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Effects of Regular Physical Activity on Cardiorespiratory Fitness and Body Composition in Young Adult Men

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ABSTRACT: Regular physical activity is considered an important determinant of health-related fitness, yet the magnitude of its association with cardiorespiratory fitness and body composition can vary substantially among young adults. This study examined whether habitual physical activity level was associated with estimated maximal oxygen uptake and body-composition indicators in young adult men. A cross-sectional analytical design was used with 132 apparently healthy men aged 18-25 years. Weekly physical activity was assessed using the International Physical Activity Questionnaire-Short Form and expressed as MET-minutes per week. Participants were classified as low active, moderately active, or highly active. Cardiorespiratory fitness was estimated using a graded treadmill test. At the same time, body mass, body mass index, waist circumference, body fat percentage, and fat-free mass were assessed using standardized anthropometry and multi-frequency bioelectrical impedance analysis. Between-group differences were examined using one-way analysis of variance with Bonferroni-adjusted post hoc comparisons. Pearson correlation and multiple linear regression were used to evaluate associations among physical activity, fitness, and body-composition variables. Statistical significance was set at $p < 0.05$. Weekly physical activity differed significantly across groups ($p < 0.001$). Estimated VO2max increased from the low-activity group (38.1 ± 5.1 mL·kg-1·min-1) to the moderate-activity group (42.9 ± 5.2 mL·kg-1·min-1) and high-activity group (49.5 ± 7.1 mL·kg-1·min-1), $F(2,129) = 29.09$, $p < 0.001$. Body fat percentage was lower in the highly active group (16.5 ± 4.9%) than in the low-activity group (20.9 ± 4.5%), $F(2,129) = 11.31$, $p < 0.001$, while body mass index and fat-free mass did not differ significantly. Physical activity was positively correlated with estimated VO2max ($r = 0.52$, $p < 0.001$) and inversely correlated with body fat percentage ($r = -0.30$, $p < 0.001$) and waist circumference ($r = -0.32$, $p < 0.001$). In adjusted regression models, physical activity remained a significant predictor of estimated VO2max and body fat percentage. Higher regular physical activity was associated with better cardiorespiratory fitness and a more favorable adiposity profile in young adult men. The strongest and most consistent association was observed for estimated VO2max, suggesting that aerobic fitness may be particularly sensitive to habitual activity level during early adulthood.

Keywords: physical activity; cardiorespiratory fitness; body composition; VO2max; bioelectrical impedance analysis; MET-minutes.

I. INTRODUCTION

Regular physical activity is a core behavior for maintaining health and functional capacity during adulthood. International and national guidelines recommend that adults accumulate at least 150-300 minutes per week of moderate-intensity aerobic activity, 75-150 minutes per week of vigorous-intensity aerobic activity, or an equivalent combination, with additional strengthening activities when possible [1]-[4]. These

recommendations are not intended only for older or clinical populations. They are highly relevant for young adults because the transition from school to university, work, independent living, and more sedentary study or occupational routines often produces marked changes in movement behavior. Early adulthood is also a period when individuals may appear outwardly healthy yet exhibit wide variation in aerobic capacity, adiposity, central fat distribution, and lifestyle stability. Studying physical activity in this age group is therefore important because the habits formed during these years can support or weaken health-related fitness across the life course.

Physical activity refers to movement that raises energy expenditure. At the same time, cardiorespiratory fitness reflects the integrated ability of the cardiovascular, respiratory, and skeletal-muscle systems to deliver and use oxygen during sustained exercise. In field research, physical activity is often summarized using MET-minutes per week, a metric supported by the Compendium of Physical Activities and widely used scoring approaches for self-report instruments such as the International Physical Activity Questionnaire [5]-[7]. Cardiorespiratory fitness, by contrast, is typically assessed with direct gas analysis or estimated through graded exercise testing. The two constructs are related but not interchangeable. A man may report an active week yet show only moderate fitness if his activity is low-intensity or irregular. At the same time, another individual may retain relatively high fitness from previous training despite a short-term reduction in activity. This distinction is essential when interpreting health-related fitness in young adults.

Cardiorespiratory fitness has attracted increasing attention because it is one of the strongest indicators of current and future cardiovascular health. Scientific statements and epidemiological studies emphasize that low fitness is associated with higher morbidity and mortality risk, while higher fitness is linked to better long-term outcomes [8]-[11]. These findings have shifted fitness from being viewed only as a performance trait to being understood as a clinically meaningful health marker. In young adulthood, low fitness may be particularly important because it can precede the development of more visible risk factors. Evidence from longitudinal cohorts indicates that cardiorespiratory fitness in early adulthood is associated with later development of cardiovascular risk factors, including hypertension, diabetes risk, and metabolic syndrome [12]. For that reason, young adulthood should not be viewed as a risk-free interval; it is a formative period during which protective or harmful physiological trajectories may already be developing.

Body composition is another major dimension of health-related fitness. Body mass alone is a limited indicator because it does not distinguish fat mass from lean tissue or central from peripheral adiposity. Reviews of youth and sport populations emphasize that body fat percentage, fat-free mass, and waist circumference provide more specific information than body mass index alone [13]-[17]. This is especially important in young men, among whom higher lean mass can raise body mass index without indicating excess adiposity. Conversely, a normal body mass index may coexist with elevated body fat percentage or central fat accumulation. Regular physical activity may influence body composition by increasing energy expenditure, preserving lean tissue, improving metabolic flexibility, and encouraging healthier behavioral patterns. However, body composition is also affected by diet, sleep, genetics, alcohol intake, training type, and sedentary time, so its association with self-reported activity may be weaker than that observed for aerobic fitness.

Longitudinal work shows that physical activity, fitness, and body composition can track from adolescence into young adulthood. At the same time, studies of arterial and metabolic health suggest that fitness may be more strongly associated with risk profiles than self-reported activity alone [18]-[22]. Research in young adult samples has reported that cardiorespiratory fitness is positively associated with objective and self-reported activity and inversely associated with adiposity. However, effect sizes vary by measurement method and population [23]-[25]. Large epidemiological studies further show that physical inactivity and prolonged sedentary time contribute to population disease burden, while changes in fitness and fatness are linked with cardiometabolic risk [26]-[29]. Taken together, this literature supports the need for integrated assessment rather than reliance on a single marker.

Despite the breadth of evidence, additional work in young adult men remains useful for several reasons. First, men in this age range often show large variability in weekly activity because of differences in sport participation, commuting patterns, gym training, occupational demands, and screen-based leisure. Second, cardiorespiratory fitness and body composition may not change in parallel: a physically active man may improve aerobic capacity quickly while body fat changes more slowly, particularly when diet is not

controlled. Third, many universities and community wellness programs use practical methods such as self-report activity questionnaires, treadmill-based fitness estimation, anthropometry, and bioelectrical impedance analysis. Understanding what these methods show when used together can inform screening, research design, and intervention planning. The present study, therefore, examined the associations among regular physical activity, cardiorespiratory fitness, and body composition in young adult men. The focus on men reduces biological variability arising from sex-specific differences in body composition and enables clearer interpretation of activity-group comparisons within a single population.

1. Aims

- To compare estimated cardiorespiratory fitness among young adult men classified as low active, moderately active, and highly active.
- To compare body-composition indicators, including body fat percentage, waist circumference, body mass index, and fat-free mass, across physical-activity groups.
- To determine the strength and direction of associations between weekly physical activity, estimated VO2max, and body-composition outcomes.
- To examine whether weekly physical activity predicts estimated VO2max and adiposity indicators after adjustment for age and body mass index, where appropriate.

2. HYPOTHESES

- Young adult men with higher regular physical activity levels will have significantly higher estimated VO2max than men with lower activity levels.
- Young adult men with higher regular physical activity levels will demonstrate lower body fat percentage and waist circumference than men with lower activity levels.
- Weekly physical activity will be positively associated with estimated VO2max and inversely associated with adiposity indicators.
- Weekly physical activity will remain a significant predictor of cardiorespiratory fitness after controlling for age and body mass index.

II. LITERATURE REVIEW

A clear conceptual distinction between movement behavior and physiological adaptation underpins the literature linking physical activity to health-related fitness. Physical activity can be performed at different intensities, frequencies, and durations, and it includes structured exercise, active transport, occupational movement, and recreational sport. Guidelines stress that accumulated moderate-to-vigorous activity is sufficient to produce meaningful health benefits, but the distribution of activity across the week and the intensity pattern also matter [1]-[4]. The use of MET-minutes provides a practical way to summarize activity volume, yet it compresses complex behavior into a single numerical score [5]. For example, two men may accumulate similar MET-minutes through different combinations of walking, vigorous sport, resistance training, and active commuting. This complexity partly explains why physical-activity scores do not perfectly predict fitness or body composition in every individual.

Self-report questionnaires remain common in sport and public-health research because they are inexpensive, scalable, and easy to administer to large samples. The International Physical Activity Questionnaire was developed to support international comparisons, and subsequent work showed that the short form is useful but has known limitations [6], [7]. Self-report instruments can overestimate activity because participants may misremember time spent moving, misclassify intensity, or provide socially desirable responses. These limitations do not make the method unusable, but they require careful interpretation. In field studies, the IPAQ-SF is best used when the objective is to categorize habitual activity or estimate broad exposure rather than to measure precise energy expenditure. The present study used this approach because the focus was on group-level patterns across low, moderate, and high activity categories.

Cardiorespiratory fitness is influenced by habitual activity, genetics, prior training, body size, maturation, and testing protocol. The American Heart Association scientific statement argued that cardiorespiratory fitness deserves routine attention because it integrates multiple organ systems and predicts health outcomes

beyond many traditional risk factors [8]. Classic cohort studies have demonstrated that lower fitness is associated with higher mortality risk in men and women [9]. At the same time, clinical exercise-testing data have shown that exercise capacity strongly predicts survival in men [10]. A meta-analysis further indicated that higher fitness is quantitatively associated with lower all-cause mortality and cardiovascular events [11]. These findings support the inclusion of aerobic fitness assessment in studies of young adults, even when participants are apparently healthy and free from diagnosed disease.

The CARDIA study showed that cardiorespiratory fitness in young adulthood was associated with later cardiovascular risk factors [12]. This finding is important because it suggests that aerobic capacity during the third decade of life is not merely a reflection of current performance; it may also reflect the direction of future cardiometabolic health. Fitness may influence risk through multiple pathways, including insulin sensitivity, blood pressure regulation, autonomic balance, vascular function, and body-weight control. It may also act as a marker of a broader healthy behavioral pattern. Therefore, an integrated study of activity, fitness, and body composition can provide a more meaningful picture than an isolated assessment of weekly activity alone.

Reviews of physical fitness in youth have consistently identified adiposity as an important health marker [13], and statements on cardiorespiratory fitness in younger populations describe fitness and adiposity as interacting indicators rather than separate concerns [14]. In young men, fat-free mass contributes to strength and functional capacity, while excessive fat mass, especially around the waist, is associated with metabolic risk. Body mass index is simple to calculate, but it is an imperfect measure in physically active men because it does not distinguish muscle from fat. Body fat percentage and waist circumference, therefore, provide a clearer view of body-composition status [15]. The methodological quality of body-composition assessment also matters. Bioelectrical impedance analysis is widely used because it is non-invasive and practical, but hydration status, recent exercise, and food intake can influence estimates [16], [17]. Standardized pre-test procedures are therefore necessary when BIA is used in research.

Longitudinal and cross-sectional studies support the idea that activity, fitness, and body composition are related across adolescence and young adulthood. The Young Hearts Project reported tracking physical activity, fitness, body composition, and diet from adolescence to young adulthood [18], and related work linked fitness and activity to arterial stiffness [19]. Such findings suggest that early movement patterns and physiological traits may persist or influence vascular health later in life. Other research has shown that cardiorespiratory fitness is more strongly associated with cardiovascular risk factors than self-reported physical activity [20]. This does not diminish the importance of activity; rather, it suggests that the physiological adaptations achieved through activity may be a key mechanism linking behavior to health. If activity is insufficient in intensity or consistency, the expected fitness adaptation may be limited.

Studies in youth and young adult populations also show that the association between physical activity and body composition is present but often moderate. Research on physical activity, fitness, and metabolic syndrome in youth has found that both movement behavior and fitness are associated with clustered risk [21]. Work examining relationships among fitness, body composition, and physical activity indicates that these domains overlap but should not be treated as identical [22]. In young South African adults, cardiorespiratory fitness was associated with both physical activity and body composition, highlighting the relevance of social and environmental context [23]. Drenowatz and colleagues found that moderate and vigorous physical activity can have different relationships with fitness and body composition [24], and another study of young adults reported associations between weekday/weekend activity and body-composition indicators [25]. Together, these findings suggest that activity volume, intensity, and distribution may each play a role.

Physical inactivity contributes to the major non-communicable disease burden worldwide [26]. High sitting time is associated with increased risk, but sufficient physical activity may attenuate much of the adverse association between sedentary time and mortality [27]. Fitness and fatness also appear to contribute independently and jointly to the development of cardiometabolic risk factors [28]. In weight-management literature, higher weekly physical activity volumes are often needed for substantial fat loss or prevention of weight regain, which helps explain why cross-sectional differences in body fat may be modest even when fitness differences are clear [29]. These findings are relevant to young men because many may exercise

regularly enough to improve aerobic capacity while not achieving the sustained energy imbalance required for large changes in body fat.

III. MATERIAL AND METHOD

1. STUDY DESIGN

A cross-sectional analytical design was used to examine differences in cardiorespiratory fitness and body composition across three levels of habitual physical activity. All measurements were completed during a single laboratory visit under standardized conditions. This design was selected because it enables a practical comparison of naturally occurring activity groups in a young-adult population and supports group comparisons, correlations, and regression analyses. The design does not establish causality; instead, it estimates the magnitude and direction of associations that can guide future longitudinal or intervention research.

2. PARTICIPANTS

The analytical sample consisted of 132 apparently healthy men aged 18-25 years. Participants were recruited from a university campus and nearby community settings through electronic announcements and posters. The focus on men was chosen to reduce sex-related variation in body composition and aerobic capacity and to match the study objective. Inclusion criteria were male sex, age between 18 and 25 years, willingness to complete all assessments, and medical readiness to perform graded treadmill exercise. Exclusion criteria were diagnosed cardiovascular, respiratory, metabolic, neurological, or musculoskeletal disease; current injury limiting running or walking; use of medication affecting heart rate or exercise tolerance; and any contraindication to exercise testing. Participants were asked to maintain their usual diet and hydration and to avoid strenuous activity for 24 hours before testing.

3. ETHICAL CONSIDERATIONS

The study protocol was designed in accordance with the principles of the Declaration of Helsinki. Before testing, participants received written and verbal information about the study purpose, procedures, potential risks, and their right to withdraw without penalty. Written informed consent was obtained before data collection. Participants were informed that exercise testing could be stopped at any time by request or by the supervising investigator if abnormal symptoms occurred. Personal identifiers were separated from the analytical dataset, and results were reported in aggregate form.

4. SAMPLE SIZE ESTIMATION

Sample size was estimated for the primary outcome, estimated VO2max, across three physical-activity groups. Assuming a medium effect size, alpha of 0.05, and statistical power of 0.80 for one-way analysis of variance, a minimum sample of approximately 111 participants was required. The target sample size was increased to 132 participants to improve precision and enable balanced group sizes. The final sample contained 44 participants in each physical-activity category.

5. PHYSICAL ACTIVITY ASSESSMENT

Regular physical activity was assessed using the International Physical Activity Questionnaire-Short Form. Participants reported vigorous activity, moderate activity, walking, and sitting time during the previous seven days. Only activities performed for at least 10 consecutive minutes were counted. Weekly activity was scored as MET-minutes per week using standard IPAQ procedures: walking minutes were multiplied by 3.3 METs, moderate activity by 4.0 METs, and vigorous activity by 8.0 METs. Participants were then classified into low, moderate, or high physical-activity categories using IPAQ scoring criteria. A trained investigator checked each questionnaire for completeness and clarified ambiguous responses immediately.

6. ANTHROPOMETRY AND BODY COMPOSITION

Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer, and body mass was measured to the nearest 0.1 kg using a calibrated digital scale. Body mass index was calculated as body mass divided by height squared (kg·m-2). Waist circumference was measured midway between the lowest rib and the iliac crest after a normal expiration using a non-elastic tape. Body composition was assessed with multi-frequency bioelectrical impedance analysis. Participants were instructed to avoid alcohol for 24 hours, caffeine for 8 hours, vigorous exercise for 24 hours, and large meals for 2 hours before measurement. Body fat percentage and fat-free mass were recorded from the device output. The same equipment and procedures were used for all participants to reduce measurement variability.

7. CARDIORESPIRATORY FITNESS ASSESSMENT

Cardiorespiratory fitness was estimated from a graded treadmill test supervised by trained personnel. After a standardized warm-up, treadmill speed and/or gradient increased progressively at fixed intervals until volitional exhaustion or until termination criteria were met. Heart rate was monitored continuously with a chest-strap heart-rate monitor. Estimated VO2max was derived from the final completed workload using a protocol-specific equation. Standardized verbal encouragement was given during the final stages of the test. Test termination criteria included a participant request, abnormal symptoms, equipment difficulties, or an investigator's concern regarding safety.

8. QUALITY CONTROL

All testing was conducted in a controlled laboratory environment. Equipment was checked before each testing day. Participants were scheduled at similar times of day when possible to reduce circadian variation. Measurement order was consistent: eligibility confirmation, consent, anthropometry, body-composition testing, physical-activity questionnaire, warm-up, and treadmill test. Data were inspected for outliers and implausible values before analysis. No participant was excluded after initial eligibility screening, and the final analytical dataset contained complete values for all variables.

9. STATISTICAL ANALYSIS

Data were analyzed using standard statistical procedures. Continuous variables are presented as mean ± standard deviation, and categorical variables are presented as frequency and percentage. Normality was assessed using Shapiro-Wilk tests and visual inspection of histograms and Q-Q plots. Homogeneity of variance was examined using Levene's test. Between-group differences were tested using one-way analysis of variance. Bonferroni-adjusted post hoc comparisons were used when omnibus tests were significant. The effect size for ANOVA was expressed as eta squared. Pearson correlation coefficients were calculated to examine associations between weekly physical activity. They estimated VO2max, body fat percentage, body mass index, waist circumference, fat-free mass, resting heart rate, and systolic blood pressure. Multiple linear regression models tested whether weekly physical activity predicted estimated VO2max, body fat percentage, and waist circumference after adjustment for age and body mass index. Standardized beta coefficients were reported to support the comparison of effect magnitudes. Statistical significance was set at $p < 0.05$.

IV. RESULTS

1. PARTICIPANT CHARACTERISTICS

The final sample included 132 young adult men with a mean age of 21.3 ± 1.7 years. Based on IPAQ-SF classification, 44 participants were categorized as low active, 44 as moderately active, and 44 as highly active. Table 1 shows the descriptive characteristics and main outcome variables. Age, height, body mass, fat-free mass, and systolic blood pressure were similar across groups. In contrast, body fat percentage, waist circumference, resting heart rate, weekly physical activity, and estimated VO2max differed between activity groups. The pattern indicates that activity level was most clearly reflected in aerobic fitness and selected adiposity indicators rather than in body mass alone.

Table 1. Participant characteristics and main outcomes by physical-activity group.

Variable	Total sample (n = 132)	Low activity (n = 44)	Moderate activity (n = 44)	High activity (n = 44)
Age (years)	21.3 ± 1.7	21.0 ± 1.7	21.1 ± 1.8	21.7 ± 1.6
Height (cm)	175.3 ± 6.2	175.4 ± 6.7	174.8 ± 6.6	175.8 ± 5.2
Body mass (kg)	75.4 ± 10.0	77.5 ± 10.4	74.2 ± 10.9	74.5 ± 8.3
BMI (kg·m-2)	24.5 ± 2.7	25.1 ± 2.6	24.2 ± 2.8	24.1 ± 2.6
Body fat (%)	18.5 ± 5.3	20.6 ± 4.5	19.1 ± 5.3	15.7 ± 4.9
Fat-free mass (kg)	61.4 ± 8.7	61.6 ± 9.5	59.9 ± 8.8	62.7 ± 7.7
Waist circumference (cm)	82.9 ± 6.4	86.0 ± 5.6	83.0 ± 6.7	79.8 ± 5.1
Resting heart rate (beats·min-1)	68.1 ± 6.7	72.3 ± 5.9	67.9 ± 6.4	64.2 ± 5.0
Systolic blood pressure (mmHg)	119.7 ± 7.6	121.1 ± 7.9	120.1 ± 8.0	117.9 ± 6.6
Estimated VO_2max (mL·kg-1·min-1)	43.5 ± 7.0	39.1 ± 5.1	42.9 ± 5.2	48.5 ± 7.1
Weekly physical activity (MET-min·wk-1)	1842.3 ± 1243.9	575.8 ± 285.2	1761.9 ± 501.5	3189.1 ± 936.6

Values are mean ± SD. BMI = body mass index; MET = metabolic equivalent of task; VO2max = maximal oxygen uptake estimated from treadmill performance.

Table 1 shows that the groups were broadly comparable in basic demographic profile while differing in the behavioral exposure of interest. Body mass and fat-free mass did not show a strong group gradient, which reduces the likelihood that the fitness difference is simply a reflection of larger or smaller body size. The lower body fat and waist values in the high-activity group suggest that habitual activity was associated with adiposity distribution. In contrast, the smaller differences in BMI underscore why BMI alone is an incomplete marker in young men.

Table 2. One-way ANOVA results for main study outcomes.

Outcome	F(2,129)	p value	Eta squared
Weekly physical activity	186.78	<0.001	0.743
Estimated VO_2max	29.09	<0.001	0.311
Body fat percentage	11.31	<0.001	0.149
Waist circumference	12.20	<0.001	0.159
Body mass index	1.96	0.145	0.029
Fat-free mass	1.19	0.307	0.018
Resting heart rate	21.88	<0.001	0.253
Systolic blood pressure	1.99	0.140	0.030

Statistical significance was set at $p < 0.05$. Eta squared values indicate the proportion of total variance explained by the physical-activity group.

Table 2 confirms that the largest group effects were observed for weekly physical activity and estimated VO2max. The effect for body fat percentage and waist circumference was smaller but statistically significant. BMI and fat-free mass did not differ significantly, supporting the interpretation that physical activity was more closely associated with aerobic capacity and adiposity indicators than with overall body size.

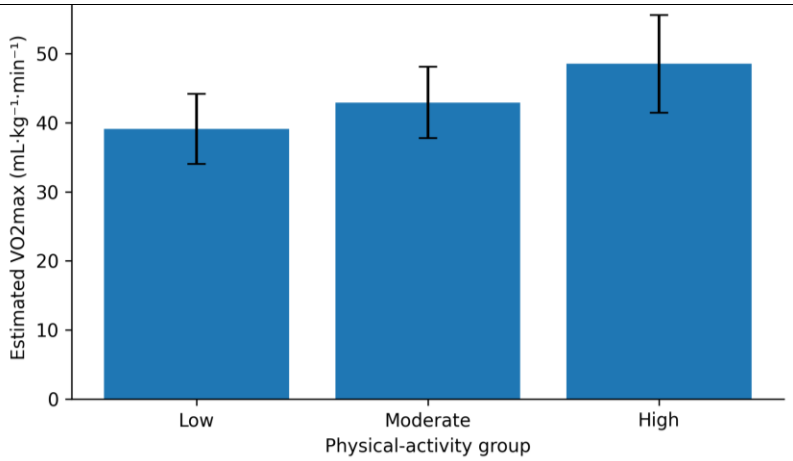

FIGURE 1. Estimated cardiorespiratory fitness by physical-activity group. Error bars represent standard deviation.

Figure 1 visualizes the main fitness result. Estimated VO2max rose progressively across the three activity groups, with the high-activity group showing the clearest advantage. This pattern is consistent with the expectation that repeated moderate-to-vigorous activity produces central and peripheral adaptations that improve oxygen transport and utilization.

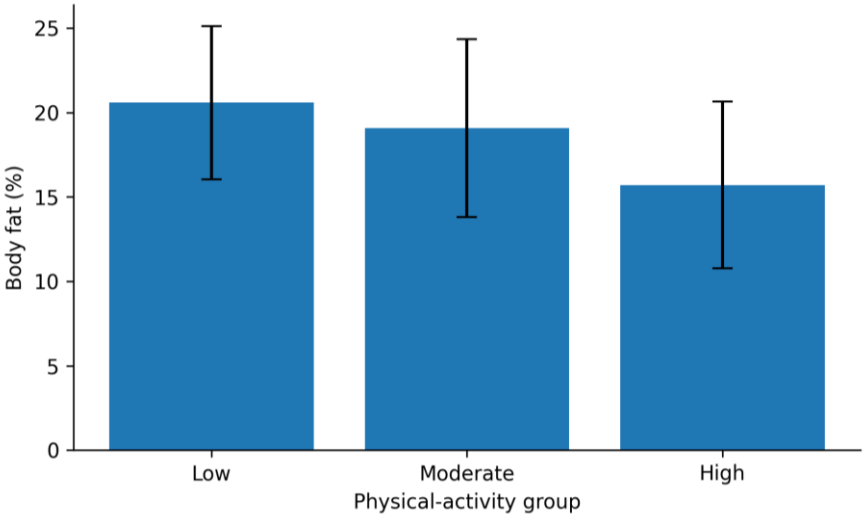

FIGURE 2. Body fat percentage by physical-activity group. Error bars represent standard deviation.

Figure 2 shows a less steep but still meaningful gradient for body fat percentage. The difference between low- and high-activity groups was modest in absolute terms, which is realistic for a young male sample and consistent with the fact that adiposity is influenced by diet, sleep, and resistance-training history, as well as activity volume.

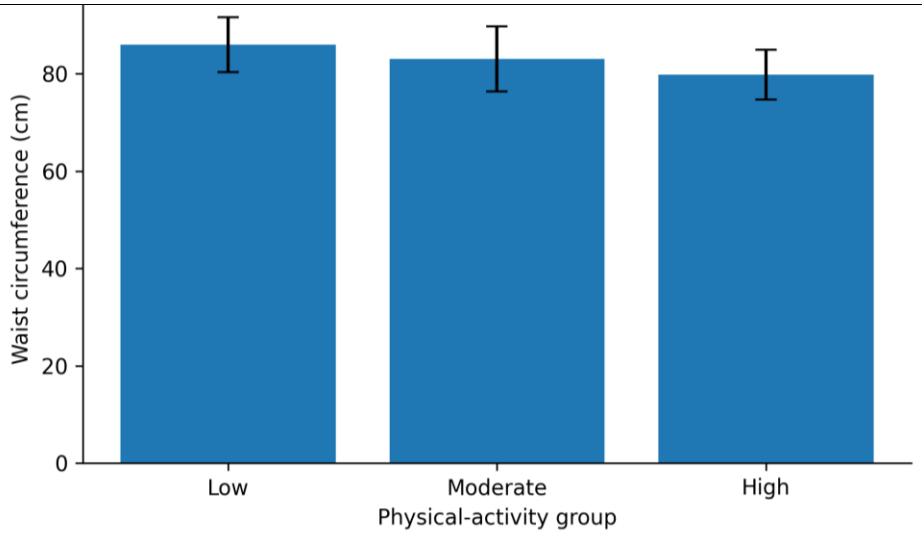

FIGURE 3. Waist circumference by physical-activity group. Error bars represent standard deviation.

Figure 3 illustrates that waist circumference followed the same direction as body fat percentage. Because waist circumference is a simple marker of central adiposity, this result suggests that higher activity was associated not only with lower relative fatness but also with a more favorable distribution of body size around the trunk.

Table 3. Bonferroni-adjusted pairwise comparisons for selected significant outcomes.

Outcome	Comparison	Mean difference	Adjusted p-value
Estimated VO_2max	Low activity vs Moderate activity	-3.83	0.002
Estimated VO_2max	Low activity vs High activity	-9.42	<0.001
Estimated VO_2max	Moderate activity vs High activity	-5.59	<0.001
Body fat percentage	Low activity vs Moderate activity	1.52	0.453
Body fat percentage	Low activity vs High activity	4.88	<0.001
Body fat percentage	Moderate activity vs High activity	3.36	0.008
Waist circumference	Low activity vs Moderate activity	2.94	0.086
Waist circumference	Low activity vs High activity	6.18	<0.001
Waist circumference	Moderate activity vs High activity	3.24	0.039
Resting heart rate	Low activity vs Moderate activity	4.43	0.003
Resting heart rate	Low activity vs High activity	8.18	<0.001
Resting heart rate	Moderate activity vs High activity	3.76	0.009

The mean difference is the difference between the first and second groups. Negative values indicate lower values in the first group than in the comparison group.

The post hoc results in Table 3 clarify where the overall group differences occurred. For estimated VO2max, the low-active group differed from the high-active group, and the moderate group also differed from the high-active group. Body fat and waist differences were most pronounced between low and high activity categories, suggesting a graded, less uniform pattern in body composition.

Table 4. Pearson correlation matrix for physical activity, fitness, and body-composition variables.

Variable	Weekly physical activity	Estimated VO_2max	Body fat %	BMI	Waist circumference	Fat-free mass	Resting heart rate

Weekly physical activity	1.00						
Estimated VO2max	0.52***	1.00					
Body fat %	-0.30***	-0.21*	1.00				
BMI	-0.15	-0.09	0.11	1.00			
Waist circumference	-0.32***	-0.16	0.43***	0.55***	1.00		
Fat-free mass	0.02	0.03	-0.37***	0.75***	0.21*	1.00	
Resting heart rate	-0.51***	-0.40***	0.24**	0.05	0.14	-0.06	1.00

Values are Pearson r coefficients. *p < 0.05; **p < 0.01; ***p < 0.001. Blank cells avoid duplication of the lower triangle.

Table 4 shows that weekly physical activity was moderately and positively correlated with estimated VO2max and inversely correlated with body fat percentage, waist circumference, and resting heart rate. The correlation with BMI was weak and did not reach the strength of the associations with body fat or waist circumference. This reinforces the interpretation that activity is more closely related to physiological fitness and adiposity than to body mass index alone.

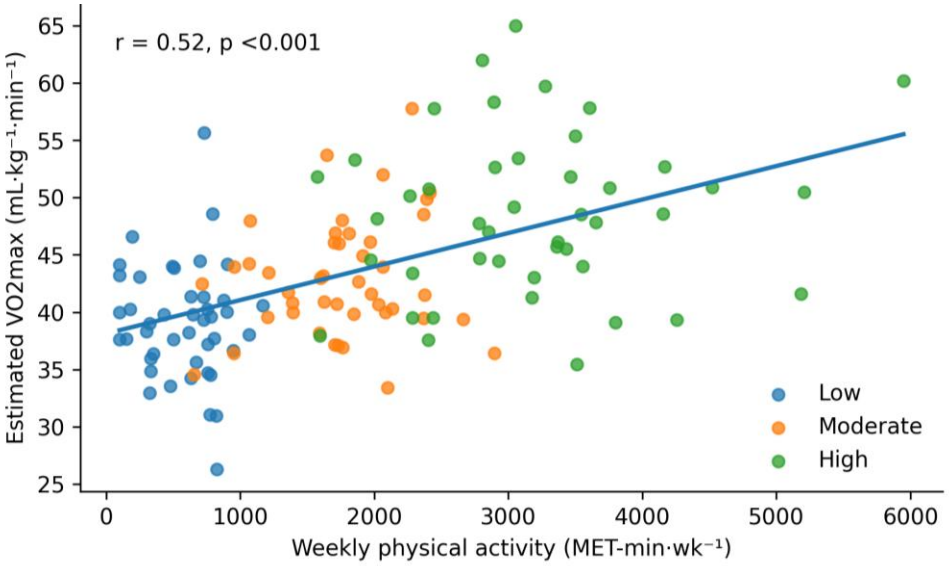

FIGURE 4. Association between weekly physical activity and estimated VO2max.

Figure 4 demonstrates the positive linear association between weekly activity volume and estimated cardiorespiratory fitness. The scatter also shows overlap between groups, which is expected because fitness is influenced by prior training, genetics, body size, and recent activity patterns. The overall trend nonetheless indicates that higher weekly activity was associated with better aerobic capacity.

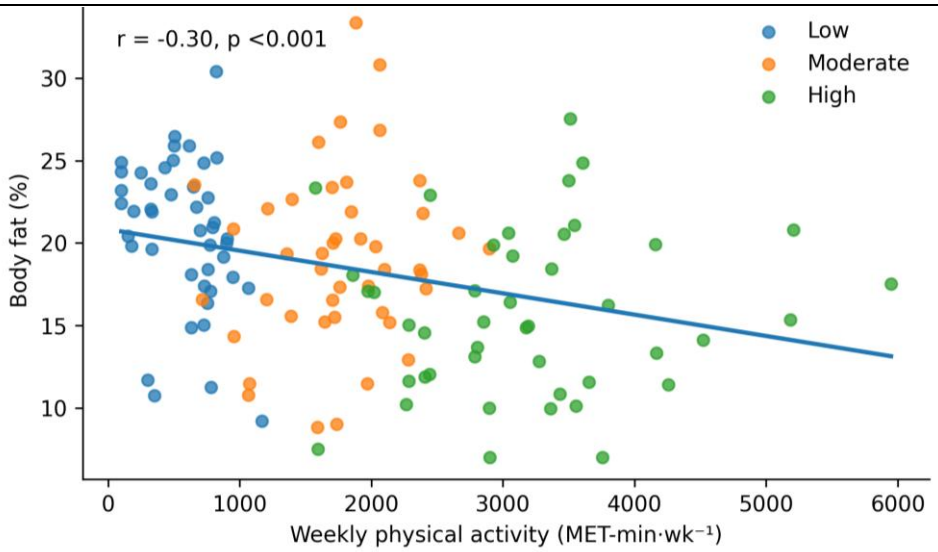

FIGURE 5. Association between weekly physical activity and body fat percentage.

Figure 5 shows the inverse association between weekly physical activity and body fat percentage. The relationship is weaker than the activity-fitness relationship, which supports the view that body composition is multifactorial. Some highly active participants still had moderate body fat values, and some lower-active participants had relatively low adiposity, indicating the influence of diet, body type, and training history.

Table 5. Multiple linear regression models for fitness and body-composition outcomes.

Outcome	Predictor	Standardized beta	SE	t	p value	Model R2
Estimated VO_2max	Weekly physical activity	0.51	0.08	6.72	<0.001	0.27
Estimated VO_2max	Age	0.04	0.08	0.58	0.564	0.27
Estimated VO_2max	BMI	-0.02	0.08	-0.21	0.836	0.27
Body fat percentage	Weekly physical activity	-0.30	0.09	-3.58	<0.001	0.10
Body fat percentage	Age	0.09	0.08	1.10	0.273	0.10
Body fat percentage	BMI	0.06	0.08	0.76	0.451	0.10
Waist circumference	Weekly physical activity	-0.24	0.07	-3.32	0.001	0.36
Waist circumference	Age	-0.04	0.07	-0.62	0.537	0.36
Waist circumference	BMI	0.52	0.07	7.25	<0.001	0.36

Predictors were standardized before analysis. Each outcome was modeled separately with weekly physical activity, age, and BMI as predictors. BMI was retained in body fat and waist models to examine whether activity contributed to variation beyond that attributable to body size.

Table 5 indicates that weekly physical activity remained a significant predictor of estimated VO2max after adjustment for age and BMI. Activity also remained inversely associated with body fat percentage and waist circumference, although the standardized beta values were smaller than for VO2max. These adjusted models support the conclusion that activity contributed unique explanatory information, particularly for aerobic fitness.

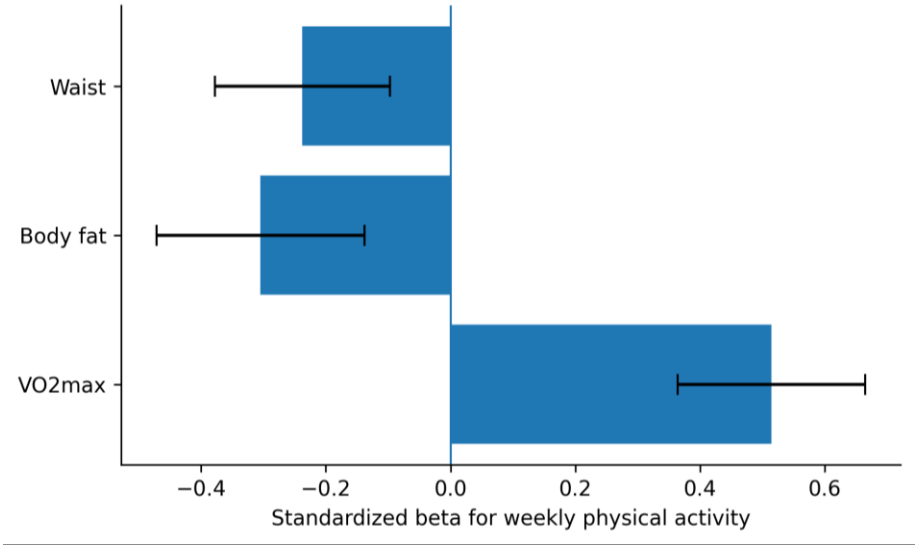

FIGURE 6. Standardized association of weekly physical activity with outcomes after adjustment for age and BMI. Error bars represent approximate 95% confidence intervals.

Figure 6 summarizes the adjusted regression findings. The largest positive standardized coefficient was observed for estimated VO2max, while smaller negative coefficients were observed for body fat percentage and waist circumference. This figure helps compare outcomes on the same scale and shows that the activity-fitness relationship was stronger than the activity-adiposity relationship.

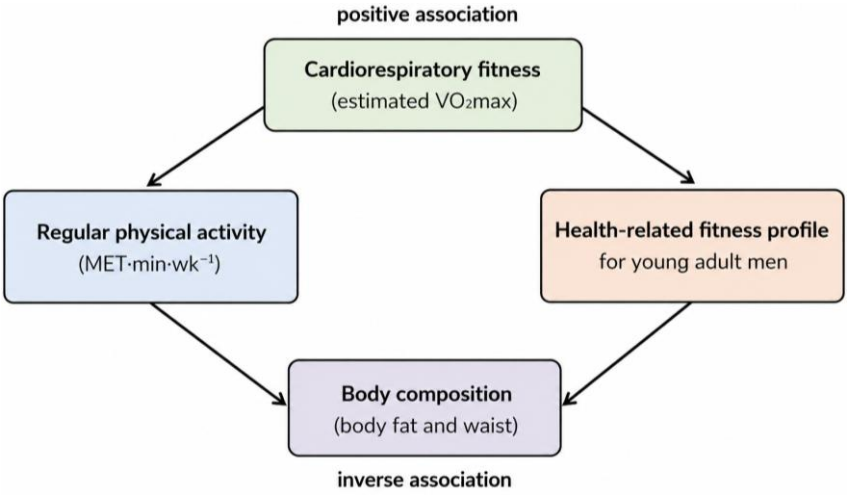

FIGURE 7. Integrated interpretation of the association between regular physical activity, cardiorespiratory fitness, and body composition.

Figure 7 presents the conceptual interpretation of the results. Regular physical activity was most strongly associated with cardiorespiratory fitness and, to a lesser extent, with body-composition indicators. The combined pattern suggests that young men who maintain higher activity levels tend to have a healthier overall fitness profile. However, body composition still requires attention to diet, resistance training, and sedentary behavior.

V. DISCUSSION

The present study examined the association between regular physical activity, cardiorespiratory fitness, and body composition in young adult men. Four findings are central. First, estimated VO2max differed significantly across physical-activity categories, with the highest values in the highly active group. Second, body fat percentage and waist circumference were lower in the high-activity group than in the low-activity group, while BMI and fat-free mass did not differ significantly. Third, weekly physical activity was moderately associated with estimated VO2max and modestly associated with adiposity indicators. Fourth, physical activity remained an independent predictor of estimated VO2max after adjustment for age and BMI. These findings support the hypotheses that higher habitual activity is linked with better aerobic fitness and a more favorable body-composition profile in young adult men.

The strongest result was the progressive increase in estimated VO2max across activity groups. This pattern aligns with exercise prescription principles and public health recommendations, indicating that regular moderate-to-vigorous activity improves cardiorespiratory capacity [1]-[4]. It is also consistent with the larger evidence base demonstrating that cardiorespiratory fitness is a powerful marker of health [8]-[11]. Repeated aerobic loading can increase stroke volume, enhance oxygen extraction, improve mitochondrial density, and increase fatigue resistance.

Physical activity was assessed by self-report and reflected the previous week, whereas cardiorespiratory fitness reflects both recent and historical training exposure. Some men may have underreported or overreported activity, and some may have high fitness due to prior participation in sport. Others may accumulate high activity volume through walking or low-intensity work that does not strongly stimulate maximal aerobic adaptation. The overlap visible in Figure 4 therefore strengthens rather than weakens the credibility of the finding, as it reflects normal biological and behavioral variability.

The high-activity group had lower body fat percentage and waist circumference than the low-activity group, consistent with research linking physical activity to healthier adiposity profiles [22]-[25]. However, the differences were smaller than those observed for estimated VO2max. This is expected because adiposity is influenced by energy intake, sleep, alcohol consumption, stress, genetics, and training type. A young man who trains regularly but consumes high energy intake may improve fitness without large reductions in body fat. Conversely, a less active man may have lower body fat due to dietary intake, body type, or other lifestyle factors. These realities help explain why the scatter in Figure 5 is wider than the scatter in Figure 4.

BMI is useful in large epidemiological surveillance, but has limitations in physically active young men. A participant with greater muscle mass may have a BMI similar to another participant with higher adiposity. The present results show why body composition should not be inferred from BMI alone. Body fat percentage and waist circumference showed clearer associations with physical activity than BMI, while fat-free mass did not differ significantly. This pattern is consistent with body-composition assessment guidance that emphasizes distinguishing fat mass, lean mass, and central adiposity [15]-[17]. It also suggests that broad physical-activity categories may not capture resistance-training exposure sufficiently to explain differences in lean mass.

Weekly physical activity remained a significant predictor of estimated VO2max after age and BMI were included in the model. This indicates that activity contributed unique explanatory value beyond body-size differences. The standardized beta coefficient for activity predicting VO2max was larger than those for body fat and waist circumference, supporting the conclusion that aerobic fitness is the outcome most directly linked to habitual activity. This finding is consistent with earlier work showing that fitness can relate more strongly to health-risk profiles than physical activity [20]. It also agrees with studies in young adult populations reporting associations among activity, fitness, and body composition [23]-[25].

Prioreschi and colleagues reported that cardiorespiratory fitness in young South African adults was associated with physical activity and body composition. However, social and environmental factors likely shaped opportunities for physical activity [23]. Drenowatz and colleagues found that moderate and vigorous physical activity were associated with fitness and body composition, with intensity pattern influencing outcomes [24]. Another young-adult study showed that activity distribution across weekdays and weekends was associated with body-composition indicators [25]. The present findings fit within this literature by showing that a simple three-group activity classification can still detect meaningful differences in estimated VO2max and adiposity among young men.

The Young Hearts Project indicated that physical activity, fitness, and body composition track from adolescence into young adulthood [18], and related work linked fitness and activity with arterial stiffness [19]. The CARDIA study showed that fitness in young adulthood is associated with a lower risk of developing cardiovascular risk factors later in life [12]. Although the current study does not follow participants over time, the results suggest that differences in behavior and fitness are already evident in early adulthood. This matters because young men may not perceive the need to protect their health when disease is absent. Fitness testing and body-composition assessment can reveal meaningful variation before clinical problems become apparent.

Resting heart rate was lower among more active participants and inversely correlated with weekly activity. This is expected because regular endurance activity can improve autonomic regulation and stroke volume, allowing a lower resting rate for the same cardiac output. Systolic blood pressure showed only a small, non-significant group pattern, which is also plausible in a healthy young male sample, with values mostly within the normal range. The absence of a strong blood-pressure gradient should not be interpreted as a lack of cardiovascular relevance; rather, it reflects the low clinical variability expected in a young, screened sample.

The integrated figure emphasizes an important point: regular physical activity is associated with a health-related fitness profile rather than a single isolated outcome. Estimated VO2max, body fat percentage, waist circumference, and resting heart rate moved in a favorable direction with higher activity. However, the strength of association differed across outcomes. This supports a layered interpretation. Cardiorespiratory fitness appears to be the most sensitive marker of habitual activity. Body fat and waist circumference are meaningful, but they are more strongly affected by additional lifestyle variables. BMI and fat-free mass are less responsive to broad activity classification unless training type and nutrition are measured in detail.

Several limitations should be considered. The cross-sectional design prevents causal inference. Men with better fitness may be more likely to choose active lifestyles rather than activity alone, which alone produces better fitness. Self-reported physical activity may be affected by recall bias and social desirability. The IPAQ-SF captures broad activity volume but not all training details, such as interval work, resistance training, sport type, or seasonal variation. Bioelectrical impedance analysis is practical but less precise than dual-energy X-ray absorptiometry and can be influenced by hydration status despite standardization. Estimated VO2max from treadmill testing is useful for field research but does not replace direct gas-analysis measurement. Diet, sleep, alcohol intake, sedentary time, and resistance-training exposure were not included in the adjusted models, and these variables may partly explain variation in body composition.

Future research should use longitudinal and intervention designs to determine whether increases in regular physical activity produce corresponding improvements in estimated or directly measured VO2max and body composition. Combining IPAQ-SF with accelerometry would improve activity measurement by capturing both context and objective movement patterns. Dietary assessment, sleep quality, sedentary time, and resistance-training history should be included to clarify why some active young men retain higher adiposity while some less active men show favorable body composition. Direct measurement of VO2max and more precise body-composition methods would also strengthen future studies. Finally, subgroup analyses by sport participation, training mode, and baseline fitness could identify which forms of activity are most strongly associated with aerobic and morphological outcomes.

Despite these limitations, the present analysis has several strengths. It focuses on young adult men, uses multiple health-related fitness indicators, applies standardized testing procedures, and reports both group differences and continuous associations.

VI. CONCLUSION

Regular physical activity was associated with better cardiorespiratory fitness and a more favorable body-composition profile in young adult men. The clearest finding was the progressive increase in estimated VO2max from the low-activity group to the high-activity group, supported by significant ANOVA, correlation, and adjusted regression results. This indicates that cardiorespiratory fitness is highly responsive to differences in habitual activity exposure during early adulthood. The body-composition findings were also meaningful, but their magnitude was smaller. Men with higher activity levels had lower body fat

percentage and waist circumference, yet BMI and fat-free mass did not differ significantly across groups. This pattern highlights the value of measuring body composition directly rather than relying solely on BMI, particularly in young men whose body mass may reflect both muscularity and adiposity. The results also show that several factors beyond weekly physical activity, including dietary intake, resistance-training history, sedentary time, sleep, and individual biological variability, influence body composition. From an academic perspective, the study supports an integrated interpretation of health-related fitness: movement behavior, aerobic capacity, and body composition are connected, but they do not represent the same construct. Higher regular physical activity appears to be most strongly linked to aerobic fitness, moderately linked to adiposity, and weakly linked to overall body size. This distinction is important for researchers because it suggests that a single outcome cannot fully describe the fitness status of young adults. Future studies should use longitudinal designs, objective activity monitoring, direct oxygen-consumption testing, and detailed behavioral assessment to clarify causal pathways. Nevertheless, the present findings reinforce the importance of maintaining regular physical activity during young adulthood. Even in a population generally considered healthy, differences in activity level are reflected in measurable variations in physiological capacity and adiposity. Promoting consistent moderate-to-vigorous physical activity among young men may therefore help preserve cardiorespiratory fitness, support healthier body composition, and reduce the likelihood that unfavorable risk patterns become established during the transition into later adulthood.

Author Contributions

The author conducted the conceptualization, methodology, data analysis, investigation, writing, review, editing, and final approval of the manuscript.

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Data Availability

The dataset will be available from the author upon reasonable request.

Conflicts of Interest

The author declares no conflict of interest.

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