	329 ± 76 (266 to 393)	228 ± 35 (199 to 257)	345 ± 45 (307 to 383)	
Effect size	1.32	1.24	0.26	
p for main effect	0.001*	0.001*	0.901	

Note: All data are presented as mean ± standard deviation; CI: confidence interval; EQ – powerlifting divisions with gear equipment; RAW – powerlifting divisions without gear equipment; *statistically significant differences $p < 0.05$.

TABLE 4. A comparison of world records between the EQ and RAW powerlifting divisions in female athletes.

Divisions	Squat [kg]	Bench Press [kg]	Deadlift [kg]	*p* for interaction
EQ	251 ± 38 (215 to 286)	181 ± 31 (152 to 209)	230 ± 32 (200 to 259)	0.001*
RAW	201 ± 44 (160 to 241)	129 ± 20 (110 to 148)	222 ± 31 (193 to 250)	
Effect size	1.22	1.99	0.25	
p for main effect	0.001*	0.001*	0.712	

Note: All data are presented as mean ± standard deviation; CI: confidence interval; EQ – powerlifting divisions with gear equipment; RAW – powerlifting divisions without gear equipment; *statistically significant differences $p < 0.05$.

Post hoc analysis for men indicated significantly greater results for the SQ ($p < 0.001$; ES = 1.31), BP ($p < 0.001$; ES = 1.27) and DL ($p < 0.001$; ES = 0.37) in the EQ compared to the RAW division (Table 1). Post hoc analysis for women indicated significantly greater results in the SQ ($p < 0.001$; ES = 1.31), BP ($p < 0.001$; ES = 1.13) and DL ($p < 0.001$; ES = 0.71) for the EQ compared to the RAW division (Table 2).

Comparison of world records between EQ and RAW divisions

The repeated measures ANOVA between EQ and RAW divisions revealed a statistically significant interaction effect in world record results for the SQ, BP and DL, both in women ($p < 0.001$) and men ($p = 0.003$). There was also statistically significant main effect of divisions for both, female ($p < 0.001$) and male athletes ($p < 0.001$).

Post hoc analyses for men indicated significantly higher results of world record for the SQ ($p < 0.001$; ES = 1.32) and BP ($p < 0.001$; ES = 1.24) in the EQ compared to the RAW division. Further there were no significant differences in world records in the DL ($p = 0.901$; ES = 0.26) between the EQ and RAW divisions (Table 3).

Post hoc analysis for women indicated significantly better results of world records in the SQ ($p < 0.001$; ES = 1.22) and BP ($p < 0.001$; ES = 1.99) for the EQ compared to the RAW division. Further there were no significant differences in world records in the DL ($p = 0.712$; ES = 0.25) between the EQ and RAW divisions (Table 4).

DISCUSSION

The main finding of the study was that supportive gear used in the EQ powerlifting division significantly increases the maximal load lifted during the specific disciplines. Significantly higher maximal lifted loads were observed for the SQ, BP, and DL in the world championships in the EQ division when compared to the RAW division. Furthermore when the differences were compared between the EQ and RAW world records, we observed significantly higher results in the SQ and BP for the EQ compared to the RAW division, however such a difference was not observed in the DL.

To the best of author knowledge, there are no available data regarding the acute impact of supportive gear used in powerlifting on maximal load lifted, which limits the possibility of comparing our results to other studies. Nevertheless, there is significant information that can be derived from the current data. Powerlifting is a sport discipline in which lifters often take part in research related to strength performance [8,9,15], therefore, it should be clearly determined whether and what effect the supportive gear has on the maximum loads lifted during particular powerlifting disciplines. The margin of differences between maximal loads lifted in the EQ compared to the RAW division is related to the powerlifting discipline. Both in the SQ and the BP we observed a large ES form 1.13 to 1.99 between the results of the EQ and RAW division, however in the DL we registered only a small to moderate ES from 0.25 to 0.71. The multiplicity of changes observed between the EQ and RAW divisions are directly related to the type of supportive gear used in particular powerlifting disciplines.

During the SQ the lifter can use three elements of supportive gear: suit, knee wraps, and erector shirt. Every different type of supportive SQ gear independently increases the possibility of lifting a higher load, and the use of these three gear at the same time cumulates the ergogenic effect of each supportive devices. From a practical point of view it seems the highest benefit comes from the application of knee wraps and the suit, however there is no data analyzing the independent impact of knee wrap's, suit or the erector shirt on maximal lifted load. Research by Harman and Frykman [16], confirmed that wearing knee wraps allows athletes to lift greater loads or perform more repetitions during a set. The phenomena of supportive gear can be explained by the elastic energy generated by the knee wraps stretch during the lowering phase, and then returning the mechanical energy during the lifting phase [16]. The suit has a similar mechanism, however, it concerns the hip area and the spine extensor area. The erector shirt is a more stabilizing and does not cause a direct maximal load increase. However during the EQ powerlifting the world record in the SQ is over 100 kg higher compared to the RAW division. The improvement of stabilizing the torso by the erector shirt is very important factor determining the technically correctness of SQ.

During the BP only one element of supportive gear can be used and it is the bench press shirt. The purpose of the bench press shirt is to assist the lifter during the eccentric phase of the lift, serving to give the lifter a ''rebound'' effect during the concentric phase of the movement [4]. The effectiveness of the bench press shirt is related to the level of compression. A tighter bench press shirt causes a higher increase in maximal load lifted what is related to the higher mechanical energy accumulated in the shirt. A shirt is a passive element, but during movement (especially in the eccentric contraction), the strain of the material of which the shirt is made may produce additional elastic energy. However, extremely tight shirts make the technical performance of the bench press significantly more difficult, which results in a higher risk of failing the attempt. The bench press shirt dictates the path – or "groove" – the bar must follow as it descends to the chest and then ascends during the effort to complete the lift [1]. Therefore, because bench press shirts are constructed in such a way that they can "catapult" the bar, the lifter may lose control of the bar as it moves out of the nan-owed path [4]. The confirmation that the mechanical energy accumulated in the bench press shirt is the main factor determining greater maximal load lifted is the fact that such an increase was observed also during the bench press under external compression used on the upper limbs with higher pressure [2]. The study by Wilk et al., [2] showed significant increases in maximal load lifted during the BP when external compression on the upper limbs was used with 150% arterial occlusion pressure (AOP). However such an increase was not observed at a pressure of 100%AOP. This confirms that the level of external compression pressure is a factor determining the effect of increasing the maximal load lifted. It should be noted, that in the study by Wilk et al., [2] the external compression was not set up in the joint area, but on the muscles of the upper limbs, so this comparison may not be equivalent to bench shirts.

During the DL in the EQ division usually only one element of powerlifting gear is used, the suit. Some lifters also use erector shirts however it is not a common practice. Although the DL suit is an independent product manufactured by factories, it is in fact extremely similar to the SQ suit in construction. In case of the DL two types of suits can be used, depending on the technique of performing the lift – conventional or sumo. Previous research investigated the biomechanical differences between the sumo DL and the conventional-style DL [17]. With a greater stance width and slightly more narrow grip width for the sumo compared with the conventional DL, there are differences in the amount of mechanical work and stress placed on various joints between the sumo DL and conventional DL [18]. Electromyography recorded during the two DL styles suggests greater knee extensor muscle activity during the sumo, compared with the conventional DL [19]. McGuigan and Wilson [20] provided a thorough description of the kinematic differences between the two styles of deadlift in competitive powerlifters during competition; the authors observed that the sumo DL has a shorter range of motion than the conventional DL while both lifts take the same time to complete. Despite the fact that during the DL the used suit is extremely similar to that used in the SQ, the results of the presented analysis showed much smaller differences in results DL between the EQ and RAW division when compared to the SQ. Such differences may arise for two reasons: first that during the DL, usually only one element of powerlifting gear is used, while in the SQ two or even three supportive elements are used. Moreover, what seems to be particularly important, when performing the DL, the beginning of the movement is a concentric phase, without being preceded by an eccentric phase. Therefore, due to the lack of an eccentric phase, there is no "rebound" effect during the concentric phase of movement [4] witch can partially explain the lower differences in results of the DL between the EQ and RAW division of powerlifting, when compared to differences between result of the SQ.

These results indicate that powerlifting gear increases maximal load lifted during the SQ, BP and DL. However, this study has limitations which should be addressed. Although the results showed significantly higher maximal loads lifted for the EQ compared to RAW powerlifting division, there was no precise information about what type powerlifting gear and what manufacturer was used. Furthermore, the level of external compression caused by powerlifting gear may also have a significant impact on maximal load lifted, which requires further studies.

CONCLUSIONS

The results of this study indicate that powerlifting gear significantly increases the maximal load lifted in the SQ, BP and DL. However the differences are related with specific powerlifting disciplines. This suggests that external compression could be an important tool in eliciting greater load lifted, and thus improving strength performance during resistance exercise. Powerlifting gear or external compression could be an additional resistance training modality that could help athletes break through plateaus and prevent training monotony.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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