

Strength Patterns in Female Powerlifting Athletes

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Abstract—More females are competing in powerlifting meets with incredible strength in the contemporary world. There is more and more data on female powerlifting athletes, however, there is a research shortage on female powerlifting athletes in comparison to male powerlifting athletes. Therefore, it is important to provide more insights into female powerlifting athletes. This paper analyzes the strength patterns of female powerlifting athletes in all three lifts: bench press, squat, and deadlift. The research uses data from the 2023 United States Powerlifting Coalition female powerlifting ranking. The three research questions regarding female powerlifting athletes are the correlation between deadlift score and squat score, the correlation between body weight and total score, and the age range that has the highest bench press scores. The results show that deadlift score and squat score are strongly positively correlated, body weight and total scores have weak positive correlation, and the age range 50-59 has the highest bench press scores overall.

Keywords—female, powerlifting, athletes, squat, deadlift, bench press, scores

I. INTRODUCTION

Powerlifting consists of three lifts – bench press, squat, and deadlift [1]. Powerlifting athletes' goal at a meet is to attempt to lift the maximum weight possible for one repetition in each of the three lifts above [1]. Athletes have three attempts for every lift, and the total score is the summation of the heaviest completed weight for each of the three lifts [1]. The overall winner at a powerlifting meet is determined by the Dots score, as indicated by [4]. Dots score is a ratio between an athlete's body weight and the total weight they lifted at the powerlifting meet [4]. In the modern world, there are no limitations on who can train and compete in sports. More females are competing in powerlifting, more data is generated on female powerlifters, and more research should be done on female powerlifters. Powerlifting is a strength sport; research on female powerlifter strength patterns can assist athletes and coaches in enhancing training methodologies to improve strength or meet results. Proper knowledge of female powerlifting athletes' strength patterns can minimize training fatigue, and the risk of injury, as well as maximize training and meet performances. The research questions this paper will investigate are as follows: first, squat and deadlift both involve leg movements, which could imply that strong leg strength produces higher squat and deadlift results, and squat and deadlift scores are correlated. Do female powerlifters who

have high deadlift scores also have high squat scores? Second, it is a common conception that someone who has a higher body weight can also lift more weight. Do female powerlifters with high body weights also have high total scores in bench press, squat, and deadlift? Third, the research found that female powerlifters have positive strength changes with increased age [3], what age range has the highest bench scores overall? The research results showed that the deadlift score and the squat score had a strong positive correlation, with a Pearson correlation coefficient [9] of approximately 0.84. Additionally, body weight and the total score exhibited a weak positive correlation, with a Pearson correlation coefficient [9] of approximately 0.25. The age range 50 to 59 had the highest bench press scores overall, with a median of approximately 65 kilograms. In conclusion, female powerlifting athlete strength patterns ought to be understood further, the results can generate positive effects on female athletes' performance and recovery. This research produces insights on lift performance correlation, the impact of body weight on total score, and identifies the age range associated with the highest bench scores.

II. LITERATURE REVIEW

As part of research preparation, other relevant and recent research results are being investigated and considered. The first relevant research is related to factors of powerlifting competition success, published in 2022 [2]. The below summarization is based on [2]. For strength-based competition like powerlifting, the competitors are categorized by multiple factors to ensure fair competition. The factors range from the most basic factors such as sex, body weight, and age to competition-orientated factors such as competitor years of experience, compete duration, and opening attempt weight for bench press, squat, and deadlift. The research's focus is to find out the relationship between mentioned factors and competition success. In summary, for female competitors, winners have longer competition duration, higher number of competitions attended, and higher average and maximum successful attempt weights compared to those who lost. Regardless of weight class for female powerlifters, in general, for each additional age, greater first bench press, squat, and deadlift attempt weights increase the odds of winning. This research proves that female winners do not necessarily have higher body weight. The second relevant research is related to hand grip strength and female powerlifter performance,

published in 2021 [5]. The following summarization is based on [5]. With the “Jamar hydraulic hand dynamometer” as the grip strength assessment, the research shows that hang grip strength has a significant relationship with “Raw” bench press, squat, and deadlift total score. The third relevant research is about strength adaptation in male and female powerlifters, published in 2022 [3]. The following summarization is based on [3]. This research aims to investigate strength changes in powerlifters across the lifespan. In summary, female powerlifters have faster strength progression over time, have positive strength changes with increased age, and have continuous strength gains despite aging. Younger female powerlifters have better strength improvements than older female powerlifters.

III. METHODS

A. Dataset

The dataset selection for this research is the 2023 United States Powerlifting Coalition female powerlifter ranking from the open powerlifting website [6]. The website is a central hub for sharing the official results from powerlifting federations [7]. The dataset consists of “Raw” and “Wraps” female competitors. Athletes that are in the “Raw” division are not allowed to use all types of supportive equipment or some types of supportive equipment, whereas “Wraps” division athletes are allowed to use all types of supportive equipment [8]. The dataset includes nominal, ordinal, interval, and ratio data types. The dataset consists of columns, from left to right, regarding rank, athlete name, competition federation, competition date, athlete location, athlete gender, equipment division, class division in kilogram, athlete body weight in kilogram, squat score in kilogram, bench score in kilogram, deadlift score in kilogram, total weight lifted in kilogram, and “Dots” [6].

B. Hypotheses

The hypothesis for the correlation between deadlift and squat scores is that there is a strong positive correlation between deadlift scores and squat scores in female powerlifters. The hypothesis for the correlation between body weight and total score is that there is no correlation between body weight and total score. This hypothesis is influenced by the research results from [2]. The hypothesis for the age range with the highest bench press scores overall is between 40 and 49. This hypothesis is influenced by the research results from [3].

C. Procedure

The data is scraped into a CSV file with Python programming language and the Anaconda Spyder development environment. The Python libraries used for data scraping are “requests”, “json” and “pandas”. They are used for sending GET HTTP requests to the webpage, parsing the JSON data to extract information, and converting the dataset to a data frame to export to a CSV file. The analyses and graphs are generated by using R language in the RStudio development environment. The R library used is “Tidyverse”, a collection of R packages for data visualization. Various graphs are produced and interpreted to validate the

hypotheses, including scatter plots, box plots, and histograms. The columns used from the dataset for analyses are Age, Weight, Squat, Bench, Deadlift, and Total.

IV. RESULTS

Regarding the first research question, “Do female powerlifters who have high deadlift scores also have high squat scores?”. The hypothesis was, “There is a strong positive correlation between deadlift score and squat score”. The results indicated that female powerlifters’ squat and deadlift scores had a strong positive correlation. The results aligned with the initial hypothesis. As shown in Fig. 1 and Fig. 2, the squat and deadlift histograms both roughly follow a bell shape, suggesting that squat and deadlift data were normally distributed and had similar patterns. A positive correlation and linearity of the relationship between squat and deadlift scores were observed in Fig. 3 scatter plot. By computing the Pearson correlation coefficient [9], the r -value was approximately 0.84, confirming a strong positive linear correlation. Regarding the second research question, “Do female powerlifters with high body weights also have high total scores in bench press, squat, and deadlift?”. The hypothesis was “There is no correlation between female powerlifter body weight and total score”. The results indicated that there was a weak positive correlation between female powerlifters’ body weights and total scores. The results did not align with the initial hypothesis. As shown in Fig. 4, body weight data was positively skewed. In Fig. 5, the distribution of total scores roughly followed a normal distribution. Fig. 4 and Fig. 5 suggest that body weight and total score data had different underlying patterns. In Fig. 6, the data points were more spread out in the scatter plot, and the trendline showed a slight positive slope, indicating a very weak positive correlation between body weight and total score. The Pearson correlation coefficient [9] of the two variables showed an r -value of approximately 0.25, confirming a weak positive linear correlation between body weight and total score. The third research question was, “What age range has the highest bench scores overall?”. The hypothesis was that the age range 40 to 49 has the highest bench scores overall. The results indicated that female powerlifters between 50 and 59 years old had the highest bench scores overall. The results did not support the initial hypothesis. By observing the median bench scores in the box plots presented in Fig. 7, the age range 50 to 59 had the highest median bench score of approximately 65 kilograms. Additionally, by examining the box heights in the box plots presented in Fig. 7, the age range 50 to 59 also had a relatively narrow box height, suggesting a narrow spread of the data in this age range. This observation confirms that the age range 50 to 59 had the highest bench scores overall. Based on the research results, female powerlifting athletes who excelled in squats tended to excel in deadlifts. This finding can help powerlifting coaches to more effectively design female powerlifting athletes’ training plans to produce more optimized results. The results suggest that female powerlifting athletes with high body weight do not necessarily achieve higher total scores. This result challenges the common belief that heavier powerlifting athletes can lift heavier total weights. This finding aids coaches and female powerlifting athletes in assessing the relationship between body weight and overall

performance and offers outsiders a more nuanced understanding of powerlifting. Lastly, powerlifting athletes between 50 and 59 had the highest bench scores overall. This finding reinforces the conclusion that female powerlifters have positive strength changes with increased age [3]. While the research findings provide more understanding of female powerlifting athletes' strength patterns; there are certain limitations. First, the analyzed dataset has limited variability. The dataset only consists of female powerlifting athletes from the United States who competed in the USPC meet in 2023; it does not represent the female powerlifting athlete population. The dataset only includes athletes' meet statistics, and different aspects such as nutrition, hours of sleep, and training plans are not considered. Second, the analyzed dataset has a limited volume. The dataset comprises only 336 instances, requiring additional data for more accurate results. Third, the presence of outliers in the dataset may influenced the results. In Fig. 6 and Fig. 7, many outliers can be observed, and these outliers may have had a significant influence on the results. With the limitations stated, further research should be conducted for more robust results.

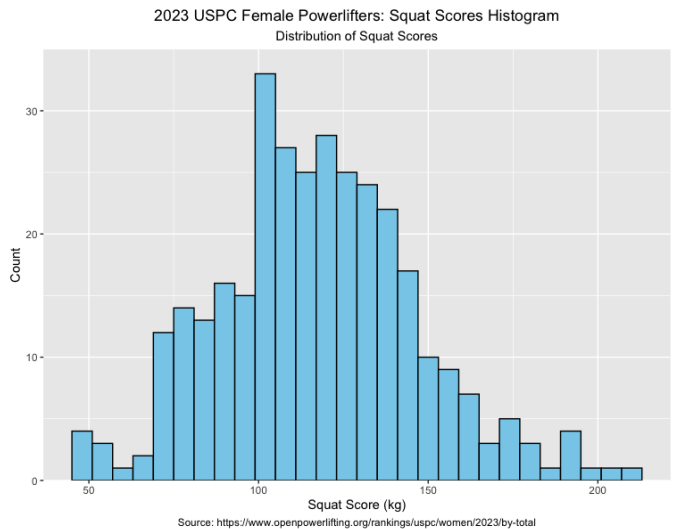


Fig. 1. 2023 USPC Female Powerlifters Squat Scores Histogram

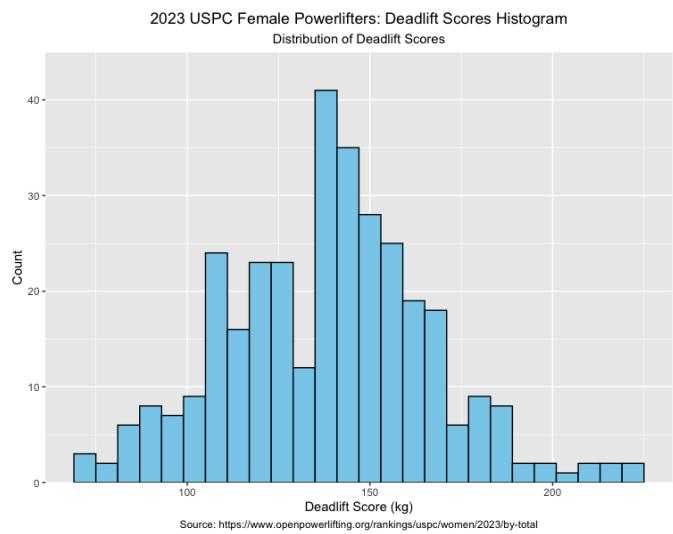


Fig. 2. 2023 USPC Female Powerlifters Deadlift Scores Histogram

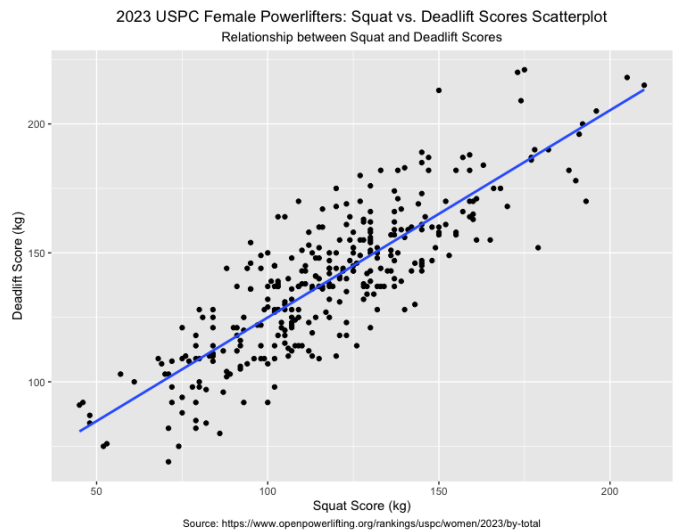


Fig. 3. 2023 USPC Female Powerlifters Squat vs. Deadlift Scores Scatterplot

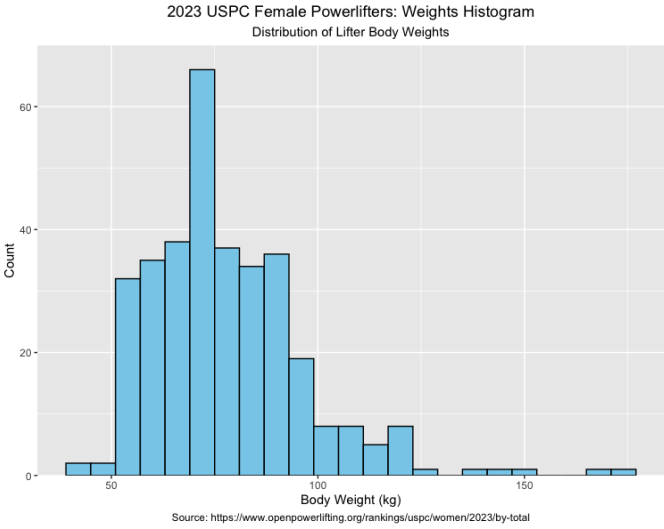


Fig. 4. 2023 USPC Female Powerlifters Weights Histogram

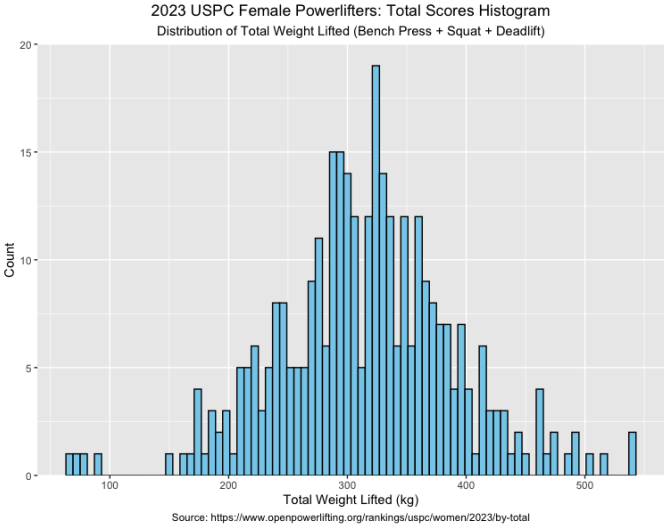


Fig. 5. 2023 USPC Female Powerlifters Total Scores Histogram

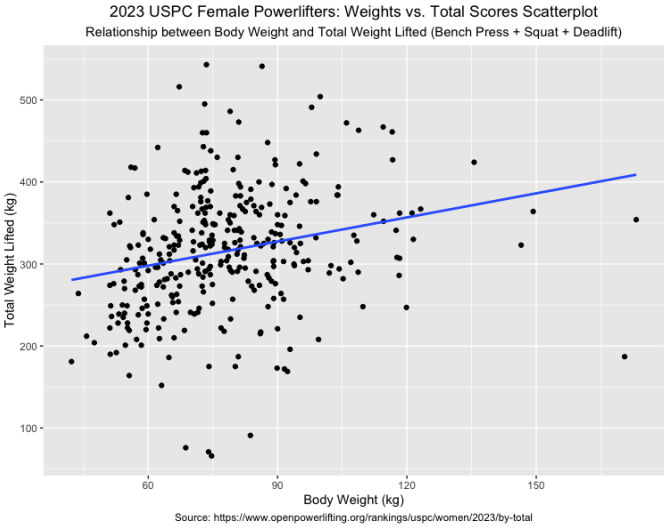


Fig. 6. 2023 USPC Female Powerlifters Weights vs. Total Scores Scatterplot

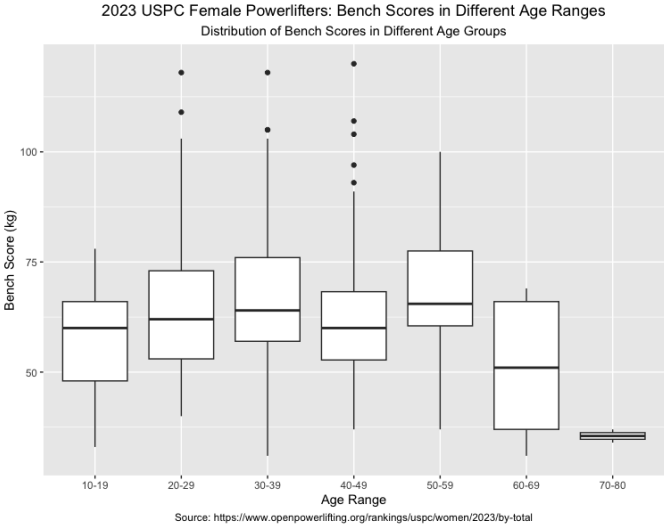


Fig. 7. 2023 USPC Female Powerlifters Bench Scores in Different Age Ranges

GLOSSARY

Term	Definition
meet	A powerlifting competition
Dots	Ratio between a lifter's body weight and the total weight they lifted
USPC	United States Powerlifting Coalition

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