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School-based obesity interventions in the metropolitan area of Rio De Janeiro, Brazil: pooled analysis from five randomised studies

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Abstract

School-based studies, despite the large number of studies conducted, have reported inconclusive results on obesity prevention. The sample size is a major constraint in such studies by requiring large samples. This pooled analysis overcomes this problem by analysing 5926 students (mean age 11·5 years) from five randomised school-based interventions. These studies focused on encouraging students to change their drinking and eating habits, and physical activities over the one school year, with monthly 1-h sessions in the classroom; culinary class aimed at developing cooking skills to increase healthy eating and attempts to family engagement. Pooled intention-to-treat analysis using linear mixed models accounted for school clusters. Control and intervention groups were balanced at baseline. The overall result was a non-significant change in BMI after one school year of positive changes in behaviours associated with obesity. Estimated mean BMI changed from 19·02 to 19·22 kg/m^2 in the control group and from 19·08 to 19·32 kg/m^2 in the intervention group (P value of change over time = 0·09). Subgroup analyses among those overweight or with obesity at baseline also did not show differences between intervention and control groups. The percentage of fat measured by bioimpedance indicated a small reduction in the control compared with intervention (P = 0·05). This large pooled analysis showed no effect on obesity measures, although promising results were observed about modifying behaviours associated with obesity.

Key words: **Adolescents: Obesity prevention: Randomised controlled trials: School-based interventions: Pooled analyses**

Schools are considered the central focus of activities for the prevention of paediatric obesity[1]. In a meta-analysis of 139 studies of childhood obesity prevention conducted in high-income countries, 83 % were conducted in schools and the strength of evidence was higher for: (1) physical activity interventions delivered in schools, but with home involvement, or (2) combined diet–physical activity interventions delivered in schools with both home and community components[2]. A previous systematic review based on findings from eight reviews, three meta-analyses and five systematic reviews of school-based programmes to prevent and control obesity did not find evidence for both prevention and reduction of obesity[3]. In a specific review of twenty-two studies conducted in low- and middle-income countries on dietary behaviour and physical activity for obesity prevention, most studies had positive behaviour effect, but the mean BMI had a small reduction only in eight studies[4], but the review was concluded by the effectiveness of the school-based approach for obesity prevention.

By June 2020, a total of twenty systematic reviews and meta-analyses[2–22] were published, including two systematic review of systematic reviews[8,20]. Studies have reported small, but statistically significant results in the treatment of obesity and less conclusive effect on prevention. In line with these findings, the editorial of the journal *Childhood Obesity* stated: (1) obesity prevention trials emphasising diet and physical activity/sedentary behaviour have had small or no effects on obesity and (2) quality of the studies has been relatively low[23]. Also, a review with pooled analysis of the reduction of sugar-sweetened beverages, one of the main goals in most dietary behaviour interventions for obesity, found only modest effectiveness of educational interventions[24]. Alternatively, comparisons of earlier studies with more recent ones showed that more recent school-based interventions are at least mildly effective in reducing BMI in children, possibly because these newer studies tended to be longer, more comprehensive and included parental support[18].

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For low- and middle-income countries, the number of studies is still small and there is no evidence of reduction of obesity even in Mexico, a country with the highest prevalence of obesity among school-age children. A 2-year controlled intervention in schools in Mexico improved children's food intake and activity, but BMI and obesity prevalence did not change[25]. In contrast, a review of ten Latin American studies found evidence to recommend school-based interventions to prevent obesity among youth, although only five studies, three prevention and two treatment interventions, found improvements in obesity-related outcomes[26].

Two major limitations in school-based studies are an underestimation of sample size due to the cluster randomised design and overestimation of changes in BMI. Also, only a sub-sample of participants may respond favourably to the intervention[27] requiring large studies or pooled analysis.

This study pooled five randomised behavioural school-based interventions, all conducted in the metropolitan area of Rio de Janeiro, Brazil, that have shown small non-significant changes in BMI after one school year of positive changes in dietary behaviours associated with obesity. This analysis with about 6000 participants may overcome the sample size limitation of the individual studies. Also, subgroup analysis was conducted for BMI status.

Materials and methods

A total of 5926 participants from public schools were included in the pooled analysis. Detailed information of participants and interventions are found in the publications, which references are in Table 1. All five studies analysed were carried out by our research group between the years 2010 and 2017 and had their raw data made available by the authors themselves. Complete follow-up varied from 87·8 % in the study number 2 to 79·0 % in the study number 5 (Table 1). In short, classroom activities were delivered by research assistants in all studies, except for study number 4, where activities were implemented by the regular teachers, after training. Culinary classes aimed at developing cooking skills to increase healthy eating choices were conducted by nutritionists. Three studies (numbers 3, 4 and 5) also encouraged physical activities and reduction of sedentarism beyond changes in dietary behaviour. Facilities for physical activities free of charge in the neighbourhood were indicated to the students and parents in two studies (4 and 5). Sedentarism approach stimulated reduction of 1 h of computer games and television; standing or walk during the interval of television programmes or in the game phase shift. In study number 4, those participants with overweight or obesity as diagnosed at school were also followed at the household monthly by healthy agents. Folders explaining the intervention programme and suggesting the participation of the family were delivered in studies 1, 2 and 4.

The allocation concealment strategy was the use of opaque envelopes with the names of the participant schools. Randomisation of the schools was conducted by professionals who were not related to the project. In all studies, baseline average BMI indicates a balance of the outcome. Blindness of outcome measure and food intake was not possible because there are many clues in the intervention schools. However, blindness has low chance to bias the results because the measurements are objective, and they were entered in the computer during the measurements by field researchers.

In all studies, school randomisation was implemented using opaque envelopes. The sample size calculation in the studies 1 and 2 was based on a difference in BMI comparing intervention and control of 1 unit and in the study 4 on 0·4 units of BMI. Study 3 was a feasibility one for primary combined with secondary activity among those overweight or with obesity through classes of dance and soccer. In study 5, the sample size was calculated to detect an average difference of 10 min in daily time spent on physical activity and a SD of 47·4.

The students completed a self-reported questionnaire with questions on food intake, sedentary behaviour, socio-demographic and the practice of physical activity. Changes in food and beverage intake were assessed by a 24-h recall and by a FFQ. Skin colour was self-defined as white, brown and black. Weight and height were measured at school, and the body composition was estimated by bioelectrical impedance at the beginning and the end of the school year by trained field workers using the same protocol in all studies. The main outcome was the change in BMI (BMI = weight (kg)/height^2 (m^2)) calculated in *Z*-score, according to WHO curves[28], using the WHO AnthroPlus programme, version 1.0. The WHO BMI classification was used. For longitudinal analysis, the main outcome was the change in the BMI because it better evaluates the change in adiposity in growing children and adolescents compared with the *Z*-score of the BMI[29,30].

The main analysis was an intention-to-treat performed through mixed models considering the cluster effect of schools. Subgroup analysis evaluated the effect of intervention by BMI classification (overweight and obesity) and stratified by sex. Age at each measurement was the time variable, allowing to correct for the increase of BMI with age. The main effect was estimated by the interaction between age and intervention, meaning that the change in BMI and percentage body fat over time is modified by the intervention. Analyses were conducted using the software Statistical Analysis System (version 9.4; SAS Institute).

Results

There were no differences between the control and intervention groups at baseline for age, skin colour and sex. Of the students, 46 % defined themselves as Brown (Table 2).

The mean age of participants increased from the first to the last study. Since age is the time variable, all longitudinal analyses were adjusted for age. The prevalence of overweight at baseline increased from 15·3 % in 2005 to 17·1 % in 2017 and the obesity from 10·2 to 11·3 %. There is a small imbalance of BMI in the intervention and control groups of the 2010 study, but at the pooled analysis, the two groups are balanced at baseline (Table 3).

Losses to follow-up were not related to weight status, both in the intervention and in the control group. Prevalence of

Table 1. Characteristics of the studies included in the present pooled analysis
(Numbers and percentages)

Study (year)	Number of schools	Number of classes	Intervention group (*n*)	Control group (*n*)	% Follow-up	Interventions	Actions	Observed behaviour modification
1. (2005)[34]	22	47	526	614	84·7	Reduced intake of sodas	Class nutritional sessions of effects of sugar on body, teeth and diabetes. Exchange soda by water. Messages were sent to the families	Reduction in the consumption of sodas
2. (2010)[37]	20	20	277	282	87·8	Reduced intake of cookies and sugary drinks	Class nutritional sessions, a set of messages were sent to the families in the form of illustrated booklets and recipes. Teachers were encouraged to work with the children on the topics addressed in each intervention session	Reduction in the consumption of sugar-sweetened beverages and cookies
3. (2014)[38]	2	16	224	272	81·5	Feasibility study adding secondary intervention of physical activity after school	Culinary classes and nutritional education activities, students could choose between dance classes and soccer	Few students with obesity or overweight enrolled for the extra classes. Majority were normal-weight ones
4. (2016)[39]	18	97	1408	1341	86·9	Reduced intake of cookies and sugary drinks, and other ultraprocessed foods, incentive to water consumption, increase in physical activity and reduction of sedentarism	Idem to study 2 by adding educational games, group debates, culinary classes and nutritional education activities with community health agents in the homes of overweight students	Increase in physical activity and a small change in intake of healthy food items
5. (2017)[40]	7	32	619	363	79·0	Encouraging eating food provided by school, water consumption and increase physical activity	Modification of the environment by displaying posters, putting towels on the tables, new receptors for fruits, creation of super-heroine (Super Water) and offering sports equipment in free access for students	Increase in water consumption and physical activity

Table 2. Characteristics of the students at baseline according to group allocation
(Numbers and percentages)

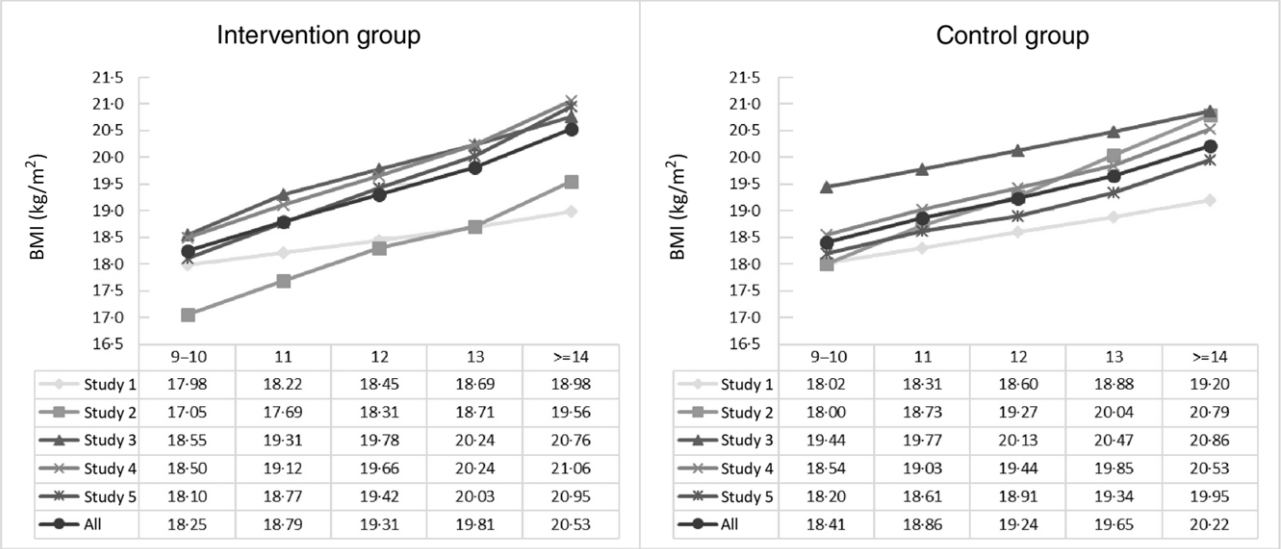
	Total		Control group		Intervention group	
	n	%	*n*	%	*n*	%
Sex						
Girls	2808	47·38	1363	47·46	1445	47·31
Boys	3118	52·62	1509	52·54	1609	52·69
Age group						
9–11 years	3156	56·79	1563	58·41	1593	55·29
12–13 years	1856	33·4	884	33·03	972	33·74
≥14 years	545	9·81	229	8·56	316	10·97
Skin colour						
White	1495	27·88	774	30·48	721	25·53
Brown	2498	46·58	1133	44·62	1365	48·34
Black	1370	25·55	632	24·89	738	26·13

overweight and obesity at baseline, among those lost to follow-up in the control group, was, respectively, 15·4 and 12·5 %; these values in the intervention group were 16·3 and 11·5 %, respectively. Both sets of values were close to the prevalence in the overall study: 16·6 and 11·5 %. Losses were also unrelated to sex. The percentage of boys in pooled analysis was 52·6 % and among those lost to follow-up was 54·8 %. However, those lost to follow-up were younger. Group 9 to 11 years represented 56·8 % of the overall participants and 49·8 % among those lost to follow-up.

BMI variation over time was linear in both control and intervention groups in all studies (Fig. 1). Overall, there was no intervention effect on BMI, also for the subgroups. The subgroup analysis by BMI classification showed the greatest increase in BMI in the intervention group compared with the control for those with obesity at baseline. The regression

Table 3. Sample size, prevalence of overweight and obesity and BMI at baseline according to group allocation (Numbers and percentages; mean values and standard deviations)

			Total				Control group BMI (kg/m^2)		Intervention group BMI (kg/m^2)	
Study	Year	Age (years)	*n*	%	Overweight %	Obesity %	Mean	SD	Mean	SD
1	2005	10·9	1140	19·2	15·3	10·2	18·3	3·6	18·2	3·2
2	2010	11·2	559	9·4	15·7	9·2	17·4	3·0	18·6	3·7
3	2014	12·2	496	8·4	19·6	12·4	19·8	4·0	19·8	4·0
4	2016	11·5	2749	46·4	16·8	11·8	19·2	4·0	19·1	4·0
5	2017	12·0	982	16·6	17·1	11·3	19·0	4·3	18·7	3·9
All		11·5	5926	100	16·6	11·2	19·0	4·0	18·8	3·8



Intervention group	9–10	11	12	13	>=14
Study 1	17·98	18·22	18·45	18·69	18·98
Study 2	17·05	17·69	18·31	18·71	19·56
Study 3	18·55	19·31	19·78	20·24	20·76
Study 4	18·50	19·12	19·66	20·24	21·06
Study 5	18·10	18·77	19·42	20·03	20·95
All	18·25	18·79	19·31	19·81	20·53

Control group	9–10	11	12	13	>=14
Study 1	18·02	18·31	18·60	18·88	19·20
Study 2	18·00	18·73	19·27	20·04	20·79
Study 3	19·44	19·77	20·13	20·47	20·86
Study 4	18·54	19·03	19·44	19·85	20·53
Study 5	18·20	18·61	18·91	19·34	19·95
All	18·41	18·86	19·24	19·65	20·22

*Random intercept and slope models and age as the time variable as continuous.
P value of age x intervention per study: study 1= 0·74; study 2= 0·87; study 3= 0.32; study 4= 0·03; study 5= 0·13; all = 0·10

Fig. 1. Estimated* mean BMI of overall studies and individual studies.

coefficient of the change in BMI was 0·15 for obesity; for overweight, the coefficient was 0·03, and among normal weight 0·05; none of these changes was statistically significant (respective *P* values of 0·30, 0·52, 0·10). However, among boys, the percentage of body fat showed a greater reduction in the control compared with the intervention group ($P < 0·01$), while, in the girls, there was an increase in both groups without statistical significance (Fig. 2).

Discussion

The pooled analysis showed a lack of change in BMI associated with the intervention, and the small change in body fat among boys was of a greater reduction in the control compared with intervention group.

As expected, there was an increase in the prevalence of overweight and obesity over the years with obesity in our study changing from 9·2 to 11·8 % from 2010 to 2016. These data are in line with what is being shown in major national surveys. In the National Survey of Schools in Brazil (PeNSE), in 2009, the percentage of adolescents with overweight was 23·0 and 7·3 % were classified with obesity. These percentages, in 2015, went up to 23·7 and 7·8 %, respectively[31,32]. Our study participants are from public schools, and the prevalence of obesity is also greater among students from public schools in the PeNSE survey.

Although our negative results for obesity prevention, school level activities may be still attractive because: (1) children and adolescents can be reached at school; (2) changes in behaviour have been observed in our and most studies and (3) adolescents tend to respond better when treated as a group. However, the results of the present study, in line with most studies, had no impact on BMI[3,4,23].

A possible explanation for the observed results is the short time between interventions and the evaluation of BMI. However, the large sample size increases the power of showing small changes, and the only observed change was against the hypothesis. Another possible explanation for the results in this and many related studies with positive changes in behaviours

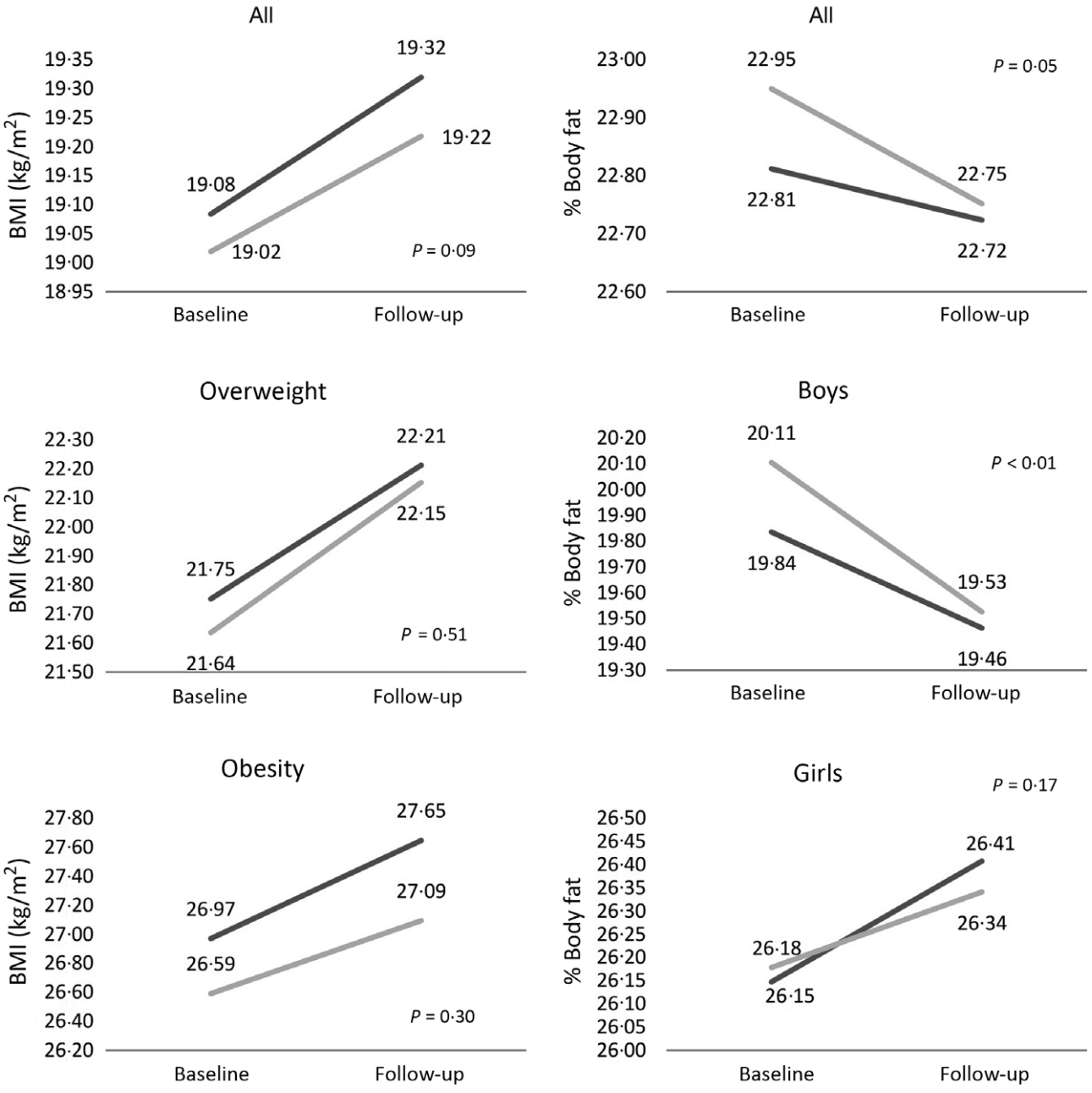


Fig. 2. Baseline and follow-up predicted BMI and percentage body fat. Overall data and according to BMI status and sex. ——, Intervention group; ——, control group.

and lifestyle habits, without BMI change, is the lack of reduction of energy intake. Reduction of energy intake is never a target in the interventions.

Messages for reducing overall energy intake, the most important factor to be changed in obesity, are not easy to implement since many students may be experiencing growth spurts which increase energy needs, whereas others could be susceptible to developing eating disorders[33]. For these reasons, primary prevention strategies have concentrated on the quality of the diet rather than energy restriction. Messages of healthy eating may not change energy intake, as documented in our first study when sodas were replaced for juices with added sugar[34]. Increasing intake of fruits also has no power to dislocate the consumption of other high-energy items[35].

Also, actions to improve physical activity at school often attract those who are more fit compared with those with excessive weight, and school prevention strategies should not focus solely on obesity due to the increased risk of stigmatisation[33].

British Journal of Nutrition

The cumulative experience from the five studies is of minimal participation of the families. All studies were conducted at schools attending families of low socio-economic level from metropolitan areas that spend many hours commuting to work. Lack of family participation may have hampered behaviour changes leading to a reduction of excessive weight gain. Also, students attending the public schools in the metropolitan area of Rio de Janeiro are in greater percentage Black or Brown, and studies conducted with African Americans also found that effects on weight-related behaviours and weight change were generally promising but often non-significant[16]. The percentage of Whites in the pooling analysis was 27·8 % compared with 47·7 % in the Rio de Janeiro population (Census 2010).

The main limitation of the study is the possibility of a social desirability bias in the reported behaviour changes, with girls showing a greater frequency of this bias compared with boys[36]; however, the behaviour changes were not the issue in this pooled analysis. Girls with overweight and obesity could avoid having weight and height measured, but losses to follow-up were unrelated to sex and to weight status both in the control and in the intervention group.

The strengths of this pooled analysis are to add information to the very few studies conducted in low- and middle-income countries, the large sample size and high follow-up participation. The positive side of all analysed studies is the possibility of behaviour change with all school-based interventions as have been shown in the individual analysis.

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There are no conflicts of interest.

References

1. Hoelscher DM, Kirk S, Ritchie L, *et al.* (2013) Position of the academy of nutrition and dietetics: interventions for the prevention and treatment of pediatric overweight and obesity. *J Acad Nutr Diet* **113**, 1375–1394.
2. Wang Y, Cai L, Wu Y, *et al.* (2015) What childhood obesity prevention programmes work? A systematic review and meta-analysis. *Obes Rev* **16**, 547–565.
3. Khambalia AZ, Dickinson S, Hardy LL, *et al.* (2012) A synthesis of existing systematic reviews and meta-analyses of school-based behavioural interventions for controlling and preventing obesity. *Obes Rev* **13**, 214–233.
4. Verstraeten R, Lachat C, Kolsteren PW, *et al.* (2012) Effectiveness of preventive school-based obesity interventions in low- and middle-income countries: a systematic review. *Am J Clin Nutr* **96**, 415–438.
5. Al-Khudairy L, Loveman E, Jl C, *et al.* (2017) Diet, physical activity and behavioural interventions for the treatment of overweight or obese adolescents aged 12 to 17 years. *Cochrane Database Syst Rev*, issue 6, CD012691.
6. Feng L, Wei DM, Lin ST, *et al.* (2017) Systematic review and meta-analysis of school-based obesity interventions in mainland China. *PLOS ONE* **12**, e0184704.
7. Bagherniya M, Taghipour A, Sharma M, *et al.* (2018) Obesity intervention programs among adolescents using social cognitive theory: a systematic literature review. *Health Educ Res* **33**, 26–39.
8. Militello LK, Kelly S, Melnyk BM, *et al.* (2018) A review of systematic reviews targeting the prevention and treatment of overweight and obesity in adolescent populations. *J Adolesc Health* **63**, 675–687.
9. Kobes A, Kretschmer T, Timmerman G, *et al.* (2018) Interventions aimed at preventing and reducing overweight/obesity among children and adolescents: a meta-synthesis. *Obes Rev* **19**, 1065–1079.
10. Bahia L, Schaan CW, Sparrenberger K, *et al.* (2019) Overview of meta-analyses on prevention and treatment of childhood obesity. *J Pediatr* **95**, 385–400.
11. Liu Z, Xu HM, Wen LM, *et al.* (2019) A systematic review and meta-analysis of the overall effects of school-based obesity prevention interventions and effect differences by intervention components. *Int J Behav Nutr Phys Act* **16**, 95.
12. Luybli M, Schmillen H & Sotos-Prieto M (2019) School-based interventions in low socioeconomic settings to reduce obesity outcomes among preschoolers: a scoping review. *Nutrients* **11**, 1518.
13. Goldthorpe J, Epton T, Keyworth C, *et al.* (2020) Are primary/elementary school-based interventions effective in preventing/ameliorating excess weight gain? A systematic review of systematic reviews. *Obes Rev* **21**, e13001.
14. Yuksel HS, Şahin FN, Maksimovic N, *et al.* (2020) School-based intervention programs for preventing obesity and promoting physical activity and fitness: a systematic review. *Int J Environ Res Public Health* **17**, 347.
15. Adom T, De Villiers A, Puoane T, *et al.* (2019) Physical activity, and body weight status of African children: a systematic review. *Nutrients* **12**, 95.
16. Barr-Anderson DJ, Adams-Wynn AW, Disantis KI, *et al.* (2013) Family-focused physical activity, diet and obesity interventions in African-American girls: a systematic review. *Obes Rev* **14**, 29–51.
17. Lavelle HV, MacKay DF & Pell JP (2012) Systematic review and meta-analysis of school-based interventions to reduce body mass index. *J Public Health (Oxf)* **34**, 360–369.
18. Sobol-Goldberg S, Rabinowitz J & Gross R (2013) School-based obesity prevention programs: a meta-analysis of randomized controlled trials. *Obesity* **21**, 2422–2428.
19. Kelley GA, Kelley KS & Pate RR (2014) Effects of exercise on BMI *Z*-score in overweight and obese children and adolescents: a systematic review with meta-analysis. *BMC Pediatr* **14**, 225.
20. Peirson L, Fitzpatrick-Lewis D, Morrison K, *et al.* (2015) Prevention of overweight and obesity in children and youth: a systematic review and meta-analysis. *CMAJ Open* **3**, E23–E33.
21. Peirson L, Fitzpatrick-Lewis D, Morrison K, *et al.* (2015) Treatment of overweight and obesity in children and youth: a systematic review and meta-analysis. *CMAJ Open* **3**, E35–E46.

22. Oosterhoff M, Joore M & Ferreira I (2016) The effects of school-based lifestyle interventions on body mass index and blood pressure: a multivariate multilevel meta-analysis of randomized controlled trials. *Obes Rev* **17**, 1131–1153.
23. Baranowski T & Taveras EM (2018) Childhood obesity prevention: changing the focus. *Child Obes* **14**, 1–3.
24. Rahman AA, Jomaa L, Kahale LA, *et al.* (2018) Effectiveness of behavioral interventions to reduce the intake of sugar-sweetened beverages in children and adolescents: a systematic review and meta-analysis. *Nutr Rev* **76**, 88–107.
25. Safdie M, Cargo M, Richard L, *et al.* (2014) An ecological and theoretical deconstruction of a school-based obesity prevention program in Mexico. *Int J Behav Nutr Phys Act* **11**, 103.
26. Lobelo F, Garcia de Quevedo I, Holub CK, *et al.* (2013) School-based programs aimed at the prevention and treatment of obesity: evidence-based interventions for youth in Latin America. *J School Health* **83**, 668–677.
27. 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.
28. de Onis M, Onyango AW, Borghi E, *et al.* (2007) Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ* **85**, 660–667.
29. Cole TJ, Faith MS, Pietrobelli A, *et al.* (2005) What is the best measure of adiposity change in growing children: BMI, BMI %, BMI *Z*-score or BMI centile? *Eur J Clin Nutr* **59**, 419–425.
30. Berkey CS & Colditz GA (2007) Adiposity in adolescents: change in actual BMI works better than change in BMI *Z* score for longitudinal studies. *Ann Epidemiol* **17**, 44–50.
31. Instituto Brasileiro de Geografia e Estatística I (2009) *Pesquisa Nacional de Saúde Do Escolar, 2009 (National School Health Survey, 2009)*. Rio de Janeiro: IBGE.
32. Instituto Brasileiro de Geografia e Estatística I (2016) *Pesquisa Nacional de Saúde Do Escolar, 2015 (National School Health Survey, 2015)*. Rio de Janeiro: IBGE.
33. Kenney EL, Wintner S, Lee RM, *et al.* (2017) Obesity prevention interventions in US public schools: are schools using programs that promote weight stigma? *Prev Chronic Dis* **14**, E142.
34. Sichieri R, Paula Trotte A, De Souza RA, *et al.* (2009) School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutr* **12**, 197–202.
35. Kaiser KA, Brown AW, Brown MMB, *et al.* (2014) Increased fruit and vegetable intake has no discernible effect on weight loss: a systematic review and meta-analysis. *Am J Clin Nutr* **100**, 567–576.
36. Hebert JR, Ma Y, Clemow L, *et al.* (1997) Gender differences in social desirability and social approval bias in dietary self-report. *Am J Epidemiol* **146**, 1046–1055.
37. Cunha DB, de Souza B da SN, Pereira RA, *et al.* (2013) Effectiveness of a randomized school-based intervention involving families and teachers to prevent excessive weight gain among adolescents in Brazil. *PLOS ONE* **8**, e57498.
38. Rodrigues R da RM, de Souza B da SN, Cunha DB, *et al.* (2020) Association between screen time and the variation of food intake markers among school-aged adolescents in Niterói/RJ, Brazil. *Cad Saúde Coletiva* **28**, 24–33.
39. Sgambato MR, Cunha DB, Souza B da SN, *et al.* (2019) Effectiveness of school-home intervention for adolescent obesity prevention: parallel school-randomized study. *Br J Nutr* **122**, 1073–1080.
40. Benthroldo RS (2019) *Arquitetura De Escolhas Como Estratégia Para Promoção Da Atividade Física Em Adolescentes (Architecture of Choices as a Strategy to Promote Physical Activity in Adolescents)*. Universidade do Estado do Rio de Janeiro, Instituto de Medicina Social.

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