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Impact of 20 Week Lifestyle Intervention Package on Anthropometric Biochemical and Behavioral Characteristics of Schoolchildren in North India

by J. S. Thakur,[1] Bhavneet Bharti,[2] Jaya Prasad Tripathy,[3] Veena Dhawan,[4] and Anil Bhansali[5]

[1]Department of Community Medicine, School of Public Health, Postgraduate Institute of Medical Education and Research, Chandigarh, India
[2]Advanced Pediatric Centre, Postgraduate Institute of Medical Education and Research, Chandigarh, India
[3]International Union against Tuberculosis and Lung Disease, The Union South East Asia Office, New Delhi, India
[4]Department of Experimental Medicine and Biotechnology, Postgraduate Institute of Medical, Education and Research, Chandigarh, India
[5]Department of Endocrinology, Postgraduate Institute of Medical Education and Research, Chandigarh, India
Correspondence: J. S. Thakur, Department of Community Medicine, School of Public Health, Postgraduate Institute of Medical Education and Research, Chandigarh, India. E-mail <jsthakur64@gmail.com>

ABSTRACT

Background: Childhood obesity is a public health problem worldwide. There is convincing evidence that school-based interventions are effective in managing childhood obesity. However, the nature of interventions, its impact on prevention of obesity and how they work remain poorly understood. The primary objective of this study was to examine the impact of a multicomponent lifestyle intervention on weight and body mass index (BMI) of children in a school-based setting. Methods: It is a cluster randomized trial where four schools were randomly selected and allocated to intervention and control arm equally. Of the 462 schoolchildren selected, 201 were assigned to the intervention group and 261 belonged to the control group. Children in the intervention arm received a multi-component lifestyle package. Primary outcome measures included anthropometric measurements (weight, BMI, skinfold thickness and waist and hip circumference), whereas secondary outcomes were biochemical parameters, physical activity and dietary intake. Results: Compared with controls and adjusting for age, sex and clustering within classes, children in the intervention group showed decrease in the weight by -0.08 (-0.15 to -0.00, $p = 0.048$) z-score units, waist circumference by -0.14 (-0.25 to -0.03, $p = 0.01$) and triceps thickness by -0.35 (-0.47 to -0.22, $p < 0.001$) z-score units; however, BMI showed no significant decrease. There was significant reduction in intake of energy, protein and fat but no to minimal reduction in biochemical parameters. Conclusion: A school-based lifestyle intervention package favorably affected anthropometric (weight, waist circumference and triceps and biceps thickness) and behavioral parameters. At least 20 weeks of healthy lifestyle promoting intervention package should be included in school

curriculum in each academic year for sustainable impact and behavioral change to reduce the burden of lifestyle disorders.

INTRODUCTION

Globally, rising prevalence of childhood obesity poses a major threat to public health. The last two decades of the previous century have witnessed dramatic increase in health care costs owing to obesity and related issues among children and adolescents [1]. It has been estimated that worldwide, >22 million children <5 years of age are obese, and 1 in 10 children is overweight [2]. A study in India showed that the proportion of overweight children increased from 4.94% in 2003 to 6.57% in 2005, demonstrating the time trend of this rapidly growing epidemic [3]. The Global School Health Survey (2007) in India also revealed that only 30% of the students were physically active for at least 60 min per day on all 7 days of a week [4]. A study in a similar population in North India found out that the overall prevalence of metabolic syndrome and overweight among school-going adolescents was 4.2% and 5.5%, respectively [5]. The evidence is strong that once obesity is established, it tends to perpetuate into adulthood, strengthening the case for primary prevention. But prevention of obesity requires a multidisciplinary approach, which includes dietary management, physical activity and restriction of sedentary behavior. There is convincing evidence that school-based interventions are effective in managing childhood obesity [6]. School-based interventions in the available literature varied widely. They were designed to decrease overweight by increased physical activity, decreased sedentary activities and decreased intake of food with high fat and sugar content. Programs were delivered as physical education classes and/or classroom lessons. Many programs were multicomponent. However, the available knowledge base on obesity prevention and appropriate public health interventions to reduce the risk of obesity remain limited [7]. The impact of interventions on prevention of obesity, the extent that they work and how they work remain poorly understood, more so in a developing setting like India.

The present study was thus conducted to examine the impact of a 20-week multicomponent lifestyle intervention package on anthropometric, biochemical and behavioral parameters of children in a school-based setting.

MATERIALS AND METHODS

A cluster randomized study was carried out in the Union Territory of Chandigarh with school taken as the unit of randomization. Both public and private schools were recruited to represent diverse socioeconomic groups. Four schools—two public and two private schools—were selected randomly from a list of public and private schools and further randomized into intervention and control groups. Of the 462 schoolchildren of class VIII–IX, 201 students were assigned the intervention group and 261 belonged to the control group. Figure 1 shows the flow chart of participants in the study. The main outcome measures were change in weight, body mass index (BMI) and other anthropometric parameters at baseline and after 20 weeks. Biochemical parameters were measured at the baseline and after 20 weeks. The lifestyle and dietary habits were also assessed using a pretested questionnaire.

All participants were weighed to the nearest 0.1 kg in light clothing, without shoes and with an empty bladder on an electronic scale (SECA 801 digital scale; at baseline and again at 12 months). Height was measured using a portable stadiometer. Waist circumference was measured to the nearest 0.5 cm at the umbilicus with a flexible tape applied directly on the skin. Hip measurements were taken at the widest point around one layer of light clothing. Biceps and triceps skin fold thickness was recorded using the Harpenden calipers. Biochemical parameters such as fasting plasma glucose, serum triglycerides, total cholesterol and plasma high-density lipoproteins (HDL)/low-density lipoproteins (LDL), Apo A1/Apo B, Insulin and C-reactive protein were done in all the children who were available in the school on the scheduled day after obtaining

Consented and present for baseline measures (N=462)

Intervention (N=201)			Control (N=261)	
Before	**After**	**Anthropometric parameters**	**Before**	**After**
168	157	Weight	250	216
168	157	BMI	250	216
168	157	Waist circumference	250	216
167	157	Hip circumference	250	216
171	149	Triceps thickness	250	216
171	149	Biceps thickness	250	216
174	157	MUAC	249	215
		Biochemical parameters		
158	143	Plasma glucose	125	105
153	142	Cholesterol	124	99
154	141	Triglycerides	124	99
146	141	HDL	124	99
146	141	LDL	124	99
		Dietary parameters		
201	158	Energy intake	261	235
195	158	Fat intake	214	234
196	158	Protein intake	214	234
196	157	Dietary fibre intake	212	226

Fig. 1. Flow chart showing the selection of the study participants.

written parental consent and the child's assent. Dietary energy and fat intake was assessed using the 3 day (including one holiday/Sunday) dietary recall and food frequency questionnaire. The modified international physical activity questionnaire (short version) was used to measure weekly physical activity. Physical activity was converted to metabolic equivalents (METs) as per guidelines of Global Physical Activity Questionnaire, World Health Organization (WHO) [8]. To provide an objective measure of physical activity, students were demonstrated the use of Pedometer (Omron) for making estimates about the physical activity.

The intervention package developed by WHO India titled 'Creating Health Promoting Schools' [9] was adapted and used to deliver sessions on topics such as food and nutrition, environment, physical fitness and lifestyle disorders such as obesity, hypertension and stroke. The intervention was delivered as a group session by trained facilitators including dieticians and pediatricians. The control group did not attend any lectures at the school; however, they received information about diet and physical activity if they so desired following filling of the baseline questionnaire. Being a pragmatic trial and considering the nature of the intervention package, masking was not applicable.

Components of the School-based Lifestyle Intervention Package

- Fortnight health education sessions at school in the form of interactive sessions and audio-visual displays.

- Maintenance of lifestyle diaries in which the child's daily diet and physical activity were self-recorded.
- Suitable dietary recommendations to the parents for the diet of their children, prepared in accordance with the guidance of the dietician.
- Ensuring one period of physical activity at school daily.
- Motivation to avoid junk food by changing the menu of the school canteen and providing healthier options.
- Reduction in television (TV)-watching hours at home by involving parents
- Display of health promotion materials such as posters and charts within the schools' vicinity.
- Active involvement of teachers in health assessment and Parent Teachers' Association.

Statistical analysis

Statistical analysis was based on the intention-to-treat principle, and results were reported at the individual level. We used mixed linear models with z-scores at follow-up as dependent variables; group (control or intervention), sex and age as fixed factors; school class as random effect; and the respective baseline z-score as a covariate. School class was the smallest cluster in the sampling design, and so it was considered as a random effect. Another linear mixed model was also used where baseline z-score was not used as a covariate (Supplementary Appendix 1).

RESULTS

Baseline characteristics

A total of 462 adolescents were enrolled in the study from four schools (two public and two private) in Chandigarh. There were significant baseline differences between the control and intervention schools in terms of gender, educational qualifications of the parents and birth order (Table 1).

Behavioral parameters

Transport-related METs showed a rise among the children in the intervention group over the control

Table 1. *Baseline socio-demographic characteristics of the study population*

Socio-demographic characteristics	Control group (N=261)	Intervention group (N=201)	p-value
Mean age in years (SD)	13.5 (0.7)	13.3 (0.8)	0.1
Gender			
Male	211 (80.8%)	116 (57.7%)	0.0001
Female	50 (19.2%)	85 (42.3%)	
Religion			
Hindu	214 (82%)	167 (83.1%)	0.94
Sikh	38 (14.6%)	28 (13.9%)	
Other	9 (3.4%)	6 (3.0%)	
Father's qualification			
Postgraduate	88 (35.6%)	16 (8%)	<0.0001
Graduate	66 (26.7%)	68 (33.8%)	
Higher secondary	23 (9.3%)	32 (15.9%)	
Matric	51 (20.6)	16 (29.8)	
Below Matric	19 (7.7%)	25 (12.4%)	
Mother's qualification			
Postgraduate	77 (31.3%)	6 (3%)	<0.0001
Graduate	53 (21.5%)	60 (29.8%)	
Higher secondary	25 (10.2%)	22 (11%)	
Matric	41 (16.7)	50 (24.9)	
Below Matric	50 (20.3%)	63 (31.3%)	
Birth order			
First	58 (22.3%)	3 (1.5%)	<0.0001
Second	132 (50.8%)	115 (57.2%)	
Third +more	70 (26.9%)	83 (41.3%)	

group by 0.30 (0.12–0.48, $p = 0.001$) z-score units although total MET's score showed no significant change (Table 2). There was a significant reduction in energy intake by 0.18 z-score (-0.34 to -0.02, $p = 0.02$), protein by 0.25 (-0.40 to -0.10, $p = 0.001$) and fat intake by -0.30 (-0.47 to $-0.13, p = 0.01$) z-score units among children in the intervention group (Table 3). There was no significant change in TV-viewing hours in both the groups.

Anthropometric parameters

Table 4 shows the results of the primary outcomes at baseline and follow-up, as well as the adjusted differences at follow-up. Compared with controls, children in the intervention group showed decrease in the weight by 0.08 (-0.15 to -0.001, $p = 0.048$)

Table 2. *Comparison of METs across study groups before and after intervention*

MET values	Control group		Intervention group		Adjusted difference[a] (95% CI)	*p*-value
	Before	After	Before	After		
School related	591.2 (616.1)	754.0 (518.0)	446.0 (298.1)	488.0 (431.7)	−0.56 (−0.75 to −0.37)	**<0.001**
Household related	346.1 (411.3)	381.2 (476.8)	349.5 (323.7)	343.7 (378.2)	−0.09 (−0.29 to 0.10)	0.35
Leisure related	1616.8 (1264.4)	3278.4 (2527.3)	1070.7 (872.7)	3653.4 (2312.5)	0.07 (−0.11 to 0.25)	0.43
Transport related	1066.2 (750.9)	611.5 (691.8)	1372.9 (715.0)	978.9 (901.1)	0.30 (0.12 to 0.48)	**0.001**
Total METs score	2891.7 (1515.5)	4929.4 (2299.3)	2805.5 (1409.7)	4735.8 (2692.4)	0.06 (−0.12 to 0.25)	0.50

[a]Adjusted difference in average z-score of respective outcome at follow-up between intervention and control group with 95% CI; adjusted for group, sex and z-score at baseline in mixed linear model with random effect for school. Bold values in tables 2-5 mean significant p value (p<0.05)

Table 3. *Comparison of dietary intake across study groups before and after intervention*

Dietary intake	Control		Intervention		Adjusted difference[a] (95% CI)	*p*-value
	Before	After	Before	After		
Energy	2666.6 (859.3)	2559.5 (836.6)	2305.7 (774.8)	2192.5 (612.1)	−0.18 (−0.34 to −0.02)	**0.02**
Protein	77.6 (30.1)	86.1 (42.4)	63.8 (21.3)	64.6 (21.5)	−0.25 (−0.40 to −0.10)	**0.001**
Fat	94.6 (36.2)	83.4 (31.6)	84.1 (34.7)	69.8 (23.5)	−0.30 (−0.47 to −0.13)	**0.01**
Dietary fiber	5.34 (4.01)	6.2 (5.2)	8.89 (5.50)	6.6 (3.0)	−0.22 (−0.42 to −0.02)	**0.03**

[a]Adjusted difference in average z-score of respective outcome at follow-up between intervention and control group with 95% CI; adjusted for group, sex and z-score at baseline in mixed linear model with random effect for school.

Table 4. *Comparison of anthropometric indices across study groups before and after intervention*

Anthropometric parameters	Control group		Intervention group		Adjusted difference[a] (95% CI)	*p*-value
	Before	After	Before	After		
Height (meters)	1.6 (0.10)	1.63 (0.11)	1.56 (0.08)	1.58 (0.09)	−0.04 (−0.14 to 0.05)	0.34
Weight (kg)	51.12 (13.64)	55.51 (15.3)	44.89 (10.63)	47.6 (11.3)	−0.08 (−0.15 to −0.00)	**0.048**
BMI	19.62 (3.71)	20.5 (4.2)	18.40 (3.72)	18.87 (3.7)	−0.09 (−0.19 to 0.01)	0.09
MUAC	24.50 (4.12)	24.37 (3.6)	21.31 (3.6)	22.58 (3.02)	0.18 (0.07 to 0.29)	0.002
Waist circumference	68.71 (10.9)	74.49 (11.9)	64.59 (9.9)	68.80 (10.2)	−0.14 (−0.25 to −0.03)	**0.01**
Hip circumference	84.34 (8.36)	87.62 (9.8)	79.32 (8.1)	82.32 (8.1)	−0.01 (−0.11 to 0.09)	0.86
Waist hip ratio	.81 (0.06)	0.85 (0.07)	0.81 (0.08)	0.84 (0.12)	−0.10 (−0.29 to 0.08)	0.27
Triceps SFT (mm)	14.0 (6.3)	12.17 (5.7)	11.6 (5.6)	8.53 (4.9)	−0.35 (−0.47 to −0.22)	**<0.001**
Biceps SFT (mm)	8.17 (4.26)	7.56 (3.7)	6.77 (3.94)	10.23 (4.7)	0.77 (0.62 to 0.91)	<0.001

[a]Adjusted difference in average z-score of respective outcome at follow-up between intervention and control group with 95% CI; adjusted for group, sex and z-score at baseline in mixed linear model with random effect for school. MUAC: Mid Upper Arm Circumference SFT: Skin Fold Thickness.

z-score units, waist circumference by -0.14 (-0.25 to -0.03, $p = 0.01$) and triceps thickness by -0.35 (-0.47 to -0.22, $p < 0.001$) z-score units.

Biochemical parameters

There was no significant change in biochemical parameters across both the study groups although LDL recorded a rise by 0.22 (0.02–0.41, $p = 0.03$) z-score units (Table 5).

Another linear mixed model where baseline z-score was not used as a covariate was constructed. This model was similar to the previous model, although variables like intake of energy and protein were rendered insignificant. HDL intake was significantly reduced in the intervention group as compared with the control (Supplementary Appendix 1).

DISCUSSION

This randomized controlled trial showed that a school-based lifestyle intervention package favorably affected anthropometric and behavioral parameters but had no to minimal effect on biochemical parameters. The intervention package resulted in a relative decrease (that is a lesser increase) in weight in the intervention group compared with the control group. These findings were consistent for waist circumference and triceps thickness as well though BMI showed no significant reduction. A meta-analysis of interventions revealed that 16 of 60 studies showed significant reduction in BMI with an overall pooled estimate of -0.17 kg/m^2 (-0.26 to -0.08, $p = 0.001$) [10]. Many school-based interventions, both long term and short term, have shown no significant difference in BMI, skinfold thickness and other anthropometric measures such as waist and hip circumference across comparison groups [11–19]. There are also many school-based interventions, which have reported significant reduction in BMI and other anthropometric parameters [20–25]. Some of the interventions have led to behavioral changes such as healthy dietary intake [16–19, 26, 27] (more fruit and vegetable intake, less fat, less energy, more fiber) similar to the results of the present study, which also reported reduced intake of energy, fat and sodium. However, reduced intake of protein and dietary fibers as found in this study needs careful attention.

Many interventions that successfully lowered BMI also successfully decreased sedentary behaviors but showed no impact on physical activity. This suggests that school-based interventions that decrease sedentary behaviors might be effective tools for obesity prevention [28, 29]. Physical inactivity is highly correlated with the risk of many chronic diseases in adulthood [29, 30] and in the short run, it has contributed to an unprecedented epidemic of childhood obesity leading into adulthood [31]. Evidence from the Cardiovascular Risk in Young Finns study also indicates that decreased physical activity levels in childhood and persistent inactivity are linked to obesity in adulthood [32]. Physical education at school is a major determinant of physical activity for children, as a third of the day is spent in school. While norms for physical education in schools have been described, adherence to these norms is

Table 5. *Comparison of biochemical indices across study groups before and after intervention*

Biochemical parameters	Control group		Intervention group		Adjusted difference[a] (95% CI)	p-value
	Before	After	Before	After		
Plasma Glucose	88.5 (9.6)	88.8 (8.5)	89.6 (9.8)	88.9 (12.8)	0.02 (-0.17 to 0.22)	0.80
Cholesterol	148.5 (34.4)	128.42 (20.14)	141.9 (33.5)	127.38 (25.6)	-0.12 (-0.31 to 0.07)	0.21
Triglycerides	83.9 (23.2)	94.08 (23.9)	83.9 (10.2)	94.34 (33.0)	0.02 (-0.18 to 0.21)	0.85
HDL direct	44.1 (4.2)	37.06 (8.9)	45.9 (4.4)	36.48 (7.1)	-0.14 (-0.33 to 0.05)	0.16
LDL	77.7 (22.1)	57.87 (19.0)	75.5 (30.7)	61.13 (21.2)	0.22 (0.02 to 0.41)	**0.03**

[a]Adjusted difference in average z-score of respective outcome at follow-up between intervention and control group with 95% CI; adjusted for group, sex and z-score at baseline in mixed linear model with random effect for school.

generally low, globally [33]. A review of interventions has indicated that in the short term, the school setting is effective in increasing physical activity [34]. Another meta-analysis has suggested that school-based interventions can significantly reduce BMI especially if they include a physical exercise component [10]. Physical education programs at school should, therefore, be strengthened to ensure adequate levels of physical activity for all children.

This study shows that it is practically feasible to implement a multicomponent lifestyle package in a school-based setting to reduce the burden of childhood obesity and bring about a behavioral change. High participation rates and support from the parents was encouraging. Importantly, the teachers and the students enjoyed the intervention, which ultimately led to high compliance to the intervention. Reducing TV-viewing hours is widely considered as a promising, population-based approach to prevent childhood obesity [29]. In this study, parents were involved to promote healthy habits among children and reduce TV-viewing hours, which received enthusiastic response. However, there was no significant change in TV-viewing hours in the intervention group. Thus, there is probably a need to have more innovative approaches to reduce TV-watching hours. Natale et al. showed that involvement of parents significantly reduced children's junk food consumption and level of sedentary behavior [35]. Thus, future obesity prevention intervention efforts targeting children should include parents as healthy lifestyle role models for their children.

This study, being a short-term interventional study, showed minimal to no changes in biochemical parameters. Manios et al. in a 6 year intervention study reported significant changes in biochemical indices [22], which lends evidence to the fact that long-term interventions might bring significant changes in biochemical and other parameters. Favorable outcomes will only be achieved through a multifactorial approach involving the parents, teachers, school administration that takes care of the cultural norms and organizational issues and provides a conducive environment for behavior change at the individual and group level. This will also have an impact on the sustainability of the intervention.

Limitations

The results of this study should be viewed with caution because of three principal reasons. First, the children in the control groups were all aware of the study aims and were assessed for height, weight, physical activity, biochemical and dietary parameters. This assessment could have had an impact on the children's diet and physical activity patterns in the same direction as the intervention, thereby leading to an underestimation of the effect. Second, the baseline differences between the control and the intervention groups could have influenced the results. Third, there were some drop outs particularly in the biochemical assessment section most likely owing to the fear of getting pricked.

CONCLUSION AND RECOMMENDATIONS

Short-term behavior change is unlikely to be sustainable or effective in impacting on weight of children. We need to consider the issues impacting on sustainability and environmental change while simultaneously addressing behavior change. Multiple stakeholders (families, school and others) should be included in the decision making. We would like to caution though, that these are early results and we need to follow-up the cohort for a long duration to see if these changes will be sustained. Evidence of interventions that aim to create an environment promoting individuals to eat a healthy diet and be more physically active is lacking. With the current available evidence, we recommend at least 20 weeks of health-promoting intervention period in each academic year on a long-term basis so as to bring about a desirable change in behavioral, anthropometric or biochemical parameters and thereby have significant impact on health and well-being.

SUPPLEMENTARY DATA

Supplementary data are available at *Journal of Tropical Pediatrics* online

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