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ORIGINAL ARTICLE

Variations of body composition, physical activity and caloric intake in schoolchildren during national holidays

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Abstract Scientific literature has described that a significant body weight increase in schoolchildren occurs during some holiday periods (summer, winter, and thanksgiving holidays), harming their health. In this regard, it is thought that this phenomenon is mainly due to changes in eating habits and the variation in levels of physical activity; however, this approach has not yet been explored during national holidays (NAH) in Chile.

Purpose To determine any changes in body composition, physical activity and caloric intake during NAH.

Methods A total of 46 schoolchildren (24 boys, age 10.5 ± 0.5; BMI 21.7 ± 4.7) participated. Measurements were performed 2 days before and after the NAH (9 days). Weight was measured and fat percentage was established using the Slaughter formula. Levels of physical activity were measured with accelerometers, validating 3 weekdays and 1 weekend; caloric intake was established through a 24-h recall.

Results Weight, percentage of fat and caloric intake increased significantly (250 g, 2.2 % and 733.3 kcal, respectively; $p < 0.05$); however, none of the variables of physical activity showed significant changes.

Conclusion The change in caloric intake seems to be the main cause of weight and fat gain during the NAH.

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Introduction

Over the past 30 years, there has been a considerable increase in obesity levels worldwide, especially in children and adolescents [1]. A report by the Organisation for Economic Cooperation and Development establishes Chile among those countries that have the highest rates of obesity in children from 5 to 17 years, with a prevalence of 27.1 % in girls, and 28.6 % in boys [2]. Here, the currently high rate of physical inactivity and eating behaviors in adolescents [3, 4] must be considered, which greatly increases the risk of these children becoming obese in adulthood [5].

In order to prevent abrupt increases in child weight during the year, certain critical periods where students significantly modify their eating habits and physical activity have been previously studied [5, 6]. This phenomenon of drastic change is mainly observed during the summer, winter, and thanksgiving holidays, among others [6–8]. Educational institutions, then, have a great responsibility in promoting healthy lifestyle habits, considering children spend most of the day in school rather than home [6].

In addition, it has been shown that only a few weeks of overeating and reduced physical activity generates several harmful effects on the body such as increased fat percentage, waist circumference, body mass index, total cholesterol and triglycerides [8]. These indicators can remain elevated for several months and even years, increasing the likelihood of being overweight or obese in adulthood [7, 9].

The National Holiday in Chile (NAH) is held in September, spring in the southern hemisphere. It is a traditional food-focused celebration where schoolchildren

significantly increase their body weight (in just 9 days). In this regard, it has been shown that educational talks on healthy habits prior to NAH seem to be a tool that could help in preventing weight gain [8]. It has also been shown that overweight or obese children are much more likely to increase their weight in this short period of time [8, 10]. However, the literature has not approached the possible causes associated to the energy balance that might be affecting the body weight of schoolchildren.

Therefore, this study aims first to establish whether an increase in body weight, fat mass, and waist circumference is observed in schoolchildren during the NAH and, second, determine intake and energy expenditure variations as possible causes of those phenomena.

Materials and methods

The study was conducted in accordance with international ethical standards for research involving human subjects of the current Declaration of Helsinki of 1964 (last modified in 2013) and was approved by the local ethics committee. A meeting was held with the guardians of the schoolchildren, and they were informed about the objectives and procedures of the study. A signed consent for the participation of their children was required.

A total of 46 schoolchildren (24 boys and 22 girls) between the ages of 10 and 11 participated in the study (age 10.5 ± 0.5 years; weight 48.4 ± 13.8 kg; height 1.50 ± 0.06 m; BMI mean 21.7 ± 4.7 kg/m^2). According to their body mass index (BMI) [11], 23 were classified as normal weight (BMI mean 18.0 ± 1.0 kg/m^2), 11 were overweight and 12 were obese (BMI mean 25.2 ± 36 kg/m^2). The NAH lasted 9 days (full holiday time) from Saturday to Sunday and the schoolchildren were evaluated during the 2 days prior (Thursday and Friday, first week) and after (Monday and Tuesday, second week). Height was measured using a stadiometer (model 216, Seca®, Germany) and body weight with a scale previously calibrated to an accuracy of 0.1 kg (model TBF-300A, Tanita®, Japan). Waist circumference and body fat percentages were calculated according to protocol for assessing body composition as proposed by Spanish Group of Kinanthropometry (GREC, in its Spanish acronym) [12] in 2009. To calculate fat mass, the calf skinfold and triceps was measured using the Slaughter formula for children [13].

All participants were measured first thing in the morning, whereupon they were asked to remain in shorts and a t-shirt while removing their sports shoes. Boys were assessed by a man and girls by a woman, both of whom were from the study team. Any children with stomach or other problems that might possibly interfere with the objectivity of the data collected (two cases) were excluded from the study.

Children participating in the study were required to use accelerometers (GT3X+, ActiGraph Manufacturing Technology Inc.®, USA) on the right side of their waists to determine physical activity levels (7 days). For better safety, the accelerometer kit was fixed to an elasticized belt, as it tends to move with habitual movement. At least 3 weekdays and 1 day of a weekend were validated using Actilife 6 (ActiGraph Manufacturing Technology Inc. ®, USA) software. For the purposes of this study, a day was considered valid with at least ten continuous hours of measurement; therefore, accelerometers could only be removed while sleeping and showering. The Freedson equation from 1997 was used to determine the energy expenditure; the Trost algorithm for children, from 1998, their MET and the time spent on sedentary, light, moderate, and vigorous physically intensive activities [14]. The total number of daily steps and steps per minute were also determined. Five-second measurement frequencies were established, as children show sudden and very short duration movement patterns.

The 24-h nutrition recall was applied at school 2 days before (Thursday, 11 and Friday, 12 September) and 1 day after (Monday, 22 September) the NAH. A group of nutrition experts guided and supported each child to complete his 24-h recall (face-to-face method). Schoolchildren were the only respondents and parents were not involved. Children were asked to describe and quantify the consumption of food and beverages during the previous day (from breakfast to the last meal or drink of the night). This description also included characteristics of the food (fresh, precooked, frozen, canned, preserved), condiments, as well as if they had eaten at home or away from home. Each interview lasted on average between 20 and 30 min. Then every nutritionist using a computer program determined the intake of food, energy and nutrients [15].

Statistical analysis

The GraphPad Prism statistical software (GraphPad Software Inc.®, USA) version 5.00 was used to determine the mean and standard deviation (mean ± SD) of all data in this study. The test for normality (Shapiro–Wilk) was applied, and then the pre- and post-holiday means were compared using a Student's *t* test for parametric data and a Wilcoxon test for nonparametric data. An alpha value of $p < 0.05$ was set as statistically significant.

Results

Results showed that body weight, percentage of fat, and energy intake increased significantly after the NAH ($p < 0.05$). On the other hand, no significant differences in

Table 1 Variation in body weight, energy intake and physical activity levels before and after the NAH

	Pre-NAH	Post-NAH	Variation	Δ %	*p* value
Body composition					
Weight (kg)	48.9 ± 15.3	49.1 ± 15.3	0.250	0.51	0.012*
Waist circumference (cm)	72.6 ± 11.0	73.0 ± 11.2	0.4	0.55	0.307
Fat mass (%)	27.8 ± 9.2	30.0 ± 10.9	2.2	2.2	0.008*
24-h recall					
Caloric intake (kcal)	1663.1 ± 471.3	2396.4 ± 767.9	733.3	44.09	0.000*
Physical activity levels					
Energy expenditure (kcal)	157.0 ± 107.8	151.6 ± 107.8	1.9	−3.43	0.678
Sedentarism (%)	69.4 ± 5.6	70.5 ± 7.7	1.1	1.58	0.478
PA light (%)	23.4 ± 3.9	22.5 ± 5.6	−0.9	−3.84	0.459
PA moderate (%)	4.4 ± 1.4	4.2 ± 1.6	−0.2	−4.54	0.643
PA vigorous (%)	2.8 ± 1.7	2.8 ± 2.0	0.0	0.0	0.949
PA moderate–vigorous (%)	7.1 ± 2.9	7.0 ± 3.4	−0.2	−2.7	0.550
Total steps (day)	8143.2 ± 2803	8163.9 ± 3913	20.7	0.25	0.987
Steps (min)	11.3 ± 3.6	10.9 ± 4.7	−0.4	−3.53	0.533

Values pre- and post-NAH expressed as mean ± SD

PA physical activity, Δ % percentage variation

* $p < 0.05$

any of the variables related to physical activity levels were obtained (Table 1).

When comparing normal-weight children with the groups of overweight and obese children, no significant differences were observed in the changes in any of the relevant variables of the study, such as body weight ($p < 0.222$), fat percentage ($p < 0.629$), waist circumference ($p < 0.375$), energy expenditure ($p < 0.222$), and caloric intake ($p < 0.175$).

Discussion

This study has investigated the possible causes of weight gain during the NAH in schoolchildren, information which is nonexistent in the literature and which is crucial to understanding such a situation. Therefore, the variation in energy intake and expenditure derived from diet and physical activity, respectively, were assessed.

The results obtained in this study regarding body composition (body weight gain and fat mass) are consistent with the findings reported in the literature with respect to the effect of the energy imbalance generated during periods of school recess [6, 8, 10, 16].

Several studies have utilized a standardized protocol to determine the effects of overeating on various health-related variables (duration of 4 weeks, increase of 5–15 % in body weight through the increase in daily caloric intake [∼50–70 %] [17], and limitation of physical activity to <5000 steps/day) [5–9]. This standard protocol design has identified significant changes in body composition (body weight, percentage body fat, waist circumference, basal metabolic rate) [9, 19] and has also shown an increase in alanine aminotransferase [18], fasting insulin [17], systolic blood pressure, LDL-Cholesterol, apolipoprotein B, fat volume in the abdominal region in men [19], C-reactive protein, and a reduction in insulin sensitivity [20]. It should be noted that most studies have measured healthy young subjects; as yet, not one has been applied to children and adolescents—that said, it is likely that any analogous occurrences in adult populations concern what might happen in schoolchildren. This oversight highlights the severity of the situation and reinforces the importance of preventing these abrupt weight gains for both school and adult populations.

Furthermore, subsequent loss of any weight gained during this short period seems to be a rather difficult task to achieve in the short term [7, 9]. It is quite possible that shedding the weight gained might not be achieved before the next critical period, thus generating a cumulative effect during the year that gradually damages the health of children.

For the reasons outlined above, it is essential to establish the periods during the year in which schoolchildren are most susceptible to weight gain in order to offer educational programs in schools to prevent this situation; viz., schools play an important therapeutic role in this regard [6, 21].

Various short- and long-term programs have been shown to help prevent body weight increases in children [8, 21,

22]. However, most investigations assessing the critical periods in weight gain during the school year are descriptive, and indeed, those that implement intervention programs to control this situation are very scarce.

One such study, implementing a series of educational talks on preventive healthy lifestyle choices during the week prior the NAH, proved to be significantly effective in controlling rising weight in children [8]. These interventions were performed during physical education classes and specifically discussed issues about habits adopted by children during NAH and how they could help to reverse them. The main focus of these lectures was promoting physical activity and healthy eating.

This same study [8], by Cristi-Montero, also showed that obese and overweight children (two groups already more prone to changes in body composition during critical periods) were 6.31 times more likely to gain weight if not participating in the preventive program. In the present study no significant differences between the normal weight group and the overweight or obese children were observed, this might be due to the small sample size in this investigation. Future studies should consider increasing the sample size to detect possible differences between these two groups.

Moreover, while it is important to consider published scientific evidence on this matter in order to make proposals to the community to prevent this phenomenon, caution should also be taken when extrapolating these programs from one country to another, because each has very different socio-cultural contexts. For example, some countries have more vacation periods during the year than others. The duration of these periods differ between countries and even between regions within the same country. In addition, the season (weather factor), level of education, and socioeconomic status are variables that strongly influence variations in levels of physical activity and the type of food consumed by schoolchildren during the holidays [22, 23].

Conclusion

In conclusion, we found in our small sample of participants that during one national holiday in Chile children increased their food intake which may account for the increase in body weight found. We did not find a difference in the amount of physical activity engaged in during the holiday and believe that the change in weight is mainly attributed to the drastic changes in eating habits and not with a decrease in energy expenditure. It is important to continue working on this subject through experimental studies to both confirm and expand upon current results.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was conducted in accordance with international ethical standards for research involving human subjects of the current Declaration of Helsinki of 1964 (last modified in 2013) and was approved by the local ethics committee. Previously attached document.

Informed consent A meeting was held with the guardians of the schoolchildren, and they were informed about the objectives and procedures of the study. A signed consent for the participation of their children was required.

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