Chapter 22
Comparative Study of Health-Related Physical Fitness Among Children Attending Municipal and International Schools in Nasik City

Manjusha Bhakay and Sabiha Vali

22.1 Introduction

India is one of the rapidly developing countries in terms of population and economy, with a population of 1.21 billion (Census of India 2011) and increasing at the rate of 10–14% annually. Rapid demographic, nutritional, and epidemiological transition has led to changes in lifestyles and dietary behaviors. The environment has gradually changed to one which requires less and less physical activity and promotes an ever-increasing sedentary lifestyle. Paradoxically, as this trend continues, the overall importance of physical activity in promoting and maintaining adequate health is only now being realized.

Physical fitness is a complex phenomenon with several dimensions, related to health and well-being and influenced by many dimensions of life. Nature can explain some aspects of physical activity and physical fitness like age, sex, or heredity, whereas nurture and culture can explain others like socioeconomic factors, diet, environment, or leisure habits (Van Der Horst K et al. 2007, p 1250). Furthermore, these factors are often associated, with one another and habitual physical activity and then health-related fitness could be mediated by all the variables. Adult health appears to be related with childhood physical activity and physical fitness (Kemper et al 2001; Twisk et al 1997, p 888) and there is a great deal of evidence of the close relationship between health status and childhood physical fitness. Physical activity and physical fitness are important in public health primarily as they affect health outcomes.

M. Bhakay (✉)
Food Science and Nutrition, S.M.R.K.B.K.A.K.Mahila Mahavidyalaya, Nasik, India
e-mail: manjushabhakay@gmail.com

S. Vali
Home Science (Retired), RSTM Nagpur University, Nagpur, India
e-mail: sabihavali@hotmail.com

U.K. De et al. (eds.), *Issues on Health and Healthcare in India*, India Studies in Business and Economics, https://doi.org/10.1007/978-981-10-6104-2_22

Socioeconomic status (SES) is an important determinant of health and well-being because it influences people's attitudes, experiences, and exposure to several health risk factors. The health-related physical fitness components are concerned with the development of qualities necessary to function efficiently and maintain a healthy lifestyle. These components include muscular strength, muscular endurance, cardiorespiratory endurance, flexibility, and body composition. The physical fitness tests for these components aim to look at anatomical and physiological components which determine a person's physical performance capacity (Power and Dodd 1996).

This study is aimed at comparing the health-related fitness components of children who attended International English medium schools and Municipal Marathi medium schools in the city of Nasik (Maharashtra state).

22.2 Methodology

236 children from three different International schools and 234 children from three different municipal schools of Nasik city, aged between 7 and 9 years who were studying in standard 2nd, 3rd and 4th were selected by purposive sampling.

The following health-related physical fitness components were assessed

- Muscular strength and endurance—bent knee sit ups/min test.
- Cardiorespiratory endurance—one-mile run/walk test.
- Body composition:
    a. Body weight—nearest to 0.1 kg was taken using a certified electronic scale.
    b. Height—nearest to 0.01 m was measured by Standard stadiometer.
    c. BMI—Calculated as Weight (kg)/Height (m^2)
    d. Waist measurement—Standard measuring tape
    e. Waist-to-Height Ratio—Calculated as Waist/Height
- Flexibility—sit and reach test.
- A questionnaire was given to the students to elicit information regarding their physical activity and dietary patterns.

22.3 Statistical Analysis

Statistical analysis was done using SPSS software (version 16.0). The data obtained on the above parameters was coded and entered in the SPSS sheet for further analysis. Pearson and Spearman correlations were applied to the data for finding associations. A priori, an alpha value of <0.05 was considered to be significant.

22.4 Results and Discussion

The field of anthropometry encompasses a wide variety of human body measurements, such as height and body size, weight, skin-fold thickness, circumferences. Anthropometry is a key component of nutritional status assessment in children. Anthropometric data for children reflects general health status, dietary adequacy, and growth and development over time. A child's growth can be compared with that of his or her peers, by referring to norms on an appropriate growth chart. More important, the indicators of a child's growth were a dynamic statement of his or her general health condition. In this study, WHO standards of 2007 had been used to compare the anthropometric parameters of the children who were distributed according to the school they attended.

The mean age of IS children was 8.00 years, while the mean age of MS children was 9.00 years. The reported ages of few of them were also above 9.00 years, yet these children were studying in 3rd or 4th standard. Ignorance was the main reason why parents of the MS children did not admit their wards at the appropriate age and time in schools (Table 22.1).

The mean height of IS children (1.30 mts) was more than MS children (1.21 mts). The range of height of IS and MS was similar (1.03–1.51). The mean weight of children also showed the same trend, that IS children weighed more (28.96 kg) than the MS children (21.07 kg). The IS children were heavier in weight, while the MS children were lean and thin. The IS children had a higher BMI (16.81) when compared to MS children (14.25). That was not surprising taking into account their mean height and mean weight.

Table 22.1 Mean anthropometric measurements of children distributed school-wise

Parameter	Mean, std deviation, range	Type of school	
		IS[a] (n = 236)	MS[b] (n = 234)
Age (Years)	M	8.00	9.00
	SD	0.81	1.21
	R	7.00–9.00	7.00–12.00
Height (M)	M	1.30	1.21
	SD	0.07	0.07
	R	1.03–1.51	1.03–1.51
Weight (Kg)	M	28.96	21.07
	SD	7.68	3.88
	R	15.20–58.40	12.90–41.00
BMI	M	16.81	14.25
	SD	3.32	1.36
	R	11.09–28.59	10.80–21.22

Source Field survey conducted on children of International and Municipal school as part of the research study. SPSS (version 16) was used as the tool of analysis

Note [a]indicates International School, and [b]indicates Municipal School

Table 22.2 Results of '*t*' test for anthropometric measurements—IS versus MS

Parameters	Schools	*t*-test for equality of means		
		t	df	Sig. (two-tailed)
Height (M)	IS versus MS	12.862	468	[b]0.000
Weight (Kg)	IS versus MS	14.030	468	[b]0.000
BMI	IS versus MS	10.883	468	[a]0.049

Source Field survey conducted on children of International and Municipal school as part of the research study. SPSS version 16 was used as the tool of analysis
Note [a]significant, [b]highly significant

The result of '*t*' test (Table 22.2) indicated that there was a significant difference between the International school and Municipal school children with respect to the anthropometric measurements. The children from MS reflect a lower mean height and weight and hence a lower BMI, whereas the IS children were taller, weighed more and hence had a higher BMI. This was a reflection of the type of diet consumed by the children attending international and municipal schools.

22.4.1 Fitness Component Measurements of Children

Muscular strength refers to the maximal force that can be generated by a specific muscle or muscle group, while muscular endurance was the ability of a muscle group to execute repeated contraction over a period of time sufficient to cause muscular fatigue or to maintain a specific percentage of the maximum voluntary contraction for a prolonged period of time. Muscular strength and endurance can be combined into one component of health-related physical fitness titled muscular fitness to better describe their integrated status. Cardiorespiratory fitness was related to the ability to perform large muscle, dynamic, moderate to high intensity exercise for prolonged periods.

Flexibility is the ability to move a joint through its complete range of movement. Flexibility is dependent upon which muscle and joint was being evaluated, therefore it was joint specific. Body composition refers to the relative percentage of body weight that was fat and fat-free tissue. The demand on the cardiorespiratory system was greater when the percentage of body fat was high. Body composition was a major area of concern in physical fitness.

Muscular strength and endurance was tested by the Bent knee sit ups/min. It was observed that the MS children had higher mean muscular strength and endurance (21.52 sit ups) followed by the IS children (19.38 sit ups). The one-mile run test was conducted for cardiorespiratory fitness. Not all children could complete the one-mile run test. It was observed from the above table that maximum number of children from IS (1.86) could finish the one-mile run test, than the MS children (1.85). The range for this test was coded as follows: (1) meaning that the children could not complete the run, and (2) meaning that the children could finish the

one-mile run test. With regard to the time of completion of the one-mile run test (which was performed to test the cardiorespiratory fitness), the MS children again registered the lowest time (10.66 min) followed by the IS children (11.09 min). The flexibility test was conducted by the sit and reach test and measured in inches. The data revealed that the MS children were more flexible (13.37 inch), than the IS children (12.97 inch). Table 22.3 indicates that the MS children had the least waist-to-height ratio (WHtR) (0.40), the normal being 0.5. The IS children had more WHtR as compared to MS children (0.46).

The overall observations tested statistically, surprisingly indicate that MS children were better than IS children in nearly all the fitness components. The result of '*t*' test for measurement of fitness components, IS versus MS as presented in Table 22.4 showed significant difference in muscular strength and endurance ($P = 0.008$), cardiorespiratory fitness—time of completion of test ($P = 0.023$) and highly significant for waist-to-height ratio ($P = 0.000$). It was insignificant for flexibility ($P = 0.084$) and cardiorespiratory—completion of test ($P = 0.571$).

From Table 22.5 it was observed that, 0.6% children from MS could perform at the 90th percentile, while only 0.4% children from IS were at the 90th percentile. Majority of the MS children were at the 50th percentile indicating that their performance was average. A large number of the IS (35%) children performed poorly in the sit up test as compared to the MS children (20.5%). The MS children played a

Table 22.3 Mean fitness components of children according to school

Sl. No	Fitness components	Mean, std deviation, range	Type of school	
			IS ($n = 236$)	MS ($n = 234$)
1	Muscular strength and endurance (Bent knee sit ups/min)	M	19.38	21.52
		SD	8.91	8.55
		R	0.00–40.00	0.00–38.00
2	Cardiorespiratory fitness—completion of test [a]	M	1.86	1.85
		SD	0.33	0.35
		R	1.00–2.00	1.00–2.00
3	Cardiorespiratory time (completion of test in min)	M	11.09	10.66
		SD	1.95	1.70
		R	6.00–18.29	7.12–16.39
4	Flexibility (Sit and reach in inches)	M	12.97	13.37
		SD	3.04	2.98
		R	7.50–19.00	7.00–19.00
5	Waist-to-height ratio	M	0.46	0.40
		SD	0.05	0.03
		R	0.24–0.66	0.29–0.53

Source Field survey conducted on children of International and Municipal school as part of the research study. SPSS version 16 was used as the tool of analysis

Note [a]1 = could not complete the test, 2 = could complete the test

Table 22.4 Results of '*t*' test for fitness components—IS versus MS

Fitness components	Schools	*t*-test for equality of means		
		t	df	Significance
Muscular strength and endurance	IS versus MS	−2.65	46	[a]0.008
Cardiorespiratory fitness—completion of test	IS versus MS	0.56	46	0.571
Cardiorespiratory fitness—time of completion of test	IS versus MS	2.27	46	[a]0.023
Flexibility	IS versus MS	−1.73	46	0.084
Waist-to-height ratio	IS versus MS	11.43	46	[b]0.000

Source Field survey conducted on children of International and Municipal school as part of the research study. SPSS version 16 was used as the tool of analysis
Note [a]significant, [b]highly significant

Table 22.5 Muscular strength and endurance of children distributed according to type of school (percentile)

Sl. No	Type of school	Muscular strength and endurance fitness category						Total
		90th percentile (%)	75th percentile (%)	50th percentile (%)	25th percentile (%)	10th percentile (%)	Poor performance (%)	
1	International school	0.4	14	28.6	14	8	35	100
2	Municipal schools	0.6	17	36	8.4	17.5	20.5	100

Source Field survey conducted on children of International and Municipal school as part of the research study

Table 22.6 Cardiorespiratory fitness—completion of test by the children distributed according to type of school

Sl.No	Type of school	Cardio fitness category		Total
		Could not finish the test	Could finish the test	
1.	International school	13.1%	86.9%	100
2.	Municipal school	15%	85%	100

Source Field survey conducted on children of International and Municipal school as part of the research study

lot of outdoor games, they walked to school, were more involved in strenuous activities as compared to IS children and hence, their muscular fitness was good.

Table 22.6 reveals that nearly equal number of children from both the schools (IS = 13.1%, MS = 15%) could not finish the one-mile run test, however majority of the children from both types of schools could finish the one-mile run test.

Table 22.7 shows that all children had a wide range of variation in performance with 2% IS children were on the 90th percentile and 9% children with poor performance. Among MS children, on the other hand, 4% were on the 90th percentile while only 3% children had performed poorly. Again, the majority of the children

Table 22.7 Cardiorespiratory fitness—(time of completion of test) by the children distributed according to type of school (percentile)

Sl. No	Type of school	Cardiorespiratory fitness—time							Total
		0 (%)	90th percentile (%)	75th percentile (%)	50th percentile (%)	25th percentile (%)	10th percentile (%)	Poor performance (%)	
1.	International school	13	2	8	34	17	17	9	100
2.	Municipal schools	15	4	10	41	9	18	3	100

Source Field survey conducted on children of International and Municipal school as part of the research study

Table 22.8 BMI according to type of school (percentile)

Sl. No	Type of school	BMI category				Total
		High risk $\geq$ 18.3 (%)	Some risk $\geq$ 17.6 (%)	HFZ 17.5–13.5 (%)	Very lean $\leq$ 13.4 (%)	
1.	International school	22	5	61	12	100
2.	Municipal schools	1	1	58	40	100

Source Field survey conducted on children of International and Municipal school as part of the research study

from both the schools were on the 50th percentile, indicating average performance. The performance of the MS children surprisingly was better when compared to IS children. This can again be attributed to their being more active, playing outdoor games. MS children played free outdoor games for more than one hour per day. Similar results were also seen by Ulf Ekelund et al. (2004, p 590).

The BMI category of the children is shown in Table 22.8. The table reveals that maximum number of children from IS (22% children) are in the high risk category (BMI $\geq$ 18.3), compared to only 1% of the children from MS. On the other hand, maximum number of lean children (BMI $\leq$ 13.4) is from MS (40% children). However, majority of the children irrespective of the type of school were in the healthy fitness region with BMI between 17.5 and 13.5. Children attending International School consumed more, oily deep-fried foods, sweet preparations, more often and hence their weight was more as compared to children attending Municipal schools whose lean diet comprised of chapatti bhaji, chutney, and dal.

The result of flexibility fitness category as seen in Table 22.9 indicated that the children from both the schools had done well in the test. 13% children from MS, and 11% from IS were at the 90th percentile. The MS had fewer poor performers (17%) as compared to IS (23%). Quite a few of the children from both schools were also at the 75th percentile (MS−23%, IS−20%,). The increased flexibility of MS children could be because of their lower BMI.

Table 22.9 Flexibility according to type of school (percentile)

Sl. No	Type of school	Flexibility fitness category						Total
		90th percentile	75th percentile	50th percentile	25th percentile	10th percentile	Poor performance	
1.	International school	11	20	22	10	14	23	100
2.	Municipal schools	13	23	19	13	15	17	100

Source Field survey conducted on children of International and Municipal school as part of the research study

Table 22.10 Waist-to-height ratio (WHtR) according to type of school (percentile)

Sl.No	Type of school	WHTR category		Total
		High	Normal	
1.	International school	22.0	78.0	100
2.	Municipal schools	0.4	99.6	100

Source Field survey conducted on children of International and Municipal school as part of the research study

From Table 22.10, it was observed that a greater number of IS children (22%) had a higher WHtR. Only 0.4% children from MS had a high WHtR. Majority of the children from both the types of schools had normal WHtR. Kuriyan et al (2011) in their study linked lifestyle, eating, and sedentary behavior to waist circumference among urban South Indian children aged 3–16 years. This study also showed similar results. These results also were observed by Esmaeilzadeh (2012, p 105), Lumeng et al (2006, p 422).

In spite of all the luxuries of life enjoyed by the International School children, the Municipal School children showed better physical fitness. Health-related physical fitness; the mode of commuting to school, frequency and duration of indoor and outdoor games played by the children, consumption of fried foods and sweets was also studied. The findings were as follows:

Figure 22.1 revealed that 119 IS children (50.5%) came by school bus, 68 children (28.8%) traveled by rickshaw, 1 child (0.4%) came cycling, 22 children (8.9%) were dropped at the school by parents. 26 children (11.4%) came walking (they stayed in hostels inside the school campus, a distance of less than a km). Of the MS children on the other hand, showed that 1 child (0.4%) came by city transport service, 4 children (1.78%) came by a shared rickshaw, 2 children (0.85%) came by cycle, 32 children (13.67%) children were brought to the school by the parents (on a cycle or two wheeler) and 196 children (83.3%) came to school walking, from the nearby slums (maximum distance of 2 km).

It was observed from Fig. 22.2 that the mean duration of indoor play for IS children (0.49) was less than 30 min of play per day. The MS children show a mean duration slightly higher (0.55) than IS. They played indoor games once or twice a week. The mean frequency of indoor games for IS children was somewhat higher (1.42) than MS children.

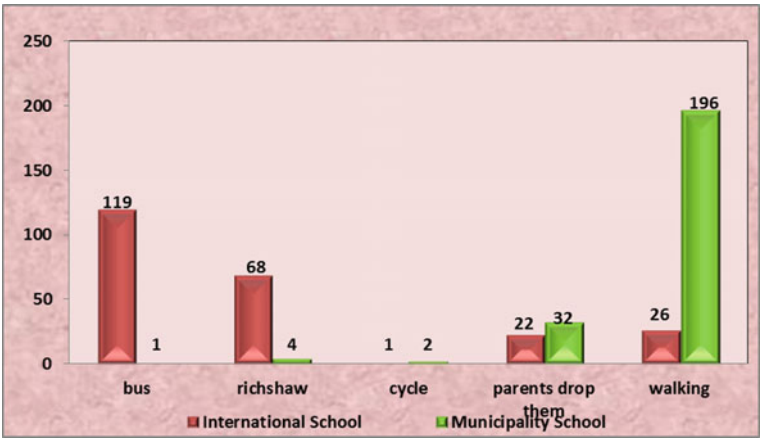

Fig. 22.1 Mode of commuting to school by children from different schools (frequency)

Figure 22.3 indicated that mean duration of outdoor play of IS children was 1.28, that meant that these children played for approximately 30 min per day. While the MS children played for a longer period of time (more than 30 min but less than one hour). The mean frequency of outdoor games played per week showed that IS children played for approximately three times/week (mean IS−3.31), whereas MS children played for more days per week (mean 4.41) as compared to IS children.

The MS children had fried food, once in 15 days (mean 4.29), while the IS children had fried food once a week (mean 3.39). The higher frequency of fried food was reflected in the higher BMI of IS children, as compared to MS children (Fig. 22.4).

All children like sweet preparations. The mean of frequency of consumption of sweets is shown in Fig. 22.5. From the figure, it is observed that the frequency of sweet consumption among IS children is 2.44, that is, they have sweet preparations nearly twice a week. The MS children had sweet preparations nearly once in a week.

The data was further analyzed by linear regression for health-related physical fitness components and activity of the children (indoor and outdoor games—frequency and duration), consumption of fried foods and frequency of consumption of sweet preparations.

When health-related fitness parameters of Municipal school children (muscular strength and endurance, cardiorespiratory fitness, body composition and flexibility) were controlled for, duration and frequency of outdoor games was significantly ($p = 0.000$) associated with physical fitness. The frequency of consumption of sweet preparation showed significant co-relation ($p = 0.000$) to BMI. In International School children, the frequency of outdoor games was significantly co-related to all the fitness parameters. The frequency of consumption of sweet preparation also showed significant co-relation ($p = 0.000$) to BMI and waist-to-height ratio (WHtR).

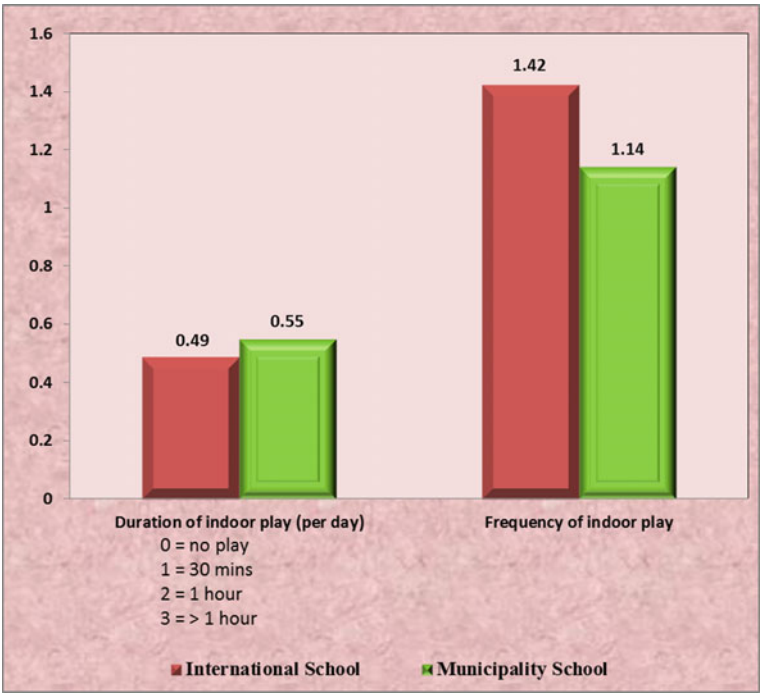

Fig. 22.2 Mean duration and frequency of indoor play

Health-related physical fitness is dependent on both, lifestyle-related factors, such as daily physical activity levels and nutritional habits and genetic factors and is an important indicator of health status (Takken et al 2003, p 885).

Adult health appears to be related to childhood physical activity and physical fitness and there is a great deal of evidence of the close relationship between health status and childhood physical fitness. The amount of physical activity during childhood is the determining factor that would prevent the prevalence of sedentary-related diseases such as obesity, cardio vascular diseases, diabetes, and some types of cancers in adults (Pino-Ortega et al. 2010).

Tharkar and Viswanathan (2009) in a cross-sectional study determined the impact of socioeconomic status on prevalence of overweight and obesity among children and adolescents in urban India. There were highly significant differences in the prevalence of overweight and obesity between LSES and USES ($P < 0.05$). The result also showed widespread prevalence of unhealthy lifestyle habits.

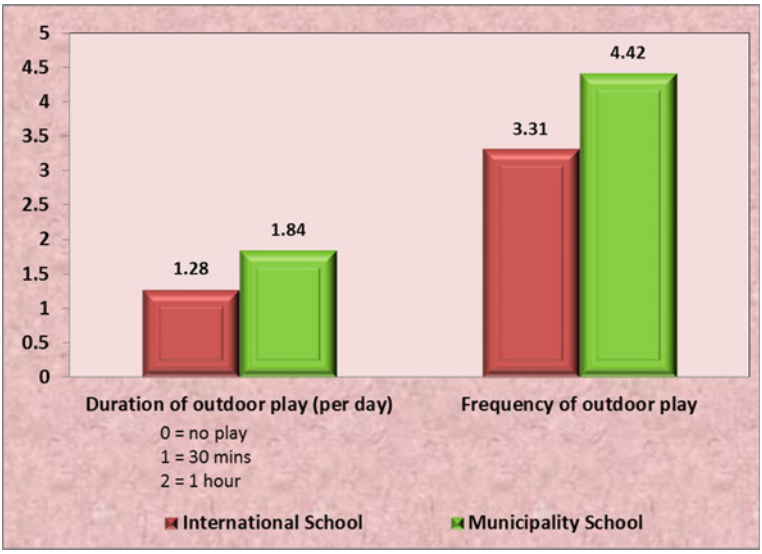

Fig. 22.3 Mean duration and frequency of outdoor play

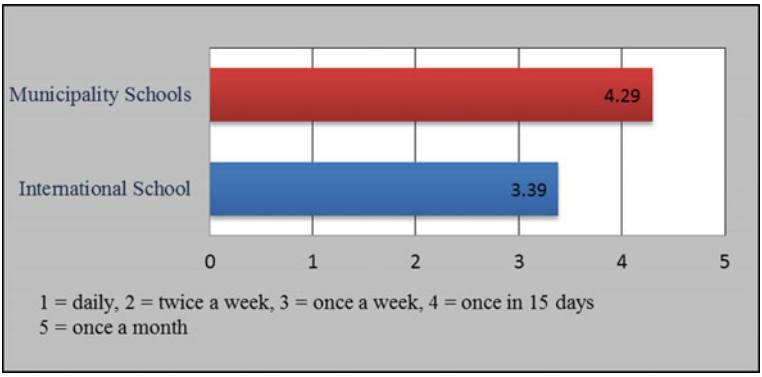

Fig. 22.4 Mean consumption of fried food by children from different schools

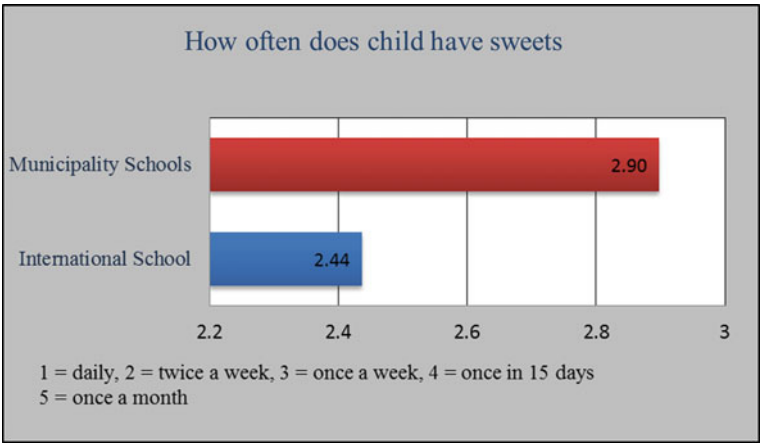

Fig. 22.5 Mean consumption of sweets by children from different schools

22.5 Conclusion

The MS children had better physical fitness as compared to children at IS. This could be because they were involved in more unstructured, free play, as they were not privileged enough to have some means of transport for commuting to school, no membership of clubs or any coaching. Walking to school daily and playing on the streets was the only means of exercise. Their diet was also a basic one with occasional sweet preparations, which helped them to remain in the healthy fitness zone.

Physical activity is considered as a key factor for a healthy physical and mental development of children (Andersen et al. 2008; Ortega et al 2008). It is a prerequisite for optimal growth and development in children and is associated with a range of health benefits. Further, physical activity via play, leisure and recreational activities, provides opportunities for children to develop their sensorimotor, cognitive and socio-emotional capacities and promotes a sense of psychological well-being. Excessive sedentariness among children potentially leads to the development of chronic health problems during adolescence and adulthood including obesity, osteoporosis, diabetes, and cardiovascular diseases (Dwyer et al 2008).

References

Andersen, L. B., Sardinha, L. B., Froberg, K., Riddoch, C. J., Page, A. S., & Anderssen, S. A. (2008). Fitness, fatness and clustering of cardiovascular risk factors in children from Denmark, Estonia and Portugal: The European Youth Heart Study. *International Journal of Pediatric Obesity, 3*(1), 58–66.

Dwyer, G. M., Higgs, J., Hardy, L. L., & Baur, L. A. (2008). What do parents and preschool staff tell us about young children's physical activity?: A qualitative study. *International Journal of Behavioral Nutrition and Physical activity, 5,* 66. doi:10.1186/1479-5868-566.

Ekelund, Ulf., Sardinha, L. B., Anderssen, S. A., Harro, M., Franks, P. W., Brage, S. et al. (2004). Association between objectively assessed physical activity and indicators of body fatness in 9–10 years old European Children: A population based study from 4 distinct regions in Europe. (The European Youth Heart Study). *American Journal of Clinical Nutrition*, *80*(5), 584–590.

Esmaeilzadeh, S., & Ebadollahzadeh, K. (2012). Physical fitness, physical activity and sedentary activities of 7 to 11 year old boys with different body mass indexes. *Asian Journal of Sports Medicine*, *3*(2), 105–112.

Kemper, H. C. G., De Vente, W., Van Mechelen, W., & Twisk, J. W. R. (2001). Adolescent motor skill and performance: is physical activity in adolescents related to adult physical fitness? *American Journal of Human Biology, 13*(2), 180–189.

Kuriyan, R., Thomas, T., Lokesh, D., Aheth, N., Mahendra, A., Joy, R., Sumitra, S., Bhatt, S., & Kurpad, A. (2011). Potential factors related to waist circumference in urban South Indian Children. Indian Pediatrics, PII: S 097475591NPE 10000225-1.

Lumeng, J. C., Rahnama, S., Appugliese, D., Kaciroti, N., & Bradley, R. H. (2006). Television exposure and overweight risk in preschoolers. *Archives of Pediatrics and Adolescent Medicine*, *160*(4), 417–422.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjostrom, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32,* 1–11.

Pino-Ortega, J., De la Cruz-Sánchez, E., & Martínez-Santos, R. (2010). Health—related fitness in school children: Compliance with physical activity recommendations and its relationship with body mass index and diet quality. *Archieves Latino America Nos De Nution*, *60*(4), 1.

Powers, S. K., & Dodd, S. L. (1996). Total fitness—Exercise, nutrition and wellness. Boston: Allyn and Bacon.

Takken, T., Van Der Net, J., Kuis, W., & Helders, P. J. M. (2003). *Annals of the Rheumatic Diseases*, *62*, 885–889.

Tharkar, S., & Viswanathan, V. (2009). Impact of socioeconomic status on prevalence of overweight and obesity among children and adolescents in urban India. *The open obesity Journal, 1,* 9–14.

Twisk, J. W. R., Kemper, H. C. G., Van Mechelen, W., & Post, G. B. (1997). Tracking of risk factors for coronary heart disease over a 14 year period: A comparison between lifestyle and biologic risk factors with data from Amsterdam growth and health study. *American Journal of Epidemiology, 145,* 888–898.

Van der Horst, K., Paw, M., Twisk, J. W. R., & Van Mechelen, W. (2007). A brief review on correlations of physical activity and sedentariness in youth. *Medicine and Science in Sports and Exercise, 38*(8), 1241–1250.