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BODY COMPOSITION AND MOVEMENT BEHAVIORS IN SAUDI SCHOOLS: AN ANALYSIS PERSPECTIVE

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ABSTRACT

The proposed study explores the relationships that exist between school type (public and private), physical activity (PA), sedentary behavior (SB), and body mass index (BMI) among Saudi children aged 6 to 9 years. It particularly looks at the relationships between BMI differences and PA and SB patterns in the educational environments. To measure anthropometrics, PA, and SB, a cross-sectional survey was carried out on 1,276 children (745 and 531 pupils in public schools and private schools, respectively). Data analyses were done based on independent t-tests and generalized linear models (GLM). Findings show that children in the private schools were much more overweight (16.6 vs. 16.2 kg/m²) and had a higher prevalence of overweight (2.63 vs. 2.41, d = 0.278) even with higher levels of PA (2.63 vs. 2.72 hours/day), but children in the public-school were older, lighter, and more sedentary, particularly in the use of mobile phones (3.41 vs. 2.72 hours/day). In the entire sample, an increased PA was correlated with decreased BMI ($B = -0.092$, $p < 0.001$), but age and total SB could explain increased BMI. Interestingly, these associations were moderated in terms of screen context: in private schools, total SB was positively associated with BMI ($B = 0.035$, $p = 0.001$), but recreational gaming and educational laptop use were negatively correlated with BMI, which also indicated the sensitive nature of screen type. The authors make the conclusion that the school context of the PA-SB-BMI relationship is dependent. It highlights the necessity of the specific intervention: in the case of public schools, it is necessary to reduce the time spent on recreational screens; in the case of private schools, it is necessary to reorganize the sedentary processes; and it is important to differentiate passive and cognitively active use of screens. The findings add to the existing evidence on the determinants of childhood obesity in Saudi Arabia and provide a practical recommendation on the health policies in schools that should be implemented based on the local socioeconomic and behavioral realities.

KEYWORDS: Sedentary Behavior (SB), Physical Activity (PA), Body Mass Index (BMI), Childhood, School Environment, Health Interventions, Screen Time.

1. INTRODUCTION

The institution of healthy lifestyle patterns in early childhood, and especially in the age range between 6 and 9 years old, is the core of long-term professional and behavioral well-being. School setting is an important source of forming these habits, as it is a primary environment for health promotion and behavioral intervention. That school-based initiative, and particularly the programs where physical activity (PA) is embedded into the daily routine, can lead to decreases in body mass index (BMI) and weight status improvement in children is backed by a growing body of evidence. The use of systematic reviews has also established that well-structured PA programs, such as physical education classes and daily motor skill games, were linked to considerable improvements in BMI, where the effect was relatively higher on the previously sedentary youth (Alhelal et al., 2024).

Furthermore, longitudinal observation shows that maintained elevations in physical activity in school settings may cause a significant decrease in the prevalence of overweight and obesity. As an illustration, another study identified that the odds of being overweight among children in intervention schools were almost three times lower than among respondents in control groups (Sigmund et al., 2012). Also, there has been an association between the school settings that posed better nutritional options in combination with the supportive PA policies with reduced BMI, largely underscoring the importance of whole multi-component responses that target both the nutrition and physical activity spheres (Dighe et al., 2020).

In combination, these results point to the significance of using comprehensive, holistic school-based programs to promote long-term health-promoting behaviors at a young age. These approaches not only have a positive effect on weight but also establish a solid outlook towards lifelong well-being in the repertoire of young students (Pippi et al., 2020).

Parents are the most important actors who influence healthy behaviors, including physical activity (PA) and the prevention of sedentary lifestyles in children. Studies reveal that parental role modeling has a significant impact on the PA levels of children; in one study, it was discovered that an extra 20 minutes of moderate-to-vigorous physical activity (MVPA) of a parent was associated with a 5- to 10-minute increase in the MVPA of their child (Garriguet et al., 2017). Moreover, systematic reviews indicate the use of parental encouragement and support as a means of influencing the engagement of kids in the PA process, leading to the reduction of their screen time (Xu et al., 2015). Moreover, most significantly, children with more parental support in being active are much more likely to have daily PA, i.e., parental support is critical in keeping children active and paying little attention to screen time and actively being involved in physical activity with their children (Zecevic et al., 2010). Altogether, the family setting plays a critical role in the health behaviors of children, and thus parents should lead the active life demonstration and encouragement (Crumbley et al., 2020).

Physical inactivity and sedentary lifestyles are very common among Saudi children and adolescents and may have severe consequences on the physical and psychological well-being of the Saudi children and adolescents. This lack of physical activity is worsened by the amount of time spent on a screen, with 84% of men and 91.2% of women exceeding the two-hour limit, which leads to body fat and the development of obesity (Al-Hazzaa et al., 2011) (Al-Hazzaa, 2018). Two features highlight the gender disparity where women are usually less active and less mobile compared to men due to the hindrance of culture, insufficiency of female-specific physical activity programs, and divergent reasons to participate in physical activities (Al-Hazzaa, 2018; Al-Hazzaa, 2018). The lack of physical activity is associated with poor health, such as obesity, diminished cardiorespiratory fitness, and psychological health (Al-Hazzaa, 2018). Also, poor eating habits, including non-consumption of breakfast and low fruit and vegetable consumption, are common and negatively related to physical exercise (Al-Hazzaa et al., 2011; Al-Hazzaa, 2018).

Several environmental and sociocultural factors have been found to have a tremendous contribution to the physical activity (PA) as well as the sedentary behavior (SB) of young children in Saudi Arabia. The available evidence shows that the prevalence of children aged 6–9 years who spend more than two hours a day in front of the screen and less than one hour on moderate-to-vigorous physical activity (MVPA) is also high (Evenson et al., 2023; Albesher & Basuodan, 2023). In particular, the researchers indicate that 68.3 percent of schoolchildren are spending too much time in front of screens, and 80-90 percent of them fail to meet the recommended thresholds of PA (Evenson et al., 2023; Alhusaini, 2017). The COVID-19 pandemic worsened these challenges: the situation was associated with increased screen time and decreased physical activity (Albesher & Basuodan, 2023). In turn, it emerges that the country requires an active lifestyle policy and measures aiming to decrease sedentary activities among children (Dobia & Bahammam, 2023).

The study analyzes viewpoints analytically on the connection relating movement behavior and body mass in the educational context in Saudi Arabia, particularly in the realm of school students in both state and independent schools in Al-Ahsa Governorate in the province of Eastern Saudi Arabia. Acknowledging that physical activity (PA) and sedentary behavior (SB) are relevant predictors of healthy development through childhood, the current study is expected to discuss the pattern of movement and its impacts on the main parameters of body composition, specifically, body mass index (BMI).

The study will be organized around three primary goals: (1) to examine the relationships between age, physical activity levels and sedentary time, and body composition; (2) to compare these relationships between students in the public and private schools; and (3) to test the specific influence of screen-based sedentary behaviors (including television viewing, laptop use, video game playing, and smartphone use) on the outcomes of body composition. The research aims to shed more light on the interrelation among school environment, daily movement patterns, and physical development through the adoption of a holistic approach to analysis in understanding the factors that influence the health of Saudi children.

2. MATERIALS AND METHODS

2.1. Participants

A multistage cluster sampling method was used to recruit the educational institutions experienced in the Eastern Province. A random sample of twenty schools was selected, comprising ten public schools and ten private schools. Two classrooms of every academic grade of each of the sampled schools were randomly chosen, with the number of students in the classroom being twenty to thirty-five. Participation was democratic, and individual considerations were made to meet some criteria requirements of data integrity and the safety of the individuals concerned. Those students who had medical contraindications, whose attendance during physical education classes was irregular, who did not properly follow the protocol of the intervention, or who lacked adequately completed parental consent forms were not included in the study. After preliminary screening processes, one thousand, two hundred and seventy-six students managed to fulfill all the requirements of the study. Of these, 44 potential participants were subsequently dropped in the final analysis; seven were classified as severely obese, five did not faithfully complete the program, and twenty-two withdrew their consent during study. The students and their guardians were given adequate information concerning the objectives of the study, methodology, and the possible rewards and risks before data collection.

The presented study was performed in compliance with the ethical principles of the Declaration of Helsinki and was authorized by the Institutional Research Ethics Committee. All the participants signed an informed consent and in the case of those who were underage, their legal guardians did the same. The involvement was voluntary, confidentiality and anonymity were kept, and all the participants were informed that they were free to withdraw at any time and could do it with no consequences. Scientific validity and complete ethical compliance were ensured because the study was conducted based on a systematic sampling approach between October and December 2024.

2.2. Instrument

The standardized anthropometric measurements and validated questionnaires were used to systematically measure physical activity prevalence and associated behaviours in students throughout regular physical education classes. There were three parts of a protocol of assessments: (1) demographic data (age, gender, and education level) to be stratified in the future; (2) the Arabic-translation version of the Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski et al., 2004) to be given to students in grades 1–4 and assess their physical activity levels during the last seven days; and (3) New South Wales Schools Physical Activity and Nutrition Survey (Hassan et al., 2025), designed to evaluate both physical

The pre-measurement standards are standard measures that were to be followed rigorously before the anthropometrical measures based on the test where the participant was required to avoid eating food and beverages at least two hours before measurements, nor to undertake any strenuous physical activity in the twenty-four hours before measurements, and to empty bladder during the pre-measurement exercise. Anthropometric measurements were taken under approved physical education teachers, under controlled environmental conditions which include temperature regulation, and confounding possible variables were minimized therefore giving accuracy and reliability of the measurements and their findings. It consisted of a predetermined procedure of data collection that facilitated an easier attainment of suitable and quantifiable measures in all the participants.

2.3. Anthropometric Measurements

The anthropometrics performed were done according to standard procedures to achieve reliability and precision. Height was measured with a calibrated stadiometer, and the subjects were set in the standard anatomical position: feet in contact with each other, arms resting along the body, and the head at the Frankfurt horizontal level. The recording of all the height measurements was done to the nearest 0.1 centimeter as a way of ensuring that measurements were accurate. Body parameters, such as body weight, Body Mass Index (BMI), and Percentage Body Fat (PBF), were measured using the Omron BF 508 Body Composition Monitor (Kyoto, Japan), which is based on the Bioelectrical Impedance Analysis (BIA) technology, to perform a detailed body composition evaluation. In the measurement process, subjects were required to stand on the scale that had built-in electrodes with bare feet as well as hold the handheld sensors so that the electrical circuit was completed appropriately. Such systematic evaluation of anthropometry allowed them to collect reliable and consistent data relating to the further examination of the body composition parameters, and all the measurements were made under the control of environmental impact to reduce the possibilities of varied measurements and increase the validity of the results.

2.4. Physical Activity

A culturally adapted Arabic form of the Physical Activity Questionnaire of children (PAQ-C) was used to determine physical activity in Saudi children, adapted to fit the culture of Saudi children (Alibrahim 2025). Since the participants were little (under 10 years old) and could not reliably report on themselves due to their lack of cognitive maturity, questionnaires were self-administered by parents and teachers. The modified PAQ-C assesses activity in various situations, such as during recess at school, physical education lessons, after school and weekends, with nine items. Questions 1-8 will be graded based on a 5-point Likert scale (1 = not active, 5 = very active), whereas item 9 (calculating changes in activity over time) will not be included in the total mark. The mean scores were classified into five levels of activities that include sedentary (<1.6), minimally (1.6-2.3), moderately (2.3-3.0), active (3.0-3.8) and highly (≥3.8) active. Such thresholds were artificially lower than the adolescent ones to capture the inherently greater level of activity among young children. This proxy-reporting method, as tested by Alibrahim (2025), is a valid way of considering the constraints of development and the methods of giving a reliable measure of physical activity habits in the Saudi school setting.

2.5. Sedentary Behaviour Scale

The sedentary behavior of children aged 6-9 years was measured with the help of a culturally adjusted adaptation of the New South Wales Schools Physical Activity and Nutrition Survey which was adjusted to younger cohorts, as described by Hassan et al. (2025) and Alibrahim (2025). The questionnaires were filled in by both the parents and teachers because of the cognitive inefficiency of this age group, including their inability to self-report the time spent in sedentary activities accurately (Alibrahim, 2025). The tool concentrated on four main areas of screen-based/passive behaviours, including mobile phones/tablets, laptops/computers, television/movies, and digital gaming or music listening.

The questionnaire was designed to be more accurate in reporting by using age-related pictures, using simplified language, and defining the time spent in sedentary activities. A 5-point scale was used: 5 = <30 minutes/day, 4 = 30-60 minutes, 3 = 1-2 hours, 2= 2-4 hours, and 1= >4 hours. As such, the scores of 4 to 5 were low sedentary behavior, whereas that of 1 to 2 was high. It has been shown that this multi-informant, developmentally sensitive method, based on the structured parental and teacher observation, is capable of reliable estimations of the sedentary pattern, taking into consideration the cognitive and perceptual limitations peculiar to the early school-aged children, in the Saudi setting.

2.6. Statistical Analysis

Data was checked for normal distribution through histograms and by computing absolute skewness and kurtosis values. The presence of significant deviations from standard normal behavior was seen when |skewness| increased above 2 and |kurtosis| rose above 7. The means ± standard deviations (SD) were used to summarize who the participants were. Because the data fitted the assumptions of homogeneity and normality, an independent Student's T-test was carried out to assess any difference in age, body composition, PA levels, and SB among students attending public and private schools. We used Cohen's d to compute effects, and values above 0.2, 0.5, and 0.8 were considered small, medium, and large effects, respectively. The presence of multicollinearity was investigated using the variance inflation factor (VIF), where five below indicated no significant problem. Because residual analysis detected heteroscedasticity, extra models with Gamma and Log transformations were used to improve the accuracy of knowing how different factors affected BMI. Two separate approaches were used: the first used only the SB score, while the second included various parts of the SB. Each study removed any potential confounders, so the analysis was accurate and detailed. A significant result was at $p < 0.05$, and all analyses were carried out using version 26 of IBM SPSS Statistics (IBM Corp., Armonk, NY, USA). The use of strict analytical methods made the results both reliable and valid by clearly explaining the factors influencing BMI in the participants.

3. RESULTS

Table 1: Age and Anthropometric Characteristics among the Groups Clustered By Category of School.

Variable	group	N	Mean	SD	Public vs. Private		
					t	p	Cohen's d
Age (years)	Public	745	7.63	0.94	8.44	<0.001	0.472
	Private	531	7.21	0.87			
	Total	1276	7.47	0.92			
Height (cm)	Public	745	122.30	7.80	6.31	<0.001	0.351
	Private	531	125.10	6.90			
	Total	1276	123.50	7.40			
Weight (kg)	Public	745	24.60	4.30	4.17	<0.001	0.234
	Private	531	26.10	4.70			
	Total	1276	25.20	4.50			
BMI (kg/m2)	Public	745	16.20	1.80	3.05	0.002	0.171
	Private	531	16.60	2.00			
	Total	1276	16.40	1.90			
PBF (%)	Public	745	22.10	4.10	3.87	<0.001	0.215
	Private	531	23.30	4.50			
	Total	1276	22.60	4.30			
Fat mass (kg)	Public	745	5.50	1.70	-1.92	0.055	0.107
	Private	531	5.80	1.90			
	Total	1276	5.60	1.80			
Fat-free mass (kg)	Public	745	19.10	3.20	5.63	<0.001	0.314
	Private	531	20.30	3.50			
	Total	1276	19.60	3.40			

Note: SD, Standard Deviation; BMI, Body Mass Index; PBF, Percentage Body Fat.

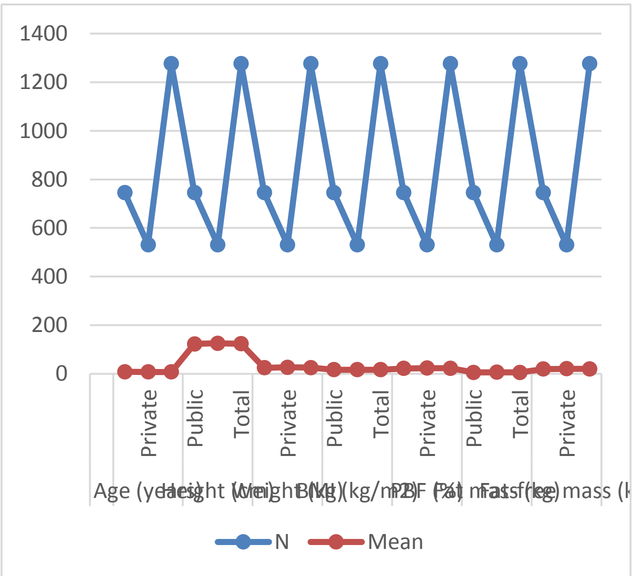

Figure 1: Comparison of Age and Anthropometric Characteristics between Public and Private School Children Aged 6–9 Years.

The results, shown in Table 1, indicate that the anthropometric characteristics of students in public schools and private schools differ significantly in a sample of 1,276 6-9-year-old children. Compared to all the other students, the public-school students were quite a bit older (7.63 ± 0.94 vs. 7.21 ± 0.87 years; $p < 0.001$, Cohen's d = 0.472), which captured the age difference in terms of the developmental level. Surprisingly enough, students in the private school proved to be markedly taller (125.10 ± 6.90 cm vs. 122.30 ± 7.80 cm; $p < 0.001$; Cohen's d = 0.351) and had higher body weights (26.10 ± 4.70 kg vs. 24.60 ± 4.30 kg; $p < 0.001$; Cohen's d = 0.234), as compared to those in the public school. The observed physical specialities introduced a substantial increase in the values of the BMI among students of a private school (16.60 +/- 2.0 kg/m² vs. 16.20 +/- 1.80 kg/m 2; p = 0.002, Cohen d = 0.171), which suggests the higher tendency to overweight within this segment. Subsequent body composition analysis indicated that compared to the national schools, the private school students had a more substantial percentage of body fat (23.3% (4.5%) vs. 22.1% (4.1%); $p < 0.001$, Cohen's d = 0.215) and fat-free mass (20.3 (3.5) kg vs. 19.1 (3.2) kg; $p < 0.001$, Cohen's d = 0.314). Even though the students attending the private schools had higher fat masses (5.80 ± 1.90 kg vs. 5.50 ± 1.70 kg), there was no statistically significant difference between the fat mass in the two groups (p = 0.055, Cohen's d = 0.107) (see figure 2).

Table 2: Participants Were Compared Based On Their Level Of Exercise And Amount Of Inactivity In All Types Of Schools.

Variable	group	N	Mean	SD	Public & Private		
					t	p	Cohen's d
Physical activity level	Public	745	2.41	0.68	4.89	<0.001	0.278
	Private	531	2.63	0.61			
	Total	1276	2.50	0.65			
Sedentary behaviors	Public	745	2.96	0.79	2.34	0.019	0.123
	Private	531	2.84	0.87			
	Total	1276	2.91	0.82			
TV	Public	745	2.72	1.38	3.21	0.001	0.174
	Private	531	2.94	1.30			
	Total	1276	2.81	1.35			
Laptop	Public	745	2.48	1.42	2.73	0.006	0.148
	Private	531	2.65	1.37			
	Total	1276	2.55	1.40			
Video games	Public	745	3.02	1.44	2.65	0.008	0.144
	Private	531	2.68	1.32			
	Total	1276	2.88	1.40			
Mobile	Public	745	3.41	1.38	7.12	<0.001	0.422
	Private	531	2.72	1.33			
	Total	1276	3.14	1.37			

Note: SD, Standard Deviation; BMI, Body Mass Index; PBF, Percentage Body Fat.

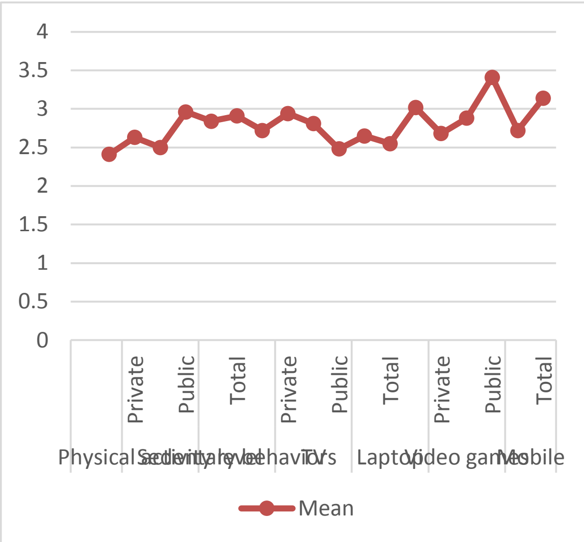

Figure 2: Comparison Of Physical Activity Levels And Screen-Based Sedentary Behaviors Between Public And Private School Children Aged 6–9 Years.

Table 2 shows that there are considerable differences in physical activity and sedentary behaviors of students of a public and private school. Physical activity values were much greater among the students at the private schools (2.63 ± 0.61 vs. 2.41 ± 0.68; p < 0.001, d = 0.278) and lower overall sedentary behavior scores (2.84 ± 0.87 vs. 2.96 ± 0.79; p = 0.019, d = 0.123). At that, it was found that mobile phone usage was significantly more prevalent among the public school students (3.41 ± 1.38 vs. 2.72 ± 1.33; p < 0.001, d = 0.422) and video gaming (3.02 ± 1.44 vs. 2.68 ± 1.32; p = 0.008, d = 0.144), while private school students engaged more in TV viewing (2.94 ± 1.30 vs. 2.72 ± 1.38; p = 0.001, d = 0.174) and laptop use (2.65 ± 1.37 vs. 2.48 ± 1.42; p = 0.006, d = 0.148).

Factors that impact participants' BMI, based on the type of school they attended.

Public school

Table 3: Estimates Of Important Variables Affecting Public Schools' BMI.

Model 1				
Metric	**Value**	**df**	**Value/df**	**Sig.**
Goodness of Fit				
Deviance	41.87	742	0.056	-
Scaled Deviance	984.32		-	-
Pearson Chi-Square	43.65		0.059	-
Scaled Pearson Chi-Square	1010.54		-	-
Log Likelihood	-2460.18	-	-	-
AIC	5280.36	-	-	-
BIC	5304.10	-	-	-
Omnibus Test				
Likelihood Ratio Chi-Square	170.32	3	-	<0.001
Parameter Estimates				
(Intercept)	2.72	0.066	[2.591, 2.849]	<0.001

Age (years)	0.026	0.0040	[0.018, 0.034]	<0.001
PA levels	-0.092	0.0083	[-0.108, -0.076]	<0.001
SB score	0.041	0.0074	[0.027, 0.055]	<0.001
(Scale)	0.043[a]	0.0019	[0.039, 0.047]	-
Model 2				
Metric	**Value**	**df**	**Value/df**	**Sig.**
Goodness of Fit				
Deviance	39.54	721	0.055	–
Scaled Deviance	980.12	–	–	–
Pearson Chi-Square	41.98	721	0.058	–
Scaled Pearson Chi-Square	1005.33	–	–	–
Log Likelihood	-2444.06	–	–	–
AIC	5267.12	–	–	–
BIC	5387.45	–	–	–
Omnibus Test				
Likelihood Ratio Chi-Square	202.15	22	-	<0.001
Parameter Estimates	**B**	**Std. Error**	**95% Wald CI**	**Sig.**
(Intercept)	3.28	0.030	[3.221, 3.339]	<0.001
Age (years)	0.027	0.0046	[0.018, 0.036]	<0.001
PA levels	-0.088	0.0086	[-0.105, -0.071]	<0.001
[TV <30 min/day]	-0.058	0.023	[-0.103, -0.013]	0.014
[TV >4 h/day]	0[a]			
[Lap 1–2 h/day]	-0.055	0.022	[-0.098, -0.012]	0.013
[Lap >4 h/day]	0[a]			
[V G = Not at all]	-0.120	0.026	[-0.171, -0.069]	<0.001
[V G <30 min/day]	-0.128	0.023	[-0.173, -0.083]	<0.001
[V G 30 min–1 h/day]	-0.122	0.021	[-0.163, -0.081]	<0.001
[V G 1–2 h/day]	-0.073	0.019	[-0.110, -0.036]	0.001
[V G 2–4 h/day]	-0.068	0.019	[-0.105, -0.031]	0.001
[V G >4 h/day]	0[a]			
(Scale)	0.041[b]	0.0018	[0.038, 0.044]	–

Note: CI, Confidence Interval, PA, Physical Activity, SB, Sedentary Behavior. A, Zero Because This Variable Is Redundant, B, Maximum Likelihood Estimate.

Table 3 shows two regression models for determining the determinants of BM in students in the public-school setting. In model 1, the results detailed notable correlations wherein older age (β=0.026, p<0.001) and sedentary activity (β=0.041, p<0.001) had a positive correlation with the BMI, and higher physical activity rates had a negative correlation (β=-0.092, p<0.001) with the BMI. Model 2 portrays more power of explanation (χ^2=202.15, df=22, p<0.001), and this shows specific relations between sedentary behaviors and BMI in a more refined manner. Interestingly, every type of video gaming (ranging between no gaming and 2-4 hours/day) also displayed strong negative correlations with BMI in comparison to extreme gaming (>4 hours), with moderate gaming time perhaps having a lower impact than extreme usage. In the same way, both limits on TV and moderate laptop time patterns had a more negative effect on BMI than excessive patterns. These two models further agree that physical activity has been a protective factor against elevated BMI (Model 1: β=-0.092; Model 2: β=-0.088, both p<0.001), and this shows how important it will be to manage their weight through physical activity among school-aged children. Such results highlight the relevance of interventions that focus on increasing physical exercise and selectively controlling sedentary lifestyles to overcome childhood obesity on educational grounds.

Private school

Table 4. Parameter Estimates For Predictors Of Private Schools' BMI.

Model 1				
Metric	**Value**	**df**	**Value/df**	**Sig.**
Goodness of Fit				
Deviance	28.450	531	0.054	-
Scaled Deviance	612.345		-	-
Pearson Chi-Square	30.123		0.057	-
Scaled Pearson Chi-Square	620.456		-	-

Log Likelihood	-1612.450	-	-	-
AIC	3244.900	-	-	-
BIC	3265.780	-	-	-
Omnibus Test				
Likelihood Ratio Chi-Square	13.450	3	-	0.004
Parameter Estimates	**B**	**Std. Error**	**95% Wald CI**	**Sig.**
(Intercept)	2.890	0.045	[2.802, 2.978]	<0.001
Age (years)	-0.003	0.0090	[-0.021, 0.015]	0.740
PA levels	-0.002	0.012	[-0.026, 0.022]	0.870
SB score	0.035	0.010	[0.015, 0.055]	0.001
(Scale)	0.048a	0.003	[0.043, 0.054]	-
Model 2				
Metric	**Value**	**df**	**Value/df**	**Sig.**
Goodness of Fit				
Deviance	26.230	520	0.050	-
Scaled Deviance	608.789		-	-
Pearson Chi-Square	27.890		0.054	-
Scaled Pearson Chi-Square	615.345		-	-
Log Likelihood	-1585.670	-	-	-
AIC	3211.340	-	-	-
BIC	3290.450	-	-	-
Omnibus Test				
Likelihood Ratio Chi-Square	75.670	18	-	<0.001
Parameter Estimates	**B**	**Std. Error**	**95% Wald CI**	**Sig.**
(Intercept)	3.100	0.044	[3.014, 3.186]	<0.001
Age (years)	-0.001	0.0088	[-0.018, 0.016]	0.890
PA levels	0.005	0.012	[-0.019, 0.029]	0.680
[Laptop use = <30 min/day]	-0.140	0.031	[-0.201, -0.079]	<0.001
[Laptop use = 30 min–1 h/day]	-0.100	0.032	[-0.163, -0.037]	0.002
[Laptop use = 1–2 h/day]	-0.145	0.033	[-0.210, -0.080]	<0.001
[Laptop use = >4 h/day]	0a			
[Video games = Not at all]	-0.130	0.032	[-0.193, -0.067]	<0.001
[Video games = <30 min/day]	-0.125	0.032	[-0.188, -0.062]	<0.001
[Video games = 30 min–1 h/day]	-0.160	0.032	[-0.223, -0.097]	<0.001
[Video games = 1–2 h/day]	-0.080	0.032	[-0.143, -0.017]	0.013
[V G 2–4 h/day]	-0.071	0.020	[-0.107, -0.033]	0.001
[Video games = >4 h/day]	0a			
(Scale)	0.045b	0.003	[0.040, 0.050]	-

Note: CI, Confidence Interval; PA, Physical Activity; SB, Sedentary Behavior. A, Set To Zero Because This Parameter Is Redundant, B, Maximum Likelihood Estimate.

Table 4 indicates that there are different trends in BMI predictors between students in private schools and students in public schools. Results in Model 1 showed no significant associations between age and physical activity levels and BMI ($p>0.05$), whereas sedentary behavior (SB score) was the only significant predictor of BMI ($\beta=0.035$, $p=0.001$). The results of the literature on the role of physical activity level, in contrast to the findings of pulsed activity in the public schools, do not match. Model 2, which had the better fit (AIC=3211.340) and a larger explanatory power ($\chi^2=75.670$, df=18, $p<0.001$), presented subtle correlations between and among sedentary activities and BMI. Interestingly, the moderate use of laptops (1-2 hours/day: $\beta=-0.145$, $p<0.001$) and moderate video gaming (30 min-1 hour/day: $\beta=-0.160$, $p<0.001$) were significantly related to lower BMI in comparison to excessive use (4 hours/day). All types of limited screen time (laptop use <2 hours/day and video gaming <2 hours/day) were associated with significant negative relationships with BMI, indicating that moderate technology use might not have as adverse an effect as extreme usage behaviors. No observed effect of significant physical activity in two models suggests that the quality of a sedentary lifestyle and the extent of time spent sitting may be the main contributors to the variation of BMI among the students of private schools; in this context, it is necessary to consider the implementation of the targeted interventions that can focus on the particular sedentary behavior or patterns as opposed to the promotion of physical activity among the students of such schools.

4. DISCUSSION

This cross-sectional study demonstrated the relationships between physical activity (PA) and sedentary behavior (SB) and body mass index (BMI) in students of public and private schools in Al-Ahsa, Saudi Arabia. The study sought to: (1) determine associations between age, PA, SB, and BMI; (2) differentiate between these associations in students of public and privatized schools; (3) and determine the effect of individual screen-based SBs (TV, laptop, video gaming, smartphone) on BMI. Findings indicated positive relationships between older age and higher SB scores and greater BMI in the group of public school students ($p < 0.001$). In both types of schools, a greater PA was always related to a smaller BMI (0.092, $p < 0.001$) that indicates a protective effect. Students with 30 minutes of TV per day were much lower in BMI compared to those with >4 hours ($p < 0.001$); the same effect was found with laptop and video gaming, but not with smartphones.

The comparison demonstrated that significant variations in school types exist: with the students of the private schools, there were no significant relationships between age and physical activity (PA) and BMI, and with the students of the sedentary behavior (SB) all times BMI is predicted (İrez et al., 2018). As it was observed in the public schools, frequent use of laptops and video games was strongly associated with high BMI in even grade-school children in a private kindergarten setting (Alibrahim, 2022). These differences indicate that the outcomes of BMI in the private environment could be mediated by socioeconomic status, dietary habits, and school environment, including physical education and nutritional assistance (Desai et al., 2024; İrez et al., 2018). Although they had more resources, the overweight/obesity rates were higher in the private school, which could be explained by structural variations in the health-promoting policies (Caputo & da Silva, 2009; İrez et al., 2018). The persistent correlation of screen-based SB with BMI between the two types of schools is indicative of a greater tendency toward inactivity among school-aged kids (da Silva et al., 2010), which suggests the significance of structured PA, as demonstrated by Desai et al. (2024) to be effective in managing weight, in any school setting.

The results highlight the importance of school-specific health policies that will encourage healthier diets and give more opportunities to exercise. These findings are consistent with the existing literature that has proven that there are strong associations between excessive screen time and an increased BMI among children and adolescents (Arias-Silva et al., 2024; Alibrahim, 2022; Bickham et al., 2013; Mitchell et al., 2013; da Silva et al., 2010). Alibrahim (2022) identified a positive correlation between intensive use of laptops and video games with higher BMI, especially in older boys, whereas da Silva et al. (2010) also found that children who had more than 120 minutes of daily screen time had 2.6 times higher chances of being overweight. In one of the studies by Bickham et al. (2013), distracted viewing television as a cause of inappropriate eating and weight gain was defined. Likewise, Mitchell et al. (2013) noted that increased screen time was associated with an increase in BMI pathways particularly in more weight adolescents. Together, these research findings can be used to emphasise the need to provide evidence-based interventions to decrease the proportion of sedentary screen time and counteract the related health risks among school-aged groups (Mitchell et al., 2013).

These relationships are also influenced by specific local and environmental context and the social and cultural complexities within Al-Ahsa, Saudi Arabia. The rapid urbanization and changes in social structures have shifted towards an increased consumption of energy dense foods, a more sedentary lifestyle, and greater reliance on powered transport, digital technologies, and motorization for everyday activities (Hamadeh, 2017). Scant climatic conditions with very hot summers and very cold winters tend to discourage outdoor physical activities (Chaabane et al., 2021). This is also compounded by the limited availability of sport and recreation facilities (Al-Nuaim et al., 2012). In addition to these environmental conditions, certain cultural contexts also emphasize academic and religious activities while neglecting the physical, thus, further exacerbating low participation, especially in females, which is also marked by a more pronounced decline with age. These culural and social barriers are exacerbated by broader patterns in the MENA region, which include poor facilities and infrastructure, limited social structures to support the activity, and extreme weather, which together restrict activity levels (Chaabane et al., 2021).This context highlights the need for action in a more comprehensive way in the design of school and community interventions aimed at increasing physical activity levels and reducing the risk of obesity.

The physical activity (PA), sedentary behavior (SB), and BMI connections among Saudi schoolchildren are influenced not just by the socioeconomic status (SES) but also by the school type and digital environment—unlike across the globe. However, contrary to global patterns, where higher SES is associated with lower BMI (Abreu et al., 2014), Saudi children in the private schools have higher BMI (16.6 vs. 16.2 kg/m²) and a greater proportion of overweight children compared to their counterparts at the public schools (Alibrahim, 2025). This contradiction is in line with previous research conducted in Saudi Arabia that revealed that adolescents in the context of private schools, especially males, are at increased risk of obesity despite having the opportunity to engage in PA (Al-Hazzaa et al., 2011; Al-Hazzaa, 2018a). Notably, the inverse relationship between PA and BMI (B = -0.092, $p < 0.001$) is present in the entire sample, but the effect of SB varies depending on the setting: in private schools, total SB positively correlates with BMI (B = 0.035, p = 0.001), but the opposite is true in recreational gaming (SB) and educational use of laptops (SB) (Alibrahim, 2022).

The findings are the continuation of the previous Saudi studies that show the context-related peculiarities of the movement behaviors. Although previous research has focused on homogenous patterns of screen time (>2 hours/day in 84.91% of adolescents) and low PA—particularly in girls (Al-Hazzaa et al., 2011; Al-Nuaim et al., 2012), this study reveals a heterogenous pattern of SB: children attending public schools are more inactive because of heavy mobile phone use (3.41 vs. 2.72 hrs/day), whereas in private schools, children have more diversified patterns of screen time, some of This puts into question beliefs that SES systemically bestows health benefits in Saudi Arabia and indicates that affluence can bring in obesogenic factors such as car addiction and high-calorie diets that negate PA benefits (Al-Hazzaa, 2018b). As a result, the school-based interventions would have to be customized: they should reduce the recreational use of mobile devices in public schools and encourage the development of balanced and high-quality movement and screen behaviors in private environments, going beyond the promotion of activities to the context-specific strategy based on local evidence (Alhelal et al., 2024; Evenson et al., 2023).

4.1. Limitations

This research paper provides multiple methodological limitations that should be considered during the interpretation of the results. First, causal conclusions about relationships between physical activity (PA), sedentary behavior (SB), and body mass index (BMI) cannot be made, as the cross-sectional design provides no mechanisms to draw such results. Though there was a notable relationship established, the timeline of these links remains unclear the directionality of the relationships between changes in PA and SB, on the one hand, and BMI, on the other. Directional relationships and trends could be more firmly established with cross-sectional studies of this sort, monitoring these variables over time. Second, the usage of self-reported instruments on physical activity and sedentary behaviour may create a bias caused by measurement. Social desirability bias might cause people to over-report on physical activity or under-report sedentary time and recall bias might have interfered with time estimates. Future studies to improve the validity and reliability of data would need objective forms of measurement, i.e., the use of accelerometery to measure physical activity and ecological momentary assessment to measure screen time. Third, the analysis failed to consider several possible confounding factors, which have the potential to exert a significant influence on the outcome of BMI. Important confounding factors such as food habits, economic status, family hereditary factors, and aspects within the neighbourhood environment were not measured systematically or controlled. One could speculate that such variables moderate or mediate the relationship between PA, SB, and BMI, so attaining greater validity of results by incorporating them into analytical models in the future would help.

4.2. Future Research Directions

Future study of the connection between physical activity (PA), sedentary behavior (SB), and body mass index (BMI) should pursue longitudinal designs and, therefore, temporal relationships and causal routes. Self-reports should instead be replaced with measurement tools such as accelerometery and digital monitoring, as objective assessments are considered more accurate and less biased. Analytical models need to integrate major confounders, such as diet, socioeconomic status, genetic factors, and family environment, to better comprehend their relative efficacy. Research needs to be extended to a wide geography and cultural and educational settings to enhance generalizability and guide culturally sensitive interventions. Research should additionally investigate mediating and moderating roles of environmental contexts, i.e., school programs, the resources available in the community, and parental involvement, and equip physical activity with psychological aspects, i.e., emotional intelligence, vitality, and resiliency, to promote comprehensive perspectives on young people's well-being.

5. CONCLUSIONS

The study investigated the links between age, physical activity (PA), sedentary behavior (SB), and the body mass index (BMI) of children aged between 6 and 9 years old in state-of-the-art and private schools. The results were found to be highly distinctive concerning the type of school, and this shows that context-specific intervention is required in early childhood. In the public schools, older children used to have a higher level of BMI, and the hours of sitting down at a specific time, especially watching TV, using a laptop, or playing video games, were a key factor related to having an elevated BMI. Although physical activity had a protective connotation, it played a relatively higher role in formal environments, indicating the necessity of how children should be given a chance to perform regular, physically active play and movement sessions during a school day to reverse the tendency toward sedentariness.

Conversely, a strong relationship was not established between age, physical activity, and BMI in the population of students with access to services in private schools. Nevertheless, even with the admission of higher scores in the sedentary behavior, there remained a strong positive correlation with higher body mass index, with overused laptops and video games having also become a dominant factor. This implies that it is possible that the quantity and nature of screen-based inactivity relative to the level of physical activity in the environment of the private schools could play a very significant role in the determination of body composition. These findings show that childhood obesity can only be tackled effectively by using strategies that extend beyond mere attempts to improve physical activity among children. They ought also to aim at decreasing recreational screen time and consider larger environmental and social economy-related components, which include diet.

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