Food consumption patterns related to excess weight and obesity in Spanish preschoolers

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Impact statement

- Childhood obesity is a serious public health concern of the 21st century owing to related adverse and chronic outcomes.
- Studies examining the dietary patterns associated with excess weight among preschoolers are scarce.
- Having a dietary pattern considered unhealthy was associated with higher prevalence of excess weight and obesity in comparison with other healthier clusters.

Abstract

Purpose: The aims of this study were (1) to identify the different food consumption patterns among Spanish preschoolers and (2) to examine the association between having a different food consumption pattern and the odds of having excess weight (i.e., overweight or obesity) or obesity among this population.

Methods: This was a nationwide cross-sectional study with data from the Spanish National Health Survey-2017. All preschoolers (aged 3-5 years) with complete information on all the variables analyzed were selected. The frequency of consumption of the fourteen food groups was evaluated by a food frequency questionnaire. Excess weight/obesity were computed following the World Health Organization criteria. A hierarchical cluster analysis using Ward's method (i.e., based on squared Euclidean distances) and k-means were performed including all food group consumption. A total sample of 663 was included in the cluster analysis.

Results: Three different clusters were established. Compared to the healthiest food consumption pattern (Cluster 1), higher odds of excess weight (OR = 1.51; CI: 95%, 1.02-2.25) and obesity (OR = 1.59; CI: 95%, 1.01-2.51) were found for participants with the unhealthiest food consumption pattern (Cluster 3).

Conclusion: Having a food consumption pattern considered unhealthy (i.e., low intake of vegetables/fruits, high consumption of confectionery products, sugar-sweetened beverages, fast-food, and snacks) was associated with presenting excess weight/obesity among Spanish preschoolers.

Impact: No studies have examined the specific food consumption patterns associated with excess weight or obesity among Spanish preschoolers. The unhealthiest food consumption pattern was characterized by a food consumption pattern that included a lower intake of vegetables and fruits and a higher consumption of confectionery products, sugar-sweetened beverages, fast-food, and snacks. Having a food consumption pattern considered unhealthy was associated with a higher prevalence of excess weight and obesity in comparison with other healthier food consumption patterns.

Introduction

Childhood obesity is a serious public health concern of the 21st century owing to related adverse and chronic outcomes[1]. There has been a dramatic rise in the prevalence of children under five years of age who have excess weight (overweight or obesity)[2]. In Spain, the last ALADINO (in Spanish, *ALimentación, Actividad física, Desarrollo INfantil y Obesidad en España*) study[3] found a high prevalence of childhood obesity among Spanish schoolchildren aged 6-9 years. More specifically, this study found that the prevalence of overweight, obesity and excess weight was 23.3%, 17.3%, and 40.6%, respectively (according to the World Health Organization (WHO) criteria[4]). Similarly, a recent longitudinal study by de Bont et al.[5] found that, in Spain, the overall prevalence of childhood obesity has increased from 0.8% at 2 years of age (in both sexes) to a peak at 7 years of age in girls (17.3%) and at 9 years of age in boys (24.1%). Despite these worrying figures, the WHO has recently warned that no European country is on track to curb rising levels of overweight and obesity by 2025[6].

In relation to dietary patterns, the WHO advises that a healthy diet helps to protect against malnutrition in all its forms, as well as noncommunicable diseases, such as diabetes, heart disease, stroke and cancer[7]. In reference to dietary habits, the need to improve them on a global scale has recently been highlighted[8], inadequate nutrition is a risk factor that causes more deaths than other factors traditionally considered, such as smoking[9]. Supporting this notion, providing assistance based on evidence for healthier lifestyles and dietary patterns could exert an essential role for public health[10].

Concerning the relationship between dietary patterns and childhood obesity, a recent systematic review by Liberali et al.[11] found that a diet with a lower percentage of unhealthier foods should be effective in reducing the risk of developing obesity. Furthermore, clusters characterized by low consumption of fruit and vegetables, and high consumption of fatty

foods, sugar snack foods, sweets, chips and fries, among other unhealthy lifestyle factors were positively associated with excess weight[12]. This is a worrisome issue since dietary patterns that are high in energy-dense, high-fat and low-fiber foods predispose young people to later overweight and obesity[13].

Previous studies in Spain have identified some dietary patterns associated with excess weight in both children[14,15] and adolescents[15,16], establishing different dietary patterns associated with excess weight. Moreover, studies examining the dietary patterns associated with excess weight among Spanish preschoolers are still scarce. Specifically, the preschool age phase is a crucial time during which long-term dietary habits (among others) are founded, with potential lifelong influences on health[17]. Hence, identifying the dietary patterns of those preschoolers who are at risk of adult obesity could serve as a guide for developing intervention programs, especially at early ages.

Based on the above, the aims of the present study are: 1) to identify the different dietary patterns among Spanish preschoolers, and 2) to examine the association between dietary patterns and the odds of having excess weight or obesity.

Methods

Population sample and study design

A nationwide cross-sectional study was conducted using data from the Spanish National Health Survey (2017)[18]. This survey was conducted by the Ministry of Health, Consumer Affairs and Social Welfare and the National Statistics Institute[19]. The sampling framework involved noninstitutionalized Spanish individuals. A three-stage sampling design was applied. The census section was the first stage, households were the second stage units, and individuals were the third stage units. Within each household, an adult (aged 15 or older) was

selected to complete the Adult Questionnaire, and if there were children (aged 0 to 14) in the household, one child was probabilistically selected among the members to complete the Minor's Questionnaire. Participants were informed of the survey methodology by means of an informative letter from the Ministry of Health, Consumer Affairs and Social Welfare that described the aims of the survey, the anonymous and voluntary nature of participation, and the visit of a qualified and authorized interviewer.

We retrieved data from the Minor´s questionnaire, which included children aged 0 to 14 years old (those who fulfilled the Minor's Questionnaire). The original sample consisted of 6101 (100.0%) participants. Participants younger than 3 (n=1024)(16.8%) and older than 5 years (n=3987)(65.3%) were excluded. Additionally, 96 participants (1.6%) were excluded due to missing data on any covariate (i.e., socioeconomic status, physical activity, screen time). Moreover, 189 participants (3.1%) were excluded because of missing data on BMI. Thus, the final sample included 663 (10.9%) Spanish preschoolers.

All data were obtained by the Ministry of Health, Consumer Affairs and Social Welfare and anonymously made public on the official website of the Spanish government[18]. According to Spanish regulations, approval by the Ethics Committee was not required as secondary data were used.

Procedures

Excess weight (independent variable)

Weight and height were reported by parents or guardians. These values were used to determine body mass index (BMI), which was transformed into BMI (z-score) following the sex- and age-criteria of the WHO criteria[20]. According to BMI (z-score), four different categories were established: a) thinness; b) normal weight; c) overweight; d) obesity. For

further analysis, participants were categorized as either “no excess weight” (“thinness” and “normal weight”) or “excess weight” (“overweight” and “obesity”).

Dietary patterns

Dietary patterns were evaluated by the Spanish Healthy Eating Index (S-HEI)[21], which is a modified version of the original Healthy Eating Index (HEI)[22]. Parents or guardians were asked about their children’s frequency of consumption of each food group. These food groups included: a) fruits; b) meat; c) eggs; d) fish; e) pasta, rice, potatoes; f) bread, cereals; g) vegetables; h) pulses; i) processed meat; j) diaries; k) cookies, pastries, sweets, jams, etc.; l) sugar-sweetened beverages; m) fast-food; and n) snacks. The following 6 response options were available: “never”, “lees than one time per week”, “once or twice weekly”, “three times weekly”, “from four to six times weekly” and “one or more times daily”). For obtaining a continuous variable, these categories were scored as follows: “never” (0 points), “lees than one time per week” (1 point), “once or twice weekly” (2 points), “three times weekly” (3 points), “from four to six times weekly” (4 points) and “one or more times daily” (5 points). Therefore, a global score of each food group was computed.

Covariates

Age, sex, region, and nativity status (native-born or foreign-born) were stated by parents or guardians. Socioeconomic status was categorized according to the occupation of the reference adult in the household unit. Physical activity was evaluated with a short questionnaire adapted from the International Physical Activity Questionnaire[23]; in our study, it was limited to a single question about the performance of physical activity in the child’s leisure time. The question had four possible response options: (a) “no exercise” (free-time occupied mainly by sedentary activities such as reading, watching television, going to the cinema, etc.); (b) “occasional physical activity or sport”; (c) “physical activity several times

a month", and (d) "sports or physical training several times a week"[18]. Recreational screen time was reported by the parents or guardians independently for weekdays and weekend days with the following question: "How much time does your child typically spend on a weekday in front of a screen, including a computer, tablet, television, video, video game, or cell phone screen?". The possible response options were (a) "no time or almost no time"; (b) "less than one hour"; and (c) "one hour or more". Sleep duration was assessed with the following question: "Can you tell me approximately how many hours your child usually sleeps daily? (Including nap times)".

Statistical analysis

Descriptive data are shown as absolute and relative numbers (%) for categorical variables and as the means and standard deviations (SD) for continuous variables medium (mean). In order to generate dietary patterns, cluster analysis was used. As previously indicated, a global score of each food group was computed and, therefore, they were converted into standardized scores (z-scores) to ensure a uniform scale. All the z-scores of the different food groups were included as cluster inputs.

Since cluster analysis is affected by the presence of outliers, values of more than three standard deviations (+3SD) above or below the mean were removed (univariate outliers) (126 participants). Moreover, to locate and remove multivariate outliers Mahalanobis distance was estimated (16 participants).

Thus, a final sample of 663 preschoolers was included in the cluster analysis. A priori, it was established three clusters according to previous studies in Spanish samples[16,24]. However, we have confirmed this number of clusters as follows: firstly, a hierarchical cluster analysis was performed using Ward's method, which is based on squared Euclidean distances[25]. A visual

examination of the dendrogram, the percentage variation in the accumulation coefficient at each step, and conceptual concerns were applied to establish the different number of clusters. Secondly, with the k-means cluster analysis the final cluster solution was obtained, together with the number of clusters found in the aforementioned step. Therefore, three different cluster were established: Cluster 1 (the healthiest), Cluster 2 – (moderately healthy) and Cluster 3 – (the unhealthiest). A further description about these established clusters can be found in Table S1. The sample was randomly split into halves so as to examine the stability of cluster solutions, and the identical processes above-mentioned (Ward's and k-means) were verified. The Cohen's kappa (κ) coefficient was determined to calculate the degree of concordance between classification of preschoolers of each of the new cluster and the total sample. Moreover, binary logistic regression analyses were performed to test associations between dietary patterns to a determined cluster and excess weight (overweight and obesity) or obesity. The model was adjusted by the following covariates: sex, age, region, nativity status, socioeconomic status, physical activity, recreational screen time, and sleep duration. SPSS Statistics software package version 25.0 (IBM Software Group, Chicago, Illinois) was used for the performance of all the analyses. Statistical significance was considered with a *p*-value < 0.050.

Results

Table 1 shows the characteristics of the study participants. The proportion of schoolchildren with low socioeconomic status was 37.7%. The prevalence of normal weight, overweight, obesity, and excess weight was 60.3%, 18.3%, 21.4%, and 39.7%, respectively.

Table 1** near here

Table 2 displays the characteristic of the participants according to the membership of each cluster established. The highest proportion of preschoolers with low socioeconomic status was found in Cluster 3 (46.7%) ($p=0.023$). Cluster 3 showed the highest prevalence of obesity and excess weight ($p<0.05$ for both). Overall, a lower physical activity level was found in Cluster 3 in comparison with both Cluster 2 and Cluster 1. Cluster 3 spent more time in recreational screen time (global) than Cluster 2 and Cluster 1 ($p<0.001$ for both). Conversely, Cluster 3 had a lower sleep duration than Cluster 1 ($p=0.001$).

Table 2** near here

Figure 1 was made to aid interpretation, and it indicates z-score mean values of different food groups included in the clustering process. In this sense, Cluster 1 showed the highest z-score values for fruit and vegetables consumption, as well as the lowest z-score values for cookies, pastries, sweets, jams, etc., sugar-sweetened beverages, fast-food and snacks. Conversely, Cluster 3 (the unhealthiest) showed the lowest z-score values for fruits, vegetables, meat, eggs, fish, pasta, rice, potatoes, bread and cereals.

Figure 1** near here

Figure 2 illustrates the associations between the membership in a particular cluster and excess weight or obesity. Compared to the healthiest cluster (Cluster 1), higher odds of excess weight (OR = 1.51; CI95%, 1.02–2.25) and obesity (OR = 1.59; CI95%, 1.01–2.51) were found for those participants located in the unhealthiest cluster (Cluster 3).

Figure 2 near here

Discussion

Overall, our findings display three different clusters according to dietary patterns, which was associated with obesity and excess weight in a national sample of Spanish preschoolers. Overall, the unhealthiest cluster, characterized by a lower intake of vegetables and fruits, and a higher consumption of confectionery products, sugar-sweetened beverages, fast-food and snacks, showed greater odds of having obesity and excess with compared to the other considered healthier clusters.

The results of the present study are in line with previous studies performed in Spain (in different age phases), which found that an unhealthier diet was linked to excess weight[16,24]. For instance, Bodega et al.[16] found that BMI (z-score) mean was significantly lower in the "Traditional" cluster (i.e., high intake of fresh and fried fish and meat, cold cuts, pasta, rice, and sweetened milk) and "Healthy" cluster (i.e., high intake of vegetables, fruit with no added sugar, and unsweetened cereals), than in the "Processed" cluster (i.e., high intake of chocolate, candy bars, pizza, crisps, popcorn, candies, and ice cream) in their study including Spanish adolescents. Pérez-Rodrigo et al.[15] found that Spanish children and adolescents with an unhealthy lifestyle (including dietary patterns) showed lower odds of having excess weight. However, this association was not statistically significant. This discrepancy may be explained by the different age of children analyzed and certain lifestyle factors (e.g., physical activity, parental education, and household income) that could have an influence on the dietary cluster patterns obtained[14]. In addition to this, we found higher odds of having excess weight and obesity in Cluster 2 (moderately healthy) than in Cluster 1 (the

healthiest) (although it was not statistically significant). One possible explanation about the lack of statistical significance could lie in the fact that Cluster 2 showed a slightly lower intake of fruits and vegetables than the healthiest cluster (i.e., Cluster 1). Furthermore, Cluster 2 showed the highest consumption of certain protein-rich foods (e.g., meat, fish, eggs). The consumption of these foods has been related to excess weight among European preschoolers[26]. However, this same cluster also showed high levels of fruit and vegetable consumption (slightly lower than Cluster 1), which could explain the lack of statistical significance compared to the healthiest cluster or the lower odds ratios of having excess weight and obesity in comparison with the unhealthiest cluster (Cluster 3).

In relation to the specific food consumption among the different clusters established, our results found that the unhealthiest cluster (Cluster 3), which included the lowest fruit and vegetables consumption, showed a higher odd of having excess weight and obesity. One possible explanation for this result could lie in the high volume of fruits and vegetables. Thus, high-volume foods can take more time to eat compared with low-volume foods, and prolonging meal duration can enhance satiety and lower energy intake[27]. This is in line with a metanalysis by Poorolajal et al.[28] including 1,636,09 children and adolescents (aged 5-19) that found consumption of fruits/vegetables (among others) was associated with lower odds of having excess weight.

Another interesting aspect was that, in the unhealthiest cluster (Cluster 3), we found the highest consumption of sugar-sweetened beverages, fast-food, snacks, etc. Similarly, this cluster showed the highest obesity and excess weight prevalence. This result agrees with the results of the above mentioned metanalysis which also found that a high consumption of sugar-sweetened beverages was associated with greater odds of having excess weight[28]. Furthermore, other studies in Spain and in other countries[29], have found that some foods (e.g.,

sugar-sweetened beverages, snacks) were associated with a higher odd of having excess weight, in comparison with other healthier dietary patterns. One plausible reason justifying this finding is that all of these foods are considered ultra-processed. Recently, García-Blanco et al.[30] found that ultra-processed foods represent 37.64% of total energy intake in a Spanish cohort of preschoolers. The intake of this type of food has been linked with a higher dietary risk of associated non-communicable diseases (e.g., excess weight), since they are rich in calories, low in nutrients and may contribute to a higher caloric intake[31]. Likewise, a dietary pattern characterized by a high energy-dense and low-fiber ultra-processed foods at 3 years is linked with excess weight and a high BMI later in childhood[32]. Moreover, an ultra-processed diet (e.g., snacks, cookies) is consumed significantly faster than an unprocessed diet (e.g., fruits, vegetables), which may contribute to a greater caloric intake[33]. In this sense, the most common cause of obesity in children is a positive energy balance due to caloric intake in excess of caloric expenditure combined with a genetic predisposition for weight gain[34]. Another plausible reason is that these ultra-processed foods are more palatable than unprocessed foods, which may affect normal appetite regulation[35] and, therefore, lead to increased calorie intake and excess weight problems.

On the other hand, although our results were adjusted for both sociodemographic (i.e., socioeconomic status, nativity status) and lifestyle factors (i.e., physical activity, screen time, sleep duration) it is interesting to highlight their characteristics according to the clusters established. Thus, a higher proportion of participants in the cluster characterized by the unhealthiest dietary pattern (i.e., Cluster 3) presented a low socioeconomic status, compared to the other two healthier groups. In this sense, unhealthier diets have been related to lower maternal educational level and parental unemployment[36], being both of these factors closely related to lower socioeconomic status. Similarly, in Spain, the existence of a significant

disparity in the weight status of schoolchildren according to family income level and parents' level of education has been pointed out[3]. In addition, the unhealthiest dietary pattern cluster (Cluster 3) reported the lowest physical activity levels, the highest recreational screen time and the lowest sleep duration. A significant association has been pointed out between more appropriate levels of these lifestyle behaviors (i.e., physical activity, recreational screen time and sleep duration) and adiposity in this age phase[37]. However, the overall prevalence of meeting with recommendations for these behaviors is low worldwide among preschoolers[38], as well as in Spain[39].

Some limitations and strengths of this study should be recognized. First, owing to the cross-sectional nature of the study it is not possible to establish the direction of the association, thus future studies of a longitudinal design are warranted. Second, excess weight was determined by height and weight measurements reported by parents or guardians, which could have introduced measurement error. Likewise, self-report questionnaires were used; therefore, the risk of social desirability and recall bias cannot be ruled out. In this regard, adults with obesity tend to underestimate carbohydrate-rich foods in particular[40] and thus, parents or guardians with obesity may have overestimated their children's intake. Moreover, parental feeding practices were not assessed in this study, which could influence on both dietary patterns[41] and excess weight[42]. Finally, it should be noted that we analyzed the study association in a large and representative sample of preschoolers from an entire country; therefore, the evidence provided is robust and has high external validity.

In conclusion, having a dietary pattern considered unhealthy, characterized by a lower intake of vegetables and fruits, and a higher consumption of confectionery products, sugar-sweetened beverages, fast-food and snacks, was associated with higher prevalence of excess weight and obesity in comparison with other considered healthier clusters. These findings

are clinically significant since unhealthy dietary patterns are a major worry in the development of childhood obesity. Moreover, these results could have public health repercussions by denoting that improving diet quality could be a strategy by which to prevent obesity and excess weight at early ages. Given that most obese children do not have an underlying endocrine or single genetic cause for their weight gain[34], public policies are needed to reverse this worrisome situation. However, these results need validation in prospective studies specifically designed to assess the medium- and long-term effects of changes in diet quality in preschoolers with obesity/excess weight throughout their childhood, adolescence and young adulthood.

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Data Availability Statement

The datasets generated during and/or analyzed during the current study are available in the Ministry of Health, Consumer Affairs and Social Welfare (Spain) repository, https://www.sanidad.gob.es/estadisticas/microdatos.do

Conflict statement

The authors declare no conflicts of interest.

Patient consent

Not applicable.

Author contributions

Conceptualization, J.F.L.-G., methodology, J.F.L.-G; software, J.F.L.-G.; validation, J.F.L.-G.; analysis, J.F.L.-G.; data curation, J.F.L.-G; writing—original draft preparation, J.F.L.-G.; supervision, J.F.L.-G., P.J.T.-L.; writing—review and editing, L.E., J.A.-H., J.A.-A., J.M.P.R., H.G.-E., R.L.-B., and P.J.T.-L. All authors have read and agreed to the published version of the manuscript.

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Figure legend

Figure 1. Standardized scores of different food groups among the different established clusters in Spanish preschoolers.

Figure 2. Association between the membership of a certain cluster and excess weight or obesity in Spanish preschoolers.