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Obesogenic clusters: excess body weight-related lifestyle behaviors in schoolchildren

Clusters obesogênicos: condutas do estilo de vida relacionadas ao excesso de peso corporal em escolares

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Abstract – The objective of the study was to identify the existence of clusters in multiple lifestyle behaviors, including fruits/vegetables intake, sweetened products/soft drinks intake, sleep duration, physical activity and sedentary behavior. In sequence, the association between identified clusters and excess body weight in schoolchildren was examined. This was a cross-sectional school-based epidemiological study with approximately 17 thousand schoolchildren aged 4-20 years who participated in the Parana Health Project. Questionnaire was applied with structured questions to collect lifestyle behaviors. Excess body weight was identified through body mass index. Cluster analysis was performed to identify sex-specific clusters of multiple lifestyle behaviors. Analysis of covariance and logistic regression were used to analyze associations between clusters and excess body weight. Five clusters were identified in both sexes. Schoolchildren in the cluster characterized by lower fruits/vegetables intake and greater time spent in sedentary behavior showed close to twice the chance of having excess body weight compared to their peers in the reference cluster (girls: OR=1.98 [1.41-2.93]; boys: OR=1.94 [1.39-3.01]). In the case of schoolchildren in the cluster characterized by high sweetened products/soft drinks intake and shorter sleep duration, the chances of having excess body weight were 69% in girls (OR=1.69 [1.23-2.67]) and 73% in boys (OR=1.73 [1.25-2.91]). In conclusion, high fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and less sedentary behavior was considered the most effective combination for maintaining a healthy body weight in the sample of schoolchildren.

Key words: Overweight; Obesity; Health promotion; Health behavior.

Resumo – *Objetivo do estudo foi identificar existência de clusters em múltiplas condutas do estilo de vida, incluindo consumo de frutas/hortaliças e produtos açucarados/refrigerantes, sono, atividade física e comportamento sedentário. Na sequência, foi examinada associação entre os clusters identificados e excesso de peso corporal em escolares. Trata-se de estudo epidemiológico transversal de base escolar, com aproximadamente 17 mil escolares de 4 a 20 anos que participaram do Projeto Paraná Saudável. Foi aplicado questionário com questões estruturadas para levantar as condutas do estilo de vida. Excesso de peso corporal foi identificado mediante o índice de massa corporal. Análise de cluster foi realizada para identificar agrupamentos específicos das múltiplas condutas do estilo de vida. Análise de covariância e regressão logística foram aplicadas para analisar associações entre os clusters e o excesso de peso corporal. Foram identificados cinco clusters em ambos os sexos. Escolares reunidos no cluster de menor consumo de frutas/hortaliças e maior tempo em comportamento sedentário demonstraram duas vezes mais chance de apresentar excesso de peso corporal do que seus pares reunidos no cluster de referência (moças: OR=1,98 [1,41–2,93]; rapazes: OR=1,94 [1,39–3,01]). As chances de escolares reunidos no cluster de elevado consumo de produtos açucarados/refrigerantes e menor duração de sono apresentar excesso de peso corporal foi de 69% nas moças (OR=1,69 [1,23–2,67]) e 73% nos rapazes (OR=1,73 [1,25–2,91]). Concluindo, elevado consumo de frutas/hortaliças, baixo consumo de produtos açucarados/refrigerantes, maior duração de sono e menor comportamento sedentário foi considerada a combinação mais efetiva para manutenção de peso corporal saudável na amostra de escolares.*

Palavras-chave: *Sobrepeso; Obesidade; Promoção da saúde; Comportamentos relacionados à saúde.*

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INTRODUCTION

In recent decades, the increasing prevalence of overweight and obesity identified in young people in all regions of the world has alarmed public health agencies, investigators, health professionals and the general public[1]. The excess body weight in childhood and adolescence is associated with a variety of outcomes for physical, mental and social health of the young, resulting in serious long-term complications[2]. In addition, children and adolescents with excess body weight tend to become obese adults[3], increasing the risk of non-communicable morbidities and premature mortality from various causes[1].

In this context, the future perspectives are worrisome, with a forecast of approximately 60% of children today to present excess body weight at 35 years of age and less than 6% of obese young people in late adolescence will reach eutrophic body weight from the third decade of life[4]. For this reason, studies and interventions involving obesogenic behaviors in children and adolescents are especially important in an attempt to minimize the chances of excess body weight appearing at an early age and to prevent overweight and obesity in adults and the associated complications.

Despite the important individual participation of lifestyle behaviors as potential predictors of excess body weight, especially food intake[5], physical activity[6], sedentary behavior[7] and sleep[8], emerging studies aim to analyze the synergistic effect of a set of them, in which combinations of multiple lifestyle behaviors become potentially more elucidative for inhibiting and controlling excess body weight than can be expected solely by the individual impact of each of them[9].

This analysis design becomes particularly opportune, considering that the protective and risk behaviors for greater accumulation of body weight are not incorporated in isolation and tend to coexist and interact with each other in the lifestyle pattern of young people[10]. Thus, studies of clusters of obesogenic behaviors have important implications for proposing and implementing actions for interventions directed to specific sets of lifestyle behaviors, rather than approaches to isolated behaviors.

Therefore, the two main objectives of the study were: (a) to identify the existence of clusters in multiple lifestyle behaviors, including fruits/vegetables intake, sweetened products/soft drinks intake, sleep duration, physical activity and sedentary behavior; and (b) to examine the association between the identified clusters and excess body weight in children and adolescents.

METHODS

The data analyzed are from the Healthy Paraná Project, a cross-sectional school-based study aimed at analyzing the associations between anthropometric nutritional status, lifestyle behaviors as well as school and family setting indicators in young people aged 4 to 20 years from the public schools of Paraná state, Brazil.

Sample

The sample size estimation and participant' selection procedures have been described in detail in a previous publication[11]. The sample consisted of 17,074 schoolchildren (8,776 girls and 8,298 boys) and the rights of all

participants were guaranteed in the informed consent form signed by the students and their legal guardians.

Data collection

The intervention protocols used were approved by the Research Ethics Committee of the Universidade Norte do Paraná – Plataforma Brasil (no. 95,056/2012). The study proposed to collect anthropometric data and apply a questionnaire divided into five sections: demographic variables, food intake, sleep duration, physical activity, and sedentary behavior.

The questionnaire was applied individually to each student, at a single session held at the school during class time. However, for kindergarten and 1st to 5th graders (age ≤ 11 years), the questionnaire was applied in the form of a face-to-face interview in the presence of their parents/guardians, who, when asked, helped the students answer the questions. In the other grades (grades 6 to 9 of elementary school and 9 to 11 of high school), students were handed out the questionnaire with instructions and recommendations for filling it out, and no time limit was established for completing the instrument. The average time spent on the questionnaire was 40 minutes. Questionnaire reliability was analyzed by reapplying it to 10% of the subjects seven days later. All the items demonstrated Cohen's kappa ≥ 0.70. Data were collected between August/2013 and June/2014 by a team of 40 investigators, divided into eight groups distributed into the different geographic regions and cities.

Anthropometric data

Anthropometric data consisted of height and body weight measures, in line with the methodology proposed by the World Health Organization[12]. Body weight was recorded to the nearest 0.1 kg, using a portable electronic scale (Type SECA 861) and height to the nearest 0.1 cm, using a portable stadiometer (Type SECA 225). Light indoor clothing could be worn, excluding shoes, long trousers and sweaters. Body mass index (BMI) was calculated dividing the body weight by the height squared (kg/m2). Based on BMI, the anthropometric nutritional status of the schoolchildren was classified into four categories, according to the cutoff points for sex and aged suggested by the International Obesity Task Force[13]: low body weight, eutrophic, overweight and obesity.

Demographic variables

With respect to demographic variables, in addition to gender and age, information related to family economic class was established based on National Association of Market Research Companies guidelines[14]. Age e family economic class were used as covariates in subsequent analysis.

Food intake

Food intake information was obtained using the Youth Risk Behavior Survey, translated, adapted and validated for Brazil[15]. In this case, the students reported the intake frequency of fruits/vegetables and sweetened products/soft drinks in

the week prior to data collection. Responses included seven categories of intake frequency: (1) none; (2) 1-3 times/week; (3) 4-6 times/week; (4) 1 time/day; (5) 2 times/day; (6) 3 times/day; and (7) 4 or more times/day. For calculation purposes, intake frequencies were converted into quantities varying from 0 to 28 times/week. Conversion factors were applied to obtain weekly intake estimates: category 1 = 0 times/week; 2 = 2 times/week; 3 = 5 times/week; 4 = 7 times/week; 5 = 14 times/week; 6 = 21 times/week; and 7 = 28 times/week.

Sleep duration

Sleep duration indicators were collected considering weekdays and weekends, based on a typical or usual week and four questions: on school days, (a) what time do you usually go to bed? and (b) what time do you wake up? On weekends, (a) what time do you usually go to bed? and (b) what time do you wake up? With this information, sleep duration was calculated for weekdays and weekends. The weighted mean of weekday and weekend data was used to obtain sleep duration per night. For calculation purposes, the sleep duration per night was stratified into six categories: 1 = < 6 hours/night; 2 = 6-7 hours/night; 3 = 7-8 hours/night; 4 = 8-9 hours/night; 5 = 9-10 hours/night; and 6 = > 10 hours/night.

Physical Activity

The Physical Activity Questionnaire for Older Children – PAQ-C and Physical Activity Questionnaire for Adolescents – PAQ-A, translated and validated for Brazil[16], were used to determine physical activity levels. The PAQ-C and the PAQ-A consists of eight structured questions aimed at sizing different aspects of physical activity in the last seven days. Response options are coded using a 1-5-point scale, where 1 means less active and 5 means physically active. The physical activity score is computed using the arithmetic mean of scores assigned to each question.

Sedentary behavior

The sedentary behavior was treated by exposure to recreational screen time through structured issues about watching TV and using computer, video game, tablet, and smartphone in a typical or usual week. A predefined time scale was made available in which the schoolchildren indicated his option among six categories: (1) < 1 hour/day; (2) 1-2 hours/day; (3) 2-3 hours/day; 4) 3-4 hours/day; (5) 4-5 hours/day; and (6) > 5 hours/day. Questions considered separately screen time equivalent to watching TV and using computer, video game, tablet and smartphone on weekdays and on weekends (Saturday and Sunday). Weighted mean involving data of weekdays and weekends was used to identify the daily screen time reported by schoolchildren. For calculation purpose, the amount of screen time was estimated as follows: category 1 = 30 min; 2 = 90 min; 3 = 150 min; 4 = 210 min; 5 = 270 min; and 6 = 330 min, respectively.

Statistical analysis

The data were statistically treated using the Statistical Package for the Social Science, version 26. All analyses were stratified by gender due to significant differences observed in the multiple lifestyle behaviors of girls and boys considered in the study. Fruits/vegetables intake, sweetened products/soft drinks intake, sleep duration, physical activity and sedentary behavior were considered as continuous standardized variables. Cluster analysis was performed to identify sex-specific clusters of multiple lifestyle behaviors.

Cluster analysis was carried out in two steps applying a combination of hierarchical and non-hierarchical clustering methods following the recommendations of Gore[17]. In the first step, a hierarchical cluster analysis was performed using the Ward method based on Euclidean distances as a measure of dissimilarity among schoolchildren. To reduce the sensitivity of the Ward method in relation to outliers, univariate discrepant values (values ≥ 3 standard deviations smaller or higher for the respective mean) and multivariate outliers (those with high distance from Mahalanobis values) for any of the five lifestyle behaviors variables investigated were removed prior to analysis. In this phase, a comparison of several possible cluster solutions was performed. Using resulting centroids, a non-hierarchical k-means cluster analysis was performed to improve the preliminary hierarchical clustering solution. To examine the stability of derived cluster solutions the sample was randomly divided into two halves and the complete two-step procedure (Ward, followed by k-means) was applied in each half. The elements of each half of the sample were assigned to a new cluster based on their Euclidean distances to the cluster centers of the other half. Subsequently, these new clusters were compared for agreement with original clusters by Cohen kappa (κ). The agreement was excellent (0.962 and 0.971 for girls and boys, respectively).

To compare indicators related to the multiple lifestyle behaviors considered in the study among clusters, One-Way covariance analysis adjusted for age and family economic class was used. Bonferroni correction was used for multiple post-hoc comparisons. Binary logistic regression analysis was used to identify the association between each cluster solution and excess body weight (overweight + obesity) of schoolchildren adjusted for age and family economic class.

RESULTS

Descriptive data of the sample selected in the study are available in Table 1. The analysis equally generated five clusters for both sexes with different coexistence configurations and individual health behaviors engagement gradients – Figure 1. The Cluster 1 consisted of schoolchildren who reported higher physical activity, while the Cluster 2 of schoolchildren who assumed low fruits/vegetables intake, together with more sedentary behavior. The schoolchildren in Cluster 3 were characterized by higher physical activity and greater sedentary behavior. On the other hand, schoolchildren in Cluster 4 reported higher sweetened products/soft drinks intake and shorter sleep duration. High fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and less sedentary behavior were the characteristics of schoolchildren in Cluster 5.

The differences between characteristics of the cluster solution according to age, family economic class, BMI and lifestyle behaviors are described in

Table 2. In both sexes, the clusters characterized by higher physical activity (Cluster 1 and Cluster 3) have higher proportion of schoolchildren aged 8-11 years. In addition, clusters that presented low fruits/vegetables intake and greater sedentary behavior (Cluster 2) had higher proportion of schoolchildren aged 16-20 years. Higher proportion of low-income family schoolchildren is found in the cluster that has high sweetened products/soft drinks intake and shorter sleep duration (Cluster 4). The schoolchildren in clusters defined by low fruits/vegetables intake together with greater sedentary behavior (Cluster 2) and high sweetened products/soft drinks intake together with shorter sleep duration (Cluster 4) presented BMI values significantly higher in comparison with their pairs belonging to the other clusters. Sex-specific clusters differ significantly in relation to age, family economic class and BMI.

The associations between the derived clusters and excess body weight identified through information produced by the logistic regression analysis are shown in Table 3. None of the clusters presented positive scores for all lifestyle behaviors selected in the study. For this reason, Cluster 5 was selected as the reference cluster because it presented positive scores in four of the five treated lifestyle behaviors (high fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and lower sedentary behavior). Significant associations between derived clusters and excess body weight (overweight + obesity) were equally observed in both sexes. The schoolchildren in the cluster characterized by lower fruits/vegetables intake and spending more time in sedentary behavior (Cluster 2) were nearly twice as likely to have excess body weight compared to their peers gathered in the reference cluster (girls: OR = 1.98 [1.41 – 2.93]; boys: OR = 1.94 [1.39 – 3.01]). In the case of schoolchildren in Cluster 4, characterized by high sweetened products/soft drinks intake and shorter sleep duration, the odds of being excess body weight was 69% in girls (OR = 1.69 [1.23 – 2.67]) and 73% in boys (OR = 1.73 [1.25 – 2.91].

Table 1. Descriptive information of the selected study sample (n=17,074).

	n (%)	
	Girls	Boys
	8776 (51.4)	8298 (48.6)
Demographic data		
Age		
4 – 7 years	526 (6.0)	431 (5.2)
8 – 11 years	3010 (34.9)	2871 (34.6)
12 – 15 years	3318 (37.8)	3286 (39.6)
16 – 20 years	1922 (21.9)	1710 (20.6)
Family economic class		
Low	2726 (31.1)	2350 (28.3%)
Middle	4120 (46.9)	3799 (45.8%)
High	1930 (22.0)	2149 (25.9%)
Lifestyle behaviors		
Fruit/vegetable intake		
None	1044 (11.9)	1643 (19.8)
1-6 days per week	4818 (54.9)	4597 (55.4)
Daily	2014 (33.2)	2058 (24.8)
Sweetened products/soft drink intake		
None	632 (7.2)	398 (4.8)
1-6 days per week	5064 (57.7)	4448 (53.6)

Table 1. Continued...

	n (%)	
	Girls	Boys
	8776 (51.4)	8298 (48.6)
Daily	3080 (35.1)	3452 (41.6)
Sleep duration		
< 6 hours per night	2089 (23.8)	2440 (29.4)
6-8 hours per night	3800 (43.3)	2821 (34.0)
> 8 hours per night	2887 (32.9)	3037 (36.6)
Physical activity		
Inactive	4801 (54.7)	2622 (31.6)
Moderately active	2536 (28.9)	3344 (40.3)
Active	1439 (16.4)	2332 (28.1)
Sedentary behavior		
≤ 2 hours per day	2747 (31.3)	2315 (27.9)
2–4 hours per day	3115 (35.5)	3120 (37.6)
> 4 hours per day	2914 (33.2)	2863 (34.5)
Body mass index		
Low body weight	325 (3.7)	407 (4.9)
Eutrophic	6336 (72.2)	6099 (73.5)
Overweight	1448 (16.5)	1286 (15.5)
Obese	667 (7.6)	506 (6.1)

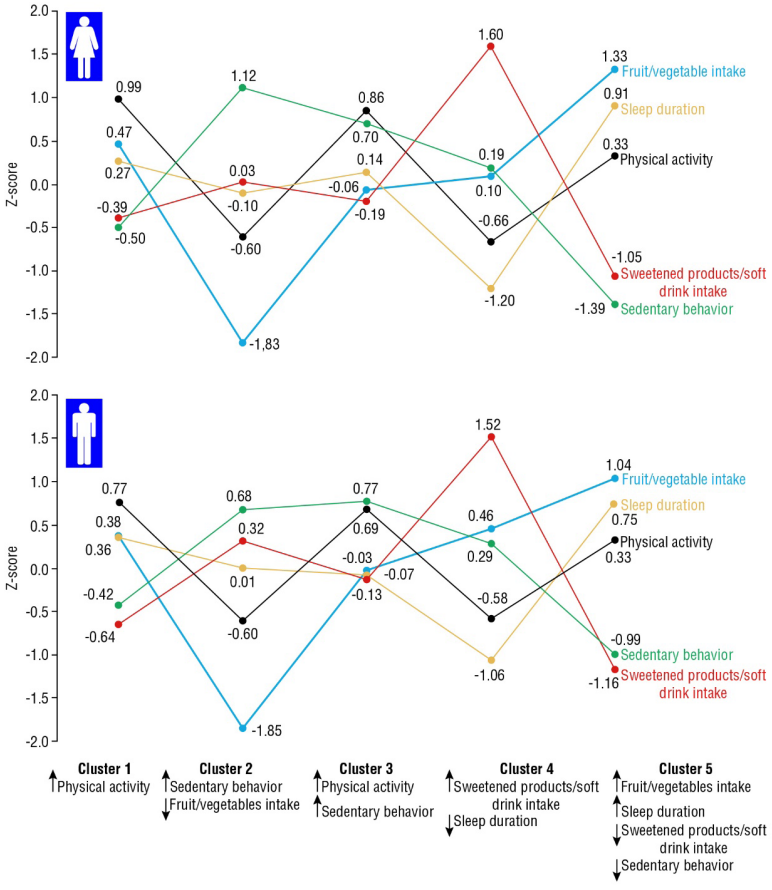

Figure 1. Cluster solutions and mean z scores of multiple excess body weight-related lifestyle behaviors in schoolchildren.

Table 2. Demographic indicators, body mass index and lifestyle behaviors according to cluster solution.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	p-value
Girls (n = 8776)						
n (%)	1843 (21)	2448 (28)	1659 (19)	1228 (14)	1598 (18)	
Age						
4-7/8-11/12-15/16-20 years (%)	(30/36/21/13)	(15/20/26/39)	(28/34/23/15)	(16/22/28/34)	(36/29/23/12)	
Family economic Class						
Low/middle/high (%)	(31/49/20)	(25/41/34)	(27/54/19)	(41/33/26)	(34/47/19)	
Body mass index						p = 0.021
X±SD (kg/m2)	21.26±2.97 a	22.83±3.61 b	21.38±3.18 a	23.15±3.79 b	20.86±2.74 a	
Fruit/vegetable intake						p < 0.001
X±SD (frequency per week)	4.51±1.96 a	2.21±1.28 b	3.98±2.27 c	4.14±2.09 a.c	5.36±2.13	
Sweetened products/soft drink intake						p < 0.001
X±SD (frequency per week)	2.85±1.37 a	3.27±1.69 a	3.05±1.53 a	4.83±2.11	2.18±1.06	
Sleep duration						p < 0.001
X±SD (hours per night)	4.22±1.97 a	3.85±2.05 a	4.09±1.83 a	2.74±1.63	4.87±2.23	
Physical activity						p < 0.001
X±SD (score)	3.19±0.74 a	1.96±0.65 b	2.83±0.68 a	1.85±0.59 b	2.74±0.81 a	
Sedentary behavior						p < 0.001
X±SD (hours per week)	4.13±1.96 a	5.74±2.49 b	5.22±2.31 b.c	4.81±2.12 c	3.23±1.47	
Boys (n = 8298)						
n (%)	2091 (25)	1891 (23)	1693 (20)	1394 (17)	1229 (15)	
Age						
4-7/8-11/12-15/16-20 years (%)	(27/34/23/16)	(17/19/28/36)	(26/31/26/17)	(15/19/26/40)	(35/31/24/10)	
Family economic Class						
Low/middle/high (%)	(32/47/21)	(23/40/37)	(31/46/23)	(39/28/33)	(35/48/17)	
Body mass index						p = 0.013
X±SD (kg/m2)	20.87±2.93 a	22.32±3.47 b	21.03±3.38 a	23.74±3.28 b	20.41±3.04 a	
Fruit/vegetable intake						p < 0.001
X±SD (frequency per week)	4.26±1.74 a	2.03±1.19 b	3.85±1.91 a	4.34±1.85 a.c	4.92±2.13	
Sweetened products/soft drink intake						p < 0.001
X±SD (frequency per week)	3.11±1.57 a	4.07±2.28 b	3.62±1.76 a.b	5.27±2.97	2.69±1.26 a	
Sleep duration						p < 0.001
X±SD (hours per night)	4.37±2.08 a	4.02±1.83 a	3.94±1.90 a	2.95±1.47	4.76±2.38	
Physical activity						p < 0.001
X±SD (score)	3.92±0.74 a	2.25±0.68 b	3.54±0.61 a	2.57±0.73 b	3.48±0.75 a	
Sedentary behavior						p < 0.001
X±SD (hours per week)	4.48±2.06 a	5.58±2.41 b	5.37±2.26 b.c	5.19±2.27 b.c	3.91±1.83 a	

Note. ANCOVA by controlling age and family economic class. Values subscribed by the same letters indicate statistical similarities between clusters (p < 0.01).

Table 3. Association between clusters of lifestyle behaviors and excess body weight in schoolchildren.

	Girls		Boys	
	OR (IC95%)	p´-value	OR (IC95%)	p´-value
Cluster 5	Reference		Reference	
Cluster 4	1.69 (1.23 – 2.67)	p < 0.001	1.73 (1.25 – 2.91)	p < 0.001
Cluster 3	1.39 (0.98 – 2.24)	p = 0.058	1.35 (0.96 – 2.31)	p = 0.062
Cluster 2	1.98 (1.41 – 2.93)	p < 0.001	1.94 (1.39 – 3.01)	p < 0.001
Cluster 1	0.87 (0.61 – 1.44)	p = 0.214	0.82 (0.58 – 1.36)	p = 0.235

Note. Cluster 1: higher physical activity; Cluster 2: lower fruit/vegetable intake and higher sedentary behavior; Cluster 3: higher physical activity and sedentary behavior; Cluster 4: higher sweetened products/soft drink intake and lower sleep duration; Cluster 5: higher fruit/vegetable intake, lower sweetened products/soft drink intake, higher sleep duration and lower sedentary behavior.

DISCUSSION

This study aimed to identify clusters in multiple lifestyle behaviors and potential associations between the clusters identified and excess body weight in

schoolchildren. Despite the well-known independent influences[5-8], there is little evidence available on the synergistic effect of lifestyle behaviors, including fruits/vegetables intake, sweetened products/soft drinks intake, sleep duration, physical activity and sedentary behavior, on excess body weight in young populations[9,10]. This study is among the first to address the issue in Latin America; therefore, it should add new knowledge to the literature and provide important support for the design of more effective interventions aimed at health promotion and education in the school environment.

Five clusters were identified in both gender with identical characteristics. The Cluster 5, at first, considered to be that with healthier lifestyle behaviors, was observed in 18% of girls and 15% of boys, in which the participants simultaneously presented high fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and more physical activity. A study conducted in European countries observed a similar proportion of adolescents in the same cluster of healthy lifestyle behavior[18]; however, in another study with a similar design, specifically involving German and Swedish adolescents, it was not possible to identify and report clusters with multiple healthy behaviors[19].

Lower amount of older girls and boys (16-20 years) were found in clusters with higher physical activity (Cluster 1 and Cluster 3), corroborating findings from previous studies that indicate a reduction in the levels of physical activity with age advancement, notably in the second half of adolescence[20]. In addition, a higher proportion of schoolchildren with lower family economic class was observed in cluster characterized by the high sweetened products/soft drinks intake and shorter sleep duration (Cluster 4).

The cluster characterized by low fruits/vegetables intake together with high sedentary behavior (Cluster 2) and the cluster characterized by high sweetened products/soft drinks intake together with shorter sleep duration (Cluster 4) were inversely associated with the cluster of reference, characterized by high fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and low sedentary behavior (Cluster 5), thus providing evidence that the schoolchildren in both clusters were more likely to present excess body weight. In a way, these findings contrast results provided by some studies that did not show significant differences in BMI between clusters identified by multiple indicators of physical activity and dietary habits[18,21]. However, they resemble a study involving children aged 2-9 years that used data processing similar to the present study[22].

In agreement with previous studies[21], another finding resulting from the present study is the possibility of specific protective and risk lifestyle behaviors for excess body weight coexisting in the same cluster. A systematic review on the clustering of diet, physical activity, and sedentary behavior among children and adolescents aged 9–21 years, found that most children and adolescents in those studies fell into a mixed category of one or more healthy behaviors together with one or more unhealthy behaviors[23]. In the present study the schoolchildren in Cluster 3 showed higher physical activity (protective behavior) and at the same time greater sedentary behavior (risk behavior), which points to the possibility that recreational screen time does not necessarily configure as a barrier to the physical activity.

Based on the findings of the present study, it was found that the cluster that combines diet rich in fruits/vegetables, low sweetened products/soft intake together with longer sleep duration and less sedentary behavior (Cluster 5)

identifies with a healthier body weight; in addition, the lower fruits/vegetables intake together with greater sedentary behavior (Cluster 2) and higher the sweetened products/soft drinks intake together with shorter sleep duration (Cluster 4), the greater the likelihood of schoolchildren of both gender being overweight and obese. Similar findings are found in the literature[24,25], which corroborates the hypothesis that the combined influence of different lifestyle behaviors should be taken into account in intervention actions directed at the prevention and control of excess body weight. In this sense, studies have detected important associations between specific lifestyle behaviors and greater accumulation of body weight since early ages. Using a longitudinal design, it was found that greater exposure to screen time in childhood tends to increase the likelihood of young people exhibiting excess body weight in early adolescence[26].

Among the limitations of the study, it is highlighted that the research method used to identify the multiple lifestyle behaviors involved a self-report questionnaire, thus allowing possible memory bias or even biased statements towards the desirable, although careful procedure of data quality control was implemented in an attempt to minimize possible inaccuracies. Furthermore, the cross-sectional nature of the data does not allow causality inferences in the association between the identified clusters and excess body weight, because the outcome and other variables were identified at the same time. Also, residual confounding caused by unidentified and unmeasured factors may somehow increase the eventual inaccuracy of the findings. Another important aspect to be observed is the fact that only some of the lifestyle behaviors related to excess body weight have been selected to define the clusters.

On the other hand, one of the study strengths is the use of cluster analysis, which allows organizing specific subgroups of schoolchildren according to multiple lifestyle behaviors and their combinations, thus allowing the planning and directing of personalized and more effective intervention actions that could benefit each subgroup. An additional strength of the study is the fact that the data were collected from a random and representative sample of schoolchildren aged 4-20 years, which together with the high stability and robustness of the cluster solutions, offering subsides for findings to be considered and generalized to other groups of young people with similar characteristics.

CONCLUSION

In conclusion, cluster analysis involving multiple lifestyle behaviors, including fruits/vegetables intake, sweetened products/soft drinks intake, sleep duration, physical activity and sedentary behavior, ranked the schoolchildren of both gender equally into five different strata. High fruits/vegetables intake, low sweetened products/soft drinks intake, longer sleep duration and less sedentary behavior was considered the most effective combination for maintenance of a healthy body weight. Schoolchildren in clusters with low fruits/vegetables intake and greater sedentary behavior (Cluster 2) and higher sweetened products/soft drinks intake and shorter sleep duration (Cluster 4) showed to be more exposed to excess body weight. Protective and deleterious behaviors for body weight control, such as high physical activity and higher sedentary behavior, may coexist in the same cluster, which implies that lifestyle behaviors are not always discriminatory in the same direction. The study findings provide interesting evidence to supports the proposal to stratify schoolchildren according

to clusters of lifestyle behaviors to identify specific issues and suggest possible more effective prevention and intervention actions.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

The project was approved by the Ethics Committee of the University of Northern Parana (Protocol number 95,056/2012). The research was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

DPG, RR and MSM conceptualized the study and were involved in methodology, data collection and analysis. All authors were involved in the writing-original draft preparation and writing-review and editing. All authors have read and agreed to the published version of the manuscript.

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