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ASSOCIATION BETWEEN HANDGRIP STRENGTH, HEALTH-RELATED QUALITY OF LIFE, AND PHYSICAL FITNESS IN ADULTS: IMPLICATIONS FOR PUBLIC HEALTH SCREENING

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Abstract

Background

Handgrip strength is increasingly recognized as an indicator of overall physical fitness and health-related quality of life (HRQOL). However, limited evidence exists regarding its relationship with HRQOL and other fitness parameters among sedentary adults.

Objective

The present study aimed to examine the relationship between handgrip strength, physical fitness components, and health-related quality of life in sedentary adults.

Methods

Twenty sedentary adults aged 18–55 years were recruited using the Physical Activity Readiness Questionnaire (PAR-Q). Physical fitness assessments included kin anthropometry, flexibility, handgrip strength, and cardiorespiratory endurance (VO_2 Max). Health-related quality of life was evaluated using a structured questionnaire incorporating physical activity measures and the World Health Organization Quality of Life instrument (WHOQOL-BREF). Pearson's correlation coefficients were used to determine associations among variables, while multiple regression analysis was performed to examine the extent to which body composition, flexibility, and handgrip strength predicted HRQOL.

Results

Significant associations were observed between selected physical fitness variables and HRQOL domains. Cardiorespiratory endurance (VO_2 Max) showed a significant positive correlation with the social relationship's domain of HRQOL ($p = 0.022$, $r = 0.507$). A significant negative correlation was found between waist–hip ratio (WHR) and the environmental domain of HRQOL ($p = 0.027$, r

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= −0.493), as well as between lean mass and the environmental domain (p = 0.040, r = −0.462). However, multiple regression analysis revealed no significant predictive association between the selected physical fitness variables and overall HRQOL.

Conclusion

Although certain physical fitness parameters demonstrated significant correlations with specific HRQOL domains, no significant predictive relationships were identified through regression analysis. These findings highlight the need for further research to better understand the multifactorial determinants of HRQOL. The study underscores the importance of adopting a systemic and multidimensional approach when examining physical fitness as a component influencing health-related quality of life.

INTRODUCTION

Physical health is very important for people's physical and clinical fitness. Physical fitness is a key predictor of health at all ages. Cardiorespiratory stamina, muscular fitness (including strength and stamina), body composition, and speed and activeness are all health-related physical fitness (1). Good physical fitness depicts a healthy body without risks of diseases. For example, healthy mental and nutritional conditions help to prevent the risks of many non-apparent diseases (1).

Medical and physical fitness is evaluated through lab tests by doctors and physicians for valid and reliable results. However, laboratory tests are inappropriate for large-scale or in situ testing due to their high cost (2). This has led to a growing number of physical performance field tests. Physical field test evaluates the lifestyle of the people, the changes to improve a healthy life, and assess the body's organs functioning and in response to the body's reactions. Medical disease can be overcome through physical fitness and increased stamina by doing exercises like increasing handgrip strength and healthily improving lifestyle (2) (3).

Handgrip strength (HGS) is a simple and precise gauge for measuring health-related quality of life. It depicts healthy body muscles and physical fitness at all ages. HGS is more accurate in adults than children or old people. It has increasingly been demonstrated as an indicator of physical health and mental health (4). Handgrip Strength testing is an easy and standard method for disease screening because it associates significantly with overall health status, and it is simple and low-cost to screen the diseases. HGS is a screening tool that provides measurable and reliable results for assessing overall health and detecting physical or clinical diseases (5). HGS testing is an easy and standard method for disease screening because it is significantly related to overall health status, with being low cost and simple(6). Over the last 50 years, multiple studies on Handgrip Strength have linked it to a variety of health issues. However, existing studies are disorganized and inconclusive because they involve diverse populations, geographical regions, and methodologies. To better understand the importance of HGS testing for screening diseases or assessing disease risk, future research should focus on a comprehensive understanding of body functioning and the impact of healthy lifestyles (7).

Handgrip strength-related literature is vibrant as well as ambiguous. The research is partially discussed not complete in one unit. The studies with specific populations and areas do not provide the proper benefits of HGS. However, the association between HGS with overall body health status, dietary habits, surgical difficulties, disability, injury, loss of protein, muscle mass, and diabetes are discussed in different studies (8). It has also been associated with physical activity levels. Muscle ability is associated with physical activity levels and the general strength of muscles. HGS is used to predict deficiencies and diseases that may occur in the future due to any factor that damages health. Furthermore, HGS shows

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validated and preferable results to laboratory and clinical results about the health status (8).

A healthy quality of life increases the handgrip strength and the body's stamina. HGS indicates muscle mass and ability to engage in physical activities. It also determines the body's nutritional condition, health-related quality of life, and clinical fitness. Handgrip strength is an indication of the body's ability to protect against the development of chronic diseases and to improve quality of life (9). As a result, Handgrip Strength has consistently been identified as a marker of well-being associated with many multiple long-term diseases rather than simply mobility or strength measures (9). It is also used to assess muscle strength, which is an important indicator of health status in adults. it also holds an important connection to the concept of sarcopenia, which encompasses the age-related decline in muscle mass, strength, and function. It has also been reported to indicated the health and strength of adults(10).

HRQoL encompasses the impact of a healthy lifestyle on both physical and mental health. Adults, who typically have stronger muscles than children and the elderly benefit more from higher HRQoL. Maintaining good HRQoL can help mitigate the risks of diseases. Adopting healthy habits, such as proper nutrition and regular exercise, improves HRQoL and can alleviate the negative health effects commonly associated with aging (11, 12).

Cardiorespiratory fitness refers to an individual's functional capacity and cardiovascular health which indicates their overall bodily function and well-being. the processes and mechanisms by which frequent physical activity promotes cardiorespiratory fitness. It can reduce the development of chronic diseases such as hypertension, diabetes, stroke, and cancer. Additionally, promotes healthy cognitive and psychosocial function(13).

HGS and physical fitness are interrelated and show the strength of the body and a healthy lifestyle. HGS is a tool that can be used to evaluate adverse medical results. It also correlates with physical and clinical disorders that have a distant connection to the physical domain. HGS tests evaluate the force generated by the muscles of the upper arm, which control the movement of the hand. This parameter is acquired by simply operating a handgrip dynamometer (14). The simplicity, accuracy, and cost-effectiveness of this test have been used in a variety of settings. However, HGS results significantly vary by gender and age. Normally, Men aged 24 to 39 have the strongest grips. In general, men have a higher Handgrip Strength than women. Exercise, general well-being, dietary habits, BMI, haemoglobin levels, and residual glomerular filtration rate all impact on HGS (15).

Adults must maintain an adequate level of HGS, as it is strongly correlated with muscle mass. Adequate Handgrip Strength during adulthood is likely to reduce the risk of developing chronic diseases later in life (11). Aging leads to anabolic impairments in skeletal muscles, resulting in significant losses of muscle mass and strength. On average, individuals lose approximately 30% of their peak muscle mass as they age. For instance, while children may have increasing handgrip strength and adults possess greater overall power, muscle mass diminishes with age, leading to decreased muscle activity. This decline adversely affects physical activity levels and nutritional status (11).

Exercising or consuming protein-based nutrition can maintain muscle strength and mass and increase physical fitness. It also improves the body's organ functioning, especially the respiratory and circulatory organs. Muscle strength and HGS are considered quick and sole markers of an individual's well-being (16).

Research has shown that a healthy quality of life enhances HGS and overall body stamina. HGS is a reliable indicator of muscle mass and the capacity to engage in physical activities. It also reflects the body's nutritional status, health-related quality of life (HRQoL), and clinical fitness. High HGS is associated with a reduced risk of developing chronic diseases and is a significant marker of overall well-being, as it is linked to multiple long-term health outcomes beyond mere measures of mobility or strength (17).

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As such, the aim of the study was to determine the association between handgrip strength, health-related quality of life, and physical fitness in adults.

METHODOLOGY

Participants

The inclusion criteria for this research were to recruit 20 participants aged 18 years to 55 years who were not regular in physical activity for the last six months. Participants with a sedentary lifestyle were selected for recruitment, as this cohort exhibits a diminished presence of confounding variables associated with exercise habits, thereby mitigating the potential for erroneous findings. The inclusion of sedentary participants further affords researchers the opportunity to delineate assessment outcomes uncontaminated by influences stemming from pre-established fitness levels or heterogeneous exercise histories. The participants were invited through moodle to take part in this study. To take part in this study, participants had to give written consent. The research adhered to the 2013 revision of the Declaration of Helsinki. The relevant institutional review board at the University of Essex in the United Kingdom, ETH2324-0367, approved the study.

Physical Activity Readiness Questionnaire (PAR-Q)

Prior to any examinations, each participant had to complete the Physical Activity Readiness Questionnaire (PAR-Q). Each participant's current health status, including any known medical illnesses or sign and symptoms and prescription procedure, was gathered using the PAR-Q. A participant will not be allowed to continue in the study if they disclose any current medical conditions or medication use that could be dangerous during the evaluations. Any participant who responds in the affirmative to any of the PAR-Q's questions 1, through 12, 20, 21, 22, 25, 26, and 28 will not be allowed to participate.

Health-Related Quality of Life (HRQOL) Assessment

The World Health Organization Quality of Life (WHOQOL-BREF) questionnaire was used to evaluate each participant's health-related quality of life (HRQOL). The questionnaire's high internal validity has been shown by prior research, as seen by its Cronback's α coefficient of 0.81. (18), which has been largely noted in previous studies (19) (20) (18).

Kinanthropometry Assessment

The same technician performed the anthropometric measurements using the guidelines provided by the International Society for the Advancement of Kinanthropometry (ISAK) (Norton & Olds, 1996).

- **Body Mass**

This was performed on participants by removing any bulky clothing and electronics (watches, phones, etc.) before standing barefoot in the center of the weight scale platform to measure their body mass (BM), which was expressed in kilograms (kg). (21).

- **Stature**

A typical stadiometer that was installed on the wall was used to measure stature.

- **Body Mass Index**

The body mass (kg) was divided by their stature squared (m2) to determine their body mass index (BMI), which was then represented as kilograms per square meter (kg.m-2).

- **Skinfolds**

Using a skinfold caliper, skinfold measurements of the triceps, suprailliac, abdomen, and thigh were obtained on the right side of the body.

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- **Body Fat Percentage:**

The percentage body fat (%BF) was calculated using the equation of Jackson and Pollock (1985): Men 4-Site Skinfold Equation (for calculating % body fat)% Body Fat = (0.29288 * sum of skinfolds) – (0.0005 * square of the sum of skinfolds) + (0.15845 * age) – 5.76377, where the skinfold sites (mm)

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are abdominal, triceps, thigh and supra-iliac, and for Women 4-Site Skinfold Equation (for calculating % body fat)% Body Fat = (0.29669 * sum of skinfolds) – (0.00043 * square of the sum of skinfolds) + (0.02963 * age) + 1.4072, where the skinfold sites (mm) are abdominal, triceps, thigh and supra-iliac.

- **Wait to hip Ratio**

Using a non-distendable measuring tape, the waist and hip circumferences (as used in the waist-to-hip ratio, or WHR) were determined. The WHR was then computed using the following formula: Waist circumference (in inches) ÷ hip circumference (in inches) equals WHR (22).

- **Fat Mass**

Body mass was multiplied by the percentage of body fat, and the result was divided by 100.

- **Lean mass**

It was computed by deducting the kilogram of fat from the kilogram of total body mass.

Flexibility Assessment

The flexibility test was a sit-and-reach exercise. With their legs extended straight ahead and their soles flat against the box, participants sat on the floor. Locked and flat on the floor were both knees. The hands were arranged with the palms facing down and one on top of the other. The subject was instructed to extend their arm as far as they could in a calm, steady motion, and to hold that position for two seconds while the distance was being measured. Out of three attempts, the best score will be noted.

Handgrip Assessment

A handheld dynamometer was used to assess the handgrip. The subjects assumed an erect stance, positioning their forearms neutrally, elbows at 90° flexion, and shoulders at 0° adduction and neutral rotation. For the right arm, three tests were run, with one minute of rest in between each. Recorded were the maximum and average values (23).

Cardiorespiratory Fitness Assessment

Using the PWC170 cycle ergometer technique, the workload (measured in watts) at which the subject's heart rate hits 170 beats per minute (bpm) was used to determine VO2max. Heart rate was measured using a heart rate monitor and telemetry strap. Participants were required to warm up by pedaling at a low resistance for five minutes. Workload was increased to 25-50 watts. Participants were instructed to maintain a continuous pedaling at the rate (50-80 revolutions per minute (RPM). Workload will be increased by adding 25 watts every two minutes. This increase will continue every two minutes until the participant's heart rate reaches or exceeds 170 bpm or until they reach their maximal effort and cannot continue. Participants also performed a cool down for minutes without resistance. Heart rate was measured immediately upon reaching the desired heart rate of 170 bpm or when they were unable to continue.

Statistical Analysis

Data is analyzed through SPSS 27, using statistical tests i.e. descriptive analysis, Pearson correlation analysis, and multi-linear regression.

Results

The mean age of the sample was 25.85 years, and the average weight was 79.15 kg. All demographic data is demonstrated in table 1.

Table 1: Descriptive Statistics

Descriptive Variables	Mean & Standard Deviation
Age (in Years)	25.85 (± 2.720)
Weight (kg)	79.150 (± 6.175)
Gender	1.40 (± .503)
Height (m)	1.671 (± .085)

Kg: Kilogramme; m: Meter

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Table 2 shows the P-value of the multiple linear regression analyses regarding the potentially significant connections between different HRQOL domains and the fitness measures with the transformed fitness score on a 0-100 scale. Regarding physical health, none of the aspects of physical fitness parameters was found to be significant (all p >0. 05).

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Table 2: Multiple Linear Regression between HRQOL (0-100 transformed score) Domains and BMI (kg.m-2), BF%, WHR, Fat mass (Kg), Lean mass (Kg), Flexibility (cm), Handgrip (Kg) and VO2max (mL/Kg/min)

HRQOL Domains	R^2	Adj. R^2	P
Physical Health	0.137	-0.491	0.98
Psychological health	0.438	0.029	0.44
Social relationships	0.356	-0.112	0.643
Environmental	0.436	0.026	0.45

- * Statistical significance was set as P≤ 0.05.
- R^2:R-squared; Adj. R^2: Adjusted R squared; P: probability value.

Table 3 shows the pearsons correlation from the correlation analyses between HRQOL domains and various fitness variables, focusing on transformed scores on a 0-100 scale. Significant correlations were found between the social relationship domain, and VO_2max (p=0.022) and the environment domain with lean mass (p=-0.040) and WHR (p= -0.027), while the other parameters did not show significant correlations.

Table 3: Correlations between Health-Related Quality of Life HRQOL (transformed score 0-100) Domains, Body Composition, Flexibility, Handgrip & Cardiorespiratory Endurance (VO_2max)

Variables	BMI (Kg.m^{-2})	BF%	WHR (Inches)	Fat Mass (kg)	Lean mass (kg)	Flexibility (cm)	Handgrip (KG)	VO_2 max (mL/Kg/min)
Physical health	0.131	-0.205	0.242	-0.216	0.091	0.176	0.117	-0.178
Psychological health	-0.182	0.054	0.033	0.149	0.115	-0.087	0.209	0.279
Social Relationships	0.074	-0.038	0.010	-0.018	0.051	0.081	-0.147	0.507*
Environmental	0.084	0.355	-0.493*	0.148	-0.462*	-0.412	-0.368	-0.165

- * Statistical significance was set as P≤ 0.05.
- BMI: body mass index; Kg.m-2: kilogram per square meter; BF%: Body fat percentage; WHR: Waist Hip Ratio; Kg: kilogram; CM: Centimeter; VO2Max: cardiorespiratory endurance; mL/Kg/min: milliliters per minute per kilogram

Table 4 shows depict correlation coefficients of pairwise comparisons of various physical fitness parameters. Concerning the relationship handgrip has a significant negative relationship with BF% and hand grip has a significant positive relationship with WHR, at the same time handgrip has making positive relationship with lean mass.

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Table 4: R-Values for Correlations between Physical Fitness Variables

Variables	BMI ($kg.m^{-2)}$	BF%	WHR	Fat mass (Kg)	Lean mass (Kg)	Flexibility (cm)	Hand grip (Kg)	VO_2max (mL/Kg/min)
BMI ($kg.m^{-2}$)	1							
BF%	0.273	1						
WHR	-0.102	-0.622*	1					
Fat mass (Kg)	0.237	0.864*	-0.463*	1				
Lean mass (Kg)	-0.220	-0.733*	0.540*	-0.293	1			
Flexibility (cm)	-0.112	-0.690*	0.736*	-0.643*	0.447*	1		
Hand grip (Kg)	-0.007	-0.499*	0.606*	-0.373	0.448*	0.723*	1	
VO_2max (mL/Kg/min)	0.080	0.225	-0.157	0.129	-0.241	0.045	-0.111	1

- * Statistical significance was set as P≤ 0.05.

BMI: body mass index; $Kg.m^{-2:}$ kilogram per square meter; BF%: Body fat percentage; WHR: Waist Hip Ratio; Kg: kilogram; CM: Centimeter; VO2Max: cardiorespiratory endurance; mL/Kg/min: milliliters per minute per kilogram

Discussions

The study aimed to determine the association between handgrip strength, health-related quality of life, and physical fitness in adulthood. The analysis of HRQOL in relation to WHR, BMI, BF%, fat mass, lean mass, flexibility, Handgrip Strength, and VO_2 max reveals insights into how these factors influence HRQOL. Among the significant findings, the most noticeable is the positive correlation between VO2 max and the social relationship domain and WHR and Lean mass have significant negative with environmental domain. The present research further proved that the increased VO_2 max corresponds to improved social contacts and interaction. Anthropological studies of school Children also validate this association. For instance, one research (24) showed that enhanced VO_2max enhances social integration in the elderly clientele. This can be explained by higher energy levels and lower fatigue observed in athletes with higher VO_2 max that are probably linked with higher levels of social activity and contacts. In the same vein, a randomized control study done by Bang-Kittilsen (25)also showed that those people who were found to have high values of VO_2 max, have more social support, and they also engaged in social interactions than the other group of people. This study's finding does imply that improved VO_2 max may be instrumental in improving social well-being or the ability of an individual to encompass social roles and sustain social relationships, hence enhancing the overall HRQOL. It is supported by existing literature that VO_2 max was positively related to the social relationships domain as shown(26, 27); cardiorespiratory fitness improves social relations and support provisions.

This thick line connecting lean mass to the environment domain further means that lean mass plays a major role in how one feels about his or her environment which comprises living conditions and all that is around them (28). This is further substantiated by the study carried out in the recent past which demonstrated that increased muscle mass directly affects the

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environment perception and physical function. A cross-sectional study showed that the people with higher lean mass are more mobile and have better physical functioning which can influence the way they encounter their physical environment(29). Studies by (30) resort to this by showing that with increased lean mass resulting from resistance training, quality of life, including the perception of the environment is boosted. Based on their findings, enhanced muscle strength and muscle mass directly enhance the feasibility and quality of the interaction with the environment, underlining the importance of muscle health in the HRQOL equation. Studies by (31) resort to this by showing that with increased lean mass resulting from resistance training, quality of life, including the perception of the environment is boosted. Based on their findings, enhanced muscle strength and muscle mass directly enhance the feasibility and quality of the interaction with the environment, underlining the importance of muscle health in the HRQOL equation.

The correlation of WHR and the environmental aspect of HRQOL shows a negative relation which was also discussed in the previous study (32) states higher WHR increases the risk of cardiovascular and metabolic diseases which provide a negative impact on the quality of life. The multiple linear regression analysis further supports (33) that increased WHR can associated with diabetes. The Swedish research (34) environmental and genetic factors affect WHR.

The correlation analysis between variables states that there is a relationship between body physical fitness and composition(35). Handgrip strength shows a positive correlation with lean mass and HGS showed a negative correlation with BF%. This same relationship of muscle mass, body fat, and strength is already shown in previous literature, similar findings were reported by (36) in their study on the determinants of muscular strength.

Conclusion

The present research investigates the correlation between HGS with HRQOL and physical fitness indices among adults. The following results: the correlation between VO2 max and the social relationship area of the HRQOL is positive, indicating that cardiovascular fitness improves an individual's social functioning and quality of life. The correlation between WHR and lean mass with[environmental factors was significant suggesting that individuals with higher WHR might experience a lower quality of life in environmental contexts. This research also confirms that changes in lean mass affect participants' views on the environment and physical functioning benefits. However, the relationship of most of the other parameters of physical fitness such as fat mass and flexibility with the different domains of HRQOL is rather weak. These findings support the notion of integrating among aspects of health-related quality of life the physical fitness, mental state, and social support. Subsequent subjective studies should expound on these numerous factors in an attempt to formulate ambitious plans for enhancing the quality of existence. Handgrip strength has shown a significant correlation with BF%. WHR, lean mass, and flexibility show that these variables have a major effect on it.

Limitations

- This paper is limited by sample bias which distorts the generality of the results to the rest of the population.
- Reproducibility is problematic because one's motivation level and the tools used to assess handgrip strength may differ between tests.
- There are other variables like nutritional status or the patient's lifestyle pattern that distort the outcome if not properly uncontrolled.

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Ethical Approval:
This study is approved by the ethical committee of University of Essex (ETH2324-0367).

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request. Due to privacy and ethical concerns, certain restrictions apply to the availability of these data.

Abreviations used in tables

kg	Kilogram
ml.kg-1.min-1	Millilitres per kilogram per minute
m	Meter
cm	Centimetre
kg.m-2	Kilograms per square meter
HRQOL	Health-Related Quality of Life
P-Value	Probability Value
VO_2max	Maximum Oxygen Uptake
R	Correlation Coefficient
R square	Coefficient of Determination
PAR-Q	Physical Activity Readiness Questionnaire
WHOQOL-BREF	World Health Organization Quality of Life
ISAK	International Society for the Advancement of Kinanthropometry
BM	Body Mass
BMI	Body Mass Index
RPM	Revolutions Per Minute
WHR	Waist-to-Hip Ratio
%BF	Percentage Body Fat
FM	Fat Mass
LM	Lean Mass

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