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EDITORIAL

Does a handful of strength imply two handfuls of health?

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The development of reference values for physical fitness is a necessity for the interpretation of screening procedures during growth and development. The investigation conducted by Duran et al. [1] made a noteworthy contribution to the research in one of the most relevant indicators of physical fitness – maximal grip strength (mGS). While incorporating multiple influencing factors such as sex, age, height, and body mass, the authors established novel reference centiles of mGS within the young German population, enabling clinicians and physicians to classify 6 to 24 years-old individuals based on their mGS. They suggested that multiple linear regression could serve as a method for creating multivariable reference centiles involving three explanatory variables.

Considering that there were recent attempts to develop mGS normative data for children and adolescents, what do the findings of this investigation represent?

Knowing that normative values represent the expected range of values for a specific measurement within a healthy population against which individual measurements can be compared to identify any deviations from the norm, important cross-sectional and longitudinal investigations have been conducted in youth with the purpose of health screening and guidance of public health policies [2]. With the available evidence suggesting a preference towards cross-sectional cohorts instead of longitudinal investigations, several limitations become evident, such as the difficulty of comprehensively capture individualized trends and variability over time. This lack of consistent participant involvement across different time points may hinder exploring dynamic health changes within a specific population, potentially impacting the depth of insights gained from the research.

One of the great added values of this investigation relates to the ability of the authors to establish, for the first time, reference centiles based on the longitudinal changes in mGS from repeated measurements from childhood until young adulthood. Instead of simply comparing normative data from two cross-sectional samples, i.e., the process from which temporal trends are usually observed, the methodology employed in this investigation allowed the extraction of normative standards regarding the expected variation in the z-scores of mGS throughout childhood and adolescence. This innovative approach enables the determination of the drop in centiles or decrease in z-scores of mGS that is needed to be considered noteworthy and clinically relevant, thus, opening doors for an alternative view on how age-related changes in mGS and other physical fitness parameters should be addressed in the future.

What is the health significance of normative values resulting from changes in z-scores from the mGS?

According to the latest evidence, there may be additional health benefits of looking at changes in mGS rather than single observations. Despite this being mostly evident during older adulthood, where a decline in mGS seems to be a stronger predictor for several physical and mental health-related outcomes compared to a single observation of low mGS, little is known about the positive or negative health implications when there is a significant change in mGS during childhood and adolescence. Although it would be plausible to speculate that low percentiles of normative values (e.g., values below the 20th percentile), which are frequently used to classify poor/low physical fitness [3], could indicate unfavorable changes in mGS, and thus, a decline in overall health status, further longitudinal studies are needed that delve into the repercussions of changes in mGS over time on specific health outcomes.

Over the last years, several cross-sectional and longitudinal investigations have consistently demonstrated a favorable association between mGS and major health outcomes, including premature death, cardiovascular risk, and bone health [4], thus providing a comprehensive perspective on the dynamic interplay between mGS and health. In one of the most striking studies in this research field, which involved over one million adolescent males, the authors found that all-cause mortality rates per 100 000 person years were 114.5, 96.5, and 90.9 for adolescents with very low, low-to-middle, and middle-to-very high muscular strength assessed with mGS, respectively [5]. Moreover, the authors demonstrated that young males with high mGS exhibited 20-35% lower risk of premature death from any cause and cardiovascular disease independently of classic risk factors, such as body mass index (BMI) and diastolic blood pressure [5], therefore reinforcing the importance of considering low musculature as an emerging risk factor for mortality in young adulthood.

Considering other standpoints, evidence has emphasized the practical utility of establishing specific cut points of mGS for meaningful health outcomes. For example, among the available reference values, those indicative of high *versus* low cardiovascular disease risk in youth were identified as 0.367 and 0.306 kg/kg body mass in male and female children, respectively, and 0.473 and 0.423 kg/kg body mass in male and female adolescents [6]. Similar to how this investigation and others have enabled the identification of mGS cut points that are associated with more favorable health outcomes, we emphasize the need for the forthcoming research to establish health-related threshold values for variations in mGS across time.

One last question remains - What if mGS assessment methodologies or analysis adjustments differ between studies?

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Besides adopting the protocol strength assessment recommendations followed by the American Society of Hand Therapists (ASHT) for standardized positioning (i.e., sitting in an upright position with the feet flat on the floor, neutral position of the shoulder and forearm, elbow flexion 90°, wrist extension 0° to 30°), the present investigation provided information on the type of protocol and equipment used in other similar investigations, the need to further describe the measurements used and the importance of establishing normative values under the same methodological considerations.

The available evidence shows that mGS results may be influenced by several methodological features (i.e., postures, hand dominance, number of repeated measurements, type of equipment) and biological conditions (i.e., hand/grip sizes, weight, height), which can lead to discrepancies among the results, compromise reproducibility of results across different investigations, and potentially pose a barrier to the feasibility and acceptability of mGS. Thus, several methodological attempts have been made to standardize and maximize mGS results across the years [7]. One of the great examples dates back to 1954, when Bechtol introduced the first dynamometer with an adjustable handle, with the aim of maximizing mGS in individuals with large and small hands and enabling a more accurate assessment of the impact of various types of hand injury [8]. More recently, particularly since the early 90 s, several investigations have emerged assessing the impact of various degrees of standardization (e.g., postures, verbal feedback, repeated measures, size of equipment) on mGS. Nevertheless, the available evidence continues to yield mixed results, hindering definitive conclusions about the optimal methodology to consider when assessing mGS.

On the other hand, it is crucial to recognize that even in studies employing similar assessment protocols and using the same equipment the interpretation of the results with and without adjustment for confounding variables (e.g., sex, age, body mass, BMI) can significantly impact comparisons. While most investigations provided normative values or have analyzed the relationship of mGS with health outcomes considering only absolute values of strength, special attention has now been given to relative strength, as a joint measure of strength and biological variables having a high impact on mGS. Body mass and BMI, for example, have been pointed out as two of the most important factors having an influence on handgrip strength, due to the fact that individuals with increased body mass generally present higher proportions of all body tissues, including fat mass and skeletal muscle mass. Moreover, overweight or obese individuals may be prone to develop compensatory mechanisms for strength production (i.e., increased strength in the upper limbs) in response to the demands of carrying excess body mass on a daily basis. Following this rationale, the higher levels of absolute mGS observed in these individuals should not be misconstrued as indicative of improved muscle or enhanced health, but rather as muscle adaptations and mechanisms resulting from the increased body mass.

With global evidence reinforcing the use of relative strength values, since they increase the translational value of mGS as a prognostic tool, there is an ongoing necessity to establish and update normative values for relative mGS. Addressing this need, the present investigation developed an original method to assess the mGS adjusted for sex, age, height, and BMI, thus contributing to the refinement of multivariable normative values of mGS in children and adolescents. While this approach enhanced the applicability and interpretability of mGS assessment among youth populations, there is now a need for further investigations to evaluate the effectiveness of this method regarding its association with health outcomes. This step marks the next phase in uncovering whether a handful of strength truly implies two handfuls of health.

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AUTHOR CONTRIBUTIONS

LBS conceptualized the present work. LBS and GBR contributed to drafting and revising all versions of this paper.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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