Effectiveness of a Kindergarten-Based Intervention for Preventing Childhood Obesity

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abstract

BACKGROUND AND OBJECTIVES: Interventions to prevent childhood obesity targeting school age children have mostly reported limited effectiveness, suggesting such prevention programs may need to start at an earlier age, but evidence has been scarce. We reported a pilot study aiming to demonstrate the feasibility of a multifaceted intervention for preschool children and to provide a preliminary assessment of the effectiveness.

METHODS: This nonrandomized controlled trial recruited children aged 3 to 6 years from 6 kindergartens in Guangzhou, China. Based on the preference of the School and Parents Committees, 4 kindergartens (648 children) received a 3-component intervention (training of kindergarten staff, initiating healthy curriculum for children, and close collaboration between families and kindergartens) over 12 months, while the other 2 kindergartens (336 children), serving as controls, received routine health care provision. Outcome measures were the changes in BMI *z* score between baseline and the end of 12 months, and the prevalence of postintervention children who were overweight or obese.

RESULTS: By 12 months, children within the intervention group had a smaller BMI *z* score increase (0.24) compared to the control (0.41), with a difference of −0.31 (95% CI −0.47 to −0.15). The prevalence of overweight or obesity was also lower among the intervention group at the end of the study (OR: 0.43, 95% CI 0.19 to 0.96), adjusted for baseline status.

CONCLUSIONS: Our results indicated a multicomponent health behavior intervention might be effective in reducing the prevalence of obesity, but the longer term effects will need confirmation from randomized controlled trials.

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Drs Qiu and Xia conceptualized and designed the study; Ms Hu conducted the entire intervention process, performed the initial analyses, and drafted the initial manuscript; Mr He performed the initial analyses and drafted the initial manuscript; Ms Liu, Mr Li, and Ms Lu coordinated and supervised data collection and critically reviewed the manuscript; Ms Xing, Ms Lin, and Ms Feng conducted the intervention project; Drs Bartington, Lam, and Cheng interpreted the data and critically reviewed the manuscript; and all authors approved the final manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: As a country with an emerging obesity epidemic, few large-scale obesity prevention programs have been conducted among children and adolescents in China. There has also yet to be definitive evidence of what constitutes effective approaches for childhood obesity intervention.

WHAT THIS STUDY ADDS: We have piloted an intervention program designed for preschool-aged children in Guangzhou. This 12-month-long multifaceted program was simple to implement and well received by stakeholders and appeared to be effective in reducing obesity prevalence.

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Childhood obesity is an important public health issue because of its association with a number of adverse health outcomes in adulthood[1] not only in Western countries but also in low- and middle-income countries.[2,3] With lifestyle and dietary changes brought about by rapid economic growth and urbanization, the childhood obesity epidemic has spread to low- and middle-income countries such as China.[2–4] Data from a nationwide survey in 2010 revealed that 15% of Chinese children and adolescents were overweight or obese,[5] prompting an urgent need for effective primary prevention strategies to curb the progression of the obesity epidemic in China.

The authors of previous prospective studies have suggested the potential origins of obesity in early life,[6–9] during which exposures such as fetal stressors, maternal smoking, and formula feeding may contribute to rapid weight gain during the first year of life,[10] predisposing to the development of obesity in childhood, which persists into adulthood.[11] Although there is evidence suggesting that obesity as a chronic condition develops in early childhood years,[12] most childhood obesity intervention studies have been conducted among school-aged children,[13–15] and few have been targeted at the preschool population, especially in China.[16–18]

Community-based weight management programs, which facilitate weight loss through long-term health-related behavioral changes in nutrition and physical activity,[17,19] may play an important role in the prevention and control of childhood obesity. However, little research into this area has been conducted in China.[20] Although there is some evidence to suggest such programs require a multidisciplinary approach (including the use of cognitive behavioral strategies and the involvement of multiple stakeholders and sectors[10]) to achieve and maintain a healthy lifestyle,[21] it is unclear how such intervention strategies can be formulated and implemented in China because of the heterogeneity in policies on health and well-being of preschool-aged children across contemporary urban China.[19,22,23]

We conducted a pilot study in Guangzhou, the largest city in southern China, aiming to develop a feasible, multidisciplinary kindergarten-based obesity prevention trial among preschool-aged children and to evaluate the acceptability among stakeholders and the effectiveness of the program. The experience and information obtained in this pilot study would inform the design of a definitive (phase III) cluster randomized controlled trial (RCT).

METHODS

Setting and Recruitment

A cluster, nonrandomized controlled pilot trial was conducted between January 2012 and December 2013 in 3 districts (Liwan, Haizhu, and Panyu) of Guangzhou. All 65 kindergartens (a brief description of preschool education in Guangzhou is given in Supplemental Information 1) in these districts were screened for eligibility, of which 22 met the inclusion criteria: (1) run by the government (public kindergarten), (2) located in the central area of the district, (3) had ≥100 students, and (4) had ≥2 school doctors. Invitation letters were sent to the principals of the eligible kindergartens, 6 of whom agreed to participate in the trial. On the basis of the preference of the School and Parents Committee and the availability of the catering software in the kindergartens, 4 kindergartens were allocated to the intervention group, and the remaining 2 were assigned as the control. All children 3 to 6 years of age enrolled in the participating preschools and their parents or legal guardians were invited to participate in the study.

The study protocol was approved by the Ethical Committee for Biomedical Research in Guangzhou Women and Children Medical Centre and Guangzhou Health and Family Planning Commission of the Peoples' Republic of China. The study was registered in ClinicalTrials.gov (NCT03022474). Written informed consent was obtained from the parents and/or guardians of all participating children.

Intervention

The intervention protocol was developed by an expert group from the National Children Obesity Intervention Team, comprising pediatricians, child health specialists, preschool teachers, and nutritionists, and included 3 integrated components (Table 1):

Component 1: training of kindergarten staff. Before the start of the program, 2 members of the intervention team (a nutritionist and a physician) delivered eight 40-minute sessions (twice a week for a month) on dietary management in children and daily food purchasing for school doctors and kitchen staff. During the trial, 2 physicians (qualified in health education) gave lectures every 2 months on general nutrition knowledge to all preschool staff, focusing on the promotion of healthy food and restriction of unhealthy food. To understand the dietary intake of children from school meals in this trial, we first conducted a dietary survey in all 6 preschools at baseline. Kitchen staff were then trained to use the dietary software to develop balanced menus specifically for preschool-aged children, in line with the prevailing nutritional guidelines (Supplemental Information 2). At ∼6 months into the trial, we repeated the survey. Overall, the nutrient content of modified menus was largely consistent with the Chinese Nutrition Society

TABLE 1 Details of the 3 Components of the Intervention Program

Component	Aims	Description
1. Training of kindergarten staff	To increase knowledge base, skills, and confidence for planning and cooking of healthy meals to influence dietary behavior	1. Before the start of the trial, eight 40-min sessions (twice a wk for a mo) on dietary management in children and daily food purchasing were organized for school doctors and kitchen staff. 2. During the trial, lectures (every 2 mo) on general knowledge in nutrition focusing on the promotion of healthy food and restriction of unhealthy food were given to all preschool staff. 3. Kitchen staffs were trained to use the dietary software for planning balanced menus appropriate for preschool-aged children.
2. A curriculum promoting healthy diet and lifestyle	1. To promote a habit of healthy eating among children	1. An additional weekly 20-min health education lesson was included in the curriculum, in which children had learning activities and games covering healthy food choice, appropriate portion sizes, and eating pace. This involved the use of various learning aids such as picture story books, cards, food models, and nursery rhymes.
	2. To increase the amount of time for physical activity	2. Physical activities were mandatory in the intervention group. Teachers were trained to act as play group leaders and organize activities after lunch. Daily 10-min dance sessions were included. Children were asked to dance to rhythm music in the activity room.
3. Collaboration between families and schools	1. To equip families with the knowledge about child development and healthy lifestyle and skills to monitor their children's growth	1. A series of lectures designed for parents were organized every 2 mo during the intervention period, covering topics such as what BMI is, reference BMI for preschool-aged children, how to use growth curves, the cause and harms of childhood obesity, and advice on healthy diet (increasing consumption of vegetables and fruit, reducing consumption of meat, snacks, and fast food, and avoiding sugary drinks).
	2. To improve communication between the school and parents	2. A handbook was issued to every family, in which children's health behaviors were documented to be reviewed by teachers and parents weekly.
	3. To engage parents as facilitators of their children's health after the intervention period	3. Parents were notified of their children's anthropometric measurements every 3 mo, so that they could plot and interpret their children's growth curves themselves.

guidance for preschool-aged children (Supplemental Table 8).

Component 2: a curriculum promoting healthy diet and lifestyle. Children in the intervention group received a 20-minute health education lesson every week, delivered through a curriculum designed by the Expert Group (with accompanying picture books), in which they had learning activities and games covering healthy food choice, dietary habit, and reduction of sedentary behaviors. The curriculum also introduced daily, short (<10 minutes) activities and dance sessions after lunch to increase children's physical activity levels.

Component 3: collaboration between families and kindergartens. We organized lectures designed for parents delivered every 2 months during the intervention period. Topics covered included childhood obesity prevention measures and how to use growth curves. We designed a questionnaire to investigate parental understanding of core content of the lectures. The awareness was measured as the percentage of correctly answering the questionnaire items, which was calculated by dividing the average number of correct answers among all participants by the number of questionnaire items. We produced a handbook for communication between families and schools (to be distributed on a weekly basis) in which children's health behaviors were documented and reviewed by teachers and parents. Finally, parents were notified of their children's height and weight every 3 months so that they could plot and interpret their children's growth curves.

Children in the control group received regular health care as per the routine practice. Apart from the anthropometric measurements at baseline and every 3 months thereafter, they did not receive any other intervention.

Outcome Measures

Our primary outcome measures were the changes in BMI *z* score between baseline and the end of 12 months and the prevalence of postintervention children who were overweight or obese. Weight and height were measured every 3 months from the beginning of the project by trained preschool doctors. Weight was determined in minimal clothing without shoes to the nearest 0.5 kg, and height to the nearest 0.5 cm by using a calibrated stadiometer provided by the research team. BMI was calculated as weight (kilogram) divided by height (meter) squared. BMI *z* scores (SD score), representing the deviation compared with an average child of the same sex and age, were calculated for each child on the basis of standardized growth charts from the Working Group on

Obesity in China.[24] Children with BMI values between 85th and 94th percentiles (z scores between 1.036–1.645) were considered overweight, and those with BMI ≥95th percentile (z score ≥1.645) were considered obese, following the BMI reference developed by Working Group on Obesity in China.[24] We combined the children with overweight and obesity in our subsequent analyses.

The secondary outcomes were the feasibility and acceptability of the intervention, which were qualitatively described. We used a number of techniques to evaluate the intervention components, including direct observation, collection of uptake data, questionnaires administered to parents and preschool staff, and interviews with key school doctors and teachers to discuss explored delivery, development, and optimization of the complex intervention components.

Covariates

Parents (or legal guardians) were requested to complete a questionnaire covering sociodemographic information, mode of infant feeding, daily activities, birth weight and length of their children, as well as parental height and weight.

Statistical Analysis

Baseline characteristics between intervention and control groups were compared and assessed by χ^2 and t tests where appropriate. The difference in prevalence of overweight or obesity (expressed as odds ratios [ORs] and associated 95% confidence intervals [CIs]) between the intervention and control groups was compared both at baseline and at the end of the intervention period by using multivariate regression analysis with PROC SURVEYLOGISTIC procedures (SAS Institute, Inc, Cary, NC) after adjusting for sex, maternal BMI, dietary factors, and physical activity measures as covariates and baseline status of overweight or obesity. For BMI and BMI z scores, we built multiple linear regression models with PROG SURVEYREG procedures to assess the intervention effect, after adjustment for the potential confounders aforementioned. The SAS Survey Procedures (PROC SURVEYLOGISTIC/PROG SURVEYREG) have been widely used in previous studies[25–27] to account for complex sampling structures (including clustering). Multilevel models were not used because the intraclass correlation coefficient (ICC) for all 3 outcomes (an indicator of the extent of clustering of data at school level) were negligibly small (0.003 for overweight or obesity, 0.01 for BMI, and 0.02 for BMI z score), and that the number of clusters (preschools) was too small (n = 6) for multilevel models to be effective (Maas and Hox[28] suggested there should be at least 30 groups for unbiased estimation). Likewise, as only 30% of the children in the control group had quarterly anthropometric measurements (as this was not part of the routine practice) we did not compute longitudinal models to avoid bias. A 2-tailed P value of .05 was considered statistically significant. All statistical analyses were based on the intention-to-treat population at the end of the final follow-up assessment and performed by using SAS 9.1 software (SAS Institute, Inc).

RESULTS

Baseline Characteristics

Among the 65 kindergartens, 59 were excluded for the following reasons: having <100 students (n = 15), having <2 school doctors (n = 19), not located in the central area of the district (n = 9), and were not willing to participate (n = 16). Supplemental Table 6 shows the characteristics of the eligible preschools, including the 16 that did not participate in the study. The participating preschools tended to have smaller school size, younger children, and a better staff-to-children ratio. Overall, 6 kindergartens located in Liwan (n = 2), Haizhu (n = 2), and Panyu (n = 2), comprising a total of 1063 children aged 3 to 6 years, participated in the study. We excluded 79 children with missing baseline information and 67 who were lost to follow-up, resulting in 917 children in the final analysis (Fig 1). There were no material differences in baseline characteristics between children who were included in final analysis and those who were excluded (data not shown).

In Table 2 and Supplemental Table 7, we summarize the baseline characteristics of the intervention and control groups and for each participating preschool, respectively. Four kindergartens were assigned to receive the intervention, and the remaining 2 served as the control. Although the 2 groups did not differ statistically in sex distribution, birth length, and family structure, children in the intervention group were younger (49 vs 52 months) and more likely to be exclusively breastfed before 6 months (45% vs 42%). The absolute differences in other characteristics were insubstantial both between and within the 2 groups.

Main Outcomes

The main outcomes of interest in the trial were the changes in the prevalence of overweight and obesity and the absolute differences in BMI and BMI z scores at follow-up. In Table 3 and Fig 2, we show the change of prevalence of overweight or obesity for both intervention and control groups at baseline and after 12 months. At the start of the trial, the prevalence of overweight or obesity was slightly higher in the control (20.8%) compared with the intervention group (15.5%), although this difference was not statistically significant (OR: 0.92, 95% CI: 0.65 to 1.31). At the end of the study, although the prevalence increased in both groups, the extent

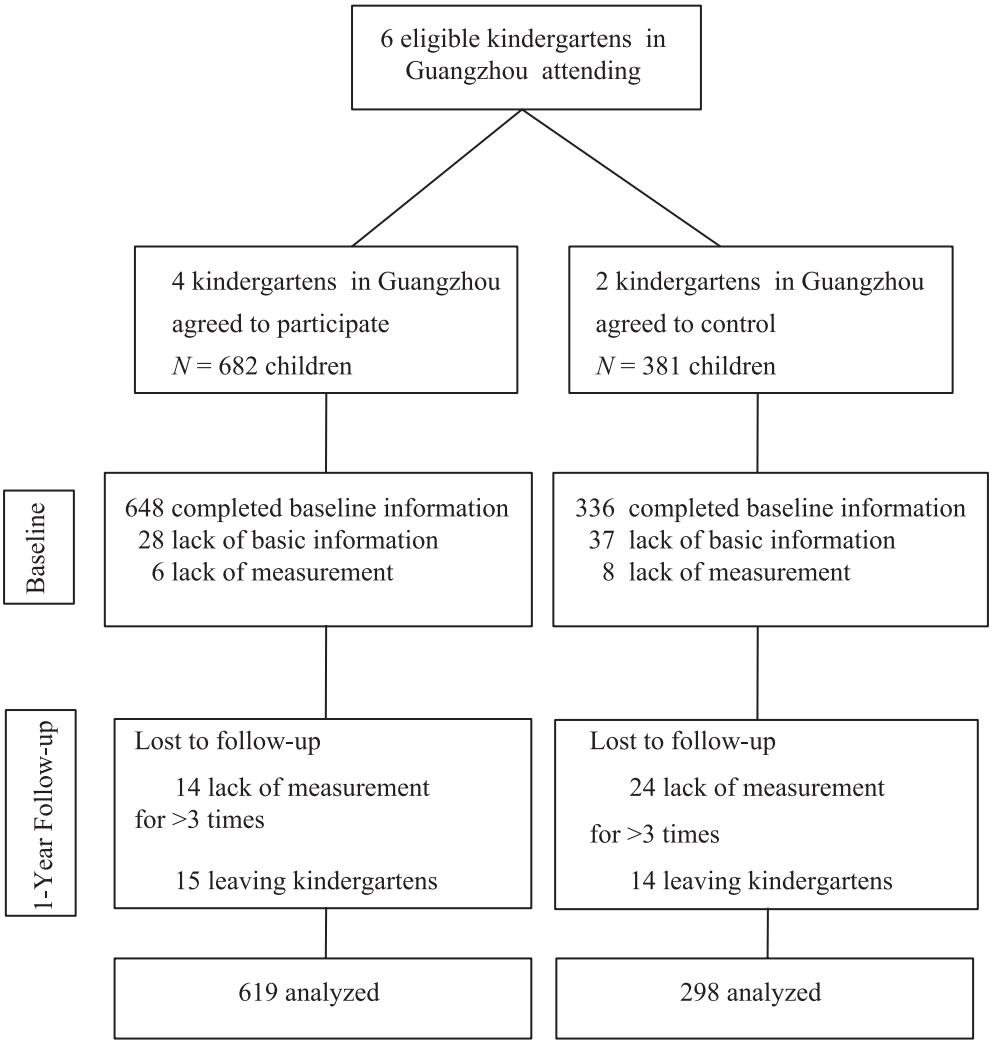

FIGURE 1
Trial profile for 1-year follow-up.

of increase was less prominent in the children who received intervention (+4.4%) compared with those who did not (+12.4%). Adjusting for baseline overweight or obesity status and other relevant confounders, the risk of becoming overweight or obese in the intervention group was more than halved (OR: 0.43, 95% CI: 0.19 to 0.96). The effect was stronger among boys (OR: 0.40, 95% CI: 0.19 to 0.85) than in girls (OR: 0.47, 95% CI: 0.17 to 1.31).

With respect to the BMI and BMI *z* scores, there were no statistically significant differences between intervention and control (15.6 vs 16.0, $P = .05$ for BMI; 0.12 vs 0.56, $P = .12$ for BMI *z* score) at baseline.

After 12 months, the increase in BMI was more than doubled in the control group (0.49) compared with the interventions (0.22), with a mean difference of −0.27 after adjusting for maternal BMI, sex, age, feeding mode before 6 months, time spent eating, sleeping time, and time spent in outdoor activities (95% CI: −0.46 to −0.08). The results were similar for BMI *z* score, with a difference of 0.31 (95% CI: −0.47 to −0.15) between the 2 groups (Table 4).

Secondary Outcomes

As a pilot study, we explored the acceptability and feasibility of specific intervention components delivered in the preschool setting . Findings of the evaluation are shown in Table 5. Overall, most of the components were deemed appropriate by the kindergarten staff and parents, reflected in high attendance levels and positive feedback throughout the trial. Nevertheless, 2 components were found to be less suitable in this setting. Exercise sessions after lunch received mixed feedback as (1) it was logistically challenging to assemble children after lunch, and (2) they shortened the break time. Although parents had expressed interest in attending bimonthly health promotion lectures, they were too busy to attend all sessions.

TABLE 2 Demographic Characteristics of the Children and Families at Baseline by Intervention Status

	Intervention Mean (SD)	Control Mean (SD)	*P*[a]
n	619	298	
Age, mo	48.8 (7.6)	52.0 (7.1)	<.001
Sex, *n* (%)			.54
Boy	317 (51.2)	159 (53.4)	
Girl	302 (48.8)	139 (46.6)	
Birth wt, kg	3.24 (0.44)	3.17 (0.51)	.04
Birth length, cm	49.9 (1.8)	49.7 (2.0)	.27
Feeding mode before 6 mo, *n* (%)			.004
Exclusive breastfeeding	279 (45.1)	120 (41.7)	
Partial breastfeeding	234 (37.9)	92 (31.9)	
Formula feeding	105 (17.0)	76 (26.4)	
Time spent outdoors, h	1.7 (1.1)	1.8 (1.0)	.04
Time spent watching television, h	1.1 (0.7)	1.3 (1.0)	.005
Nighttime sleep duration, h	9.0 (0.8)	9.6 (1.3)	<.001
Average feeding time for a meal, min	32.4 (11.6)	30.5 (9.0)	.02
Mother's BMI	20.7 (2.3)	21.1 (2.5)	.03
Father's BMI	23.4 (2.7)	23.5 (3.1)	.75
Family structure, *n* (%)			.24
Nuclear family	224 (38.2)	104 (39.7)	
Extended	332 (56.6)	150 (57.3)	
Other	31 (5.3)	8 (3.1)	

[a] Baseline characteristics between intervention and control groups were compared and assessed by using χ^2 and *t* tests where appropriate.

TABLE 3 Changes in the Prevalence of Overweight or Obesity After 12 Months by Sex and Group

			Intervention Versus Control	
	Intervention	Control	Difference (95% CI)	Adjusted OR (95% CI)
All				
n	619	298		
Baseline	15.5%	20.8%	−5.3% (−10.7 to 0.1)	0.92 (0.65 to 1.31)[a]
12 mo	19.9%	33.2%	−13.4% (−19.6 to −7.2)	0.43 (0.19 to 0.96)[b]
Change after 12 mo	+4.4%	+12.4%		
Boy				
n	317	159		
Baseline	19.2%	22.6%	−3.4% (−11.2 to 4.4)	1.19 (0.76 to 1.87)[a]
12 mo	21.1%	37.1%	−16.0% (−24.5 to −7.2)	0.40 (0.19 to 0.85)[b]
Change after 12 mo	+1.9%	+14.5%		
Girl				
n	302	139		
Baseline	11.6%	18.7%	−7.1% (−14.5 to −0.3)	0.77 (0.56 to 1.05)[a]
12 mo	18.5%	28.8%	−10.2% (−18.9 to −1.5)	0.47 (0.17 to 1.31)[b]
Change after 12 mo	+6.9%	+10.1%		

[a] Adjusted for maternal BMI, feeding mode before 6 mo, sex (where appropriate), time spent eating, sleeping time, and time spent in outdoor activities.
[b] Additionally adjusted for baseline status of overweight or obesity.

DISCUSSION

We have, to our knowledge for the first time, demonstrated the feasibility of running a weight management trial in a kindergarten setting in China, in which children are exposed to an increasing obesogenic environment as a result of recent rapid economic development.[29] This 12-month multidisciplinary pilot program, which aims to increase parental awareness of their children's weight and to discourage unhealthy behaviors, could significantly slow down the progression to being overweight or obese among preschool-aged children.

The authors of previous studies have reported comparable intervention effect sizes in older children.[30–32] In this study, the progression to overweight or obese BMI among girls appeared to be less sensitive to the intervention measures, a finding which is somewhat consistent with other studies.[32–34] It is possible that sociocultural factors account for these observed sex differences. Boys are expected to be physically stronger, and parents (especially grandparents) frequently associate this with having large appetite and may be more likely to overfeed boys.[35] Therefore, it is possible that our intervention has exerted a stronger beneficial effect on boys who might have an otherwise higher risk of unhealthy dietary habit and behaviors than girls.

We also found that children who received the intervention had a smaller increase in BMI and/or BMI *z* score, which was consistent with other childhood obesity intervention studies[36–38] despite differences in their objectives, designs, mode, and setting of intervention delivery. A systematic review of interventions targeting children of 0 to 5 years reported to have an effect of −0.26 (95% CI: 0.53 to 0.00) in BMI compared with the control.[16] However, the majority of previous studies were targeted at children aged 6 to 12 years, with interventions predominantly based on behavior change theories and implemented in education settings.[39] Some major fundamental changes were required to implement these comprehensive approaches, including the integration of healthy lifestyle promotion into the regular curriculum, improvement of nutritional quality of food provided to children, and provision of support for people who may be influential to children's growth.[40] Evidence has suggested that multicomponent methods may be more effective in prevention of overweight among children compared with community-based single-component interventions,

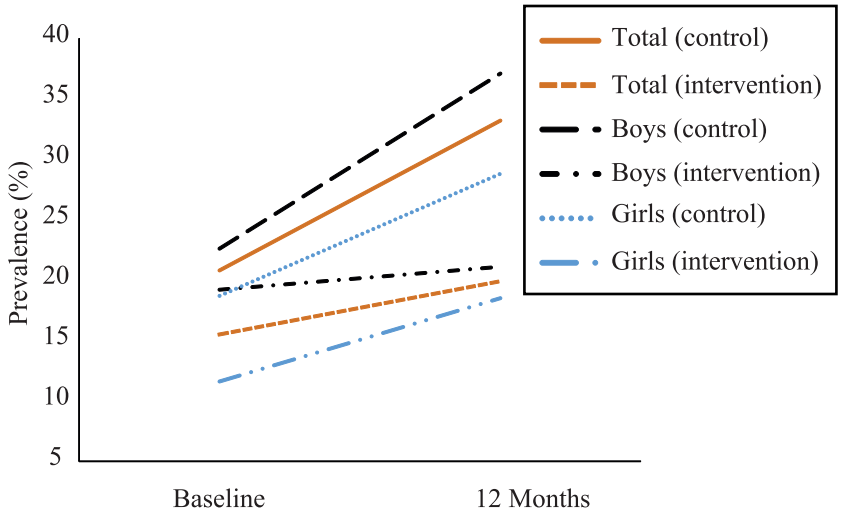

FIGURE 2
Mean change in proportion of children with overweight and obesity from baseline to follow-up at 12 months according to clusters.

TABLE 4 Adjusted Differences in Anthropometric Indices at Different Time Points

	Intervention Mean (SE)	Control Mean (SE)	Intervention Versus Control Difference (95% CI)
Baseline			
BMI[a]	15.6 (1.5)	16.0 (1.4)	−0.22 (−0.47 to 0.03)
BMI *z* score[b]	0.12 (1.44)	0.56 (1.25)	−0.16 (−0.38 to 0.06)
12 mo			
BMI[c]	15.0 (1.5)	16.4 (1.8)	−0.44 (−0.68 to −0.19)
BMI *z* score[d]	0.36 (1.41)	0.97 (1.51)	−0.45 (−0.64 to −0.26)
Change after 12 mo			
BMI[c]	0.2 (1.1)	0.5 (1.1)	−0.27 (−0.46 to −0.08)
BMI *z* score[d]	0.24 (1.11)	0.41 (1.05)	−0.31 (−0.47 to −0.15)

[a] Adjusted for sex, age, feeding mode before 6 mo, time spent eating, sleeping time, and time spent in outdoor activities.
[b] Adjusted for sex, feeding mode before 6 mo, time spent eating, sleeping time, and time spent in outdoor activities.
[c] Adjusted for maternal BMI, baseline status of overweight or obesity, sex, age, feeding mode before 6 mo, time spent eating, sleeping time, and time spent in outdoor activities.
[d] Adjusted for maternal BMI, baseline status of overweight or obesity, sex, feeding mode before 6 mo, time spent eating, sleeping time, and time spent in outdoor activities.

irrespective of the study design (ie, RCT or non-RCT).[41–43] In our current study, modification of behavioral elements was emphasized throughout the whole semester, creating a supportive environment and culture, and a home-preschool association was set up for parents to implement health promotion strategies and activities. The use of multiple strengthened component designs would be more likely to improve the outcomes.

Our findings have important public health implications because we have demonstrated the feasibility of implementing interventions in a kindergarten setting through the use of multiple tactics (monitoring and feedback) to encourage participants' self-motivation.[44] Most previous intervention programs were conducted in elementary and middle schools where food was provided by commercial caterers, whereas we were able to monitor children's diet through school doctors and chefs because food choice and quality in Chinese preschools is monitored by the government, allowing full adherence to the nutritional goals.[16,45] The success of the intervention may be partly attributed by the participation of parents in the intervention program as they paid more attention to their children's diet and lifestyle. By asking parents to monitor their children's growth curves regularly, families may become more involved and compliant to the intervention regimen. Therefore, it is important that future researchers incorporate health education lectures and other relevant tools as core components of obesity prevention intervention to engage family members and to encourage active lifestyle and healthy eating within the family.

As a pilot trial, there were some limitations in the current study. Our trial has relatively insufficient power to detect the intervention efficacy compared with a large-scale RCT. Kindergartens were allocated to the intervention group on a voluntary basis, and, therefore, randomization was not possible and resulted in imbalance of confounding factors between the 2 groups and allocation bias. It is possible that the kindergartens (and parents) opting in for the intervention had stronger intentions and health behaviors to tackle childhood obesity than the control kindergartens, hence our observed effect size might have been overestimated. Nevertheless, our findings (from a nonrandomized trial) were similar to those obtained from randomized studies.[46] Our intervention was limited to 12 months, and we do not have long-term follow-up data to assess compliance after the intervention. However, 1 of our purposes was to evaluate the feasibility of the intervention and to inform optimization in this setting. We demonstrated the feasibility and acceptability of delivering a multicomponent obesity intervention in preschool, which provided the opportunity to refine and modify the program. This information will form part of the strategy plan for the future phase III RCT to provide

TABLE 5 Methods and Findings of the Evaluation of the Intervention Program

Component	Methods of Evaluation	Key Findings
1. Training of kindergarten staff	1. Interview of preschool staff focusing on the appropriateness of the content	1. Acceptability for the course on general nutrition knowledge was high. Preschool staff found it useful and the level was appropriate. Some kitchen staff thought the catering software was too advanced for them due to their relatively lower educational level.
	2. Pre- and postcourse questionnaires testing the understanding of core content and the use of the catering software	2. Nonetheless, after training, 76% of the kitchen staff were able to operate the software on their own.
	3. Awareness and attendance of preschool staff in the courses	3. Overall, 96% of the preschool staff were aware of the courses. Attendance was also high at 93%.
2. A curriculum promoting healthy diet and lifestyle	1. Interview of preschool staff focusing on the appropriateness of the curriculum	1. Teachers who were responsible for delivering the health education lessons had positive feedback and thought the content was appropriate.
	2. Observation of sessions to learn satisfaction and acceptance of teachers and children.	2. The "healthy activities," although acceptable to the children, the timing (after lunch) was impractical because it shortened the lunch break (which includes a nap). Nevertheless, dancing in the activity room was highly acceptable to children and preschool staff.
	3. Questionnaires for parents on their knowledge of their children's dietary habits and health behaviors	3. Parents' response showed that they were familiar with their children's dietary habit and health knowledge.
3. Collaboration between families and schools	1. Interview of parents and preschool staff	1. Parents were too busy to attend all the lectures. They were more prepared to attend twice: at the start and during the intervention. Parents liked the idea of tracing their children's growth curve, although they found the lecture material difficult.
	2. Awareness and attendance of parents in the courses	2. This was reflected by a high awareness at 92% but a lower attendance rate at 69%.
	3. Compliance and usefulness of the handbook	3. Parents would welcome the feedback to be sent via text messages or a smartphone app. However, they still preferred to use a handbook as a means to communicate with the teachers. On average, 96% of the handbooks were handed in on time; 99% of the children in the intervention group had a complete set of BMI records.

definitive evidence. Finally, we did not perform a formal sample size calculation because this was a pilot study, and we have included all eligible kindergartens of the targeted area which agreed to take part in the study.

CONCLUSIONS

This kindergarten-based comprehensive intervention, consisting of regular BMI monitoring by preschool doctors and parents and education to increase awareness among parents and teachers on obesity and healthy diet and lifestyle, has led to a reduced prevalence of obesity in a sample of preschool-aged children attending kindergarten in Guangzhou, China. The findings have demonstrated the feasibility of implementing an effective multidisciplinary preschool-based obesity intervention program. A large, definitive RCT is now required to determine the long-term effectiveness of child obesity intervention.

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ABBREVIATIONS

CI: confidence interval
OR: odds ratio
RCT: randomized controlled trial

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