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Physical Fitness, Sedentary Behavior, and Health Indicators Among Adolescents

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Abstract

Background: Adolescent physical fitness and sedentary behavior are distinct, potentially interrelated dimensions of health. Objective: This simulation-based cross-sectional study illustrates associations among cardiorespiratory fitness, muscular endurance, sedentary time, and selected health indicators. Methods: A synthetic dataset of 240 adolescents aged 13–17 years was constructed with anthropometric, fitness, activity, sedentary, and self-rated well-being measures. Descriptive comparisons, Pearson correlations, and adjusted linear models were specified. Results: The generated sample had a mean age of 15.1 years, mean daily sedentary time of 7.1 hours, and a modeled cardiorespiratory fitness score of 42.6 $mL \cdot kg^{-1} \cdot min^{-1}$. Sedentary time was inversely associated with cardiorespiratory fitness ($r = -.31$) and positively associated with body mass index z score ($r = .22$). Fitness was positively associated with well-being ($r = .28$). In the illustrative adjusted model, sedentary time retained a modest negative association with fitness (standardized $\beta = -.24$). Conclusions: The synthetic model demonstrates how fitness and sedentary indicators can be analyzed jointly without equating correlation with causation. All numerical results are constructed and do not represent measurements from adolescents.

Keywords: adolescents; cardiorespiratory fitness; sedentary behavior; muscular endurance; well-being; simulation

How to Cite This Article

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Research classification: Simulation-based original research manuscript. No adolescents were recruited, examined, or surveyed; all records and numerical outputs are synthetic.

1. Introduction

Adolescence is a developmental period in which patterns of physical activity, sitting, sleep, and recreational screen use can become established. These behaviors occur alongside changes in body composition, cardiorespiratory capacity, muscular fitness, and psychosocial well-being. Their relationships are of interest to school health, youth sport, and preventive health research.

Physical fitness is not interchangeable with physical activity. Fitness describes capacities demonstrated during a test, whereas activity describes behavior over time. Similarly, sedentary behavior refers to waking activity characterized by low energy expenditure while sitting, reclining, or lying. A physically active adolescent may still accumulate substantial sedentary time.

Observational associations among fitness, sedentary exposure, and health indicators are shaped by numerous factors, including maturation, social environment, sleep, and measurement characteristics. Consequently, cross-sectional findings require cautious interpretation, particularly when causal mechanisms are proposed.

The present manuscript uses an explicitly synthetic dataset to demonstrate an integrated analytical framework for these constructs. It provides coherent numerical examples of descriptive comparisons, bivariate relationships, and adjusted models without presenting generated records as empirical observations.

1.1 Research Questions and Conceptual Model

The primary research question concerns the association between modeled daily sedentary time and cardiorespiratory fitness. Secondary questions concern relationships with muscular endurance, body mass index standardized for age and sex, and self-rated well-being. A further question examines whether the sedentary–fitness association persists after accounting for age, sex, and modeled moderate-to-vigorous physical activity.

The conceptual model treats physical activity and sedentary behavior as separate exposures. Cardiorespiratory fitness and muscular endurance are performance outcomes, while body mass index z score and well-being represent selected health-related indicators. This distinction prevents the analysis from treating all measures as equivalent indicators of health.

The synthetic model specified a modest inverse sedentary–fitness association, a modest positive fitness–well-being association, and substantial unexplained variability. These are design assumptions used to create an illustrative dataset, not hypotheses tested against independently collected observations.

The analytical emphasis is on effect sizes, covariate adjustment, and interpretation of overlapping but distinct constructs. The design also demonstrates why a statistically coherent model does not automatically imply clinically meaningful or causal relationships.

2. Methods: Synthetic Cross-Sectional Design

A dataset of 240 fully synthetic adolescent records was constructed to represent ages 13 through 17 years. The model included an approximately balanced sex distribution and variability in body mass, activity exposure, sedentary time, and performance scores. No identifiable information, school records, or existing participant data were used.

Variables were generated using plausible marginal ranges and prespecified moderate correlations. Residual variation was retained so that individual profiles overlapped considerably. In particular, high sedentary exposure did not deterministically imply low fitness, and favorable fitness scores did not guarantee favorable well-being scores.

The design was cross-sectional: each synthetic record contained one set of measures. The simulated structure therefore cannot describe developmental trajectories, seasonal change, or the effect of interventions. Its purpose is to illustrate analysis and reporting practices for an adolescent health manuscript.

All values and results are illustrative outputs of a constructed model. The manuscript does not claim recruitment, informed consent, school authorization, ethical review of human-participant research, or measurement of actual adolescents.

Design characteristic	Synthetic specification
Sample size	240 generated records
Age range	13–17 years
Design	Cross-sectional
Primary association	Sedentary time and fitness
Adjustment variables	Age, sex, activity exposure

2.1 Measures and Operational Definitions

Cardiorespiratory fitness was represented by an estimated aerobic-capacity score in $mL \cdot kg^{-1} \cdot min^{-1}$. The variable was modeled as a continuous performance indicator rather than a direct physiological measurement. Muscular endurance was represented by the number of correctly completed repetitions in a standardized exercise task.

Daily sedentary time was expressed in hours per day and treated separately from moderate-to-vigorous physical activity, which was expressed in minutes per day. The distinction reflects the possibility that adolescents may accumulate both substantial activity and substantial sitting within the same day.

Body mass index z score was used as a standardized anthropometric indicator. Self-rated well-being was represented by a bounded composite score, with higher values indicating more favorable modeled well-being. Neither measure was intended to serve as a clinical diagnosis.

All instruments were conceptual rather than administered. The values were generated to permit transparent discussion of associations and adjustment, not to establish normative cutoffs or prevalence estimates for any geographic population.

Variable	Unit or representation
Cardiorespiratory fitness	$mL \cdot kg^{-1} \cdot min^{-1}$
Muscular endurance	Repetitions
Sedentary time	Hours/day
Physical activity	Minutes/day
BMI indicator	Age/sex standardized z score
Well-being	Composite score

2.2 Statistical Strategy

Continuous synthetic variables were summarized with means and standard deviations. Correlation coefficients were used to characterize linear relationships among sedentary time, fitness, activity, body mass index z score, and well-being. Correlation magnitude was interpreted as descriptive association rather than evidence of causation.

An illustrative multiple linear regression model used cardiorespiratory fitness as the outcome and sedentary time as the focal predictor. Age, sex, and modeled moderate-to-vigorous activity were included as adjustment variables. Standardized coefficients were reported to compare relative magnitudes.

A secondary model treated well-being as the outcome and included fitness and sedentary time as predictors. This model was used to illustrate the possibility that relationships among health-related constructs persist only partially after adjustment.

Sensitivity considerations included possible nonlinearity, differences by age group, and attenuation under greater measurement error. Because the dataset is synthetic, confidence intervals and significance tests would quantify uncertainty under the chosen generator rather than sampling uncertainty about an actual population.

3. Results: Descriptive Characteristics

The generated cohort had a mean age of 15.1 years. Average modeled sedentary time was 7.1 hours per day, with substantial variation across records. Mean cardiorespiratory fitness was 42.6 $mL \cdot kg^{-1} \cdot min^{-1}$ and mean muscular endurance was 24.8 repetitions.

The activity and sedentary distributions overlapped: some records with higher modeled activity also had long sedentary durations. This feature was included to avoid portraying activity and sitting as perfect opposites. Body mass index z score and well-being also showed broad dispersion.

Table 1 summarizes the principal synthetic variables. These values are not reference standards, survey estimates, or measurements from an Albanian adolescent sample. They are descriptive statistics of an illustrative dataset.

The variation in the constructed records was sufficient to support multivariable examples without producing perfect prediction. No outcome was defined solely by one explanatory variable.

Measure	Synthetic mean ± SD
Age (years)	15.1 ± 1.4
Sedentary time (hours/day)	7.1 ± 1.8
Activity (minutes/day)	52 ± 22
Cardiorespiratory fitness	42.6 ± 7.9
Muscular endurance (repetitions)	24.8 ± 8.1
BMI z score	0.18 ± 0.94
Well-being score	68.4 ± 12.2

3.1 Sedentary Time and Fitness

The synthetic correlation between sedentary time and cardiorespiratory fitness was negative and moderate in magnitude ($r = -.31$). Records with longer modeled sedentary exposure tended, on average, to have lower fitness values, although the relationship left most variation unexplained.

The corresponding association between sedentary time and muscular endurance was smaller ($r = -.19$). This contrast illustrates that different fitness domains need not show the same relationship with a behavioral exposure. A single fitness score should not be treated as a comprehensive measure of physical capability.

In the adjusted illustrative model, sedentary time retained a negative standardized association with cardiorespiratory fitness ($\beta = -.24$). Modeled activity showed a positive association ($\beta = .33$). The combined predictors accounted for approximately 24% of the generated variance in fitness.

These coefficients reflect the prespecified covariance structure of the simulation. They cannot be used to predict the effect of reducing sitting time in actual adolescents.

Association	Illustrative estimate
Sedentary time–aerobic fitness	$r = -.31$
Sedentary time–muscular endurance	$r = -.19$
Adjusted sedentary coefficient	$\beta = -.24$
Adjusted activity coefficient	$\beta = .33$
Model explained variance	$R^2 \approx .24$

3.2 Health Indicators and Well-Being

Sedentary time was positively associated with body mass index z score in the synthetic data (r = .22). This was a modest association with considerable overlap between lower- and higher-sedentary records. The modeled relationship was not intended to estimate obesity risk or the prevalence of elevated body mass.

Cardiorespiratory fitness showed a positive correlation with self-rated well-being (r = .28). Muscular endurance also had a smaller positive association with well-being. These results illustrate that physical and psychosocial measures can be related without being redundant.

In a secondary adjusted model, the coefficient for fitness remained positive but was smaller than its bivariate association. Sedentary time showed a modest negative association with well-being. These patterns were constructed to demonstrate partial covariate overlap rather than a specific psychological mechanism.

Well-being was represented by a generic composite score and not by a validated clinical screening instrument. Interpretation is therefore restricted to the illustrative structure of the synthetic data.

Synthetic variable pair	Pearson r
Sedentary time–BMI z score	.22
Aerobic fitness–well-being	.28
Muscular endurance–well-being	.17
Sedentary time–well-being	−.21

3.3 Age-Stratified and Sensitivity Patterns

Age-stratified synthetic summaries showed the same general direction of the sedentary–fitness association across younger and older adolescent records. The magnitudes differed modestly, reflecting random variation and the chosen model parameters rather than established developmental effects.

When a nonlinear term for sedentary exposure was included, it contributed little additional explanatory value under the specified data generator. A model with greater measurement error in sedentary time produced a weaker estimated association, illustrating attenuation that can occur when behavioral exposure is measured imprecisely.

Excluding the most extreme synthetic sedentary-time observations reduced the range of the predictor and slightly weakened the bivariate correlation. This is consistent with the statistical dependence of correlation on the distribution of observed values.

These analyses demonstrate useful robustness questions for empirical research. Their agreement does not independently validate the modeled relationships, because the same constructed data underlie each analysis.

4. Discussion: Interpretation of the Modeled Associations

The main pattern in the synthetic dataset is a modest inverse association between sedentary time and cardiorespiratory fitness, accompanied by a positive association between activity exposure and fitness. The model also illustrates weaker relationships involving muscular endurance, body mass index z score, and well-being.

These findings reinforce an important conceptual distinction: activity, sedentary behavior, and physical fitness are separate constructs. An adolescent may engage in regular sport while also spending substantial time seated during school and leisure. Conversely, lower sedentary time does not guarantee high aerobic fitness.

The moderate and small coefficients leave substantial unexplained variation. Fitness is influenced by maturation, genetics, training history, and test conditions; health-related indicators are shaped by additional biological and contextual factors. It would therefore be inappropriate to interpret one behavioral measure as a complete explanation of adolescent health.

Because the values are simulated, the discussion focuses on the interpretation of associations and the design of future empirical studies rather than on claims about the health status of a particular country or school population.

4.1 Implications for Measurement and Research Design

An empirical investigation of adolescent activity and sedentary behavior would benefit from standardized exposure measurement, transparent fitness testing, and careful attention to developmental status. Self-report and device-based estimates of sitting and activity may differ in systematic ways, affecting observed associations.

Cardiorespiratory fitness should be distinguished from the method used to estimate it. Field-test prediction equations, direct gas-exchange measurement, and submaximal protocols differ in accuracy and feasibility. Reporting the exact protocol is necessary for comparison across studies.

Body mass index z score provides an anthropometric indicator but cannot fully describe body composition or metabolic health. Likewise, a brief well-being score cannot substitute for a comprehensive mental-health assessment. Claims should remain aligned with what each measure actually captures.

Prospective designs would be needed to examine temporal ordering, and controlled interventions would be needed to assess whether changing sedentary exposure causes improvements in fitness or well-being. Cross-sectional adjustment cannot resolve all unmeasured confounding.

The defining limitation is the complete absence of observed human data. All sample characteristics, correlations, regression coefficients, and sensitivity patterns were generated from an illustrative model. They are not empirical estimates and should not be cited as evidence about adolescents in Albania or elsewhere.

The model also simplifies maturation, socioeconomic context, school schedules, sleep, nutrition, and measurement error. The well-being indicator is generic, and the fitness measures are modeled scores rather than instrument outputs. These restrictions limit interpretation to methodological demonstration.

Within these boundaries, the synthetic analysis illustrates how adolescent fitness, sedentary exposure, and selected health indicators can be considered jointly. The modeled associations were modest and supported a multidimensional rather than single-indicator view of adolescent health.

Ethics: No human-participant study was conducted. Funding: No external funding supported this simulation manuscript. Conflict of interest: None declared for the illustrative document. Data availability: All values are synthetic.

References

Bull, F. C., et al. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. British Journal of Sports Medicine, 54(24), 1451–1462.

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: A pooled analysis of 298 population-based surveys with 1.6 million participants. The Lancet Child & Adolescent Health, 4(1), 23–35.

Tremblay, M. S., et al. (2017). Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. International Journal of Behavioral Nutrition and Physical Activity, 14, 75.

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