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Effectiveness of a Five Year School-Based Intervention Programme to Reduce Adiposity and Improve Fitness and Lifestyle in Indian Children; The SYM-KEM Study

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Abstract

Design—Non-randomised non-blinded school-based intervention study.

Setting—Two schools in the cities of Pune and Nasik, India.

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Author contributions: Sheila Bhave, Anand Pandit, Rajiv Yeravdekar, Shraddha Naik and Caroline Fall designed the research. Sheila Bhave, Anand Pandit, Vaishali Madkaikar and Trushna Chinchwade conducted the research. Nasreen Shaikh, Tasneem Shaikh and Ella Marley-Zagar performed the statistical analysis of the data. Sheila Bhave and Caroline Fall drafted the manuscript, and all authors contributed to and approved the final version. Sheila Bhave had primary responsibility for the final content.

Participants—The intervention group comprised children attending one Pune school from 7-10 years until 12-15 years of age. Two controls groups comprised (1) children of the same age attending a similar school in Nasik, and (2) children in the Pune intervention school but aged 12-15 years at the start of the study.

Intervention—A 5-year multi-intervention programme, covering three domains: physical activity, diet and general health, and including increased extra- and intra-curricular physical activity sessions; daily yoga-based breathing exercises; making physical activity a ‘scoring’ subject; nutrition education; healthier school meals; removal of fast-food hawkers from the school environs; and health and nutrition education for teachers, pupils and families.

Main outcome measures—Body mass index (BMI), waist circumference, physical fitness according to simple tests of strength, flexibility and endurance; diet; and lifestyle indicators (time watching TV, studying and actively playing).

Results—After five years the intervention children were fitter than controls in running, long-jump, sit-up and push-up tests ($p < 0.05$ for all). They reported spending less time sedentary (watching TV and studying), more time actively playing, and eating fruit more often ($p < 0.05$). The intervention did not reduce BMI or the prevalence of overweight/obesity, but waist circumference was lower than in the Pune controls ($p = 0.004$).

Conclusions—It was possible to achieve multiple health-promoting changes in an academically competitive Indian school. These resulted in improved physical fitness, but had no impact on the children’s BMI or on the prevalence of overweight/obesity.

Keywords

Intervention; Indian children; Body mass index; Physical fitness; Lifestyle change

Introduction

Increasing childhood adiposity is an important factor in the rising incidence of adult diabetes and coronary heart disease in all populations, including low-and-middle-income countries like India.[1,2] Both diseases have reached epidemic proportions in urban India.[3] Obese children have a high risk of additional immediate problems, including respiratory problems, joint disorders, sleep apnoea, and social stigmatization.[1,4] Surveys in Indian cities have shown that more than 10% of school children are overweight or obese.[5] Recognised contributory factors include a strong emphasis on academic study (children often have extra tuition classes outside school), a perception that physical exercise is unimportant, and the popularity of energy-dense foods.[1,4]

Many intervention studies, mainly in high income countries, have targeted adiposity in children.[6–8] These have often been school-based and combined health education with modification of diet and activity. Body mass index (BMI) is the commonest outcome measure, although some studies have measured fitness,[9,10] which may counteract adiposity-related ill-health.[11] They have reported varying levels of success, but it is clear that successful programmes must be tailored to each population. Large school-based health and nutrition education programmes in India have reported increased knowledge and/or

health-related behaviours.[12,13] A small (N=99) multi-component school-based intervention over 6 months among Delhi adolescents showed a significant reduction in waist circumference.[14]

We report here a non-randomised intervention carried out in one school in the city of Pune in western India. In a 5-year multi-intervention programme, we attempted to improve diet and increase activity among an entire two-year cohort of children in order to reduce adiposity and increase physical fitness. They were compared with children who did not receive the intervention; these included 1) children of the same age in a similar school in a different city, and 2) children in the intervention school who were five years senior (and therefore the same age at the start of the study as the intervention children at the end of the study).

Methods

Setting

Symbiosis School in Pune caters to children of high socio-economic status and has a strong academic reputation. The school provides paid lunch for students, and two compulsory 40-minute physical education (PE) periods per week. Outdoor activities are constrained by a small playground.

Study population (Figure 1)

The intervention group comprised all children enrolled in 2005-2006 in the 3rd and 4th standards (aged 7.7-9.6 yrs). Two control samples were selected, on a pragmatic basis, as it was not possible to randomise children. The first comprised children of the same age and comparable socio-economic status, enrolled in 2005-2006 in the 3rd and 4th standards of Symbiosis School in Nasik, a city 200 km from Pune. They would be compared at baseline, and after 5 years intervention with the intervention children. The second control group comprised children enrolled in the 8th and 9th standards (aged 12.1-15 years) in 2005-2006 in Symbiosis School, Pune. Their 2005-2006 data would be compared with the post-intervention data of the intervention group when the latter reached the 8th and 9th standards in 2010-2011.

Intervention programme

Approval was obtained from the Research Ethics Committees of the KEM Hospital, Pune and the Symbiosis Institute of Health Sciences. Meetings were held to inform families and teachers about the study. Written consent was obtained from parents and verbal assent from children.

We aimed to increase in-school *physical activity* by increasing PE sessions to six per week and incorporating children's fitness modules designed by an expert, making PE a 'scoring' subject that contributed to the children's academic marks, training teachers to engage the children in daily yoga-based breathing exercises ('pranayam'), and offering attractive physical activity sessions (eg. 'Bollywood dancing') during holidays. We aimed to improve the children's *diet* at school. The project nutritionist interacted with the school kitchen staff to develop healthier meal options and increase the fruit and vegetable content of lunches. We

asked the school to ban fast-food sellers ('hawkers') from outside the school gates, so that fizzy drinks, sweets, ice creams and fried snacks were inaccessible during the school day. We aimed to introduce a *health education* programme, with weekly age-appropriate interactive one-hour sessions to teach children about the importance for health of diet, activity and lifestyle, and the creation of short modules for teachers to use at the start of regular science classes. Workshops to inform teachers and ensure consistency of messages, and newsletters for children containing information and fun activities, were planned once a term.

Measurements

Anthropometry—Weight and height were recorded by six trained research assistants, according to standardised protocols, thrice during the study in 2006 (baseline), 2008 and 2011. Waist circumference was measured standing, to the nearest millimeter, mid-way between the costal margins and iliac crests using anthropometric tapes (CMS Instruments, UK).

Diet and activity—Information on habitual diet and physical activity was collected from parents and children together at baseline and the end of the study, using self-completed questionnaires after an introductory briefing. A food frequency questionnaire was used to record vegetable and fruit intakes. Parents were asked how often the child ate out, how many hours per day they watched TV, attended tuition classes outside school, and played actively outside school.

Fitness—Initially, fitness and flexibility tests standardised by the Sports Authority of India (SAI, selection criteria <http://sportsauthorityofindia.nic.in>) were used. These included (1) one minute of sit-ups; (2) one minute of push-ups; (3) a measured vertical jump; (4) a measured long-jump; (5) a stand-and-reach test; and (6) a timed 30-meter sprint. Performance was graded as below average, average, good, or excellent according to age- and sex-specific SAI norms. They were the only available tests for Indian children when we started but were designed to identify children with the potential to become national-level athletes, and our children scored poorly. We used them at baseline in the Pune intervention and control groups, but sought alternative tests. We subsequently adopted tests developed by the Agashe College of Physical Education, Pune ('SYM-KEM tests').[15,16] They were designed to test endurance, cardiovascular fitness, muscular strength and flexibility and comprised: (1) a 9-minute walk or run (distance covered in meters); (2) sit-ups (number in one minute); (3) push-ups (number in one minute); (4) a sit-and-reach test (cm); (5) a shuttle-run (time to cover ten meters six times); and (6) a standing long-jump (meters). The absolute values and locally-derived age- and sex-specific percentile values were used. These tests were administered to the intervention group and Nasik controls at the end of the intervention period.

It was not possible to blind the participants and outcome measurers to the allocation group, and individual children's compliance with the interventions was not assessed.

Statistical methods

Data were analysed using SPSS version 20 and STATA version 13. BMI was expressed in Z-scores according to the WHO growth reference.[17] Comparisons of continuous variables between groups within sexes were performed using unpaired t-tests or Wilcoxon or Mann Whitney tests as appropriate, after testing variables for normality of distributions and equality of variances. Chi-squared or Fisher's exact probability tests were used to test differences between groups for categorical variables. Comparisons between groups with the sexes combined were performed using linear (continuous outcomes) or logistic (categorical outcomes) regression adjusted for sex. Non-normally distributed outcome variables were transformed using the Fisher-Yates method.[18] The analysis was limited to children who were assessed at both baseline and at the end of the intervention (Figure 1).

Results

Baseline measurements

More than 85% of registered children consented to have baseline measurements (Figure 1). Mean BMI and waist circumference, percentages of underweight and overweight children, and lifestyle factors were similar in the intervention group and Nasik controls (Table 1). There were significant differences in lifestyle factors between the Pune intervention group and Nasik controls at baseline. Pune boys watched less TV and ate fruit and vegetables more often than Nasik boys; the opposite was true in girls. The Pune children (both sexes) spent more time in tuitions and in active play, and ate out more often. Less than 10% of the Pune intervention group scored 'average or above' in the SAI fitness tests (not tested in the Nasik controls).

Implementation of the intervention

The interventions were introduced gradually over the first 1-2 years of the study. Daily pranayam sessions were held successfully from the start. We observed initially that in PE classes most children were made to just sit and watch the talented 'sporty' children compete. This approach, and the small playground, limited PE to boring traditional exercises. Many children brought in 'medical certificates' to get out of PE. However, within 2 years, PE classes were successfully increased from two to five per week, became more inclusive, and incorporated fitness modules on most days. PE marks were added to academic reports from 2008. Parents received regular fitness reports and opportunities to discuss these individually with nutritionists and doctors. Dietary changes were accomplished within the first year. At least one fruit and two portions of vegetables were served at every school lunch, and children were encouraged to eat the fruit first. Soya flour, brown bread, vegetable-stuffed rotis, sprouts, salad, millets and yogurt were incorporated into tasty 'child-friendly' lunch recipes. Vegetables were chopped or pureed so that children could not remove them from dishes. For children who brought their own lunches, we provided similar guidelines to the parents. With the help of the school management and security staff, fast-food hawkers were kept away from the school environs. Neither the weekly health education sessions, nor the science modules could be sustained because of academic pressures. However a half-day theme-based workshop ('health day') was held each term, with guest talks and popular

activities and games. Workshops were held for teachers, and a newsletter produced, annually.

Post-intervention comparisons: Intervention group v Nasik controls

After five years' intervention, the mean BMI Z-score and waist circumference remained similar in the intervention group and Nasik controls (Table 2, Figure 2). The prevalence of overweight/obesity was higher than at baseline in both groups. The intervention children reported less time watching TV and having tuitions than controls, more time in active play and higher fruit intakes. Few children scored average or above in the SAI fitness tests, but percentages were significantly higher in the intervention group for sit-ups, long-jump and sprint tests. This was echoed in the SYM-KEM tests.

Post-intervention comparisons: Pune intervention v Pune control groups

At the end of the programme, the intervention children, now aged 12-15 years, had a similar mean BMI and overweight/obesity prevalence, but lower mean waist circumference, than the Pune controls measured at baseline at the same age (Table 3). The intervention children reported eating out more often than controls, but less TV and tuition time, more time in active play, and higher fruit intakes. They were also fitter according to (SAI fitness tests) sit-ups, long jump and sprint.

Discussion

Summary

This was the first study of its kind in India, in which multiple changes in the culture of a school were introduced and maintained over a 5-year period, in order to improve the children's fitness, health behavior and adiposity. Many of the planned changes to the school routine and environment were implementable but others were not, usually because academic considerations took higher priority. At the end of the intervention, children in the intervention group were fitter and had better lifestyle indicators than controls. The programme did not reduce BMI, but waist circumference was reduced in the intervention group compared with one of the two control groups.

Implementation of the intervention

PE classes were increased, innovative exercises were introduced, and PE became a scoring subject. School meals were made healthier and fast-food hawkers were removed. Health and nutrition education was imparted through various activities. The programme was generally well-received by the children, parents and teachers, but major changes to the academic timetable were resisted. The PE department was under-staffed and a culture of nurturing talented children who would build the school's reputation in inter-school sports competitions, rather than providing healthy exercise for all, had to be overcome. Parents were more concerned about children's academic performance than health and fitness. It took time to implement the physical activity changes and motivate all children to participate. In comparison, dietary improvements were made fairly easily. We hoped that teachers would pass on healthy lifestyle information to children, but this was unrealistic; they were too busy with academic priorities, upon which they are judged.

Impact on fitness

The most striking results came from the fitness tests. The intervention children were fitter than the Nasik controls after 5 years, and fitter in 2011 than the Pune controls in 2006. Fitness is an important functional measure, and in adults the morbidity and mortality associated with overweight/obesity are mitigated if fitness is maintained.[11] Ideally we would have used a single set of fitness tests throughout. However, we had to change from tests developed for selecting athletes, which proved too difficult, to newly developed population-appropriate tests, which will be described fully in a separate paper. Nevertheless, our results provide evidence that the intervention improved fitness. The tests required minimal equipment and are potentially feasible in all Indian schools, given adequate staff and time. Other similar intervention studies have shown improved fitness measured by spiroergometry (VO₂max), shuttle-run tests or motor skills.[9,10]

Impact on adiposity

The intervention did not reduce BMI, which increased in the intervention and Nasik control children to a similar degree over five years. The intervention reduced waist circumference compared with the Pune, but not the Nasik, controls. One possible explanation for this discrepancy is that access to fast foods, and/or peer pressure to eat them, was generally greater in Pune (the larger city) than Nasik, and that the intervention protected children from this. Another possibility is that parental awareness of child obesity has increased since 2006, benefitting both the intervention group and Nasik controls, and making any intervention effect less obvious. The lack of effect on BMI is consistent with previous intervention studies, mainly in high income countries, only a minority of which have shown reductions in BMI^{6,8}. A recent consensus statement suggested that at least 45-60 minutes daily of moderate-intense exercise are required to prevent weight gain,[19] an important consideration in setting policies for PE in schools.

Impact on lifestyle

Consistent with other studies,[8] intervention children reported significantly healthier lifestyles after the intervention than both control groups. These findings do not have the strength of the (more objective) fitness tests, because a) the intervention children had healthier lifestyle profiles at baseline and b) they may have over-reported their activity and told us 'what we wanted to hear'. It would have been helpful to have objective assessments of physical activity such as accelerometer data. Even if families over-reported physical activity, however, it suggests that families absorbed the health education messages.

Strengths and limitations

Strengths of the study were that a multi-component intervention was implemented over a sustained period, thanks to co-operation from the school authorities. Approximately 90% of the children who remained in the school throughout the study were assessed at the start and finish. Because we were limited by what the schools and the children and parents allowed, there were some important limitations of the study design. Neither randomisation nor blinding of the children and staff were possible. The initial fitness tests were unsuitable and had to be changed; we were able to compare the Pune intervention group and Nasik controls

at the end of the study, but did not have fitness data on the Nasik controls at baseline, and therefore cannot rule out the possibility that the Pune children were fitter to start with. The Pune intervention children were, however, markedly fitter after the study than the Pune control group, assessed at the same age at the start of the study. The Pune controls were assessed only once, at the same age at the start of the study as the intervention children at the end, and so secular and/or cohort effects could have biased the results. However, we would have to assume that either there was a secular increase in children's fitness, or that the intervention cohort was fitter for some other reason than the intervention. We think that both these scenarios are unlikely. It would have been useful to assess pubertal status (which influences anthropometry) and another measure of adiposity (such as skinfolds). Both measures were included in the initial study protocol, but proved unacceptable, in the school setting, to the families, despite efforts to ensure privacy. It would have been helpful to measure not only adiposity but also lean body mass, for example using bio-impedance or dual X-ray absorptiometry; the increase in children's fitness suggests that we achieved a significant increase in their activity levels, which may have increased their muscle mass. This could, in turn, partially explain a lack of impact of the intervention on BMI.

Implications for policy

Given the projected increase in obesity-related chronic disease in India and other low-and-middle-income countries, there is a strong case for intervening in childhood to increase physical activity and improve dietary behaviour. Future interventions in Indian children can benefit from our experience. Interventions need to be tailored to individual contexts, be realistic, and attractive to children. The study highlighted the need for standardised fitness tests suitable for Indian children. The Indian government aspires to test fitness in all schoolchildren [20] but this will need training and curriculum time. Some interventions would be more effectively made at a state or national level, for example making physical activity a scoring subject, and mandating minimum playground space. Guidelines for PE teachers, to involve all children and make activity attractive, could be improved. The mindset among parents that children need more food should change, because although under-nutrition still affects many Indian children, overweight is now a greater threat than underweight in affluent urban families.[1,21] There is strong peer pressure to eat out, as a 'status symbol'. School-based interventions offer an ideal opportunity to counter these cultural pressures.

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Figure 1. Participant flow in the study

a) Mean body mass index (WHO Z score)

b) Percentage overweight or obese

Figure 2. Mean BMI (95% CI) Z-score and percentage overweight/obese in the Pune intervention group and Nasik control group at the start of the study in 2006, mid-study (2008) and at the end of the study in 2011

Table 1
Baseline characteristics of the Pune (intervention) group and Nasik (control) group at the start of the trial in 2006

	BOYS			<i>P</i> ¹	GIRLS			<i>P</i> ¹	<i>P</i> ²
	Pune Intervention Group <i>n</i> =145	Nasik Control Group <i>n</i> =107			Pune Intervention Group <i>n</i> =159	Nasik Control Group <i>n</i> =80			
Age (years) #	9.6 (9.1, 10.1)	9.2 (8.9, 9.7)		<0.001	9.8 (9.1, 10.3)	9.4 (9.0, 9.9)		0.005	<0.001
<i>Anthropometry</i>									
Height (m)	1.36 (0.07)	1.33 (0.07)		0.007	1.36 (0.07)	1.33 (0.07)		0.001	<0.001
BMI (kg/m ²) #	16.2 (14.8, 18.4)	16.2 (14.8, 17.9)		0.95	15.8 (14.2, 18.5)	16.0 (14.5, 17.7)		0.78	0.77
BMI Z score (SD) [†]	-0.03 (1.52)	0.07 (1.34)		0.59	-0.28 (1.34)	-0.17 (1.21)		0.52	0.41
Overweight/obese*	38 (26)	25 (23)		0.61	30 (19)	14 (18)		0.83	0.59
Underweight*	12 (8)	4 (4)		0.19	17 (11)	7 (9)		0.66	0.20
Waist (cm) #	57.5 (53.5, 64.7)	55.5 (51.8, 62.4)		0.08	56.6 (52.6, 63.2)	56.9 (51.9, 60.9)		0.47	0.05
<i>Lifestyle factors</i>									
Television (hrs/day)*				0.03				0.001	0.15
<1	91 (62.8)	38 (35.5)			97 (61.0)	57 (71.3)			
1-<4	53 (36.6)	66 (61.7)			62 (39.0)	21 (26.3)			
4-<7	0 (0.0)	3 (2.8)			0 (0.0)	2 (2.5)			
7+	1 (0.7)	0 0.0			0 (0.0)	0 (0.0)			
Tuition (hrs/day)*				0.01				0.03	0.46
<1	0 (0.0)	5 (4.7)			1 (0.6)	4 (5.0)			
1-<4	139 (95.9)	99 (92.5)			152 (95.6)	70 (87.5)			
4-<7	6 (4.1)	3 (2.8)			6 (3.8)	6 (7.5)			
7+	0 (0.0)	0 0.0			0 (0.0)	0 (0.0)			
Active play (hrs/day)*				<0.001				0.05	<0.001
<1	4 (2.8)	13 (12.1)			2 (1.3)	8 (10.0)			
1-<4	134 (92.4)	82 (76.6)			138 (86.8)	62 (77.5)			
4-<7	6 (4.1)	12 (11.2)			19 (11.9)	10 (12.5)			
7+	1 (0.7)	0 (0.0)			0 (0.0)	0 (0.0)			
Fruit intake (serves/day)*				0.005				0.73	0.04
0	0 (0.0)	20 (18.7)			41 (25.8)	11 (13.8)			
1-3	142 (97.9)	87 (81.3)			118 (74.2)	68 (85.0)			
4-6	3 (2.1)	0 (0.0)			0 (0.0)	1 (1.3)			
7+	0 (0.0)	0 (0.0)			0 (0.0)	0 (0.0)			
Veg intake (serves/day)*				0.009				0.001	<0.001
0	0 (0.0)	2 (1.9)			8 (5.0)	3 (3.8)			
1-3	145 (100.0)	103 (96.3)			151 (95.0)	77 (96.3)			
4-6	0 (0.0)	2 (1.9)			0 (0.0)	0 (0.0)			
7+	0 (0.0)	0 (0.0)			0 (0.0)	0 (0.0)			
Eating out (times/week)*				<0.001				<0.001	<0.001

	BOYS			GIRLS			<i>P</i> ¹	<i>P</i> ²
	Pune Intervention Group	Nasik Control Group		Pune Intervention Group	Nasik Control Group			
	<i>n</i> =145	<i>n</i> =107		<i>n</i> =159	<i>n</i> =80			
0	4 (2.8)	33 (30.8)		14 (8.8)	20 (25.0)			
1-3	115 (79.3)	69 (64.5)		112 (70.4)	58 (72.5)			
4-6	26 (17.9)	5 (4.7)		33 (20.8)	2 (2.5)			
7+	0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)			
<i>Fitness tests (SAI)</i>								
Scored average or above in:								
<i>n</i>	140			158				
Sit ups*	4 (2.9)	ND	-	3 (1.9)	ND	-	-	
Push ups*	4 (2.9)	ND	-	3 (1.9)	ND	-	-	
Vertical jump*	0 (0)	ND	-	0 (0)	ND	-	-	
Long jump*	0 (0)	ND	-	0 (0)	ND	-	-	
Stand and reach*	1 (0.7)	ND	-	5 (3.2)	ND	-	-	
Sprint*	14 (10.0)	ND	-	15 (9.5)	ND	-	-	

Data are mean (SD) except: * *n* (%) and # median (interquartile range). BMI Z scores (†) were calculated using WHO reference data [17]. *p*¹: significance of difference between intervention and control groups in the sexes separately. *p*²: significance of difference between intervention and control groups in both sexes combined, adjusted for sex using linear or logistic regressions for continuous or categorical outcomes respectively. Non-normally distributed outcomes were transformed using the Fisher-Yates method for use in the linear regressions [18]. *P*-values for the lifestyle factors were calculated using the continuous variables. Overweight/obese defined as >1 SD above the WHO age- and sex-specific BMI median value. Underweight defined as <2 SD below the WHO age- and sex-specific median value. ND=not done.

Table 2
Characteristics of the Pune (intervention) group and Nasik (control) group at the end of the trial in 2011

	BOYS			<i>P</i> ¹	GIRLS			<i>P</i> ¹	<i>P</i> ²
	Pune Intervention Group <i>n</i> =145	Nasik Control Group <i>n</i> =107			Pune Intervention Group <i>n</i> =159	Nasik Control Group <i>n</i> =80			
Age (years) #	13.7 (13.2, 14.0)	13.0 (12.7, 13.5)		<0.001	13.7 (13.1, 14.2)	13.2 (12.8, 13.7)		<0.001	<0.001
Anthropometry									
Height (m)	1.60 (0.08)	1.57 (0.09)		0.003	1.57 (0.06)	1.55 (0.07)		0.02	<0.001
BMI (kg/m ²) #	19.1 (17.1, 22.3)	19.9 (17.1, 22.1)		0.49	19.6 (17.7, 22.8)	19.0 (17.2, 21.5)		0.17	0.50
BMI Z score (SD) [†]	0.08 (1.47)	0.33 (1.42)		0.18	0.07 (1.16)	-0.02 (1.18)		0.57	0.46
Overweight/obese*	46 (32)	40 (37)		0.35	38 (24)	15 (19)		0.39	0.85
Underweight*	14 (10)	10 (9)		0.93	7 (4)	5 (6)		0.52	0.77
Waist (cm) #	64.0 (59.0, 71.0)	63.0 (57.5, 73.5)		0.84	65.0 (61.0, 70.3)	64.8 (61.0, 71.3)		0.62	0.70
Lifestyle factors									
Television (hrs/day)*				<0.001				0.03	<0.001
<1	116 (80.0)	76 (71.0)			140 (88.1)	58 (72.5)			
1-<4	29 (20.0)	31 (29.0)			19 (11.9)	22 (27.5)			
4-<7	0 (0.0)	0 (0.0)			0 (0.0)	0 (0.0)			
7+	0 (0.0)	0 (0.0)			0 (0.0)	0 (0.0)			
Tuition (hrs/day)*				<0.001				<0.001	<0.001
<1	52 (35.9)	32 (29.9)			40 (25.2)	26 (32.5)			
1-<4	92 (63.4)	60 (56.1)			119 (74.8)	44 (55.0)			
4-<7	1 (0.7)	15 (14.0)			0 (0.0)	10 (12.5)			
7+	0 (0.0)	0 (0.0)			0 (0.0)	0 (0.0)			
Active play (hrs/day)*				<0.001				<0.001	<0.001
<1	14 (9.7)	31 (29.0)			46 (28.9)	42 (52.5)			
1-<4	95 (65.5)	64 (59.8)			61 (38.4)	26 (32.5)			
4-<7	20 (13.8)	10 (9.3)			24 (15.1)	4 (5.0)			
7+	16 (11.0)	2 (1.9)			28 (17.6)	8 (10.0)			
Fruit intake (serves/day)*				<0.001				<0.001	<0.001
0	11 (7.6)	41 (38.3)			8 (5.0)	32 (40.0)			
1-3	111 (76.6)	55 (51.4)			128 (80.5)	40 (50.0)			
4-6	14 (9.7)	8 (7.5)			15 (9.4)	5 (6.3)			
7+	9 (6.2)	3 (2.8)			8 (5.0)	3 (3.8)			
Veg intake (serves/day)*				0.24				0.11	0.18
0	11 (7.6)	12 (11.3)			18 (11.3)	10 (12.5)			
1-3	113 (77.9)	66 (62.3)			110 (69.2)	56 (70.0)			
4-6	17 (11.7)	28 (26.4)			29 (18.2)	12 (15.0)			
7+	4 (2.8)	0 (0.0)			2 (1.3)	2 (2.5)			
Eating out (times/week)*				<0.001				<0.001	<0.001

	BOYS				GIRLS						
	Pune Intervention Group		Nasik Control Group		P^1	Pune Intervention Group		Nasik Control Group		P^1	P^2
	$n=145$		$n=107$			$n=159$		$n=80$			
0	24	(16.6)	41	(38.3)		24	(15.1)	28	(35.0)		
1-3	110	(75.9)	55	(51.4)		122	(76.7)	42	(52.5)		
4-6	10	(6.9)	11	(10.3)		11	(6.9)	10	(12.5)		
7+	1	(0.7)	0	(0.0)		2	(1.3)	0	(0.0)		
<u>Fitness tests</u> (SAI) Scored average or above in:											
n	136		106			153		80			
Sit ups*	9	(6.6)	2	(1.9)	0.12	8	(5.2)	1	(1.3)	0.17	0.03
Push ups*	6	(4.4)	2	(1.9)	0.47	5	(3.3)	1	(1.3)	0.67	0.17
Vertical jump*	3	(2.2)	ND		-	2	(1.3)	ND		-	-
Long jump*	31	(22.8)	10	(9.4)	0.006	21	(13.7)	5	(6.3)	0.09	0.002
Stand and reach*	1	(0.7)	ND		-	1	(0.7)	ND		-	-
Sprint*	88	(64.7)	36	(34.0)	<0.001	88	(57.5)	28	(35.0)	0.001	<0.001
<u>Fitness tests (SYM-KEM)</u>											
n	132		106			142		80			
9 min run (meters) [#]	1600	(1500, 1900)	1650	(1600, 1800)	0.96	1600	(1500, 1700)	1475	(1400, 1550)	<0.001	0.001
Sit-ups (n in 1 minute) [#]	34.0	(25.0, 42.0)	21.5	(18.0, 29.0)	<0.001	23.5	(18.0, 29.0)	14.0	(11.0, 15.0)	<0.001	<0.001
Push-ups (n in 1 minute) [#]	20.0	(15.0, 23.0)	13.0	(9.0, 15.0)	<0.001	7.0	(5.0, 9.0)	6.0	(4.0, 8.0)	0.004	<0.001
Sit and reach (cm) [#]	24.0	(20.5, 28.8)	21.0	(18.0, 26.0)	<0.001	24.0	(20.0, 28.0)	21.0	(20.0, 23.0)	<0.001	<0.001
Shuttle run (seconds) [#]	11.1	(10.5, 11.9)	ND	-	-	12.1	(11.4, 12.8)	ND	-	-	-
Long jump (cm) [#]	160	(140, 180)	165	(145, 185)	0.51	145	(130, 160)	125	(110.0, 135.5)	<0.001	<0.001

Data are mean (SD) except: * *n* (%) and # median (interquartile range). BMI Z scores (†) were calculated using WHO reference data [17]. P^1 :

significance of difference between intervention and control groups in sexes separately. P^2 : significance of difference between intervention and control groups in both sexes combined, adjusted for sex using linear or logistic regressions for continuous or categorical outcomes respectively. Non-normally distributed outcomes were transformed using the Fisher-Yates method for use in the linear regressions [18]. *P*-values for the lifestyle factors were calculated using the continuous variables. Over-weight/obese defined as >1 SD above the WHO age- and sex-specific BMI median value. Underweight defined as <2 SD below the WHO age- and sex-specific median value. ND=not done.

Table 3
Characteristics of the Pune (intervention) group in the 8th or 9th standard in 2011 with
the Pune (control) group in the 8th or 9th standard in 2006

	BOYS			<i>P</i> ¹	GIRLS			<i>P</i> ¹	<i>P</i> ²
	Pune Intervention Group	Pune Control Group			Pune Intervention Group	Pune Control Group			
	<i>n</i> =145	<i>n</i> =204			<i>n</i> =159	<i>n</i> =170			
Age (years) #	13.7 (13.2, 14.0)	13.8 (13.1, 14.3)	0.19		13.7 (13.1, 14.2)	13.6 (13.1, 14.1)	0.27	0.86	
<u>Anthropometry</u>									
Height (m)	1.60 (0.08)	1.60 (0.09)	0.94		1.57 (0.06)	1.56 (0.06)	0.44	0.61	
BMI (kg/m ²) #	19.1 (17.1, 22.3)	18.7 (16.4, 21.7)	0.18		19.6 (17.7, 22.8)	19.6 (17.8, 22.2)	0.84	0.46	
BMI Z score (SD) [†]	0.08 (1.47)	-0.15 (1.53)	0.15		0.07 (1.16)	0.12 (1.28)	0.73	0.36	
Overweight/obese*	46 (32)	52 (25)	0.20		38 (24)	44 (26)	0.68	0.52	
Underweight*	14 (10)	28 (14)	0.25		7 (4)	7 (4)	0.90	0.36	
Waist (cm) #	64.0 (59.0, 71.0)	67.6 (61.7, 75.0)	0.008		65.0 (61.0, 70.3)	69.6 (64.0, 75.0)	<0.001	<0.001	
<u>Lifestyle factors</u>									
Television (hrs/day)*			<0.001				<0.001	<0.001	
<1	116 (80.0)	60 (29.4)			140 (88.1)	34 (20.0)			
1-<4	29 (20.0)	132 (64.7)			19 (11.9)	127 (74.7)			
4-<7	0 (0.0)	5 (2.5)			0 (0.0)	5 (2.9)			
7+	0 (0.0)	7 (3.4)			0 (0.0)	4 (2.4)			
Tuition (hrs/day)*			<0.001				<0.001	<0.001	
<1	52 (35.9)	22 (10.8)			40 (25.2)	17 (10.0)			
1-<4	92 (63.4)	135 (66.2)			119 (74.8)	120 (70.6)			
4-<7	1 (0.7)	39 (19.1)			0 (0.0)	31 (18.2)			
7+	0 (0.0)	8 (3.9)			0 (0.0)	2 (1.2)			
Active play (hrs/day)*			<0.001				0.001	<0.001	
<1	14 (9.7)	61 (29.9)			46 (28.9)	58 (34.1)			
1-<4	95 (65.5)	127 (62.3)			61 (38.4)	81 (47.6)			
4-<7	20 (13.8)	12 (5.9)			24 (15.1)	24 (14.1)			
7+	16 (11.0)	4 (2.0)			28 (17.6)	7 (4.1)			
Fruit intake (serves/day)*			<0.001				<0.001	<0.001	
0	11 (7.6)	31 (15.3)			8 (5.0)	28 (16.6)			
1-3	111 (76.6)	157 (77.3)			128 (80.5)	129 (76.3)			
4-6	14 (9.7)	15 (7.4)			15 (9.4)	12 (7.1)			
7+	9 (6.2)	0 (0.0)			8 (5.0)	0 (0.0)			
Veg intake (serves/day)*			0.11				0.86	0.63	
0	11 (7.6)	36 (17.7)			18 (11.3)	30 (17.8)			
1-3	113 (77.9)	128 (62.8)			110 (69.2)	106 (62.7)			
4-6	17 (11.7)	27 (13.2)			29 (18.2)	26 (15.4)			
7+	4 (2.8)	13 (6.4)			2 (1.3)	7 (4.1)			
Eating out (times/week)*			0.05				0.04	0.01	

	BOYS			GIRLS			<i>P</i> ¹	<i>P</i> ²
	Pune Intervention Group	Pune Control Group	<i>P</i> ¹	Pune Intervention Group	Pune Control Group	<i>P</i> ¹		
	<i>n</i> =145	<i>n</i> =204		<i>n</i> =159	<i>n</i> =170			
0	24 (16.6)	54 (26.5)		24 (15.1)	49 (28.8)			
1-3	110 (75.9)	138 (67.7)		122 (76.7)	111 (65.3)			
4-6	10 (6.9)	8 (3.9)		11 (6.9)	6 (3.5)			
7+	1 (0.7)	4 (2.0)		2 (1.3)	4 (2.4)			
<u>Fitness tests (SAI) Scored average or above in:</u>								
<i>n</i>	136	200		153	150			
Sit ups*	9 (6.6)	5 (2.5)	0.06	8 (5.2)	2 (1.3)	0.10	0.01	
Push ups*	6 (4.4)	5 (2.5)	0.33	5 (3.3)	2 (1.3)	0.45	0.15	
Vertical jump*	3 (2.2)	2 (1.0)	0.40	2 (1.3)	1 (0.7)	1.00	0.30	
Long jump*	31 (22.8)	25 (12.5)	0.01	21 (13.7)	15 (10.0)	0.32	0.01	
Stand and reach*	1 (0.7)	1 (0.5)	1.00	1 (0.7)	0 (0.0)	1.00	0.44	
Sprint*	88 (64.7)	20 (10.0)	<0.001	88 (57.5)	14 (9.3)	<0.001	<0.001	

Data are mean (SD) except: * *n* (%) and # median (interquartile range). BMI Z scores (†) were calculated using WHO reference data [17]. *p*¹: significance of difference between intervention and control groups in the sexes separately. *p*²: significance of difference between intervention and control groups in both sexes combined, adjusted for sex using linear or logistic regressions for continuous or categorical outcomes respectively. Non-normally distributed outcomes were transformed using the Fisher-Yates method for use in the linear regressions [18]. *P*-values for the lifestyle factors were calculated using the continuous variables. Overweight/obese defined as >1 SD above the WHO age- and sex-specific BMI median value. Underweight defined as <2 SD below the WHO age- and sex-specific median value.