

# Comparison of Olympic-Style Weightlifting Performances of Elite Athletes: Scaling Models Account for Body Mass

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<sup>1</sup>*Department of Statistics and Probability, Michigan State University, East Lansing, MI;* <sup>2</sup>*Department of Kinesiology, Michigan State University, East Lansing, MI;* <sup>3</sup>*College of Integrative Sciences and Arts, Arizona State University, Mesa, AZ;* <sup>4</sup>*Star-Oddi Ltd, Gardabaer, ICELAND;* and <sup>5</sup>*School of Mathematics, Statistics and Physics, Newcastle University, Newcastle upon Tyne, UNITED KINGDOM*

## ABSTRACT

HUEBNER, M., D. E. MELTZER, Á. BJARNASON, and A. PERPEROGLU. Comparison of Olympic-Style Weightlifting Performances of Elite Athletes: Scaling Models Account for Body Mass. *Med. Sci. Sports Exerc.*, Vol. 55, No. 12, pp. 2281–2289, 2023. **Purpose:** We developed a scale for comparison of performances by weightlifters of different body mass and compare this scaling formula to current systems. **Methods:** Data from Olympics and World and Continental Championships from 2017 to 2021 were obtained; results from athletes with doping violations were excluded, resulting in performances from 1900 athletes from 150 countries for use in analysis. Functional relationships between performance and body mass were explored by testing various transformations of body mass in the form of fractional polynomials that include a wide range of nonlinear relationships. These transformations were evaluated in quantile regression models to determine the best fit, examine sex differences, and distinguish fits for different performance levels (90th, 75th, and 50th percentiles). **Results:** The resulting model used a transformation of body mass with powers  $-2$  and  $2$  for males and females and was used to specify a scaling formula. The small percentage deviations between modeled and actual performances confirm the high accuracy of the model. In the subset of medalists, scaled performances were comparable across different body masses, whereas both Sinclair and Robi scalings, currently used in competitions, were more variable. The curves had similar shapes for the 90th and 75th percentile levels but were less steep for the 50th percentile. **Conclusions:** The scaling formula we derived to compare weightlifting performances across a range of body mass can easily be implemented in the competition software to determine the overall best lifters. This is an improvement over current methods that do not accurately account for differences in body mass and result in bias or yield large variations even with small differences in body mass despite identical performances. **Key Words:** OLYMPICS, WEIGHTLIFTING, ELITE ATHLETES, DOPING, QUANTILE REGRESSION, FRACTIONAL POLYNOMIALS