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Article

Ethnic Variations in Muscle Mass and Strength: Evidence, Gaps, and Future Directions

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Abstract: Muscle strength and size vary widely among individuals and populations. This paper examines factors contributing to these differences with a focus on ethnic disparities. A literature-based synthesis was conducted using peer-reviewed studies examining differences in muscle physiology between ethnicities. While the literature shows that major differences across different ethnicities exist, the underlying causes remain poorly understood. Factors such as cultural diets as well as muscle quality are proposed as potential contributors. Socioeconomic status (SES) has also been considered, but contradictory findings suggest it is not a primary factor, suggesting deeper biological and cultural influences. These insights are relevant for developing equitable training, rehabilitation, and healthcare strategies tailored to diverse populations.

Keywords: muscle strength; muscle size; muscle health; ethnic differences; exercise physiology; interethnic variation

1. Introduction

Muscle size and strength is significantly variable between individuals and populations. These differences have been observed across age, gender, and ethnicity [1–3]. This current paper briefly explores the underlying factors that may be potentially contributing to these differences, with a focus of differences between ethnicities. The purpose of this paper is to summarize and support the current literature and research exploring the discrepancies of muscle size and strength between ethnicities, highlight the existing knowledge gaps observed within the current literature, as well as proposing possible directions for future research in the field of studying the root causes of the ethnic disparities. Regarding the relevance of this paper, understanding the root causes and factors behind muscle differences between ethnicities is highly important for performance optimization, personalized training programs, as well as rehabilitation programs and injury prevention. Furthermore, it has been found that the disparities exist even after controlling for socioeconomic conditions (SES), despite SES being a well-established determinant of muscle health. This raises important questions about the role of other factors such as genetic, cultural, dietary, evolutionary, and even lifestyle factors that may have an influence on muscle size and strength.

2. What Is Currently Known

The current literature consists of ample research showing that the discrepancies of muscle strength and size between ethnicities does in fact exist. Several studies reveal that Black populations tend to consistently have

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higher baseline muscle mass on average but have relatively lower strength per unit of muscle when compared to White populations, indicating discrepancies in muscle quality as well as size [1,2]. While the listed studies had differing methodologies of obtaining the necessary data–with one using calculations derived from strength tests and muscle mass scans, and the other using Echo Intensity (EI) to determine muscle quality – the findings remain consistent between them. The findings in the current literature seem to apply to both male and female subjects. While a lot of the current studies on this topic mainly focuses on males [3] showcased that the patterns of muscle mass discrepancies between ethnicities were consistent even with women, with Black individuals having significantly higher total body lean mass than White and Hispanic individuals.

One very interesting study done by [4] not only once again demonstrates that the difference in lean mass and strength exists between ethnicities with Black individuals having more lean mass on average, but also included the control variables of education and income, and adjusted the data accordingly. All the subjects of this study were of similar levels of income and education. Ultimately, even after adjusting for the socioeconomic factors, the findings of the current literature remain consistent.

Taken together, the current literature is robust when it comes to providing strong evidence that ethnic differences in muscle mass are consistent, but the opposite can be observed when explaining the causes of these differences. This gap raises the question of which underlying mechanisms have a strong influence on creating the ethnic disparities and highlights the need to examine the limitations of the existing research.

3. Current Limitations in the Literature

While the current literature documents the existence of discrepancies in muscle mass and strength between ethnicities extremely well, a glaring gap can be seen within it: what is the root cause of these discrepancies? Currently, the answer to this question is poorly understood, and is consistently addressed to be a glaring problem within all the studies that explore muscle discrepancies.

There seems to be a lack of understanding in the relationships between ethnicity and muscle mechanics and structure. Certain muscle and bone structures create advantageous conditions for increased strength output, such as muscle quality. Muscle quality can be seen as a broad term for various concepts, and each concept influences the amount of strength that could be generated per unit of muscle. The concepts are as follows: Phase angle (PhA), a measurement that reflects cellular integrity and muscle cell health. Higher PhA values indicate healthier muscle tissue with better contractile properties, which translates into greater strength output. Echo intensity (EI): measured through ultrasound, reflects the muscle's composition for fat and connective tissue infiltration. A lower EI measurement usually corresponds to higher muscle quality. Muscular adipose tissue (MAT): The fat stored within or between muscle fibers. Excess adipose tissue negatively affects contractile efficiency and can impair force production even if total muscle mass is high. Facile architecture: The arrangement and length of muscle fibers. Longer fascicles or advantageous pennation angles can generate greater force and power. Oxidative capacity: The ability of muscle cells to generate energy through aerobic metabolism. Muscles with higher capacity resist fatigue and maintain higher force output over time. Insulin Sensitivity: The ability for muscle cells to take up glucose and synthesize protein. Poor IS may limit muscle hypertrophy and reduce quality. Neuromuscular activation: The ability for the nervous system to recruit muscle fibers. Stronger and more efficient neural drive leads to higher strength. Motor unit characteristics: Referring to the size, number, and firing rate of motor units, these can also significantly influence strength. Larger or more efficiently recruited mortar units increase strength output. Muscle fiber types: type I and type II muscle fibers differ in size, contractile speed, and fatigue resistance. A higher proportion of type II fibers often supports greater strength and power [5, 6]. Together, all of these factors interact with each other to determine the efficiency of strength production per unit of muscle mass. While Kushel et al. proved that the 9 factors listed are in fact highly correlated with the varying strength output between individuals, currently, no studies on the relationship between ethnicity and strength that cites this review. Future research should scope more deeply into these factors and how they are different in individuals of different ethnicities.

There is currently no study that examines the relationship an ethnicity's cultural diet choices and availability has with body composition. Ethnic differences in muscle mass and muscle quality may partially be

created by differences in culturally ingrained dietary and physical activity patterns that are unique to each ethnicity. These differences may influence differing body composition and muscle health between ethnicities. Diets with higher protein intake seem to be associated with higher muscle mass on average [7]. Furthermore, diets that are lower in refined sugars, processed foods, and saturated fats are also associated with positive effects on muscle mass [8].

4. Major Contradiction within the Literature

Various studies have shown that an individual's socioeconomic status (SES) and socioeconomic environments have the potential to significantly influence their muscle mass and strength. Studies such as [9–11] show the positive association between SES and muscle strength and mass. The data from these studies can be interpreted as follows: a higher SES means a higher level of education and a higher income, allowing for more access to facilities that help in gaining muscle mass and strength, such as "higher quality" foods, supermarkets, fitness facilities, safe outdoor spaces, more free time, and healthcare. Therefore, SES can be seen as a strong predictor of muscle health.

However, when comparing the ethnicities White, Black, Hispanic, and Asian in terms of average SES and income in the US, Asian was found to be highest, followed by Whites, Hispanics, and then at the very bottom, Black/African American. This is where the contradiction really shows, because studies that compare ethnicity with muscle mass and strength consistently reveal that Asians have the lowest amount of average skeletal mass, muscle mass, and strength despite having the highest average income and SES. Furthermore, the black population consistently on average has the highest amount of average skeletal and muscle mass, despite having the lowest average income and SES in the US [12].

This contradiction can be viewed in the lens of the Simpson's Paradox. Within each ethnicity, a higher SES generally correlates with higher muscle mass and strength. For example, within Asian communities, those of higher SES tend to have greater muscle mass, and the same can be seen within African American communities. However, when combining the data from both ethnicities, the overall pattern looks reversed: higher SES seems to be associated with lower muscle mass and strength, and lower SES with higher muscle mass and strength. This happens because the two groups start at very different baseline levels of SES and muscle, which can skew the results when data is put together.

It can be seen, therefore, that although SES–affecting environment and diet–is known to be a significant variable when determining muscle mass and strength, it fails to fully explain the discrepancies observed between ethnicities, highlighting a fundamental gap in understanding the underlying causes. Although SES may have some level of influence on the disparities, it cannot be used to great extents.

Much of health research assumes that SES is a strong and reliable indicator of physical health markers such as muscle mass or size. However, with this gap in the literature, it clearly showcases the flaw within this assumption; SES cannot be solely relied on when it comes to determining physical health. Instead, other factors may play a more dominant role influencing the disparities and should be the focus of future research. Genetic factors: the large variety in alleles and muscle fiber type distributions may influence certain groups to have greater muscle mass on average, regardless of SES. Physiological factors: differences in hormone levels, metabolism, and muscle fiber type ratios may affect differences in muscle growth rates between ethnicities. Cultural and lifestyle factors not captured by SES: certain exercise habits, routines, diet patterns, and activity norms unique to each ethnicity that are not tied to income and education may also play a role in explaining the discrepancies. Evolutionary adaptations may also play a role in that historical environmental pressures may have influenced differences in muscle adaptation and composition in different populations.

If SES is used as a main tool for demonstrating differences in muscle mass and size between ethnicities, the aforementioned factors can be potentially overlooked. Another risk factor that comes with an overreliance on SES as a sole determinant of muscle strength and size would be that it impacts clinical risk assessment tools. Many tools that determine an individual's risks of developing conditions such as sarcopenia, frailty, or even dosing for certain drugs utilize muscle mass and strength in its calculations. If the current literature (or rather lack thereof) showcases that SES is independent from the muscle differences between individuals, clinicians

may miscalculate the health risks within certain demographics, especially Black populations and Asian populations.

5. Future Steps

Like previously mentioned, future research should seek to remove the reliance on SES as a main determinant on muscle health. Instead, further research should be done on the biological, genetic, physiological, and evolutionary factors and their differences between ethnicities because understanding these mechanisms is a crucial step for accurately explaining the observed disparities in muscle mass and strength. The findings should become a new source of reliance when it comes to determining muscle health. This would likely provide much more precise data, which in turn would improve diagnostics, treatment plans, and also preventative care. Possible areas of research include but are not limited to: Muscle quality differences, Early-life physical development differences and its influence, cultural norms and its influence on muscle mass, as well as the evolution of ethnicities and their respective trait differences.

6. Conclusions

In summary, the current literature clearly establishes the fact that significant differences in muscle size and strength exist between ethnicities, but the underlying causes of these differences still remain poorly understood. While SES, environmental factors, as well as cultural factors do in fact contribute to muscle health, they are unable to fully explain the disparities that can be seen, especially after considering the paradox between SES and muscle size and strength in Asian and Black populations. This significant limitation within the current literature highlights the need for future research to move on from exploring SES, environmental factors, and cultural factors and instead look towards biological, genetic, physiological, and evolutionary factors that may influence the discrepancies. The outcome of this shift in focus would improve understanding of the mechanisms behind ethnic variability in muscle mass and strength, allow for more accurate clinical assessments, develop better culturally informed interventions, improve strategies for sports optimization, rehabilitation, disease treatments, and even prevention. Ultimately, grasping a deeper understanding of the discrepancy's root causes would not only advance scientific knowledge, but also enhance health and performance equity and precision.

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