Sustained impact of the "Healthy Habits, Healthy Girls – Brazil" school-based randomized controlled trial for adolescents living in low-income communities

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A B S T R A C T

Pediatric obesity is a major public health concern in low- and middle-income countries, such as Brazil. There is an urgent need for preventive programs for adolescents and, the assessment of their sustained impact. This paper reports the longer-term (6-month post intervention) effects of the "H3G-Brazil" obesity prevention program on weight status and weight-related behaviors. A cluster randomized controlled trial starting with 10 public schools in the city of São Paulo, Brazil involved 253 adolescent girls [mean (se) age = 15.6 (0.87) years]. Body mass index (BMI), waist circumference (WC), dietary intake, physical activity (PA) and sedentary behaviors (SB) were assessed at baseline, immediate post-intervention and 6-month post-intervention (follow-up). ANCOVA was performed using intention to treat principles. There was no effect on BMI, the primary outcome. Although, meaningful increases occurred in waist circumference for both groups, the intervention group presented a lower increase ($F = 3.31$, $p = 0.04$). This effect size, however, was lower than the criterion for small ($d = 0.102$). Unfortunately, significant results favored the control group for time spent on TV/weekdays ($F = 5.13$, $p = 0.01$), TV/weekends ($F = 5.46$, $p = 0.01$) and sedentary behaviors/weekdays ($F = 5.32$, $p = 0.04$). No other significant results were found. This obesity prevention intervention among Brazilian adolescent girls did not have the desire effect on BMI. The significantly lower increase in waist circumference in the intervention groups is inconsistent with the adverse changes detected in sedentary time.

1. Introduction

Since treatment of obesity is difficult, costly and often unsuccessful (Selker et al., 2010), preventive interventions are necessary. Most research on prevention interventions were conducted in high-income countries (Baranowski, 2012) and targeted only obesity. Since obesity is more common among lower socioeconomic groups, interventions are needed for low- to middle-income (LMIC) countries, including Brazilian adolescents from low-income socioeconomic status (Araujo et al., 2017; Boff et al., 2017; WHO, 2012). Schools provide easy access to deliver prevention interventions among adolescents who are "at risk" of obesity and other weight-related problems (Hills et al., 2015; Kelishadi and Azizi-Soleiman, 2014). Obesity prevention interventions should target those most susceptible, such as adolescents of low-income backgrounds (Smith et al., 2014b). The global prevalence of obesity is higher among female compared with male youth (Ng et al., 2014). Evidence from a

representative cross-sectional study showed that Brazilian adolescent girls were more likely to report inadequate dietary and physical activity patterns (Azeredo et al., 2016). They regularly ($\geq 5 \times$/week) consumed foods considered to be unhealthy, e.g., savory snacks, deep-fried salty snacks, processed meats, sweets and cookies (Azeredo et al., 2014); and were less physically active (Hallal et al., 2010) compared to the boys. Furthermore, girls were more prone to engage in unhealthy weight control behaviors, such as fasting, dieting and using meal replacements in an attempt to reduce or maintain their weight. These can be harmful since they can lead to both obesity and eating disorders (ED) (Haines and Neumark-Sztainer, 2006; Neumark-Sztainer et al., 2002).

Studies in LMIC have not focused on adolescent girls living in low-income communities or on changing their weight related behaviors, which can combine in complex ways to exert a cumulative effect on weight status (Leme and Philippi, 2015). School-based obesity prevention interventions targeting multiple components seem to be more

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                      ┌─────────────────────────┐
                      │   Schools assessed for   │
                      │    eligibility (n=13)    │
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Schools assessed for eligibility (n=13)

Excluded (n=3)
- Not meeting inclusion criteria (n=1)
- Declined to participate (n=2)

Schools randomized (n=10)

Control group
- Schools allocated (n=5)
- Individuals allocated (n=111)

H3G group
- Schools allocated (n=5)
- Individuals allocated (n=142)

Lost schools (n=0)
Lost individuals (n=28)
Reasons:
18 absent on the testing day
10 refused to be measured

Lost schools (n=0)
Lost individuals (n=35)
Reasons:
12 left the program
22 absent on the testing day
1 pregnant

Lost schools (n=0)
Lost individuals (n=56)
Reasons:
26 absent on the testing day
30 refused to be measured

Lost schools (n=0)
Lost individuals (n=53)
Reasons:
12 left the program
40 absent on the testing day
1 pregnant

111 analysed for primary outcome
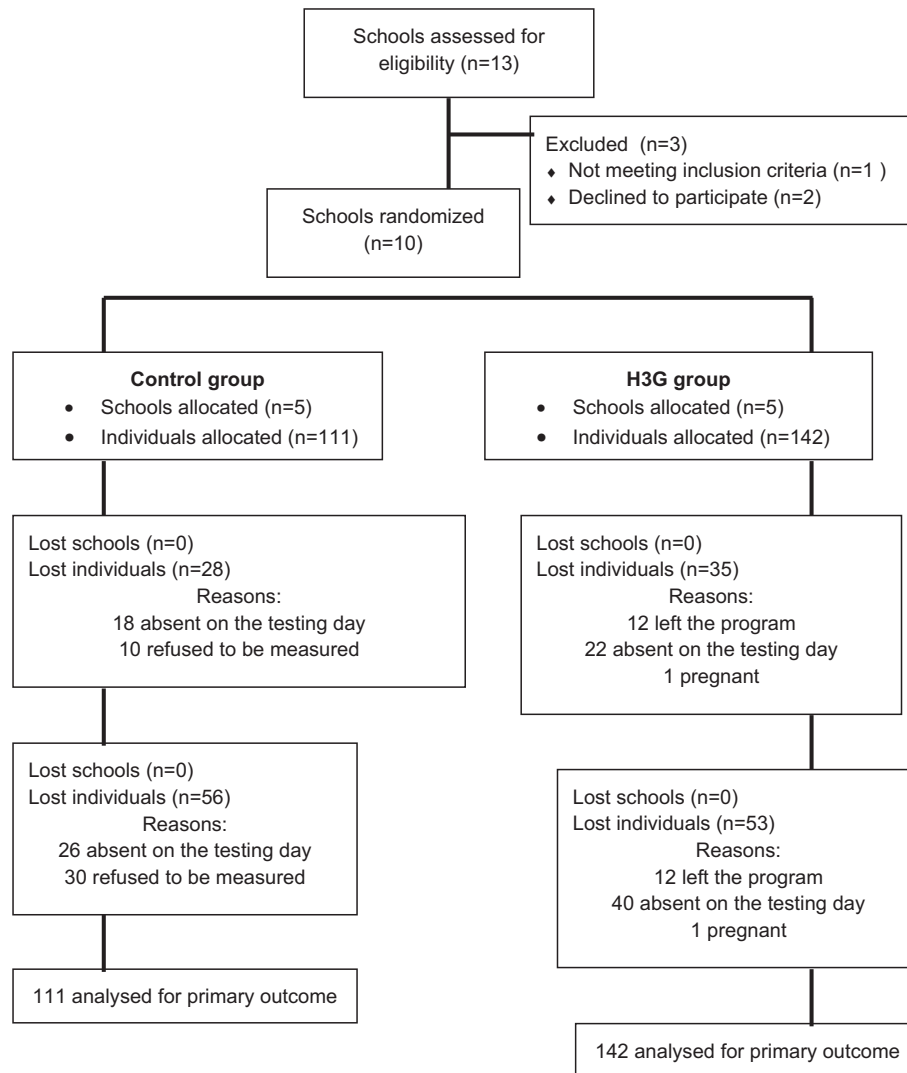
142 analysed for primary outcome

Fig. 1. Flowchart of the "Healthy Habits, Healthy Girls – Brazil" study.

successful than those that target either diet, physical activity or sedentary behaviors separately (Leme and Philippi, 2015). The "Nutrition and Enjoyable Activity for Teens Girls" (NEAT Girls) (Lubans et al., 2010) program was created to target school-based diet, physical activity and sedentary behaviors among girls in Australia. The "Healthy Habits, Healthy Girls -Brazil" (H3G-Brazil) adapted the NEAT Girls Study to the Brazilian context (Leme et al., 2016; Lubans et al., 2016a) and added a focus on eating disorders. H3G-Brazil refined NEAT for implementation in schools in São Paulo, Brazil using literature reviews from theory based trials (Leme and Philippi, 2015).

This paper reports the longer-term (6-month post intervention) effects of the "H3G-Brazil" obesity prevention program on weight status and weight-related behaviors. The primary goal of H3G-Brazil was to impact BMI and to teach students the skills to use healthy strategies for long-term changes, to be shared with family and friends (Leme and Philippi, 2015) and to reduce unhealthy weight control behaviors and weight stigma. The primary hypothesis was that H3G-Brazil would improve diet and physical activity behaviors and as a consequence prevent unhealthy weight gain in adolescents.

2. Methods

This study was registered in ClinicalTrials.gov (NCT02228447) and reported according to the CONSORT checklist (Moher et al., 2010).

2.1. Study design

Details of the study design, protocol and participant characteristics at baseline were reported in detail elsewhere (Leme and Philippi, 2015). In summary, "H3G-Brazil" was assessed through a cluster randomized controlled trial design and included 10 public technical high schools (i.e., 5 intervention and 5 control schools) located in low-income communities in the city of São Paulo, Brazil. Recruitment and baseline assessments were conducted prior to randomization. The schools were pair matched based on geographic location, size and demographics and randomized within pairs by an individual not involved in the research project. For instance, the numbers one or two were written on individual small papers then folded, and added to a plastic bag. Each number represented a school (e.g., number 1 was school A). Schools remained in their allocated group for the duration of the study. Trained undergraduate and graduate students conducted follow-up assessments blinded to group allocation (Leme and Philippi, 2015).

2.2. School selection and participants

Technical high schools in Brazil are intended for adolescents (i.e., 14 to 18 years old) from low-income backgrounds. These schools deliver regular high school education, along with vocational training in different areas (e.g., chemistry, environmental science, visual

communication, health, and business and management). The adolescents spend full-time during weekdays at schools, i.e., part of the day at regular high school class and the other learning specific technical skills. Technical public schools that offer nutrition and dietetics training (13 of 43 schools) in the city of São Paulo were selected for the current study because they provided opportunities for partnership with accredited dietitian teachers who allowed their Nutrition and Dietetics students to work as research assistants (RA) (i.e., 3–4 individuals per school). Once schools agreed to participate in the study, teachers invited the girls to voluntarily participate. Eligible girls were not enrolled in any nutrition, dietetics or other health-related courses, and were attending 1st to 3rd year high school, concomitantly with the following training courses: building trades, business and management, chemistry, environmental sciences, and visual communication. One class per school participated in the study. The total number of adolescents from both sexes in each class ranged from 30 to 35 individuals. On average 30 girls from each school participated in the study (i.e., 2 classes per school).

Ethics approval was obtained from the Institutional Review Board of the School of Public Health, University of São Paulo, Brazil (protocol no. 01658112.6.0000.5421). School principals, teachers, parents/caregivers and study participants provided written informed consent.

2.3. Statistical power

Sample size was based on change in BMI. The power calculation was based on power of 80% and significance of 5% (two-tailed) and equal proportion of non-exposed and exposed to the intervention. Considering potential dropout of 20%, 266 participants were necessary to detect a between-group difference in BMI of $0.4 \, kg/m^2$ and 27 participants from each of the 10 schools were required. Since we were only able to recruit 253 participants, and dropout exceeds 20% in both groups, this study was underpowered to detect changes. Baseline assessments were carried out before randomization during February/2014. The immediate post-intervention assessments were completed during August/2014 and have been previously reported (Leme et al., 2016). The present study reports the 6-month post-intervention follow-up body composition and weight related behavioral outcomes (February/2015) (Fig. 1).

2.4. Intervention

H3G-Brazil was based on Social Cognitive Theory (SCT) (Bandura, 1986), which specifies that learning occurs by observing others (i.e., modeling) (Bandura, 1986; Bandura, 2004). Thus, H3G-Brazil had strong peer and parent involvement to help the girls acquire diet, physical activity and eating disorder preventive behaviors.

H3G-Brazil, adapted from the Australian NEAT Girls study (Lubans et al., 2010) was a 6-month obesity prevention program with nutrition, physical and sedentary behaviors components to help the girls achieve healthy food choices, promote lifestyle and lifetime physical activity, and reduce screen-time activities. Eating disorders components were added to the obesity prevention program since obesity and eating disorders have shared risk factors (i.e., weight teasing, body satisfaction and weight control behaviors) (Haines and Neumark-Sztainer, 2006; Neumark-Sztainer, 2005). There were 10 intervention components described elsewhere (Leme and Philippi, 2015) guided by social theory concepts, to help the girls acquire the desired behaviors (Supplement Table 1).

2.5. Data collection

Trained research assistants collected the data at the schools. Physical assessments were conducted in a sensitive manner and questionnaires were completed after the physical assessments in exam-like conditions.

2.6. Outcomes

Body mass index (BMI) was the primary outcome (Leme et al., 2016; Lubans et al., 2010; Smith et al., 2014a). Weight and height were measured using a portable digital scale (Plenna® São Paulo, Brazil) and a stadiometer (Alturaexata® Minas Gerais, Brazil). BMI was calculated using the standard formula (kg/m^2). BMI percentile was used to classify weight status (i.e., underweight, normal weight, overweight and obese) according to World Health Organization data (de Onis, 2007). BMI z-scores were also calculated (Cole and Green, 1992). A secondary outcome was waist circumference, assessed to the nearest 0.1 cm against the skin using an inelastic tape in line with the umbilicus (Pereira et al., 2015).

The adapted and validated (Sao-Joao et al., 2013) version of the Godin-Shephard Leisure-Time Physical Activity Questionnaire was used to assess physical activity. Participants were classified into inactive (i.e., ≤ 30 min/week), moderate (MPA) (i.e., 30 to 90 min/week) and extensive physical activity (EPA) (i.e., ≥ 90 min/week) according to the World Health Organization Physical Activity guidelines (WHO, 2010). Students' reported hours per week were averaged.

Girls self-reported their time spent on television, computer use, electronic devices such as smartphones and tablets, and non-active videogames using the adapted New Moves Questionnaire (Conceicao et al., 2017) which was transculturally adapted. In order to ensure translation accuracy, two researchers fluent both in English and Portuguese independently translated the English version of the screen-time questionnaire into Portuguese. Then it was compared and reconciled with each other, also by an English as a second language teacher to create the 1st version of the questionnaire. Next, another researcher fluent in English and Portuguese back translated this version to English and compared it with the original version. No discrepancies were found. A specialist panel of nine experts in the areas of physical activity, sedentary behaviors, adolescents, or questionnaire cultural adaptation was consulted to review and improve a final version. This was administered to 173 adolescents and again to a subgroup (n = 22) two-weeks later to assess test-retest reliability. For each type of screen-media use, participants were to report daily average hours during weekdays and weekend days for the last 7 days with categorical response options from zero hours/day to ≥ 5 h/day. The sum of screen-time activity time was calculated. Internal consistency was acceptable (α = 0.50 to 0.73).

Dietary intake was assessed using the "Brazilian Food Frequency Questionnaire based on the Food Pyramid (BFFQ-FP)" (Martinez et al., 2013). The BFFQ-FP was a 50-item tool consisting of two parts: (i) a front page with food items from the eight food pyramid groups, i.e., items that should be eaten on a daily basis (also called core food items); and (ii) a back page with the "SoFAS" (Solid Fats and added Sugars) items, such as soft drinks, sweetened juices, ready-to-eat cereals and Brazilian salty pastries (e.g., "deep-fried chicken cakes" and cheese bread). The girls reported the frequency and amount eaten in usual measures (units, cups and spoons) of each food item. The 7-category frequency scale was: never, ≤ 1×/month, 1-3×/month, 1×/week, 2–4×/week, 1×/day, and ≥ 2×/day. The number of servings/day of each Brazilian Food Pyramid group was calculated and the total kilocalories/day reported. Total kcal was calculated with the aid of the Virtual Nutri® software (Philippi, 2012) and the Brazilian food table (Philippi, 2013).

For the number of food groups and total kilocalories, the girls reported the quantity of each food item consumed, and this quantity was transformed to daily servings using codes (i.e., codes represent an estimate of the daily servings). After calculating the daily servings of each food item, the foods were added to the respective eight groups according to their main(s) nutrient(s) composition. Some items needed to be aggregated into more than one group (e.g., pizza which was added to the "Rice (…) group" due to the main composition is carbohydrates; "Cheese (…) group" main composition proteins and calcium; and oil

group). One serving for each group has a kilocalorie equivalent, and so the reported number of servings of each food group was multiplied by their calorie equivalent. After, the calories of each food group were calculated, the total energy intake was estimated. Energy intakes < 500 kcal or > 5000 kcal (Philippi and Barco Leme, 2015) were removed from the data base (57 from baseline, 29 from immediate post-intervention and 25 from 6-month post-intervention). The eight food pyramid groups were divided into four levels according to their main nutrient composition and adapted from the first USA Food Pyramid (Philippi et al., 1999).

2.7. Data analyses

Descriptive statistics were conducted using mean (standard error) for continuous variables and frequency (%) for categorical variables. Chi-square and independent *t*-tests were used to compare retained and dropped out participants in terms of the differences in socio demographic variables. Mixed model repeated measures analysis of covariance (ANCOVA), controlling for the baseline values (de Boer et al., 2015; Van Breukelen, 2006) and Cohen's d effect size were performed to examine differences in the mean percentage change in the outcome variables between the groups over time. Cohen's d is the standardized mean difference between the population mean. A d of 1 indicates the two groups' means differ by one standard deviation; a d of 0.5 indicates that two groups' means differ by half a standard deviation; and so on. Cohen suggested that d = 0.2 be considered a "small" effect size, 0.5 represents a "medium" effect size and 0.8 a "large" effect size, e.g., if two groups' means don't differ by 0.2 standard deviations or more, the difference is trivial, even if statistically significant (Cumming, 2013). To minimize the problem of participation bias, all statistical analyses followed the intention-to-treat principle (Gupta, 2011), significance was set at p < 0.05 and the confidence interval was estimated to be 95%. All analyses were conducted using SPSS version 21.0 for Mac (SPSS Inc., Chicago, Illinois, USA).

3. Results

3.1. Participants

At baseline, 2.8% of the girls were classified as underweight, 70.4% as normal weight, 18.6% as overweight, and 8.3% as obese. Most were Caucasian/White (55.6%), followed by Brown (26.3%) and African Descent (13.9%). Most were born in the state of São Paulo, Brazil (89.7%). The mean (standard deviation – sd) age of the sample was 15.6 (sd 0.87) years. At the 6-month post-intervention assessments, 89 (62.7%) and 55 (49.6%) girls were retained in the intervention and control groups, respectively (Fig. 1) and no significant differences were found between retained and dropped girls in relation to socio-demographic variables (Table 1).

3.2. Effects of the "Healthy Habits Healthy Girls, Brazil" program and outcome variables

Body composition variables including weight, height, BMI and waist circumference were examined. Table 2 presents the mean and standard deviations of intervention and control groups at three time points. ANCOVA revealed no significant effect for BMI, the primary outcome (F = 2.120, p = 0.135). Girls from both the intervention and control groups increased waist circumference, but a higher increase was found for the control at the 6-month post-intervention (77.7 cm, se 10.2) vs intervention group (76.7 cm, se 8.7) (F = 3.31, p = 0.03), resulting in a less than small effect size (d = 0.102). Significant adverse changes were found for time spent on TV/weekdays (F = 5.12, p = 0.01), TV/weekends (F = 5.46, p = 0.01) and total sedentary behaviors/weekdays (F = 3.31, p = 0.04). No other significant results were found.

Table 1
Social demographics characteristics of the study participants: retention vs. dropout girls. São Paulo, Brazil, 2017.

	Total	Retention	Dropout	p-Value
Age [mean (se)]	15.61 (0.05)	15.64 (0.07)	15.58 (0.08)	0.604
Weight [mean (se)]	57.85 (0.76)	57.45 (0.90)	58.40 (1.33)	0.544
Height [mean (se)]	1.61 (0.00)	1.60 (0.00)	1.61 (0.00)	0.348
Waist circumference [mean (se)]	73.97 (0.67)	73.82 (0.81)	74.16 (1.16)	0.808
Body mass index (kg/m^2)	22.23 (0.25)	22.16 (0.30)	22.31 (0.43)	0.769
Weight status [n (%)]				
Underweight	7 (2.8)	3 (2.1)	4 (3.7)	0.826
Normal weight	178 (70.4)	104 (71.7)	74 (68.5)	
Overweight	47 (18.6)	27 (18.2)	20 (18.3)	
Obesity	21 (8.3)	11 (7.4)	10 (9.3)	
Ethnicity [n (%)]				
White/Caucasian	135 (52.5)	73 (52.5)	62 (59.6)	0.498
Brown	64 (24.9)	42 (30.2)	22 (21.2)	
African descendent	33 (12.8)	17 (12.2)	16 (15.4)	
Asian	7 (2.7)	4 (2.9)	3 (2.9)	
Native	2 (0.8)	2 (1.4)	–	
Other	2 (0.8)	1 (0.7)	1 (1.0)	
Parents' level of education [n (%)]				
High school or less	133 (54.7)	78 (56.1)	55 (52.9)	0.921
Technical school	29 (11.9)	16 (11.5)	13 (12.5)	
College education	50 (20.6)	29 (20.9)	21 (20.2)	
Post graduate study	19 (7.8)	9 (6.5)	10 (9.6)	
Don't know	12 (4.9)	7 (5.0)	5 (4.8)	

4. Discussion

"H3G-Brazil" was the first randomized controlled trial of a school based obesity prevention intervention among low-income girls in Brazil employing social cognitive constructs such as self-efficacy, social support and outcome expectations. The current study reports the 6-month post-intervention outcomes. At 6-month post-intervention, no effect was detected in the primary outcome, BMI. While waist circumference increased in both groups, it increased less so in the intervention group, resulting in a small significant effect size (d = 0.102). The null findings for BMI are consistent with previous obesity prevention interventions targeting older adolescents (i.e., 14 to 19 years old) which have generally been less successful compared to those conducted with children (Jones et al., 2011). One study evaluated the impact of a Self Determination and Social Cognitive based intervention on waist circumference among adolescent boys (Lubans et al., 2016b) and did not find a sustainable impact on the boys' waist circumference (Lubans et al., 2016b).

Adverse changes in sedentary behaviors were unexpected and to our knowledge unprecedented. The small effects and no significant findings for most of the weight-related behaviors are consistent with other obesity prevention programs worldwide (Ardic and Erdogan, 2017; Collins et al., 2013, 2014; Skouteris et al., 2016). Inaccurate measurement of health behaviors may be a contributing factor to the null findings (Baranowski and Lytle, 2015). Use of self-reported measurements, such as food and physical activity frequency questionnaires may have resulted in specific intakes or activities being missed due to omission from questionnaire items, or have led to misreporting of foods and activities specifically common with higher weight status (Collins et al., 2010).

Strengths of the current study included the cluster randomized controlled design, the lower income population of girls and the inclusion of a 6-month post-intervention assessment. However, some

Table 2

Effect of Healthy Habits, Healthy Girls, Brazil program of outcome variables of adolescents. Sao Paulo, 2015.

Variables	Groups	Baseline (T1)	Immediate post-intervention (T2)	6-month post-intervention (T3)	F	Cohen's D
		Mean (SD)	Mean (SD)	Mean (SD)	p-Value	
Physical variable						
Weight (kg)	Intervention	58.65 (11.25)	59.68 (10.88)	58.97 (10.57)	2.12	−0.042
	Control	57.38 (10.82)	58.40 (10.92)	58.51 (11.15)	0.135	
Height (cm)	Intervention	1.60 (0.05)	1.61 (0.06)	1.61 (0.06)	1.912	0.167
	Control	1.61 (0.06)	1.61 (0.06)	1.62 (0.06)	0.166	
Waist circumference (cm)	Intervention	74.61 (9.57)	74.52 (9.21)	76.73 (8.71)	3.314	0.102
	Control	73.85 (10.28)	74.80 (10.17)	77.69 (10.24)	0.038	
BMI (kg/m^2)	Intervention	22.43 (3.78)	22.70 (3.67)	22.48 (3.50)	0.426	−0.023
	Control	22.21 (3.49)	22.42 (3.46)	22.40 (3.61)	0.602	
BMI Z score	Intervention	0.41 (1.15)	0.29 (0.90)	0.20 (0.79)	1.028	−0.121
	Control	0.16 (1.18)	0.26 (0.94)	0.11 (0.68)	0.055	
Behavioral variables						
Light PA (h/week)	Intervention	125.13 (131.81)	157.60 (142.48)	132.53 (139.30)	0.578	−0.173
	Control	119.64 (146.76)	121.42 (133.86)	108.57 (133.82)	0.549	
Moderate PA (h/week)	Intervention	46.04 (19.06)	44.37 (16.20)	42.70 (18.61)	0.189	−0.428
	Control	36.78 (12.91)	39.64 (16.50)	35.71 (12.81)	0.807	
Extensive PA (h/week)	Intervention	38.66 (17.66)	43.52 (25.75)	44.15 (25.55)	0.156	−0.366
	Control	31.07 (3.90)	33.92 (12.42)	36.07 (16.58)	0.856	
TV weekdays (h/day)	Intervention	1.11 (1.03)	1.24 (1.09)	1.47 (1.28)	5.128	−0.135
	Control	1.61 (1.06)	1.21 (1.08)	1.31 (1.06)	< 0.01	
TV weekends (h/day)	Intervention	1.75 (1.44)	1.82 (1.42)	2.27 (1.49)	5.46	−0.295
	Control	2.29 (1.53)	2.15 (1.56)	1.88 (1.07)	< 0.01	
Computer weekdays (h/day)	Intervention	2.10 (1.32)	1.87 (1.47)	1.81 (1.55)	0.856	−0.099
	Control	2.18 (1.53)	1.95 (1.82)	1.65 (1.68)	0.425	
Computer weekends (h/day)	Intervention	2.71 (1.08)	2.29 (1.70)	2.32 (1.66)	0.737	−0.149
	Control	2.35 (1.63)	2.22 (1.68)	2.07 (1.69)	0.480	
Sedentary weekdays (h/day)	Intervention	3.22 (2.25)	3.11 (1.90)	3.28 (2.35)	3.315	−0.14
	Control	3.79 (2.07)	3.17 (2.17)	2.97 (2.01)	0.040	
Sedentary weekends (h/day)	Intervention	4.46 (2.69)	4.12 (2.41)	4.59 (2.65)	2.236	−0.257
	Control	4.64 (2.55)	4.38 (2.33)	3.96 (2.17)	0.109	
Rice Group (servings/day)	Intervention	8.62 (4.27)	6.93 (4.19)	9.66 (4.30)	0.514	−0.205
	Control	8.51 (3.71)	6.71 (4.68)	8.81 (3.94)	0.599	
Veggies group (servings/day)	Intervention	4.22 (3.32)	4.07 (3.15)	5.09 (3.45)	2.049	−0.35
	Control	4.24 (3.17)	2.75 (2.60)	3.92 (3.21)	0.133	
Fruits group (servings/day)	Intervention	0.72 (0.60)	1.13 (0.91)	1.23 (1.12)	0.033	−0.008
	Control	0.78 (0.61)	1.13 (0.87)	1.22 (1.56)	0.948	
Milk group (servings/day)	Intervention	2.14 (1.40)	1.74 (1.13)	2.29 (1.99)	1.029	0.051
	Control	2.17 (1.17)	2.26 (1.52)	2.38 (1.41)	0.359	
Meats group (servings/day)	Intervention	2.11 (0.90)	1.89 (0.95)	1.88 (1.08)	0.704	0.274
	Control	2.06 (0.91)	1.82 (0.74)	2.16 (0.94)	0.486	
Beans group (servings/day)	Intervention	1.53 (0.81)	1.45 (0.76)	1.53 (0.96)	0.245	0.011
	Control	1.56 (0.71)	1.58 (0.65)	1.54 (0.83)	0.783	
Oils group (servings/day)	Intervention	3.97 (1.22)	3.49 (1.17)	3.66 (1.35)	0.728	0.187
	Control	3.95 (1.38)	3.89 (0.89)	3.90 (1.19)	0.484	
Sweets group (servings/day)	Intervention	4.33 (1.13)	3.37 (1.33)	3.17 (1.46)	2.439	0.592
	Control	4.30 (1.14)	3.64 (1.16)	3.98 (1.24)	0.093	
EEI (kcal/day)	Intervention	3293.03 (754.46)	2818.12 (835.46)	2978.91 (981.31)	1026	0.123
	Control	3147.76 (848.27)	2975.31 (817.47)	3091.20 (809.33)	0.360	

Note: EEI: Estimate Energy Intake; PA: physical activity, SD: standard deviation.

limitations should be noted: the use of self-report measures to assess changes in health behaviors; low retention rate at follow-up; no correction for the substantial number of tests conducted; weight status using BMI and waist circumference parameters, which cannot precisely determine total body fat; the targeted nature of the intervention which may not be generalizable to other groups (e.g., male subjects, those from other socioeconomic strata and other regions in Brazil or other LMICs); although groups were randomized after baseline assessments, statistical differences between groups at baseline were detected and may have influenced the study findings, and the sample size was underpowered to test effects.

5. Conclusion

This obesity prevention intervention among low-income Brazilian adolescent girls, did not have the desire effect on BMI. The lower increase in waist circumference was inconsistent with the adverse effects on sedentary behaviors. New methods are needed to prevent obesity in this population.

Abbreviations

BMI — body mass index
FFQ-FP — food frequency questionnaire – food pyramid
H3G-Brazil — Healthy Habits, Healthy Girls – Brazil
LMIC — low- and middle-income countries
MPA — moderate physical activity
EPA — extensive physical activity
SCT — social cognitive theory
WHO — world health organization

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Ethics approval and consent to participate

Consent for publication

Not applicable.

Conflict of interests

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Authors' contributions

All authors truly contributed to the development of this study.

AL: participated in study concept and design, acquisition of data, analysis and interpretation of data, drafting the manuscript, critical revision of the manuscript for intellectual content and statistical analysis.
TB: participated in analysis and interpretation of data, and critical revision of the manuscript for intellectual content and statistical analysis.
DT: participated in critical revision of the manuscript for intellectual content and statistical analysis.
TN: participated in critical revision of the manuscript for intellectual content and statistical analysis.
SP: senior research of this project, participated in study concept and design, acquisition of data, interpretation of data and critical revision of the manuscript for important intellectual content.

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Author disclosure statement

References

Araujo, A.J., Santos, A.C., Prado, W.L., 2017. Body composition of obese adolescents: association between adiposity indicators and cardiometabolic risk factors. J. Hum. Nutr. Diet. 30, 193–202.
Ardic, A., Erdogan, S., 2017. The effectiveness of the COPE healthy lifestyles TEEN program: a school-based intervention in middle school adolescents with 12-month follow-up. J. Adv. Nurs. 73, 1377–1389.
Azeredo, C.M., de Rezende, L.F., Canella, D.S., et al., 2014. Dietary intake of Brazilian adolescents. Public Health Nutr. 1–10.
Azeredo, C.M., Levy, R.B., Peres, M.F., Menezes, P.R., Araya, R., 2016. Patterns of health-related behaviours among adolescents: a cross-sectional study based on the National Survey of School Health Brazil 2012. BMJ Open 6, e011571.
Bandura, A., 1986. Social Foundations of Thought and Action: A Social Cognitive Theory. Prentice-Hall, Englewood Cliffs, NJ.
Bandura, A., 2004. Health promotion by social cognitive means. Health Educ. Behav. 31, 143–164.
Baranowski, T., 2012. School-based obesity-prevention interventions in low- and middle-income countries: do they really work? Am. J. Clin. Nutr. 96, 227–228.
Baranowski, T., Lytle, L., 2015. Should the IDEFICS outcomes have been expected? Obes. Rev. 16, 162–172.
Boff, R.M., Liboni, R.P.A., Batista, I.P.A., de Souza, L.H., Oliveira, M.D.S., 2017. Weight loss interventions for overweight and obese adolescents: a systematic review. Eat. Weight Disord. 22, 211–229.
Cole, T.J., Green, P.J., 1992. Smoothing reference centile curves: the LMS method and penalized likelihood. Stat. Med. 11, 1305–1319.
Collins, C.E., Watson, J., Burrows, T., 2010. Measuring dietary intake in children and adolescents in the context of overweight and obesity. Int. J. Obes. 34, 1103–1115.
Collins, C.E., Dewar, D.L., Schumacher, T.L., Finn, T., Morgan, P.J., Lubans, D.R., 2013. 12 month changes in dietary intake of adolescent girls attending schools in low-income communities following the NEAT Girls cluster randomized controlled trial. Appetite 73, 147–155.
Collins, C.E., Dewar, D.L., Schumacher, T.L., Finn, T., Morgan, P.J., Lubans, D.R., 2014. 12 month changes in dietary intake of adolescent girls attending schools in low-income communities following the NEAT Girls cluster randomized controlled trial. Appetite 73, 147–155.
Conceicao, L.M., Leme, A.C., Philippi, S.T., 2017. Alimentos denso-energéticos e tempo de tela entre adolescentes de escolas públicas de São Paulo. Nutrição em Pauta (June) (in press).
Cumming, G., 2013. Cohen's d needs to be readily interpretable: comment on Shieh (2013). Behav. Res. Methods 45, 968–971.
de Boer, M.R., Waterlander, W.E., Kuijper, L.D., Steenhuis, I.H., Twisk, J.W., 2015. Testing for baseline differences in randomized controlled trials: an unhealthy research behavior that is hard to eradicate. Int. J. Behav. Nutr. Phys. Act. 12, 4.
de Onis, M., 2007. Development of a WHO growth reference for school-aged children and adolescents. Bull. World Health Organ. 85, 660–667.
Gupta, S.K., 2011. Intention-to-treat concept: a review. Perspect. Clin. Res. 2, 109–112.
Haines, J., Neumark-Sztainer, D., 2006. Prevention of obesity and eating disorders: a consideration of shared risk factors. Health Educ. Res. 21, 770–782.
Hallal, P.K., AG, Cruz, D.K.A., Mendes, M.I., Malta, D.C., 2010. Prática de atividade física em adolescentes brasileiros. Cien. Saude Colet. 15, 3035–3042.
Hills, A.P., Dengel, D.R., Lubans, D.R., 2015. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. Prog. Cardiovasc. Dis. 57, 368–374.
Jones, R.A., Sinn, N., Campbell, K.J., et al., 2011. The importance of long-term follow-up in child and adolescent obesity prevention interventions. Int. J. Pediatr. Obes. 6, 178–181.
Kelishadi, R., Azizi-Soleiman, F., 2014. Controlling childhood obesity: a systematic review on strategies and challenges. J. Res. Med. Sci. 19, 993–1008.
Leme, A.C., Philippi, S.T., 2015. The "Healthy Habits, Healthy Girls" randomized controlled trial for girls: study design, protocol, and baseline results. Cad Saude Publica 31, 1381–1394.
Leme, A.C., Lubans, D.R., Guerra, P.H., Dewar, D., Toassa, E.C., Philippi, S.T., 2016. Preventing obesity among Brazilian adolescent girls: six-month outcomes of the Healthy Habits, Healthy Girls-Brazil school-based randomized controlled trial. Prev. Med. 86, 77–83.
Lubans, D.R., Morgan, P.J., Dewar, D., et al., 2010. The Nutrition and Enjoyable Activity for Teen Girls (NEAT girls) randomized controlled trial for adolescent girls from disadvantaged secondary schools: rationale, study protocol, and baseline results. BMC Public Health 10, 652.
Lubans, D.R., Smith, J.J., Peralta, L.R., et al., 2016a. A school-based intervention incorporating smartphone technology to improve health-related fitness among adolescents: rationale and study protocol for the NEAT and ATLAS 2.0 cluster randomised controlled trial and dissemination study. BMJ Open 6, e010448.
Lubans, D.R., Smith, J.J., Plotnikoff, R.C., et al., 2016b. Assessing the sustained impact of a school-based obesity prevention program for adolescent boys: the ATLAS cluster randomized controlled trial. Int. J. Behav. Nutr. Phys. Act. 13, 92.
Martinez, M.F., Philippi, S.T., Estima, C., Leal, G., 2013. Validity and reproducibility of a food frequency questionnaire to assess food group intake in adolescents. Cad. Saude Publica 29, 1795–1804.
Moher, D., Hopewell, S., Schulz, K.F., et al., 2010. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ 340, c869.
Neumark-Sztainer, D., 2005. Can we simultaneously work toward the prevention of obesity and eating disorders in children and adolescents? Int. J. Eat. Disord. 38, 220–227.
Neumark-Sztainer, D., Story, M., Hannan, P.J., Perry, C.L., Irving, L.M., 2002. Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. Arch. Pediatr. Adolesc. Med. 156, 171–178.
Ng, M., Fleming, T., Robinson, M., et al., 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic

analysis for the Global Burden of Disease Study 2013. Lancet 384, 766–781.

Pereira, P.F., Serrano, H.M., Carvalho, G.Q., et al., 2015. Measurements of location of body fat: an assessment of colinearity with body mass, adiposity and stature in female adolescents. Revista paulista de pediatria : orgao oficial da Sociedade de Pediatria de Sao Paulo 33 (1), 63–71.

Philippi, S.T., 2012. VirtualNutri Plus. Keeple.

Philippi, S.T., 2013. Tabela de composição de alimentos: suporte para decisão nutricional. Editora Manole, Barueri.

Philippi, S.T., Barco Leme, A.C., 2015. Dietary intake and meal frequency of Brazilian girls attending a school-based randomized controlled trial. Nutr. Food Sci. 45, 954–968.

Philippi, S.T., Latterza, A.R., Cruz, A.T.R., Cruz, L.C., 1999. Pirâmide alimentar adaptada: guia para escolha dos alimentos. Rev. Nutr. Campinas 12, 65–80.

Sao-Joao, T.M., Rodrigues, R.C.M., Gallani, M.C.B.J., Miura, C.T.d.P., Domingues, G.d.B.L., Godin, G., 2013. Adaptacao cultural da versao brasileira do Godin-Shephard Leisure-Time Physical Activity Questionnaire. Rev. Saude Publica 47, 479–487.

Selker, H.P., Strom, B.L., Ford, D.E., et al., 2010. White paper on CTSA consortium role in facilitating comparative effectiveness research: September 23, 2009 CTSA consortium strategic goal committee on comparative effectiveness research. Clin. Transl. Sci. 3,

29–37.

Skouteris, H., Hill, B., McCabe, M., Swinburn, B., Busija, L., 2016. A parent-based intervention to promote healthy eating and active behaviours in pre-school children: evaluation of the MEND 2-4 randomized controlled trial. Pediatr. Obes. 11, 4–10.

Smith, J.J., Morgan, P.J., Plotnikoff, R.C., et al., 2014a. Rationale and study protocol for the 'active teen leaders avoiding screen-time' (ATLAS) group randomized controlled trial: an obesity prevention intervention for adolescent boys from schools in low-income communities. Contemp. Clin. Trials 37, 106–119.

Smith, J.J., Morgan, P.J., Plotnikoff, R.C., et al., 2014b. Smart-phone obesity prevention trial for adolescent boys in low-income communities: the ATLAS RCT. Pediatrics 134, e723–31.

Van Breukelen, G.J., 2006. ANCOVA versus change from baseline: more power in randomized studies, more bias in nonrandomized studies. J. Clin. Epidemiol. 59, 920–925 (corrected).

WHO, 2010. Global Recommendations on Physical Activity for Health. World Health Organization, Geneva, Switzerland.

WHO, 2012. Population-based Approaches to Childhood Obesity Prevention. W.H. Organization, Geneva, Switzerland.