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Association between sedentary behavior, diet and nutritional status in adolescents: baseline results from the LONCAAFS Study

Associação entre comportamento sedentário, dieta e estado nutricional em adolescentes: resultados do estudo LONCAAFS

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Abstract *The aim of the present study was to analyze the relationship between time spent engaged in sedentary behaviors, type of diet, and overweight in adolescents. A cross-sectional study using data from the Longitudinal Study on Sedentary Behavior, Physical Activity, Eating Habits, and Health of Adolescents – LONCAAFS Study. A total of 1,438 adolescents (10 to 14 years old) from public schools in the city of João Pessoa, Brazil, participated in the study. To evaluate the combined effects of excessive time in sedentary behavior and consumption from two food groups: Convenience and Prudent on overweight, we performed multiple logistic regression analyses, adjusted for energy, level of physical activity, sex, and age. Excessive time in sedentary behavior increased the chance of adolescents being overweight by 37% (OR = 1.37; 95%CI: 1.04-1.80). This chance increased to 43% when the adolescents were simultaneously engaged in excessive sedentary behavior and had high consumption of the Convenience food group (OR = 1.43; 95%CI: 1.05-1.94) and increased to 39% on those who engaged in excessive sedentary behavior and had low consumption of foods from the Prudent (OR = 1.39; 95%CI: 1.04-1.84). Excessive sedentary behavior is associated with being overweight and the chance increases with the consumption of convenient foods.*

Key words *Overweight, Sedentary lifestyle, Diet, Adolescents*

Resumo *O objetivo do estudo foi analisar a relação entre tempo gasto em comportamentos sedentários, dieta e excesso de peso em adolescentes. Estudo transversal com dados do Estudo Longitudinal sobre Comportamento Sedentário, Atividade Física, Hábitos Alimentares e Saúde do Adolescente – Estudo LONCAAFS. Participaram 1.438 adolescentes (10 a 14 anos) de escolas públicas de João Pessoa, Brasil. Para avaliar os efeitos combinados do tempo excessivo no comportamento sedentário e no consumo de dois grupos de alimentos: Conveniência e Prudente sobre o excesso de peso, foram realizadas análises de regressão logística múltipla, ajustadas para energia, nível de atividade física, sexo e idade. O tempo excessivo em comportamento sedentário aumentou em 37% a chance de os adolescentes apresentarem excesso de peso (OR = 1,37; IC95%: 1,04-1,80). Essa chance aumentou para 43% quando os adolescentes apresentaram, simultaneamente, comportamento sedentário excessivo e alto consumo do grupo de alimentos de conveniência (OR = 1,43; IC95%: 1,05-1,94), e aumentou para 39% naqueles com excesso de comportamento sedentário e baixo consumo de alimentos do Prudente (OR = 1,39; IC95%: 1,04-1,84). O comportamento sedentário excessivo está associado ao excesso de peso e a chance aumenta com o consumo de alimentos convenientes.*

Palavras-chave *Excesso de peso, Comportamento sedentário, Dieta, Adolescentes*

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Introduction

The increase in the prevalence of overweight in children and adolescents is a global concern due to the associated health problems that manifest at this stage of life and into adulthood[1]. It is one of the main risk factors for chronic non-communicable diseases (NCDs)[2] and is very costly with respect to health spending[3].

Overweight has multiple causes, and it is known that that they are closely correlated to increased consumption of high-energy foods rich in sugars and fats[4], low rates of physical activity[5], and excessive engagement in sedentary behaviors[5-7]. Sedentary behaviors are activities with low energy expenditure (< 1.5 metabolic equivalents [METs]), performed while awake in a sitting or reclining position[8]. These include watching television, using a computer, sitting during a transit commute, playing video games, using mobile devices and tablets, and others[9,10].

Screen time, defined as the sum of the time spent watching television, using the computer, or playing video games, is the most frequently used method to determine a measure of sedentary behavior in studies with children and adolescents. Results from *The Health Behaviour in School-aged Children* (HBSC)[11], a research collaboration with the World Health Organization (WHO) Regional Office in Europe performed in 48 countries and regions in Europe and North America, in 2013/2014, reported that about 60% of adolescents, between 11 and 15 years old, spent two hours or more per day watching television[11]. In Brazil, according to the National Survey of Health in Schools (PeNSE) performed in 2019, approximately 40% of adolescents spend more than 2 hours a day watching television[12]. The Study of Cardiovascular Risks in Adolescents (ERICA) also showed that 70% of adolescents spend two or more hours per day in front of a television, computer, or video games[13].

Studies of adolescents have identified a direct association between screen time or its components (e.g, television and computer time) and an increase in the consumption of unhealthy foods[14,15]. An inverse association has similarly been identified with the consumption of healthy foods such as fruit and vegetables[15,16]. In Brazil, the ERICA study showed that 40% of adolescents reported consuming snacks in front of screens[17]. However, these results are still controversial; to specific questions about having meals and snacks in front of the television, which is a method that and uses time spent watching television as the only factor to estimate time in sedentary behaviors, when in actuality time spent in front of other types of screens is particularly relevant[17]. In addition, these studies were conducted primarily with adolescents from developed countries[17].

It is assumed that adolescents who spend more time on screen activities have a poorer quality diet, with higher consumption of snacks with high energy density and low nutritional value, and that the consumption of these foods and screen time act synergistically and are directly associated with overweight. Thus, this study analyzed the relationship between time spent engaging in sedentary behaviors, type of diet, and overweight in adolescents.

Materials and methods

This study uses data collected in the base year (2014) of the Longitudinal Study on Sedentary Behavior, Physical Activity, Diet and Health of Adolescents (LONCAAFS Study). LONCAAFS is a longitudinal study (2014-2017), carried out with a representative sample of 6th grade adolescents, in the base year (2014), from public schools (municipal and state) of elementary education II in the city of João Pessoa, Paraíba, with the aim of analyzing the interrelationships between sedentary behavior, physical activity, nutrition and health in adolescents.

For the calculation of sample size, the following parameters were considered: a reference population size of 9,520 schoolchildren in their sixth year of primary school II in 2013, an outcome rate of 50%, a degree of error of four percentage points, a confidence interval of 95%, and a design effect (*deff*) equal to 2. Based on these parameters, the minimum sample size established was 1,130 adolescents. This was, however, increased by 40% to compensate for losses and refusals, resulting in a sample of 1,582 adolescents. Subsequently, the sample power was calculated for the present study, which was 99%.

Twenty-eight schools (15 municipal and 13 state schools) were systematically selected to constitute the sample. They were distributed proportionally to the geographical region (North, South, East, and West) and to number of students enrolled in their sixth year. In the selected schools, all students in their sixth year of primary school II education were invited to participate in the study.

Adolescents who were part of the 1st moment of LONCAAFS and who had performed analysis of food consumption, anthropometry and

answered a questionnaire on sedentary behavior were included for analysis. The exclusion criteria adopted were: adolescents outside the age range of interest in the study (under 10 and over 14 years old in 2014); having a disability that prevented or limited the practice of physical activity or answering the questionnaire; be pregnant; not having performed anthropometric measurements (height, body mass); not having performed the 24-hour recall.

Data collection

The LONCAAFS Study began in February 2014, with three more consecutive years (2015 to 2017) with collections carried out annually, in the same schools and in the same evaluation periods of the initial year. The present study used data collected in 2014. Data collection was conducted in the school during regular classes' hours, between February and December 2014 by a trained team consisting of undergraduate and graduate students and professionals in the areas of nutrition and physical education. For data collection of demographic variables, sedentary behavior, and physical activity, a questionnaire was administered in a face-to-face interview that lasted, on average, for 50 minutes. The questionnaire was previously tested, in a pilot study[18-20], with students in the same school grade, from schools that were not selected for the study.

The data were tabulated with EpiData 3.1 (Epidata Assoc., Odense, Denmark), following a double data entry process with automatic checks of the consistency and amplitude of the responses for the variables. The "validate double data entry" tool was used to identify typographical errors, which were subsequently corrected.

Dietary assessment

Information on adolescents' dietary intake was collected based on their memory of the preceding 24 hours. Adolescents reported the food and beverages they consumed during the last 24 hours, the way it was prepared, the commercial brand of any processed foods, and the weight and size of portions. A second R24h was applied to 30% of the total sample to decrease the intrapersonal variability of the diet and increase the accuracy of the estimated dietary intake. The collected data were converted in to energy and nutrients using a Brazilian software, Virtual Nutri Plus version 2015 (January 2015). Usual energy, macro and micronutrient consumption was estimated using Multiple Source Method (MSM)[21]. This method is suitable to estimate individual usual intake in the case of repeated measurements and a defined time period. The Multiple Source Method (MSM) is characterized by a two-part shrinkage technique applied to residuals of two regression models, one for the positive daily intake data and one for the event of consumption[21].

Two food groups were formed, which were not inclusive of all foods: Group 1 – Prudent foods, were characterized by foods low in sugars, fats, and sodium and with high nutritional value, such as fruits and natural juices, beans and vegetables, dairy products, root vegetables, and tubers; Group 2 – Convenience foods, were characterized by high-energy foods rich in sugars, fats, and sodium, and with low nutritional value. Examples are sweets, desserts, ice cream, cookies, cakes, pies, biscuits, sugary drinks, snacks in general, sausages, pastries, and instant noodles. Based on reported consumption of foods from these groups, an individual's energy consumption with respect to each group was considered. In order to identify adolescents with higher or lower consumption of foods from the two groups, the median value of energy from each food group (Prudent and Convenience) was used.

Sedentary behavior

Sedentary behavior ("screen time") was determined through measuring the average time spent in activities such as watching television, using the computer/tablet, and playing video games. Separate measures were considered for weekdays and weekends. For analytical purposes, the arithmetic mean was calculated by multiplying the mean time for weekdays by five and by multiplying the mean for weekends by two, and then dividing by seven to obtain the mean time per day (hours/day) of sedentary behavior. The cutoff time of more than two hours per day was used to define "excessive time in sedentary behavior", based on screen time[22,23].

Outcome assessment

For weight measurement, a digital Techline brand scale, with an accuracy of 100 g, was used. To measure height, a portable Sanny brand stadiometer was used. Measures of each adolescent's weight and height were taken in triplicate, always by the same evaluator, and the average was used for posterior calculations. Body Mass Index (BMI) was calculated in accordance with the rec-

ommendations of the WHO, with sex and age taken into account[24,25]. The adolescents were then categorized as either overweight or not overweight.

Covariate assessment

The sociodemographic variables were: sex (male or female), age in complete years (the difference between the date of data collection and date of birth), skin color (brown, black, white, Asian, or indigenous – according to the Brazilian Institute of Geography and Statistics – IBGE)[26], the mother's level of education (illiterate or studied up to the 3rd grade, up to the 4th grade, incomplete primary education, completed primary education, incomplete secondary education, completed secondary education, incomplete higher education, or completed higher education) and economic class (using the methodology of the Brazilian Association of Research Companies – ABEP[27], which considers the presence of material goods and the presence of a salaried domestic employee in the residence, as well as the level of education of the parents, and groups people in the following classes: "A/B", "C/D/E"). The groups "A/B" represent people higher economic status, and "C/D/E" correspond to lower economic status.

Level of physical activity was measured using a previously validated questionnaire, the Physical Activity Questionnaire for Adolescents[28]. From a list of 19 physical activities ranging from moderate to vigorous, plus active commuting, the adolescents reported if they had performed or not such activities, for at least ten minutes each in the week prior to data collection. Those adolescents who did perform the activities then also reported the frequency and duration of performance of each activity. For purposes of analysis, a physical activity score, in minutes per week, was created from the sum of the performance time of all activities during the week. Adolescents were classified as physically active when they performed 420 minutes of physical activity or more per week[29].

Statistical analysis

Descriptive analysis, tests were performed to ascertain mean, median, and frequency measurements. The Chi-square test was used to compare the proportion of adolescents with excessive time in sedentary behavior and the median consumption of food from the Prudent and Convenience food group, with sex, age, skin color, economic class, parental education, overweight and level of physical activity.

The association between intake from the Prudent and Convenience food groups, excessive time in sedentary behavior, and overweight was evaluated using logistic regression. Overweight was considered the outcome, and the combined effect of excessive time in sedentary behavior and food consumed was considered to be the independent variable. Thus, to obtain the combined effect, two variables were created. The variable that expressed the interplay of engagement in excessive time in sedentary behavior and prudent food consumption pattern had three categories. The first category (for reference) was defined as without engagement in sedentary behavior based on screen time (≤ 2 hours/day). The second category was defined as engagement in excessive time in sedentary behavior (> 2 hours/day) along with below the median consumption of foods from the Prudent group (lower consumption of foods considered to be indicators of a healthy diet). The third category was defined engaged in excessive time in sedentary behavior (> 2 hours/day) as well as above the median consumption of foods from the Prudent group (higher consumption of prudent foods considered to be indicators of a healthy diet). The second variable, that expressed the interplay of engagement in excessive time in sedentary behavior and Convenience food consumption pattern, was created in the same way, using the medians of the Convenience group (being above the median consumption of foods considered an indicator of unhealthy diet).

Variables that are well-established as associated with the outcome in the literature were considered as potential confounding factors: sex, age, economic class, skin color, level of physical activity, and total energy consumed. In the adjusted model, the variables were selected using the stepwise method. The final model was adjusted for total energy, level of physical activity, sex, and age. The goodness of fit of the model was assessed using the Hosmer-Lemeshow test ($p = 0.48$). A significance level of 5% was used for all tests. All analyses were performed using Stata 14.0 (StataCorp LP, College Station, USA) through the *survey* module, which considers the effects of complex sampling.

Ethical aspects

The project was approved by the Human Research Ethics Committee of the Health Sciences Center of the Federal University of Paraíba (Protocol No. 0240/13). Each interview was conducted only after clarification of the research

objectives and consent of the participant as well as signing of the Informed Consent Form by parents or guardians.

Results

A total of 2,767 adolescents were invited, of whom 372 (13%) refused to participate and 830 (30%) did not return the Informed Consent Form. A total of 1,565 adolescents consented to participate in the study; however, 127 (8%) were excluded according to previously set criteria. The final sample size was 1,438 adolescents, 53% female and 56% were between the ages of 10 and 11 years. The majority was non-white (81.1%), almost two-thirds (63.0%) belonged to economic classes C/D/E and 53.4% were physically active. Approximately, 76.4% of adolescents was excessive time in sedentary behavior and 52.2% was consumption above the median Convenience group, being that 34.0% and 28.8% of these adolescents were overweight, respectively (Table 1).

The characteristics of the sample with regard to excessive time in sedentary behavior and consumption of foods belonging to the Prudent and Convenience groups are presented in Table 2. Higher mean values for time involved in s excessive time in sedentary behavior were observed in male adolescents ($p < 0.01$), belong-

Table 1. Nutritional status according to the characteristics of the adolescents. LONCAAFS Study, João Pessoa, 2014.

Variables	n (%)	Overweight n (%)		p*
		Not overweight	Overweight	
n (%)		969 (67.4)	469 (32.6)	-
Sex				0.636
Male	677 (47.1)	452 (66.8)	225 (33.2)	
Female	761 (52.9)	517 (67.9)	244 (32.1)	
Age group (years)				
10-11	800 (55.6)	523 (65.4)	277 (34.6)	0,069
12-14	638 (44.4)	446 (69.9)	192 (30.1)	
Skin color				
Whites	271 (18.9)	184 (67.9)	87 (32.1)	0,900
Non-Whites	1160 (81.1)	783 (67.5)	377 (32.5)	
Education of mother				0,243
Elementary education	483 (40.6)	337 (68.8)	146 (31.2)	
High school education	339 (28.5)	223 (64.1)	116 (35.9)	
Higher education	368 (30.9)	235 (67.4)	133 (32.6)	
Economic class				
Class A/B	467 (37.0)	298 (63.8)	169 (36.2)	0,096
Class C/D/E	797 (63.0)	545 (68.4)	252 (31.6)	
Prudent group				0,063
Below the median	686 (46.8)	532 (69.5)	233 (30.5)	
Above the median	783 (53.2)	437 (64.9)	236 (35.1)	
Convenience group				**0,001**
Below the median	673 (47.8)	434 (63.1)	253 (36.8)	
Above the median	765 (52.2)	488 (71.2)	277 (28.8)	
Sedentary behavior				
≤ 2 hours/day	339 (23.6)	244 (72.0)	95 (28.0)	**0,039**
>2 hours/day	1099 (76.4)	725 (66.0)	374 (34.0)	
Physical activity				
Physically active	768 (53.4)	509 (66.3)	259 (33.7)	0,347
Physically inactive	669 (46.6)	459 (68.6)	210 (31.4)	

*Chi-square test.

Source: Authors.

ing to economic classes A/B ($p < 0.05$) and with excess body weight ($p < 0.05$). There was also a statistically significant difference between having an above the median level of consumption of foods from the Prudent group and being male ($p < 0.01$) and being physically inactive ($p < 0.01$). There was also a statistically significant difference between having an above-the-median consumption of Convenience foods and being in the 12/14 year-old age group ($p < 0.05$), being of white ethnicity ($p < 0.05$), and not having an excess body weight ($p < 0.01$).

It was found that engagement in excessive time in sedentary behavior increased the chance that adolescents being overweight by 37% (Table 3). The results of this analysis of the association between excessive time in sedentary behavior, consumption the Convenience or Prudent groups, and overweight among adolescents are shown in Table 4. It was observed that the chance of adolescents being overweight increased by 39% among those who were simultaneously engaged excessive time in sedentary behavior and who also had low consumption of foods from the Prudent group (OR = 1.39; 95%CI: 1.04-1.84).

It was also observed that there was a 43% increase in the chance of being overweight in adolescents who were simultaneously engaged in excessive time in sedentary behavior and who had higher consumption of foods from the Convenience group, (OR = 1.43; 95%CI: 1.05-1.94).

Discussion

This study, by analyzing two determinants of nutritional status (time engaged in sedentary behavior and patterns of food consumption) found an increased probability that an adolescent be overweight if the adolescent engaged in

Table 2. Association between screen time and diet with sociodemographic factors, nutritional status, and level of physical activity in adolescents from João Pessoa, Paraíba, Brazil, 2014.

Variables	n (%)	Sedentary behavior n (%)		*p**	Energy (Kcal) of the prudent group n (%)		*p**	Energy (Kcal) of the convenience group n (%)		*p**
		≤ 2 hours	>2 hours		Below the median	Above the median		Below the median	Above the median	
Sex										
Male	677 (47.1)	137 (20.6)	540 (79.4)	**0.003**	282 (41.6)	395 (58.4)	**0.001**	313 (46.5)	364 (53.5)	0.374
Female	751 (52.9)	202 (26.7)	549 (73.3)		391 (51.6)	370 (48.4)		374 (49.1)	387 (50.9)	
Age group (years)										
10-11	800 (55.6)	199 (25.2)	601 (74.8)	0.205	390 (48.8)	410 (51.2)	0.171	407 (51.0)	393 (49.0)	**0.018**
12-14	638 (44.4)	140 (22.1)	498 (77.9)		283 (44.4)	355 (55.6)		280 (43.9)	358 (56.1)	
Skin color										
Whites	261 (18.9)	57 (21.0)	214 (79.0)	0.227	117 (43.2)	154 (56.8)	0.174	113 (41.9)	158 (58.1)	**0.039**
Non-Whites	1160 (81.1)	282 (24.6)	878 (75.4)		555 (47.9)	605 (52.1)		573 (49.5)	587 (50.5)	
Education of mother										
Elementary education	654 (55.0)	161 (24.9)	493 (75.1)		302 (46.2)	352 (53.8)		296 (45.4)	358 (54.6)	
High school education	490 (41.2)	114 (23.6)	376 (76.4)	0.712	215 (44.0)	275 (56.0)	0.587	249 (51.0)	241 (49.0)	0.120
Higher education	46 (3.8)	9 (19.8)	37 (80.2)		23 (50.5)	23 (49.5)		23 (50.2)	23 (49.8)	
Economic class										
Class A/B	467 (37.0)	86 (18.4)	381 (81.6)	**0.026**	215 (46.4)	252 (53.6)	0.919	254 (54.4)	213 (45.6)	0.301
Class C/D/E	797 (63.0)	206 (26.3)	591 (73.7)		368 (46.1)	429 (53.9)		390 (49.1)	407 (50.9)	
Overweight										
Not overweight	969 (67.4)	244 (25.3)	725 (74.7)	**0.045**	437 (45.2)	532 (54.8)	0.089	434 (44.9)	535 (55.1)	**0.001**
Overweight	469 (32.6)	95 (20.7)	374 (79.3)		236 (50.3)	233 (49.7)		253 (54.0)	216 (46.0)	
Physical activity										
Physically active	768 (53.4)	167 (21.9)	601 (78.1)	0.114	318 (41.6)	450 (58.4)	**0.001**	354 (46.2)	414 (53.8)	0.177
Physically inactive	669 (46.6)	172 (26.1)	497 (73.9)		355 (53.0)	314 (47.0)		332 (49.7)	337 (50.3)	

*Chi-square test.

Source: Authors.

Table 3. The association between sedentary behavior and excess weight (overweight or obese) in adolescents from João Pessoa, Paraíba, Brazil, 2014.

Sedentary behavior	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
≤ 2 hours	Reference	Reference	Reference	Reference
> 2 hours	1.30 (1.01-1.67)	1.30 (1.01-1.68)	1.29 (1.00-1.67)	1.37 (1.04-1.80)

* Model 1: crude (excess weight and sedentary behavior). ** Model 2: adjusted for sex and age. *** Model 3: adjusted for level of physical activity in addition to the previously mentioned variables. **** Model 4: adjusted for total energy in addition to the previously mentioned variables.

Source: Authors.

Table 4. Binary logistic regression results for the association between sedentary behavior and dietary indicators in adolescents from João Pessoa, Paraíba, Brazil, 2014.

Diet + sedentary behavior	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)	Model 4 OR (95%CI)
Prudent group				
≤ 2 hours of sedentary behavior	Reference	Reference	Reference	Reference
Below the median with > 2 hours of sedentary behavior	1.40 (1.07-1.83)	1.40 (1.06-1.85)	1.41 (1.06-1.87)	1.39 (1.04-1.84)
Above the median with > 2 hours of sedentary behavior	1.21 (0.90-1.62)	1.21 (0.90-1.62)	1.20 (0.89-1.60)	1.35 (0.98-1.86)
Convenience Group				
≤ 2 hours of sedentary behavior	Reference	Reference	Reference	Reference
Below the median with > 2 hours engaged in sedentary behavior	1.12 (0.85-1.46)	1.13 (0.85-1.48)	1.12 (0.85-1.46)	1.30 (0.96-1.76)
Above the median with > 2 hours engaged in sedentary behavior	1.53 (1.14-2.04)	1.51 (1.13-2.01)	1.52 (1.13-2.02)	1.43 (1.05-1.94)

* Model 1: crude analysis (excess body weight and diet + sedentary behavior). ** Model 2: adjusted for sex and age. *** Model 3: adjusted for level of physical activity in addition to the previously mentioned variables. **** Model 4: adjusted for total energy in addition to the previously mentioned variables.

Source: Authors.

sedentary behavior for excessive amounts of time while also having increased consumption of food from the Convenience group. The Convenience group consisted of food that is generally associated with an unhealthy diet. Also, adolescents with excessive time in sedentary behavior and food consumption belonging to the Prudent group, which are low in sugars, fats and sodium and high in nutritional value, below the median had a higher chance (39%) of being overweight when compared to those with consumption above the median (35%).

Recently, a new proposal of food classification was developed, named NOVA [30] categorizing food into four groups, according to the extent and purpose of its processing: (1) fresh or minimally processed foods; (2) processed culinary ingredients; (3) processed foods; and (4) ultra-processed foods[30]. Although the ultra-processed foods group includes some foods that compose the Convenience group of this study, we built a group based on the concept of easy and ready to eat food, which minimizes the time and physical effort required for preparation, consumption and cleaning[31].

In the present study, the prevalence of overweight among adolescents was 32.6%. This was higher than the rate of overweight in developed countries, which was 23.8% for boys and 22.6% for girls[32]. In Brazil, data from the Household Budget Survey during 2008-2009 (the *Pesquisa de Orçamentos Familiares*)[33], showed a high prevalence of overweight in adolescents, reaching 27.6% in male adolescents and 23.4% in female adolescents. More recently, the 2015 National School Health Survey (PeNSE)[12] also showed a high incidence (23.7%) of overweight in adolescent students. These rates are higher than the

prevalence of overweight in children and adolescents in developing countries, which is 12.9% for boys and 13.4% for girls[32].

This high rate of overweight among adolescents in Brazil may be attributed to the nutritional transition that Brazil has experienced, resulting in obesity and also nutritional deficiencies caused by poor diet[34]. These have been attributed to increased consumption of high-energy foods, rich in sugars, fats, and sodium, and with low nutritional value, which compose the Convenience group in this study, decreased levels of physical activity, and increased time engaged in sedentary behavior[35]. The findings of the present study, show an association that are in line with this view.

The practice of physical activity, despite being associated with various health benefits for adolescents, has decreased among this age group, while there has been a simultaneous increase in the prevalence of sedentary behaviors[12,36,37]. This change in behavior may be related to safety conditions, violence and social relations in the place of residence, since the perception of less security in the neighborhood, on the part of parents of children and adolescents, seems to be associated with more time in sedentary behavior when compared to parents who consider their neighborhood safe[38,39].

The results of the present study corroborate the data from previous research, showing that 76% of adolescents spend more than two hours a day in sedentary activities, most of them classified as physically inactive. Besides that, in this study, approximately 80% of those classified as overweight was engaged excessive time in sedentary behavior. This result is on line with the reported findings of a systematic review of studies conducted in Brazil, where 55.5% (n = 27) of 49 studies identified reported a positive association between screen time and overweight in adolescents[40].

Our findings showed that sedentary behavior was associated with being overweight, independent of total energy consumed, level of physical activity, sex, and age. Moreover, by performing a joint analysis of sedentary behavior and diet, the results point to a greater probability of being overweight when there was a greater amount of consumption of foods from the Convenience group, and a decrease in the chance of being overweight when there was greater consumption of foods from the Prudent group. These findings confirm a study that showed a positive association between sedentary behavior, measured by screen time, and the choice of foods that are low in nutritional value and high in calories, fats, and sugars[4,40]. The results of the present study are concerning, since adolescents are consuming greater amounts of foods belonging to the Convenience group and, consequently, reducing their consumption of foods from the Prudent group[12]. This behavior is related to the food culture of today's society, which encourages people to opt for practical foods that are easy to access[41].

Another plausible explanation for this result may be due to the high number of advertisements for convenience foods broadcast mainly on open television[42], since these adolescents spend more time in front of the television than in other screen activities[43]. A recent study showed that 18.1% of the advertisements aired on Brazilian open TV are for food and beverages, and more than 80.0% of these were outside the nutritional quality standards of the World Health Organization (WHO) or the Pan American Health Organization (PAHO), which makes them eligible for marketing restrictions[42]. The most frequently advertised foods and beverages all belong to the convenience group of the present study, such as soft drinks, processed meats, convenience foods, sugary drinks, sweets and desserts[42].

Another interesting finding in this study was that there was greater consumption of food from the Convenience group among adolescents from lower economic classes. This result reinforces that one of the factors influencing diet is economic, since the foods from the Convenience group of this study often have a lower cost when compared to foods from the Prudent group, making them more accessible to those belonging to lower economic classes [44]. This is in agreement with data from the literature [44]. The increase in the consumption of this type of food has been reported in low-income countries and within the same country in poorer regions[45].

Brazil has a long traditional of school lunch polices, the School Health Program (PNAE)[46], has and one of the goals is the development of healthy eating habits among students in the public-school system. This program encourages the consumption of foods from the Prudent group and increases access to these foods through school lunches and educational initiatives about diet and nutrition. In addition, some state laws are also being created to regulate food sold in schools[47], which encourage reductions in the consumption of foods belonging to the Convenience group in order to promote more healthy eating habits and provide subsidies for healthy food policies at school[47]. However, according our

results, it is clear that more efforts have to be put on these polices.

Diet deserves attention, because an excessive intake of foods with high energy density, when combined with sedentary behaviors, generates a positive energy balance, which in turn plays a fundamental role in the development of overweight [8,48]. Although this study did not focus on the adequacy of adolescents' energy intakes through food, the data point to an association between the type of food consumed and sedentary behaviors associated with nutritional status, suggesting that this assertion may be corroborated.

Faced with the impact of these behaviors on obesity, adolescents, parents and educators should be the focus of health education measures, promoting changes in eating habits and reducing sedentary behavior, in order to minimize the risks of obesity and associated pathologies in the future.

In this sense, the WHO recommends several strategies to reduce the consumption of foods belonging to the Convenience group and reduce sedentary behavior, such as the elaboration of nutritional information and guidelines for adults and adolescents with dissemination in a simple, understandable and accessible way to all groups in society; taxation of sugary drinks; reducing exposure of children and adolescents to foods belonging to the Convenience group; reduction of the marketing power of foods belonging to the Convenience group; implement interpretive front-of-pack labeling supported by public adult education and adolescents for nutritional literacy; creation of healthy eating environments; guide children and teenagers, their parents, caregivers, teachers and health professionals about healthy body size, physical activity and appropriate use of screen-based entertainment, i.e. time in sedentary behavior; availability of adequate facilities in schools and in public spaces for physical activities during recreational time for all teenagers (including people with disabilities), with the provision gender-friendly spaces where appropriate[49].

One of the limitations of this study is the cross-sectional design, which only allows exploring associations between variables, and it is not possible to ascertain causal relationships. However, our study describes the combined effect analysis of two risk factors for overweight, what is not usual in the literature of this field. In addition, the study has a representative sample of students from public schools in the sixth year of elementary school in the city of João Pessoa.

Conclusions

This analysis of adolescents show that a large proportion of adolescents are engaged in excessive time in sedentary behavior, but when adolescents favor diets high in ready-to-eat energy dense foods or diets low in nutritious and healthy foods, their chances of being overweight increase even more.

Therefore, it is suggested that measures and interventions should be undertaken to encourage healthy food choices, to create the conditions to make these choices possible, encourage physical activity, and reduce time in sedentary behavior during this stage of life.

Collaborations

We certify that we have participated substantially in the conception and design of this work, collecting, analyzing and interpreting data, as well as writing the manuscript. We have reviewed the final version of the manuscript, approved it for submission, and we take full responsibility for its content.

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