BODY COMPOSITION AND NON-INVASIVE CARDIOVASCULAR RISK FACTORS IN URBAN AND RURAL STUDENTS: THE IMPACT OF REGULAR PHYSICAL ACTIVITY AND DIET BEHAVIOR

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ABSTRACT

Aims: This study aims to investigate and compare these factors among children, including physical activity time, blood pressure, and screen time, in both urban and rural areas, utilizing non-invasive methods related to cardiovascular risk.
Study design: We proposed an ex-post-facto and quantitative study.
Place and Duration of Study: Sample: Students selected from two regions of Rondônia (Brazil), between August 2023 and December 2023.
Methodology: After we recruited a total of 1045 schoolchildren aged 8 to 14 years, with 545 in the urban area and 500 in the rural area. The "Quantitative Food Frequency Questionnaire" (QQFA) assessed the quality and quantity of food consumed over a year. Additionally, the "Self-Administered Physical Activity" (SAPAC) questionnaire evaluated daily physical activity time and sedentary behavior. Body composition of the children was also assessed.
Results: Children in rural areas demonstrated higher levels of physical activity ($p < 0.05$), with greater intensity ($p < 0.05$), and exhibited a preference for natural foods, including animal fat and unprocessed juices ($p < 0.05$). Moreover, they displayed lower body fat accumulation ($p < 0.05$), lower body mass ($p < 0.05$), lower BMI ($p < 0.05$), smaller waist circumference ($p < 0.05$), and improved waist-to-hip ratio ($p < 0.05$) and waist-to-height ratio ($p < 0.05$). No significant differences were observed in blood pressure values ($p > 0.05$).
Conclusion: Non-invasive factors related to the development of cardiovascular diseases are more prevalent among urban schoolchildren compared to their rural counterparts. These factors are associated with a sedentary lifestyle and the quality and quantity of food consumed.

Keywords: Intense Exercise, Eat behavior, Leasure Physical Activity, Food Consumption.

1. INTRODUCTION

Living in urban or rural environments may influence children's levels of physical activity and sedentary behaviors [1]. Although we know about the importance of the physical activity, in special for children, because inactive children often became a sedentary adult [2], we know little about variations in device-measured physical activity and sedentary levels of urban and rural children using representative samples.

The present study highlights cardiovascular risk factors in urban and rural students for the scientific community. With the increasing incidence of heart disease among young people [3] [4], providing population data for preventive interventions and for the planning of public health policies can be crucial. In this way, an investigation into dietary and physical activity habits, both inexpensive and easily modifiable behavioral factors, can offer opportunities for viable alternatives.

In this contextphysical activity is a complex behavior influenced by multiple factors within the environmental, social/cultural, and psychological/cognitive domains. In the social/cultural domain, social support has been associated with regular physical activity among Youth [5] [6]. However, the Science has been shown that regular physical activity is linked to a variety of health benefits, including a reduced risk of heart attack, colon cancer, diabetes, high blood pressure, and possibly stroke [7]. Nonetheless, the physical activity may have impact in cognitive domains [8] [9] including in the adult life.

Despite the importance of establishing a physically active lifestyle early in life [1] [10], results from a national CDC study involving 9 to 13-year-old children indicated that 61.5% do not engage in any organized physical activity during non-school hours, and 22.6% do not participate in any physical activity during leisure time [11]. Children tend to become less physically active as they progress into adolescence, with female teenagers engaging in less physical activity than their male counterparts[1].

Sedentary behaviors, such as watching television, have been associated with potentially adverse health conditions, including childhood overweight [12] [13], and have been hypothesized to displace time spent in physical activity [14]. Two common sedentary behaviors among children are television viewing and video gaming, with a national study indicating that American children watch an average of 199 minutes of television and video and play 33 minutes of video games per day [15]. In the study conducted by [16] an assessment of the daily screen time among schoolchildren aged 6 to 14 revealed an average duration of 2.77 hours per day. Notably, 46.4% of this cohort exhibited a screen time equal to or exceeding 2 hours per day. The prevalence of school-aged children engaging in screen time of 2 hours or more per day was found to be 41.3% before January 2020, and this increased to 59.4% after January 2020.

This extended screen time is associated with heightened levels of physical inactivity, contributing to significant disparities in the prevalence of physical activity. The observed disparities underscore the imperative for continued investigation into the factors influencing physical activity among adolescents, with particular attention to the female demographic.

Due to the sedentary behavior, the overweight and obesity among children, and young adults have become emerging issues in every region of the world, including in low- and middle-income countries [17], however, we don't know exactly the influence of the rural or urban environment on the physical activity practice, sedentary behavior, and the consequences in the body composition. Although there was a wide variation in overweight and obesity rates between countries, over the last 33 years, there has been no significant improvement in obesity reduction [17] [18], and to determine if the life style could be a real factor among others is important. So, our study, aimed to investigate the association between moderate to vigorous physical activity, sedentary behavior, on body composition, and factors associated with the development of cardiovascular diseases.

2. MATERIAL AND METHODS

2.1 Study Type

This study was designed as an exploratory cross-sectional study of an ex-post-facto, and quantitative approach to explain and quantify an existing phenomenon.

2.2Population and Volunteer Group

The population consisted of 2891 students from two public schools in Ariquemes, Rondônia, a city 200 km from the capital, and 7643 students from Porto Velho, the capital of Rondônia, composed the universe of this research. Before the recruitment of the participants, sample size and power calculations were performed based on changes in body composition among the two groups most critical to the null hypothesis. The distribution does not follow a common standard deviation (p>0.05). A sample size of 510 subjects in capital and 435 per group was required to obtain at least 80% power to detect mean differences between groups. After, the volunteer group was convenient recruited included 500 volunteers from the rural area and 545 from the capital, totaling 1045 volunteers. The actual performance to the capital is 81.4% and to the group of the rural area is of the 88.9%. All of them were duly enrolled in elementary and high schools in both municipalities and ranged in age from 8 to 14 years, representing both sexes. For the purposes of this study, 357 female subjects and 143 male subjects were selected from the rural area. In the capital, the volunteer group consisted of 390 female subjects and 155 male subjects. The legal guardians of the minors signed the Informed Consent Form (ICF) to participate in this research. Is important to comment that the approach of the volunteer was performed in one opportunity, and after, one specific day was scheduled to data collection.

2.3Data Collection Instruments

In this research, data were collected using two questionnaires, and body composition was measured through doubly indirect methods. To assessment of the daily time of the physical activity, we used the Self-Administered Physical Activity Checklist (SAPAC), and to the food habits the Quantitative Food Frequency Questionnaire (QQFA) was used. To the body composition, Waist-to-Hip Ratio (WHR), the Waist Circumference (WC), the Boby Mass Index (BMI), and the Waist-to-Height ratio (WHtR). Additionally, to assess the lean mass and the fat mass, an octopolar scale (In Body, model 170, South Corea) was used. During all procedures, one parent stood present to warrant safe, privacy, and, if necessary, to interpretate, support, and help the children to fit all questions of the questionary.

2.4Self-Administered Physical Activity Checklist (SAPAC)

Physical activity was measured in daily minutes using a self-administered physical activity checklist. The Self-Administered Physical Activity Checklist (SAPAC), developed and validated with a sample of fifth-grade students from various ethnicities, aims to assess the intensity (e.g., moderate or vigorous), duration, and types of physical activity [19] SAPAC is a one-day record of 22 common physical activities, also capturing time spent watching television and playing video games. The self-report version was previously validated by Sallis et al., (1996) against heart rate monitors (r= 0.57, p= 0.0001), Caltrac accelerometers (r= 0.30, p= 0.001), and interviewer-administered checklists (r= 0.76, p= 0.0001) in 125 fifth-grade children. To enhance accuracy, SAPAC was administered to study participants on three separate days, including one weekend day and two weekdays, and an average score was calculated for each participant. This study included moderate to vigorous physical activity (MVPA), which is the sum of minutes corresponding to these intensity levels, and vigorous physical activity (VPA).

Sedentary behaviors were measured using three SAPAC variables: a) daily average minutes of television and video watching; b) daily average minutes of computer games and video game playing; and c) daily average minutes of combined sedentary behavior (the sum of minutes spent watching television and video games and playing computer and video games). All sedentary variables represented the average values from the three days of SAPAC measurements.

Four items assessed social support, asking students how often, in the past month, their a) families engaged in physical activities with them; b) their families encouraged them to be physically active; c) their friends engaged in physical activities with them; and d) their friends encouraged them to be physically active. All items used a five-point Likert scale ranging from 'never' to 'most of the time.' These items were taken from the Calcium Osteoporosis Physical Activity (COPA) questionnaire, a self-administered questionnaire with 85 items developed specifically for the IMPACT study, which assesses behavioral and psychosocial aspects of physical activity and nutrition. These items were adapted from similar questions used in the Child and Adolescent Trial for Cardiovascular Health, which were validated and shown to detect differences between treatment and control groups after one and two years of intervention [20].

2.5Quantitative Food Frequency Questionnaire (QFFQ)

The QQFA was originally developed and validated for the Japanese-Brazilian community in São Paulo [21]. In the QFFQ, participants indicate their usual frequency of food consumption, the corresponding time unit (per day, per week, per month, or per year), and the size of their typical individual portion (small, medium, large, or extra-large in relation to the reference portion of each food in the QFFQ). This provides consumption frequency as a continuous variable rather than a categorical one.

The list of 120 foods in the QFFQ was compiled based on a survey that recorded the three-day food consumption of a random sample of first and second-generation Japanese individuals in São Paulo (n = 166; aged 45-70 years) [22]. Portion sizes were categorized as small, medium, large, and extra-large, based on the percentage distribution of equivalent weights to household measures from dietary records.

Additionally, the questionnaire includes other questions about typical dietary practices and preferences, such as the type of sweetener used in beverages, the type of fat used in meal preparation, the number of meals per day, visible fat intake from meat, other non-listed foods consumed weekly, and the use of dietary supplements.

2.6Body Composition Assessment

Data collection took place over a three-month period. All subjects were instructed to wear appropriate clothing for measurements in the day of the data collection, be barefoot, and dressed in lightweight attire. The location was provided by the schools and reserved in case any clothing needed to be removed for measurements. For height measurement, the volunteer stood barefoot on the stadiometer, facing away from the device, looking straight ahead, with hands and arms placed alongside the body in an upright posture. For body weight measurement, the volunteer stood on the scale with as little clothing as possible and was instructed to remain still until an accurate reading could be obtained. Waist circumference was measured by placing the anthropometric tape at the level of the navel scar, with all sides of the tape parallel to the ground. Hip measurement was taken at the point of maximum gluteus maximus volume using the anthropometric tape, following the same procedure as before. All data collection procedures were previously published [23] [24].

The anthropometric measurements in this study adhered to established standards, with subjects wearing light clothing, no shoes, empty bladder and rectum, and a minimum 4-hour fasting period. All measurements were conducted twice, and the average of the two readings was recorded. For height measurement, subjects stood with feet together, arms extended along the body, buttocks, scapulae, and head in contact with a vertical backboard, and the head in the Frankfort Horizontal Plane position. Height was measured to the nearest 0.1 cm using a portable stadiometer, and weight to the nearest 0.1 kg using a personal digital scale (In Body, Model 170, South Corea).

Waist circumference was measured at the end of normal expiration, with a flexible tape positioned at the midpoint between the lowest rib and the top of the iliac crest. Hip circumference was measured at the widest girth below the wings of the ilia.

BMI was utilized to categorize individuals into underweight, normal body mass, overweight, and obesity groups. WHtR categories were established following guidelines by Ashwell and Gibson [25], with values below 0.40 deemed too low, 0.40-0.49 as normal, 0.50-0.59 as increased, and equal to or higher than 0.60 classified as very high. Abdominal obesity was defined as WHtR≥0.50.

2.7Data Interpretation

The cutoff points for waist circumference, according to pubertal staging for identifying central obesity in children, which demonstrated the best performance in the ROC curve, are as follows:

Table 1: Cutoff points for waist circumference according to pubertal staging for central obesity determination in children.

Waist Circumference for Pre- and Post-Pubertal Girls and Boys		
	Girls	Boys
Pre-Pubertal	≤ 71.65	≤ 70.25
Post-Pubertal	≤ 67.90	≤ 66.45
Rev. Paul. Pediatr. (Ed. Port., Online) *; 37(1): 49-57, Jan.-Mar. 2019. tab*		

Table 2: Values for classifying the risk of developing cardiovascular diseases according to WHR.

Table for Risk Zone Associated with WHR

	Men	Women
High-risk	> 0.95	>0.85
Moderated-risk	0.90-0.95	0.80-0.85
Low-risk	<0.90	<0.80
Source: O.M.S.– 1997		

2.8Equations

Waist-to-Hip Ratio (WHR)

WHR = Waist Circumference

Hip Circumference

Body Mass Index (BMI)

BMI= weight/height2 (kg/m2)

Waist to Height Ratio (WHtR)

WHtR= Waist Circumference/Height (cm/cm)Some guidelines for Medical papers:

2.9Energy Expenditure

Total Energy expenditure is the number of calories burned by the human body in one day adjusted to the amount of activity (sedentary, moderate or strenuous). It is calculated by adding 30% of the Basal Energy Expenditure (BEE) calories to the BEE for sedentary activity. 50% of the BEE calories for moderate activity and 100% of the calories for strenous activity.

2.9.1 Calculate Total Energy Expenditure (TEE)

TEE=Moderate+MVPA+VPA+TV/Vídeo+Computador+Sedentary Behavior

2.9.2Estimate Resting Energy Expenditure (REE)

HEE=10×weight (kg)+6.25×height (cm)−5×age (years)+constant

2.9.3Constants

For males: +5

For females: −161

2.9.4Calculate Physical Activity Level (PAL)

PAL=TEE

REE

2.9.5Calculate Metabolic Equivalent (METs):

METS, or metabolic equivalents, are a highly effective way to measure their clients' progress.

1 METs = 3.5 x weight in kg ÷ 200.

2.10Statistical Analysis

The data were analyzed using GRAPH PAD PRISM version 9.05. Initially, descriptive statistics were calculated to describe the sample and the distribution of variables. Daily physical activity minutes and combined sedentary minutes were treated as continuous variables. In describing the sample, a one-way analysis of variance one and two-way ANOVA way were conducted to evaluate mean differences in daily minutes of physical activity and sedentary behavior followed by Sìdák Post-hoc test with 5% of significance. Additionally, the multivariate logistic regression, adjusted for potential confounders, examined the associations of domain-specific PA and sedentary behavior with percent body fat. Pearson correlation coefficients were computed to assess the bivariate relationship between physical activity and sedentary behavior with the variables related the body composition. Differences were considered statistically significant if the p-value was < 0.05.

3. RESULTS AND DISCUSSION

3.1The total and vigorous physical activity are higher in rural children while the sedentary behavior is higher in capital children.

Participating rural students consistently reported higher levels of moderate, moderate/vigorous physical activity (MVPA) and vigorous physical activity (VPA) compared to their urban counterparts (Fig. 1A). Conversely, urban students demonstrated lower engagement in physical activity, as well as higher durations of sedentary behavior (Fig. 1B). Statistical analyses confirmed these differences, indicating that rural students were more physically active, particularly in high-intensity activities. The overall pattern of physical activity, showcase the energy expenditure and activity types. Boys tended to be more active than girls (Fig. 1C and D), with most children participating in at least one moderate or vigorous activity over the observed period. Notably, boys demonstrated a longer duration of vigorous activities compared to girls, and in all comparison the students of rural area are less sedentary than the capital (Fig. 1E and F). These findings underscore the disparities in physical activity patterns between rural and urban school students which is confirmed after calculation of the Total Energy Expenditure (TEE) (Fig. 1G), Resting Energy Expenditure (REE) (Fig . 1H), the Physical Activity Level (PAL) (Fig . 1I), and the Metabolic Equivalents (METs) (Fig . 1J).

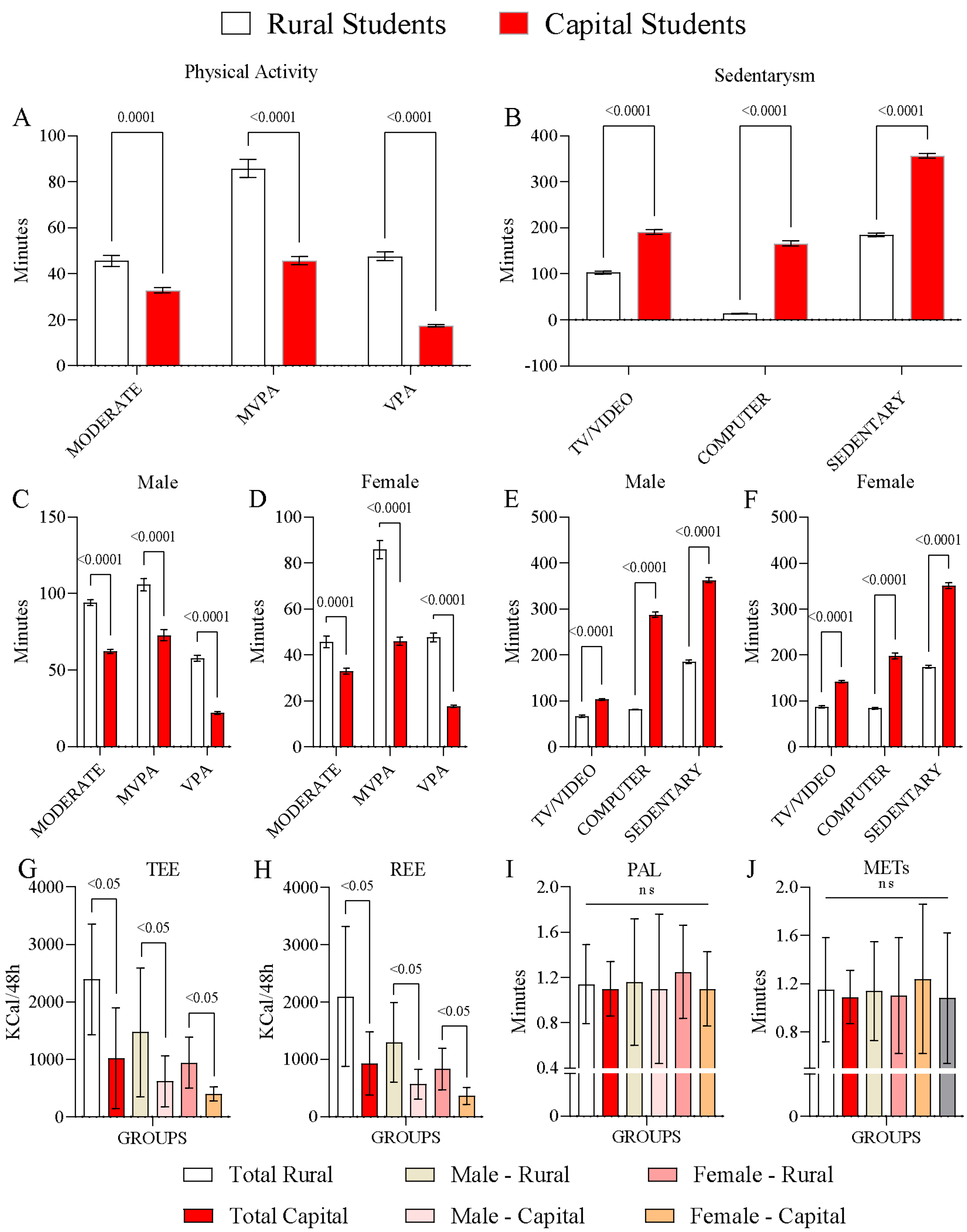

Figure 1: Physical Activity and Sedentarism

1045 children were selected, 500 of a rural area of an inner city, and 545 in the capital of the same state far 200km of distance. The Self-Administered Physical Activity Checklist (SAPAC) was used for these data assessment. The Fig. 1A display the physical activity level divided in three intensity stages (moderate, moderate to vigorous, and vigorous physical activity) in minutes. Fig. 1B display the time expended with TV/Video, Computer, and the combination express the sedentary behavior. The Fig. 1C and 1D display and compare the physical activity between Male and Female, and the Figures 1E and 1F the sedentary behavior between sex. The Total Energy Expenditure (TEE) is exposed in Fig. 1G, the Resting Energy Expenditure (REE) in Fig. 1H, the Physical Activity Level (PAL) in the Fig. 1I, and the Metabolic Equivalents (METs) in Fig. Fig. 1J.The ANOVA ONE WAY followed by Sìdák with 5% of significance were used to investigate the differences. Legend: ns= non-significant.

3.2 The dietary habits display a preference for natural foods and the consumption of less total calory and fat in rural children if compared with children of the capital.

In the realm of dietary habits, total rural children, male, and female exhibited lower energy consumption (Fig. 2A, 2B and 2C) with predilection for natural foods, showing lower consumption of fat (Fig. 2D), higher consumption of items such as fiber (Fig. 2E), fruits (Fig. 2F), and vegetables (Fig. 2G). Gender disparities emerged, with boys displaying a significantly higher fat-derived energy proportion, while girls exhibited a preference for energy from carbohydrates in both, however, the consumption of fat is higher capital group independent of the sex (Fig. 2H).

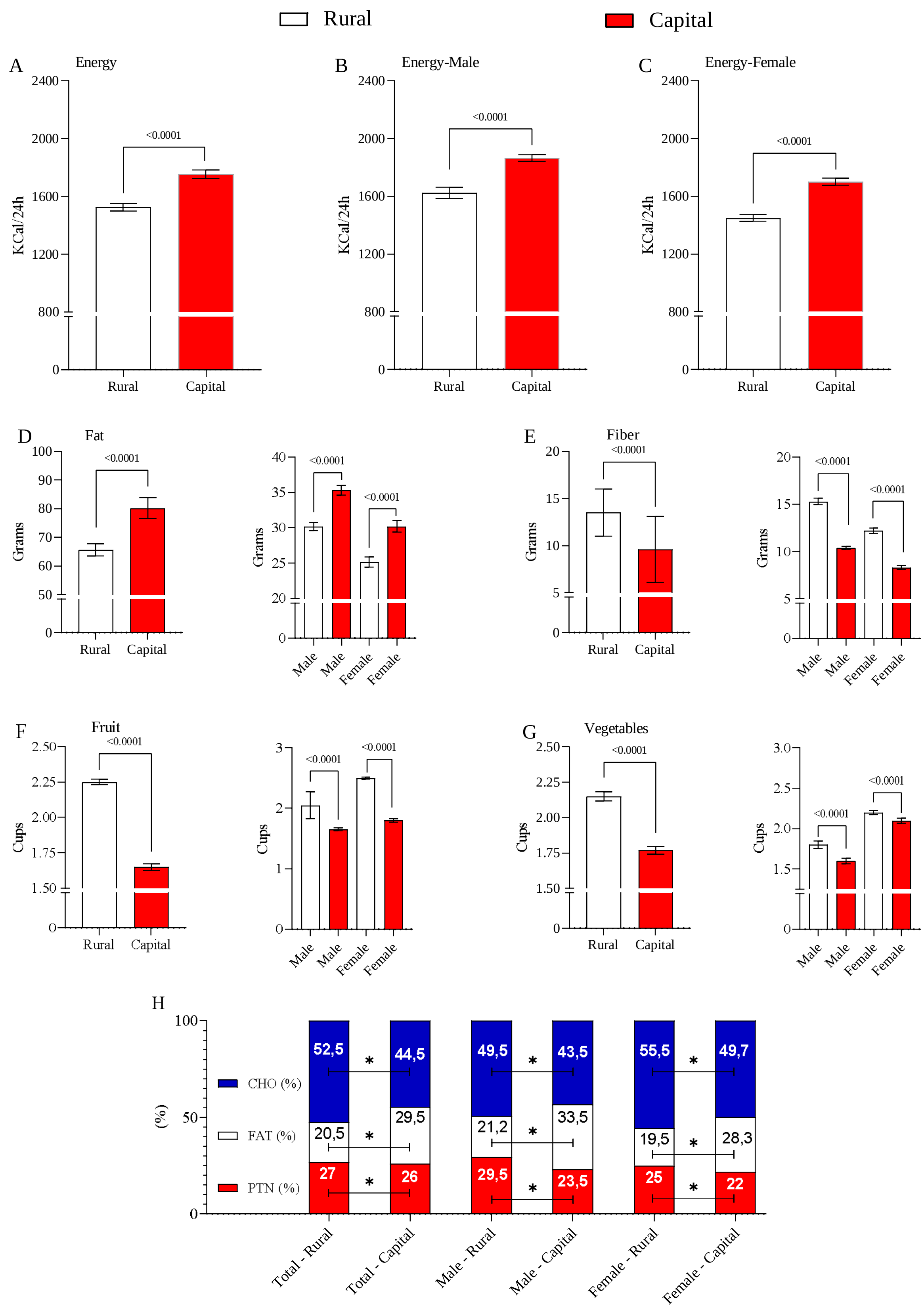

Figure 2: Food Consumption behavior

1045 children were selected, 500 of a rural area of an inner city, and 545 in the capital of the same state far 200km of distance. The Quantitative Food Frequency Questionnaire (QQFA) was used for these data assessment. The Fig. 1A display the total energy intake for the total group. Fig. 1B display the energy intake divided by sex. The Fig. 1C and 1D display and compare the physical activity *between Male and Female, and the Fig. 1E and 1F the sedentary behavior between sex. The Total Energy Expenditure (TEE) is exposed in Fig. 1G, the Resting Energy Expenditure (REE) in Figure 1H, the Physical Activity Level (PAL) in the Fig. 1I, and the Metabolic Equivalents (METs) in Figure Fig. 1J. The ANOVA ONE WAY followed by Sìdák with 5% of significance were used to investigate the differences. Legend: ns= non-significant.*

3.3 The body composition of rural children exhibits more muscle mass, less fat mass and lesser cardiac risk factor if compared to capital students

Children living in rural areas showed lower body fat accumulation, lower body mass, lower BMI, smaller WC, and a better WHR, WHTR ratio, along with higher muscle mass. In contrast, students of both genders from the capital exhibited higher body weight, as well as a higher percentage of body fat and a lower percentage of lean mass.

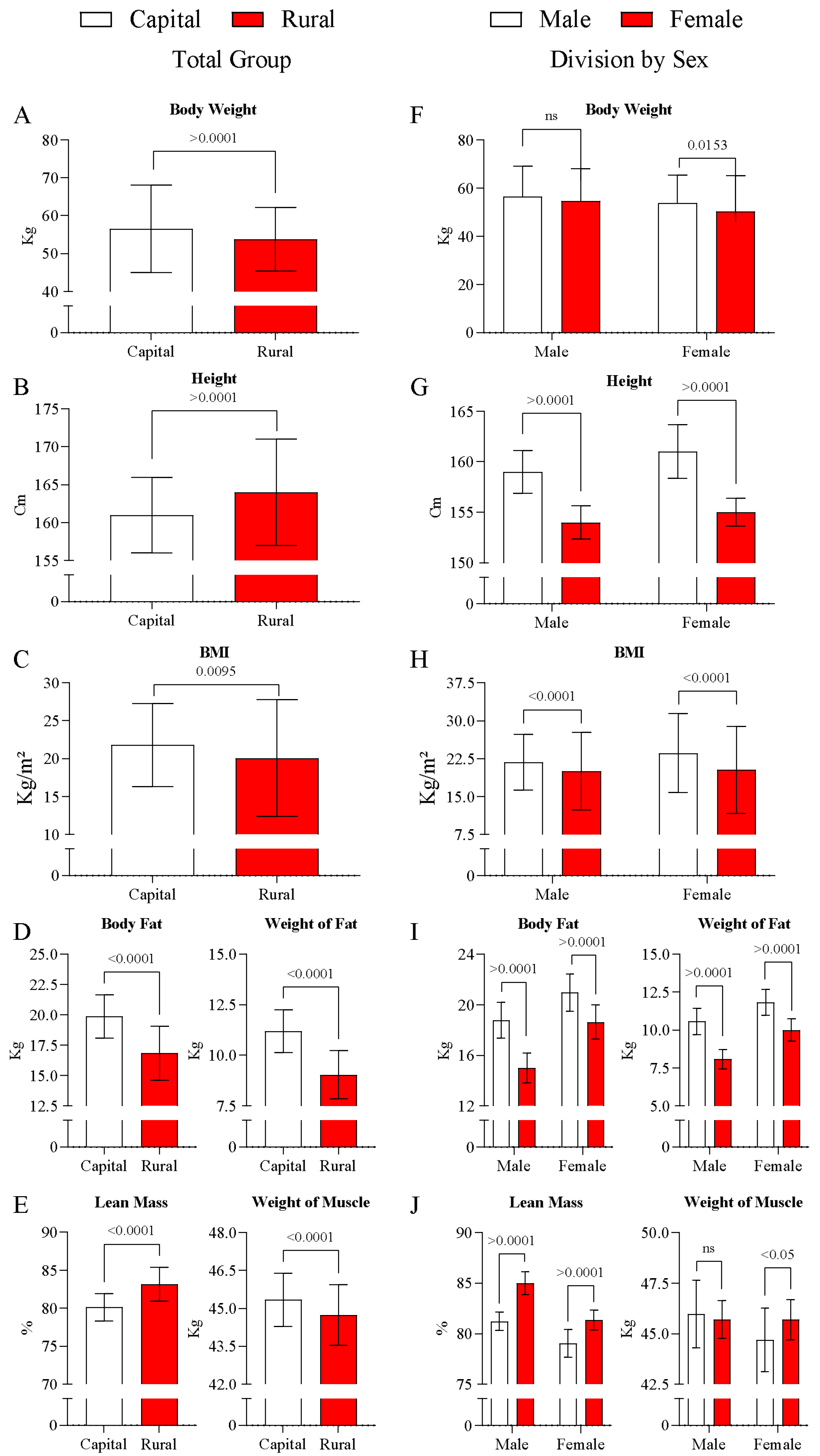
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Figure 3: Body composition

1045 children were selected, 500 of a rural area of an inner city, and 545 in the capital of the same state far 200km of distance. The quantitative and qualitative body composition was assessed. In the left collum, the Fig. 3A display the Body weight, Fig. 3B display the height, Fig. 3C display the BMI, 3D left the % of Body Fat and Hight the Weight of Fat, Fig. 3E left the weight of Body Muscle and 3E high the % of Body Muscle. In the right collum the data are segmented by sex. Figure 3F display the Body weight, Fig. 3G display the height, Fig. 3H display the BMI, 3D left the % of Body Fat and High the Weight of Fat, Fig. 3I left the weight of Body Muscle and 3J High the % of Body Muscle. The ANOVA ONE WAY followed by Sìdák with 5% of significance were used to investigate the differences. Legend: ns= non-significant.

3.4 All group display correlation between body composition and VPA/MVPA and sedentarism behavior

The analysis of physical activity in relation to BMI indicates that increased physical activity is correlated with a better body composition. Students who reported a higher average of daily minutes of vigorous physical activity (VPA) compared to those with lower averages also exhibited a better body composition in all analyzed variables, with special attention to increased BMI and muscle mass in a linear combination of variables and covariates significantly related to VPA ($R2 = 0.061$ - $p < 0.01$). The complete model accounted for a smaller amount of variance compared to the model with moderate-to-vigorous physical activity (MVPA).

The averages of daily minutes of combined sedentary behaviors such as watching TV-videos and playing computer-video games were lower as the frequency of participation in physical activities increased. The correlation between BMI and minutes of combined sedentary behavior was positive ($R2 = 0.67$ - $p < 0.01$), and BMI was significantly correlated with combined sedentary behavior in the complete model ($R2 = 0.73$ - $p < 0.01$). Moreover, we observed a high correlation between VPA and lower waist circumference ($R2 = 0.85$ - $p < 0.01$) and waist-to-hip ratio ($R2 = 0.83$ - $p < 0.01$).

3.5 Discussion

This manuscript aims to delve into and compare various health factors among children, encompassing physical activity time, blood pressure, and screen time, within both urban and rural settings. Employing non-invasive methodologies associated with cardiovascular risk assessment, our investigation revealed noteworthy disparities in physical activity and sedentary behavior patterns between rural and urban children. Specifically, rural children reported higher levels of total, moderate, and vigorous physical activity, with boys exhibiting elevated physical activity levels compared to their urban counterparts. Corroborating these findings, calculations of Total Energy Expenditure (TEE), Resting Energy Expenditure (REE), Physical Activity Level (PAL), and Metabolic Equivalents (METs) further substantiated the distinctions in energy expenditure and metabolic activity between rural and urban students. When coupled with dietary preferences indicating a penchant for natural foods and lower overall energy consumption, particularly in terms of fat, these results culminate in favorable outcomes for rural children, including lower body fat accumulation, reduced BMI, smaller waist circumference, and a more favorable waist-to-hip ratio, along with higher muscle mass, suggestive of a potentially healthier body composition. Importantly, a correlation analysis indicated a significant positive relationship between body composition and physical activity levels, highlighting the potential health benefits associated with increased physical activity, particularly in vigorous activities.

The observed rural-urban disparities in physical activity patterns among children underscore the profound impact of the living environment on the health behaviors of this demographic. Notably, our study brings to light significant differences in the levels of total, moderate, and vigorous physical activity between rural and urban students. In essence, rural children consistently reported engaging in higher levels of physical activity across these categories when compared to their urban counterparts as previously observed [26]. This discrepancy suggests that the distinctive characteristics and dynamics of rural and urban settings play a pivotal role in shaping the activity levels of children.

The higher reported levels of physical activity in rural areas may be attributed to various environmental factors, including greater access to open spaces, natural surroundings, and recreational areas that facilitate active play and exercise [27] [28]. Additionally, the potential influence of community structures, social norms, and lifestyle patterns specific to rural settings might contribute to the observed disparities. The finding not only highlights the impact of environmental factors on physical activity but also underscores the need for tailored interventions that consider the unique attributes of both rural and urban contexts. Understanding these disparities is crucial for informing public health strategies aimed at promoting physical activity among children, ensuring that interventions are contextually relevant and effectively address the diverse needs of different communities.

The examination of gender disparities in physical activity within our study reveals noteworthy differences in activity levels between boys and girls [2]. A compelling observation emerges, indicating a consistent gender disparity, with boys demonstrating higher overall activity levels than girls. The data elucidates that boys tend to participate more frequently in both moderate and vigorous physical activities, showcasing a proclivity for higher-intensity exercises. Moreover, a distinct gender divergence is evident in the duration of vigorous activities, where boys exhibit a longer engagement compared to girls as previously published [2] [26].

These findings draw attention to the nuanced ways in which physical activity behaviors manifest across genders during childhood. The observed disparities may be influenced by a combination of biological, sociocultural, and environmental factors that contribute to varying preferences and engagement levels in physical activities. Understanding these gender-specific patterns is crucial for tailoring interventions that not only address the overall population but also account for the unique needs and preferences of boys and girls. Such insights can inform targeted strategies to promote physical activity, ensuring inclusivity and effectiveness across diverse gender groups.

The examination of sedentary behavior within our study brings to light notable distinctions between rural and urban students. The results underscore significant differences, with urban children exhibiting prolonged durations of sedentary behavior compared to their rural counterparts. This finding accentuates the impact of the urban environment on fostering a more sedentary lifestyle among children.

The higher prevalence of sedentary behavior in urban settings may be influenced by various environmental and lifestyle factors characteristic of urban living [29]. Factors such as increased screen time, availability of electronic devices, and sedentary leisure activities may contribute to the observed trends. Additionally, the urban landscape, with potential limitations on open spaces and active play areas, could further contribute to extended periods of sedentary behavior.

Understanding these urban-rural distinctions in sedentary behavior is pivotal for public health initiatives aimed at mitigating the adverse effects of a sedentary lifestyle among children [30]. Tailored interventions that address the specific challenges posed by the urban environment can be developed to promote healthier activity patterns and reduce sedentary time, contributing to improved overall health outcomes in this demographic.

The TEE, REE, PAL, and METs served to corroborate and accentuate the discernible differences in energy expenditure and metabolic activity between rural and urban students. These calculations offer valuable insights into the overall energy equilibrium and metabolic health of the two groups, shedding light on the intricacies of their respective physiological responses to daily activities. The disparities identified through these measures underscore the multifaceted nature of the energy dynamics at play in rural and urban settings, contributing to a comprehensive understanding of the metabolic profiles within each demographic.

The TEE, REE, PAL, and METs not only reaffirms the pronounced differences in energy dynamics between rural and urban students but also provides nuanced insights into the broader metabolic health of these distinct populations. By delving into the intricacies of TEE, which encapsulates the total energy output during various activities, REE, representing baseline metabolic requirements, PAL, reflecting the ratio of total energy expenditure to resting energy expenditure, and METs, quantifying the intensity of physical activities, a more holistic understanding emerges.

These measures collectively contribute to unraveling the unique physiological responses and energy utilization patterns exhibited by rural and urban students. The disparities identified extend beyond mere energy expenditure, offering glimpses into the intricate interplay between lifestyle, environmental factors, and metabolic health. Such insights are invaluable for tailoring interventions that address the specific metabolic challenges faced by each group, ultimately contributing to more targeted public health strategies aimed at enhancing the overall well-being of both rural and urban populations.

Unpacking the dietary habits of the studied population unveils intricate patterns, notably emphasizing distinctions in rural areas and revealing nuanced gender-specific preferences [2]. A discernible trend emerges as rural children showcase a distinct inclination towards natural foods, coupled with an overall lower energy intake, particularly in terms of fat consumption. This dietary preference suggests a health-conscious pattern prevalent in rural settings, marked by elevated consumption of fiber, fruits, and vegetables. This inclination towards whole, unprocessed foods not only aligns with recognized health benefits associated with increased fiber and nutrient-rich choices but also reflects the influence of local food culture and availability in shaping dietary preferences.

Further exploration delves into gender-specific nuances within dietary habits, uncovering evident disparities. Boys exhibit a notable preference for a higher proportion of energy derived from fat, reflecting distinct dietary choices. Conversely, girls demonstrate a contrasting inclination, showing a preference for energy sourced from carbohydrates. Intriguingly, despite these gender-specific patterns, a paradox surfaces within the capital group, consistently registering higher fat consumption across genders. This paradox suggests that urban dietary habits may be influenced by broader environmental and lifestyle factors that transcend individual gender preferences.

These dietary intricacies contribute not only to a granular understanding of individual dietary behaviors but also shed light on broader dietary trends within specific demographic groups contributing for tailoring nutritional interventions that account for both gender-specific and regional dietary preferences, fostering a more nuanced approach to promoting healthier eating habits among children [31] [32].

The meticulous analysis of body composition not only affirms but also elucidates the noteworthy advantages observed in rural children. This examination reveals a constellation of favorable outcomes, painting a comprehensive picture of the distinct physiological profiles within these demographic groups. Rural children, in particular, exhibit lower levels of body fat accumulation, indicative of a potentially healthier metabolic profile. This is complemented by a lower BMI, a pivotal metric that considers weight in relation to height, further underscoring the advantageous body composition observed in rural areas [33] [34].

Delving deeper into the analysis, rural children display a smaller waist circumference, suggesting a reduced risk of central adiposity and associated health complications. The meticulous consideration of the waist-to-hip ratio adds another layer of insight, indicating a more favorable distribution of fat in rural children, which is often linked to reduced cardiovascular risk.

A particularly noteworthy finding is the higher muscle mass observed among rural children, marking a central distinction in body composition. This elevation in muscle mass not only contributes to a potentially healthier metabolic state but also implies a lifestyle that may involve higher levels of physical activity and engagement in muscle-strengthening activities [23] [35] [36].

The juxtaposition of these body composition metrics underscores the complexity of factors influencing health outcomes in rural and urban settings. Beyond the numerical data, these findings prompt further exploration into the environmental, lifestyle, and cultural determinants that contribute to the observed disparities. Recognizing the nuanced interplay between these factors offers a more comprehensive understanding of the health landscape, paving the way for targeted interventions that address the unique needs of each demographic group.

Thorough correlation analyses bring to light a significant and positive relationship between body composition and levels of physical activity. The findings emphasize that heightened physical activity, particularly in the realm of vigorous activities, is associated with improved body composition. This correlation implies that individuals engaging in more robust physical activities tend to exhibit a more favorable balance between muscle and fat mass, contributing to an overall healthier physique.

Expanding the scope, the analyses also shed light on the impact of sedentary behaviors on body composition. Intriguingly, higher participation in sedentary activities displays a positive correlation with BMI [37] [38]. This correlation underscores the profound of lifestyle choices on the composition of the body. It suggests that prolonged periods of sedentary behavior may contribute to the accumulation of excess body weight, highlighting the importance of not only promoting physical activity but also mitigating prolonged periods of inactivity. These correlation findings not only affirm the interconnected nature of physical activity, sedentary behavior, and body composition but also accentuate the need for holistic lifestyle interventions. Recognizing the intricate interplay between these variables is pivotal for developing targeted strategies that address both the promotion of active lifestyles and the reduction of sedentary behaviors, ultimately contributing to improved body composition and overall health outcomes.

The holistic examination of the data yields crucial insights that underscore the significance of a multifaceted approach, encompassing both environmental and individual determinants, in fostering physical activity and cultivating healthy dietary habits among children. The findings serve as a roadmap for potential targeted interventions, aiming to bridge the disparities in lifestyle and health outcomes observed between rural and urban populations.

The overall implications derived from this comprehensive analysis extend beyond the numerical data, emphasizing the complex interplay of factors that shape children's behaviors and health. The environmental context, encompassing the distinct characteristics of rural and urban settings, interacts intricately with individual choices, influencing lifestyle patterns and health outcomes. Recognizing these nuances is paramount for developing interventions that align with the specific needs of each demographic, thereby fostering a more tailored and effective approach to health promotion.

In light of the identified disparities, the findings propose potential avenues for targeted interventions. Strategies aimed at promoting physical activity and instilling healthier dietary habits should be crafted with a nuanced understanding of the unique challenges and opportunities presented by both rural and urban contexts. Community-based initiatives, informed by further research, can serve as catalysts for sustainable change, engaging local stakeholders and fostering environments conducive to healthier lifestyles for children. The call for further research emerges as a vital component of the recommendations, seeking to deepen our understanding of the intricate dynamics influencing lifestyle choices among children. Community-based initiatives, rooted in evidence-based interventions, can be instrumental in not only addressing the identified disparities but also in cultivating a culture of health that extends beyond individual behaviors.

In conclusion, the amalgamation of environmental considerations, individual behaviors, and community-based strategies forms the foundation for a comprehensive approach to promoting a healthier lifestyle among children. By heeding these implications and recommendations, we pave the way for impactful interventions that have the potential to transform the health landscape for the better.

While the study provides robust insights, certain limitations should be acknowledged. The cross-sectional design offers a snapshot rather than tracking changes over time, limiting causal inferences. Reliance on self-reported data introduces potential biases. The study's regional focus on urban and rural areas may constrain generalizability to diverse demographics. Socioeconomic influences on physical activity and dietary habits might not be fully captured, and more detailed dietary assessments are warranted. Unmeasured confounding variables could impact results, and the study's observational nature restricts insights into effective interventions. Relying on single measures like BMI oversimplifies body composition, and a closer examination of diverse sedentary behaviors could provide a more nuanced understanding. Finally, it is needed to comment that the QQFA was not validated to the population here investigated. Addressing these limitations fortifies the study's reliability and guides future research directions.

3.6Practical recommendations

In light of the significant disparities observed between urban and rural students in terms of physical activity levels and dietary habits, it is imperative to implement targeted interventions promoting healthier lifestyles. Urban children, in particular, exhibited lower physical activity levels and poorer dietary choices, contributing to increased cardiovascular risk factors. Schools and community organizations should collaborate to enhance physical education programs, providing more opportunities for active play and sports, especially in urban areas. Additionally, nutrition education campaigns tailored to young audiences and their families can encourage healthier eating habits. These measures, alongside policies supporting accessible recreational spaces and nutritious food options, can mitigate the growing trend of cardiovascular diseases among urban youth and foster long-term health benefits.

4. CONCLUSION

Our findings underscore the significance of physical activity among 8 to 14-year-old students, while also suggesting that a natural diet may impact body composition and the incidence of risk factors for cardiovascular diseases. The results indicate that daily household activities play a crucial role in promoting vigorous physical activity, while family relationships at home may be more influential in increasing sedentary behaviors, such as watching TV and playing video games. This has led to a higher prevalence of non-invasive factors associated with the development of cardiovascular diseases among urban schoolchildren compared to their rural counterparts. In conclusion, future research should delve into the causal and potentially reciprocal relationships among social influences, dietary patterns, and physical activity among adolescents.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

FN, JRV-S, JC did the conceptualization; data curation; formal analysis; investigation; methodology; project administration; resources; software; supervision; validation; visualization; roles/Writing - original draft; and writing - review & editing references.

ETHICAL APPROVAL AND CONSENT

The study was submitted to, and approved by the Ethics and Human Research Committee of FIMCA College under protocol number 79724. In order to attend the legal exigences of the Ethical Council one parent signed a consent to the children to participate of this investigation, and the children was consulted about his consensual participation during the document assignation of the parent.

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REFERENCES

1. Aadland KN, Moe VF, Aadland E, Anderssen SA, Resaland GK, Ommundsen Y. Relationships between physical activity, sedentary time, aerobic fitness, motor skills and executive function and academic performance in children. *Ment Health Phys Act*. 2017;12:10-18. doi:10.1016/j.mhpa.2017.01.001

2. Alzamil HA, Alhakbany MA, Alfadda NA, Almusallam SM, Al-Hazzaa HM. A Profile of Physical Activity, Sedentary Behaviors, Sleep, and Dietary Habits of Saudi College Female Students. *J Family Community Med*. 2019;26(1):1-4. doi:10.4103/jfcm.JFCM

3. Schroeder EC, Franke WD, Sharp RL, Lee D chul. Comparative effectiveness of aerobic, resistance, and combined training on cardiovascular disease risk factors: A randomized controlled trial. *PLoS One*. 2019;14(1). doi:10.1371/journal.pone.0210292

4. A O, P G, S S. Income disparities in absolute cardiovascular risk and cardiovascular risk factors in the United States, 1999-2014. *JAMA Cardiol*. 2(7):782-790.

5. Pitetti K, Baynard T, Agiovlasitis S. Children and adolescents with Down syndrome, physical fitness and physical activity. *J Sport Health Sci*. Published online 2013. doi:10.1016/j.jshs.2012.10.004

6. de Greeff JW, Bosker RJ, Oosterlaan J, Visscher C, Hartman E. Effects of physical activity on executive functions, attention and academic performance in preadolescent children: a meta-analysis. *J Sci Med Sport*. 2018;21(5):501-507. doi:10.1016/j.jsams.2017.09.595

7. Guimarães AC, Pernambuco CS, Rodrigues RV, et al. Sixteen Weeks of Different Volume of HIIT and MICT on Quality of Gait , Respiratory Fitness , Power of Lower Limbs , Risk of Falls , and Dementia Symptoms in Frailty Older Adults in the world , with it , a condition called frailty is becoming increasingly. *Eur Acad Res*. 2022;IX(10):6189-6207.

8. Lima RF, Da Silva VF, De Oliveira GL, et al. Practicing karate may improves executive functions of 8-11-year-old schoolchildren. *Journal of Physical Education and Sport*. 2017;17(4):2513-2518. doi:10.7752/jpes.2017.04283

9. Vieira Catelani M, Lameira de Oliveira G, Perini de Oliveira T, Reis de Souza F, Valentim-Silva J. Efeitos de um programa de exercícios resistidos na composição corporal e aspectos cardiovasculares em idosos hipertensos. *RevistaBrasileira de Prescrição e Fisiologia do Exercício (RBPFEX)*. 2014;8(48):10.

10. de Greeff JW, Bosker RJ, Oosterlaan J, Visscher C, Hartman E. Effects of physical activity on executive functions, attention and academic performance in preadolescent children: a meta-analysis. *J Sci Med Sport*. Published online 2018. doi:10.1016/j.jsams.2017.09.595

11. Davis C. L, Litwin SE, Pollock NK, Waller JL, Zhu H, Dong Y. Exercise Effects On Arterial Stiffness And Heart Health In Children With Excess Weight: The SMART RCT. *Int J Obes*. Published online 2019.

12. Warren TY, Barry V, Hooker SP, Sui X, Church TS, Blair SN. Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Med Sci Sports Exerc*. 2010;42(5):879-885. doi:10.1249/MSS.0b013e3181c3aa7e

13. Patel A V., Friedenreich CM, Moore SC, et al. American College of Sports Medicine Roundtable Report on Physical Activity, Sedentary Behavior, and Cancer Prevention and Control. *Med Sci Sports Exerc*. Published online 2019. doi:10.1249/MSS.0000000000002117

14. METHNANI J, AMOR D, YOUSFI N, BOUSLAMA A, OMEZZINE A, BOUHLEL E. Sedentary behavior, exercise and COVID-19: immune and metabolic implications in obesity and its comorbidities. *J Sports Med Phys Fitness*. 2021;61(11):1538-1547. doi:10.23736/s0022-4707.20.11898-x

15. Schoene D, Lord SR, Delbaere K, Severino C, Davies TA, Smith ST. A Randomized Controlled Pilot Study of Home-Based Step Training in Older People Using Videogame Technology. *PLoS One*. 2013;8(3):1-8. doi:10.1371/journal.pone.0057734

16. Qi J, Yan Y, Yin H. Screen time among school-aged children of aged 6–14: a systematic review. *Glob Health Res Policy*. 2023;8(1). doi:10.1186/s41256-023-00297-z

17. Levesque RJR. Obesity and Overweight. In: *Encyclopedia of Adolescence*. ; 2018. doi:10.1007/978-3-319-33228-4_447

18. Blüher M. Obesity: global epidemiology and pathogenesis. *Nat Rev Endocrinol*. Published online 2019. doi:10.1038/s41574-019-0176-8

19. SALLIS JF, TRIKMILLER PK, HARSHA DW, et al. Validation of interviewer and self administered physical activity checklists for fifth grade students. *Medicine & Science in Sports &Exercise* . 1996;28(7):840-851.

20. Edmundson E, Parcel GS, Feldman HA, et al. *The Effects of the Child and Adolescent Trial for Cardiovascular Health upon Psychosocial Determinants of Diet and Physical Activity Behavior*. Vol 25.; 1996.

21. Cardoso CB. Efeitos da política de cotas na Universidade de Brasília: uma análise do rendimento e da evasão. *Universidade de Brasília*. 2008;(abnt):134.

22. Cardoso1 MA, Hamada3 GS, De Souza4 JMP, Tsugane5 S, Tokudome2 S. *Dietary Patterns in Japanese Migrants to Southeastern Brazil and Their Descendants*. Vol 7.; 1997.

23. Júnior ALAL, da Silva JMJM, da Silva VFVF, et al. Multimodal HIIT is more efficient than moderate continuous training for management of body composition, lipid profile and glucose metabolism in the diabetic elderly. *Int J Morphol*. 2020;38(2):392-399. doi:10.4067/S0717-95022020000200392

24. Marques AA, Buratti Nogueira TR, da Silva VF, et al. Pilates plus Cardiovascular Training in Body Composition: Effects of Adding Continuous Cardiovascular Training to the Pilates Method on Adult Body Composition. *MOJ Sports Med*. 2018;2(1):1-5. doi:10.15406/mojsm.2018.02.00038

25. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. *Obesity Reviews*. 2012;13(3):275-286. doi:10.1111/j.1467-789X.2011.00952.x

26. Davis HA, Riley EN, Smith GT, Milich R, Burris JL. Alcohol use and strenuous physical activity in college students: A longitudinal test of 2 explanatory models of health behavior. *J Am Coll Health*. 2017;65(2):112-121. doi:110.1016/j.bbi.2017.04.008

27. Chen C, Tsai LT, Lin CF, et al. Factors influencing interest in recreational sports participation and its rural-urban disparity. *PLoS One*. 2017;12(5). doi:10.1371/JOURNAL.PONE.0178052

28. McCrorie P, Mitchell R, Macdonald L, et al. The relationship between living in urban and rural areas of Scotland and children's physical activity and sedentary levels: A country-wide cross-sectional analysis. *BMC Public Health*. 2020;20(1). doi:10.1186/s12889-020-8311-y

29. Olfert MD, Barr ML, Charlier CC, Greene G, Zhou W, Colby SE. Sex differences in lifestyle behaviors among U.S. college freshmen. *Int J Environ Res Public Health*. 2019;16(3). doi:10.3390/ijerph16030482

30. Atkin AJ, Sharp SJ, Harrison F, BrageSø, Van Sluijs EMF. Seasonal Variation in Children's Physical Activity and Sedentary Time. *Med Sci Sports Exerc*. 2016;48(3):449. doi:10.1249/MSS.0000000000000786

31. Ayuzo-Del Valle NC, Covarrubias-Esquer JD. Eating disorders. *Revista Mexicana de Pediatria*. Published online 2019. doi:10.7326/0003-4819-156-7-201204030-01004

32. de Oliveira GL, de Oliveira TAP, de Pinho Gonçalves PS, Silva JRV, Fernandes PR, Filho JF. Body image and eating disorders in female athletes of different sports. *Journal of Exercise Physiology*. 2017;20(2):44-54.

33. Laing EM, Massoni JA, Nickols-Richardson SM, Modlesky CM, O'Connor PJ, Lewis RD. A prospective study of bone mass and body composition in female adolescent gymnasts. *J Pediatr*. 2002;141(2):211-216. doi:10.1067/mpd.2002.126599

34. Seron BB, Silva RAC, Greguol M. Effects of two programs of exercise on body composition of adolescents with Down syndrome. *RevistaPaulista de Pediatria*. Published online 2014. doi:10.1590/s0103-05822014000100015

35. Eklund D, Häkkinen A, Laukkanen JA, Balandzic M, Nyman K, Häkkinen K. Fitness, body composition and blood lipids following 3 concurrent strength and endurance training modes. *Applied Physiology, Nutrition, and Metabolism*. 2016;41(7):767-774. doi:10.1017/ice.2017.306

36. Melchiorri G, Viero V, Sorge R, et al. Body composition analysis to study long-term training effects in elite male water polo athletes. *Journal of Sports Medicine and Physical Fitness*. Published online 2018. doi:10.23736/S0022-4707.17.07208-5

37. Lee HT, Oh HO, Han HS, Jin KY, Roh HL. Effect of mat pilates exercise on postural alignment and body composition of middle-aged women. *J Phys Ther Sci*. 2016;28(6):1691-1695. doi:10.1589/jpts.28.1691

38. Song JK, Stebbins CL, Kim TK, Kim HB, Kang HJ, Chai JH. Effects of 12 weeks of aerobic exercise on body composition and vascular compliance in obese boys. *Journal of Sports Medicine and Physical Fitness*. 2012;52(5):522-529. doi:10.1080/02640414.2010.525519