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Relationship of Muscular Fitness and Self-Rated Health of Children and Adolescents in Germany

Zusammenhang zwischen Kraftfähigkeit und subjektiver Gesundheit bei Kindern und Jugendlichen in Deutschland

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Summary

› **Objectives:** To examine the relationship between muscular fitness and self-rated health in German children and adolescents aged 11 to 17 years.
› **Methods:** A binomial logistic regression was conducted to assess the association between muscular fitness and self-rated health, accounting for sex, age group, socioeconomic status, and migration background. Results are presented as Odds Ratios, including 95% confidence intervals and p-values.
› **Results:** Data from 1,632 children and adolescents were analyzed. Lower muscular fitness was strongly associated with poorer self-rated health. Participants categorized as "Below Average" in muscular fitness had nearly eight times the odds (OR=7.79; 95 %-CI: 1.89–32.17; p=.005), and those "Well Below Average" had over 13 times the odds (OR=13.28; 95 %-CI: 2.90–60.61; p < .001) of reporting poor self-rated health compared to the "Well Above Average" reference group. Low socioeconomic status also significantly increased the likelihood of poor self-rated health (OR=1.87; 95 %-CI: 1.12–3.12; p=.016). In contrast, sex, age group, and migration background were not significant predictors. Despite a good model fit (Hosmer-Lemeshow-Test, p=.538), the explained variance was relatively low (Nagelkerke's R^2=.062), suggesting that additional contributing factors remain unaccounted for.
› **Discussion:** Muscular fitness and socioeconomic status are key determinants of self-rated health among children and adolescents. Promoting muscle strengthening activities may support current and long-term well-being. To better understand the complexity of children's and adolescent's health perceptions, future research should employ longitudinal designs and incorporate psychological, behavioral, and environmental factors.

KEY WORDS:
Physical Strength, Perceived Well-Being, Health Inequality

Introduction

Muscular fitness, alongside cardiorespiratory fitness, has emerged as a crucial determinant of both current health status and future disease risk in children and adolescents (12, 13, 31). The term muscular fitness is an integrated measure (2, 31) that combines muscular strength, endurance, and power (6). Higher levels of muscular fitness are associated with enhanced cardiovascular and skeletal health, healthier body composition, greater self-esteem, and improved self-image (22, 31). Recognizing these benefits, the World Health Organization recommends regular muscle-strengthening activities for all age groups as part of its global physical activity guidelines, emphasizing the importance of muscular fitness (4).

In addition to its role in physical health, a growing body of evidence links muscular fitness to self-rated health, a widely used indicator of overall health that predicts future morbidity and mortality (10, 29). In children and adolescents, lower muscular fitness is associated with higher odds of reporting poorer self-rated health (24, 25). Similar patterns appear in middle aged and older adults: greater muscle strength - assessed by handgrip strength (15, 18, 30) or the 30 second chair stand test (15) – is linked to better self-rated health. The positive predictive value of muscular fitness on self-rated health later in life has been demonstrated by longitudinal analyses; however, findings are not entirely consistent. Padilla-Moledo et al. (2020) (25) reported that muscular strength did not predict better self-rated health in children and adolescents after a two-year follow-up. In contrast, Hanssen-Doose et al. (2021) (16) found that higher muscular fitness during childhood and adolescence significantly predicted better self-rated health over time. Similarly, Sirola et al. (2010) (30) reported that greater handgrip strength was associated with higher self-rated health in elderly women over a 10-year period.

Overall, muscular fitness represents not only a critical component of physical health but also plays a significant role in individuals' perceptions of their own well-being. Good health is a prerequisite for the successful development of children and adolescents and is influenced by various factors, including socioeconomic status and migration

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Table 2

Odds ratios for a poor self-rated health. OR=Odds ratio; 95%-CI=95% confidence interval; *p<.05; Model fit: Nagelkerke's R^2=0.062; Effect size: f^2=0.066.

VARIABLES		OR	95%-CI	P-VALUE
Muscular fitness index	Well Above Average	Ref.	-	-
	Above Average	3.99	0.957 - 16.634	0.057
	Below Average	7.788	1.885 - 32.172	.005*
	Well Below Average	13.275	2.907 - 60.617	<.001*
Sex	Male	Ref.	-	-
	Female	1.205	0.887 - 1.637	0.233
Age group	11-13 Years	Ref.	-	-
	14-17 Years	1.333	0.981 - 1.810	0.066
Socioeconomic status	High	Ref.	-	-
	Medium	1.34	0.838 – 2.141	0.222
	Low	1.872	1.122 – 3.124	.016*
Migration background	None	Ref.	-	-
	One-sided	0.976	0.599 – 1.589	0.921
	Two-sided	1.237	0.830 – 1.843	0.297

background (19, 32). Despite the recognized importance of both muscular fitness and self-rated health, few studies have investigated their relationship in youth populations, leaving the current body of research relatively limited. Therefore, the aim of this study was to examine the association between muscular fitness and self-rated health among children and adolescents in Germany, while taking sociodemographic factors into account.

Material and Methods

Study Design

The MoMo 2.0-Study is a nationwide, cross-sectional study conducted between September 2023 and December 2024, focusing on children and adolescents aged 4–17 years in Germany (33). It aims to assess current levels of motor performance, physical activity, and health, while also examining long-term trends by comparing data with previous MoMo study cohorts collected from 2003 to 2022 (33). Key objectives include evaluating the impact of major societal changes - such as the COVID-19 pandemic, climate crisis, and migration - on youth development, and analyzing socioeconomic and spatial disparities in motor performance, physical activity, and health (33).

Participants

The total sample of the MoMo 2.0-Study included 4,394 children and adolescents aged 4 to 17 years. Since assessing self-rated health requires the ability to reflect on one's own health status, children under the age of 11 were excluded, as their level of self-perception does not yet allow for reliable responses (16). This resulted in a sample of 1,632 children and adolescents at the age of 11 to 17 years.

Self-Rated Health

Self-rated health was assessed using a one-item scale ("How is your health in general?") offered with a 5-point response scale (1="very good", 2="good", 3="fair", 4="poor", or 5="very poor") (33). The children and adolescents filled out the question themselves, which was part of a health questionnaire. The question wording met the recommendations of the WHO (9). For the analyses, self-rated health was grouped into two categories. The "Good" self-rated health status category included the responses "very good" and "good," while the "Poor" self-rated health status category included the responses "fair," "poor," and "very poor" (16).

Muscular Fitness

In the MoMo 2.0 test profile muscular fitness was assessed using the standing long jump, sit-ups, push-ups, and handgrip tests (33). To create an overall muscular fitness index, performance results were converted into percentiles based on age- and sex-specific reference values, using Niessner et al. (2020) (21) for the standing long jump, sit-ups, and push-ups, and Ortega et al. (2023) (23) for the handgrip test. The handgrip test was only included in the MoMo 2.0 study, which is why no reference percentiles from the MoMo study (21) are available. The mean percentile score was then calculated for each individual. Based on these scores, the muscular fitness index was categorized into four groups: the "Well Below Average" group (mean percentiles 1st to below 15th), the "Below Average" group (15th to below 50th), the "Above Average" group (50th to below 85th), and the "Well Above Average" group (85th to 99th). The 15th percentile cut-off for the "Well Below Average" group has been chosen since gross motor coordination difficulties have been linked to physical performance at or below the 15th percentile (5, 16). Accordingly, the 85th to 99th percentiles were chosen for the "Well Above Average" group.

Socioeconomic Status

Socioeconomic status (SES) was operationalized using a composite measure based on parental education, parental occupation, and equivalized disposable household income (20). Each SES dimension was scored on a scale from 1 to 7, with the higher score of the two parents used for the parental indicators (20). These scores were then aggregated to produce a multidimensional index ranging from 3 to 21 (20). Based on this index, participants were categorized into three SES groups: „High", „Medium", and „Low" (20). The high SES group comprised the top 20% of participants with the highest SES scores, while the low SES group included the bottom 20% (20). The remaining 60% were classified as the medium SES group (20). ›

Table 1

Sample characteristics. SD=Standard deviation.

VARIABLES		TOTAL	DISTRIBUTION [%]
Sample size [N]	Total (11-17 years)	1632	100.0
	11-13 Years	875	53.6
	14-17 Years	757	46.4
Age [Years]	Mean (±SD)	14.0 (1.9)	-
	Minimum	11.0	-
	Maximum	17.9	-
Sex [N]	Male	864	52.9
	Female	768	47.1
Self-rated health [N]	Good	1438	88.1
	Poor	194	11.9
Muscular fitness index [N]	Well Above Average	90	5.5
	Above Average	737	45.1
	Below Average	739	45.2
	Well Below Average	66	4.2
Socioeconomic status [N]	High	307	18.8
	Medium	943	57.8
	Low	382	23.4
Migration background [N]	None	1191	73.0
	One-sided	188	11.5
	Two-sided	253	15.5

Migration Background

The migration background of the participants was assessed by asking in which country their parents were born (33). Participants whose parents were both born in Germany were classified as having no migration background. If one parent was born outside of Germany, participants were classified as having a one-sided migration background. If both parents were born outside of Germany, participants were classified as having a two-sided migration background.

Data Analysis

A binomial logistic regression was used to examine the association between self-rated health and muscular fitness. Since sociodemographic differences can influence health parameters, the analysis accounted for sex, age groups (11-13 and 14-17 years), socioeconomic status, and migration background (19, 32). Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test and Nagelkerke's R^2. The presented Odds Ratios (ORs) indicate the factor by which the risk for a "Poor" self-rated health status is increased compared to the reference category of "Good" self-rated health status. For all results 95% confidence intervals (95%-CI) and p-values are reported (statistical significance set at $p \leq 0.05$). All statistical analyses were performed using SPSS (IBM, Version 30).

Results

Sample Characteristics

The analyzed sample consisted of 1,632 individuals aged 11 to 17 years. The mean age of the participants was 14 years, with 53.6% belonging to the 11-13 year age group. The sample included slightly more males (52.9%) than females (47.1%), and the majority rated their health as "Good" (88.1%). In terms of muscular fitness, only 5.5% were classified as "Well Above Average" and 4.2% as "Well Below Average", while the proportions of those rated "Above Average" and "Below Average" were nearly identical, each at approximately 45%. Most participants had a medium SES (57.8%) and no migration background (73.0%). A smaller portion of the sample had a high SES (18.8%) or low SES (23.4%). Regarding migration background, 11.5% had a one-sided and 15.5% a two-sided migration background. All descriptive statistics, including total values and distributions, are presented in table 1.

Binomial Logistical Regression Model

A binomial logistic regression was conducted to examine the effects of muscular fitness, sex, age group, SES, and migration background on the likelihood of reporting "Poor" self-rated health (table 2). Goodness-of-fit was assessed using the Hosmer-Lemeshow-Test, indicating a good model fit ($\Xi^2(8)=6.985$, $p=.538$), though it accounted for a relatively small proportion of variance, as indicated by Nagelkerke's $R^2=.062$ (3). Among the five predictors, two variables significantly contributed to the prediction of "Poor" self-rated health: muscular fitness ($p < .001$) and SES ($p=.038$). In contrast, sex ($p=.233$), age group ($p=.066$), and migration background ($p=.555$) were not statistically significant predictors. Regarding muscular fitness, individuals in the "Below Average" group had significantly higher odds of "Poor" self-rated health compared to the "Well Above Average" reference group (OR=7.79; 95% CI=1.89–32.17; $p=.005$). Those in the "Well Below Average" group had even higher odds (OR=13.28; 95% CI=2.90–60.61; $p < .001$). For SES, individuals with a low SES were significantly more likely to report "Poor" self-rated health compared to those with high SES (OR=1.87; 95% CI=1.12–3.12; $p=.016$).

Discussion

Consistent with existing literature, the majority of the children and adolescents in this population-based study in Germany reported having good or very good self-rated health (16, 26). This can be considered a positive finding, as very good or good health provides an optimal foundation for the overall development of children and adolescents and their ability to successfully meet developmental tasks. Our results showed that children and adolescents with lower muscular fitness were significantly more likely to rate their health poorly. Those categorized as "Well Below Average" had over 13 times the odds of reporting "Poor" self-rated health compared to peers with "Well Above Average" fitness, while the "Below Average" group had nearly 8 times the odds. These findings align with previous studies indicating that lower muscular fitness is associated with an increased likelihood of poor health among children and adolescents (24, 25). Possible reasons for this may include health risk behaviors, such as smoking and drinking, which were inversely associated with muscular fitness in the study by Padilla-Moledo et al. (2012) (24).

In addition to muscular fitness, SES was the only other significant predictor of a "Poor" self-rated health. Children and adolescents with low SES were nearly twice as likely having "Poor" self-rated health compared to those with high SES. This is consistent with previous findings that underscore a social gradient in health, wherein children and adolescents from low SES families, who are facing socioeconomic challenges are more vulnerable to "Poor" self-rated health (26). SES may influence health through multiple pathways, including less healthy behaviour, differential access to healthcare, unequal assess to structures that foster and encourage sport participation, differences in recreational opportunities, and exposure to chronic stressors (14).

Contrary to some prior research, sex, age group, and migration background were not significant predictors of self-rated health in our model (1, 8, 28). The lack of significant associations for migration background may be attributed to sample characteristics or limitations in the categorization of migration experience. While studies revealed negative effects of the migration background on different health parameters in Germany (27), the relatively high proportion of participants without a migration background and the use of broad groupings may have reduced sensitivity to detect differences regarding self-rated health in this study. Age group approached significance (p=.066), suggesting a potential trend worth further investigation, perhaps reflecting developmental shifts in self-perception or health awareness during adolescence.

Despite the model's good fit, the explained variance (R^2=.062) and the effect size (f_2=.066) was relatively low, indicating that other unaccounted factors may also influence self-rated health. This underlines the complexity of self-rated health perception of children and adolescents.

Strengths and Limitations

This study benefits from a large sample and the use of validated measures for both muscular fitness and self-rated health. The inclusion of some key covariates into the regression model strengthens the robustness of the findings. Notably, using self-rated health as an outcome variable connects muscular fitness to a well-established predictor of long-term health, emphasizing its public health relevance in youth.

Despite these strengths, the study has several limitations. First, although the sample was large, we were unable to apply weighting procedures, leaving potential over- or underrepresentation unaddressed. Second, the majority of participants (88.1%) rated their health as good or very good, which may have inflated the odds ratios for "Poor" self-rated health and should be considered when interpreting the findings. Additionally, categorizing fitness scores may have reduced the sensitivity of the observed associations. Moreover, broad categorizations of SES and migration background may have oversimplified complex, multidimensional influences. Finally, the regression model accounted for only a limited proportion of the variance, suggesting that other relevant variables were not included in the analysis.

Implications for Future Research

This study highlights several areas for future research. The strong association between muscular fitness and self-rated health suggests a need for longitudinal studies to explore causality and how muscular fitness predicts self-rated health (16, 25). As the model explained only a small portion of the variance in self-rated health, future work should investigate additional predictors, including psychological, behavioral, and environmental factors.

The significance of SES also calls for more detailed investigations into the mechanisms linking social disadvantage and health perceptions. Incorporating more nuanced SES indicators - particularly parental education, which studies have shown to directly influence differences in self-rated health (1, 8, 28) – could enhance understanding of these relationships. Similarly, refining the assessment of migration background and including factors like acculturation and length of residence may help clarify its impact, which was not evident in this study.

Additionally, the near-significant trend for age group suggests developmental changes in health perception that should be further explored in longitudinal research. Tracking individuals across adolescence could reveal how self-rated health evolves over time. Overall, future studies should aim to build more comprehensive models that capture the complexity of self-rated health in youth and guide targeted public health strategies.

Conclusion

In summary, our findings reinforce the relevance of muscular fitness and SES in children and adolescents' self-rated health. These results emphasize the value of integrating muscle strengthening activities into school curricula and public health strategies, particularly among youth from disadvantaged backgrounds. Given the predictive power of muscular fitness for both current and future health outcomes, early intervention could be a key strategy in fostering lifelong well-being (11). The World Health Organization rightly recommends regular muscle-strengthening activities for all age groups as part of its global physical activity guidelines (4), and compliance with these guidelines should be regularly monitored to ensure equitable and effective implementation.

Future research should build on these findings by using longitudinal designs to explore causal relationships and developmental trends in self-rated health. Additionally, incorporating more detailed measures of for example SES - especially parental education - and exploring a wider range of psychological, behavioral, and environmental factors could provide a deeper understanding of the complex influences on young people's health perceptions.

Conflict of Interests
The authors declare that they have no conflict of interest. All authors have completed the ICMJE Uniform Disclosure Form.

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Ethical Approval
All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the Institutional Research Committee and with the Declaration of Helsinki of 1975 and its subsequent amendments or comparable ethical standards. Ethical approval for the MoMo 2.0-Study was obtained from the Ethics Committee of the Karlsruhe Institute of Technology on 6 November 2023 (application number A2023-077).

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Summary Box

Muscular fitness is increasingly recognized as a key determinant of both current and future health. In this context, growing research interest has focused on the impact of muscular fitness on the subjective health of children and adolescents. Accordingly, this study aimed to examine the relationship between muscular fitness and self-rated health among German children and adolescents aged 11 to 17 years.

Lower muscular fitness was strongly associated with poorer self-rated health: individuals classified as "below average" had 7.79 times, and those "well below average" had 13.28 times the odds of reporting poor health compared to their "well above average" peers. Additionally, low socioeconomic status increased the odds of reporting poor self-rated health by 1.87 times. These findings underscore the importance of promoting muscle strengthening activities to support current and long-term well-being.

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