CHAPTER 4   RESULTS

Children's health-related physical fitness, physical activity levels, body composition and television viewing among the 264 Portuguese middle school children.

The effects of school aerobic exercise intervention on children's health-related physical fitness on 141 Portuguese middle school children.

Children's physical activity levels during the school physical education classes by heart rate monitoring of the 28 Portuguese middle school children.

CHAPTER 4   RESULTS

4.1 Children's Health-Related Physical Fitness and Physical Activity Levels Among 264 Portuguese Middle School Children

A total of 264 children participated in FITNESSGRAM test and questionnaire. Their characters, FITNESSGRAM test, physical activity levels, and television viewing time, organized by genders and age groups, are described in Table 4-1 & 4-2, and Figure 4-1.

Table 4-1   Characteristics, FITNESSGRAM results, PA levels, TV viewing time among the 264 students

	All	Boys	Girls
Age	10-15	10-15	10-15
Number	264	131	133
Height (cm)	156.4±10.6	158.4±11.9	154.5±8.8
Weight (kg)	50.2±11.5	51.5± 12.5	48.9±10.3
BMI (kg/m^2)	20.4±3.4	20.5±3.3	20.4±3.5
Overweight (Obesity) (%)	27.3% (6.8%)	29.8% (6.1%)	24.8% (7.5%)
FITNESSGRAM			
AC in HFZ	83.3%	87.0%	79.7%
AS in HFZ	76.5%	80.9%	72.2%
BC in HFZ	82.6%	74.8%	90.2%
OF in HFZ	57.2%	65.7%	48.9%
TES in HFZ	89.4%	90.8%	88.0%
UBS in HFZ	29.8%	36.6%	21.1%
Physical fit(Physical not fit)	17.4% (82.7%)	22.1% (77.9%)	12.8% (87.2%)
PA Levels (MVPA)			
Sedentary	19.2%	10.3%	27.6%
Low	36.4%	27.7%	45.0%
Moderate	38.9%	51.7%	26.8%
Vigorous	5.5%	10.3%	0.8%
TV TIME			
< 2 hours	32.6%	37.9%	27.6%
2-3 hours	28.5%	29.3%	27.6%
3-4 hours	15.9%	13.8%	17.9%
> 4 hours	23.0%	19.0%	26.8%

AC= Aerobic Capacity; AS=Abdominal Strength; BC=Body Composition; OF=Overall Flexibility; TES=trunk extensive strength; UBS=upper body strength; HFZ=Health Fitness Zone; Physical fit= pass all six items in FITNESSGRAM. MVPA= moderate to vigorous physical activity.

Table 4-2   Characteristics, FITNESSGRAM results, PA levels, TV viewing time among the 264 students

|	Boys			Girls		
Age	10-11	12-13	14-15	10-11	12-13	14-15
Number	52	31	48	52	35	46
Height (cm)	148.3±5.4	159.5±5.9	168.6±8.8	147.8±7.5	154.9±4.8	161.7±6.4
Weight (kg)	42.0±7.0	54.6±11.4	59.8±11.0	44.2±11.3	48.8±7.9	54.2±8.2
BMI (kg/m^2)	19.6±3.2	21.5±3.7	20.9±2.7	20.1±4.2	20.4±3.1	20.7±2.8
Overweight (Obesity) (%)	34.6% (5.8%)	45.2% (9.7%)	14.6% (4.2%)	34.6% (13.5%)	25.7% (5.7%)	13.0% (2.2%)
FITNESSGRAM						
AC in HFZ	92.3%	67.7%	93.8%	88.5%	80.0%	69.6%
AS in HFZ	82.7%	74.2%	83.3%	63.5%	74.3%	80.4%
BC in HFZ	65.4%	71.0%	87.5%	84.6%	91.4%	95.7%
OF in HFZ	63.5%	54.8%	75.0%	44.2%	42.9%	58.7%
TES in HFZ	92.3%	93.6%	87.5%	82.7%	82.9%	97.8%
UBS in HFZ	40.4%	22.6%	41.7%	19.2%	20.0%	23.9%
Physical fit (Physical not fit)	26.9% (73.1%)	12.9% (87.1%)	22.9% (77.1%)	11.5% (88.5%)	14.3% (85.7%)	13.0% (87.0%)
PA Levels (MVPA)						
Sedentary	11.6%	11.1%	8.7%	33.3%	15.2%	31.1%
Low	11.6%	11.1%	8.7%	33.3%	15.2%	31.1%
Moderate	53.5%	40.7%	56.5%	28.9%	27.3%	24.4%
Vigorous	4.7%	18.5%	10.9%	0.0%	0.0%	2.2%
TV TIME						
< 2 hours	48.9%	25.9%	34.8%	28.9%	36.4%	20.0%
2-3 hours	25.6%	37.0%	28.3%	24.4%	12.1%	42.2%
3-4 hours	16.3%	7.4%	15.2%	8.9%	24.2%	22.2%
> 4 hours	9.3%	29.6%	21.7%	37.8%	27.2%	15.6%

AC= Aerobic Capacity; AS=Abdominal Strength; BC=Body Composition; OF=Overall Flexibility; TES=trunk extensive strength; UBS=upper body strength; HFZ=Health Fitness Zone; Physical fit= pass all six items in FITNESSGRAM. MVPA= moderate to vigorous physical activity.

The Results from FITNESSGRAM of all subjects showed that 17.4 percent of students (boys: 22.1% vs. girls: 12.8%) met all six fitness standards within the healthy fitness zone (HFZ) in FITNESSGRAM. Most students (boys: 77.9% vs. girls: 87.2%) tested were unable to meet all minimum standard of 6 items in FITNESSGRAM to be considered physically fit. The most frequently passed item by the Portuguese students was Trunk Extensive Strength (89.4%), followed by Aerobic Capacity (83.3%), Body Composition (82.6%), Abdominal Strength (76.5%), Overall Flexibility (57.2%), and Upper Body Strength (28.8%). We found that many Portuguese school children failed to pass the Upper

Body Strength test, only 19 to 42 percent of them passed the test cut-offs, with little difference in scores between the genders (see Table 4-2).

Figure 4-1   Result of FITNESSGRAM test among the 264 students
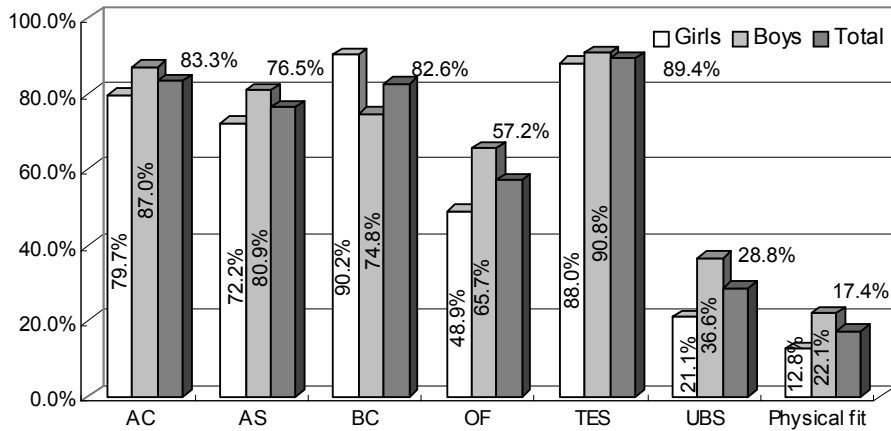
AC=Aerobic Capacity; AS=Abdominal Strength; BC=Body Composition; OF=Overall Flexibility; TES=trunk extensive strength; UBS=upper body strength; Physical fit= pass all six items in FITNESSGRAM.

Overweight and obesity

Based on the recent international BMI charts for overweight and obesity Appendix-08), we found 27.3 percent (boys: 29.8% vs. girls: 24.8%) of subjects either suffered from overweight or obesity. 6.8 percent (boys: 6.1% vs. girls: 7.5%) were obesity (Figure 4-2).

Figure 4-2   Overweight and obesity among the 264 students
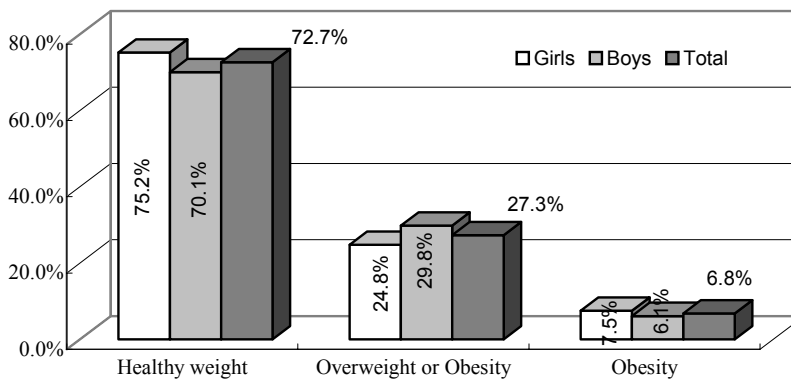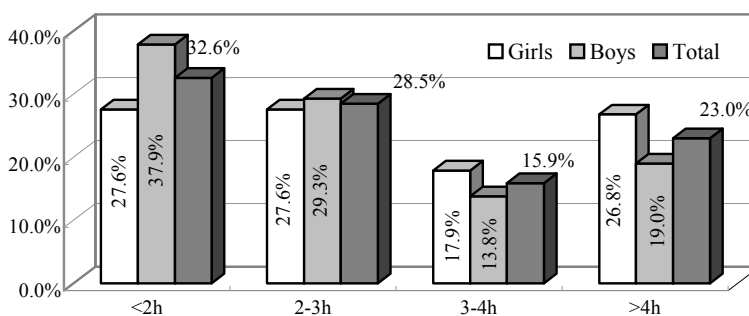
Children's physical activity levels

According to the questionnaire (mainly based on the IPAQ) completed by all subjects, 44.4% of students engaged in moderate to vigorous physical activity-MVPA regularly (five or more days per week for 30 minutes or more per occasion). 55.6 percent of subjects did not have enough MVPA; 19.2 percent (boys: 10.3% vs. girls: 27.6%) didn't participate in MVPA beyond school physical education classes (Figure 4-3). To assess the instrument reliability, the two-week test-retest assessment was assessed with a random sub-sample of 28 Portuguese children. The reliability was 0.84.

Figure 4-3   Children's physical activity levels (MVPA) among the 264 students
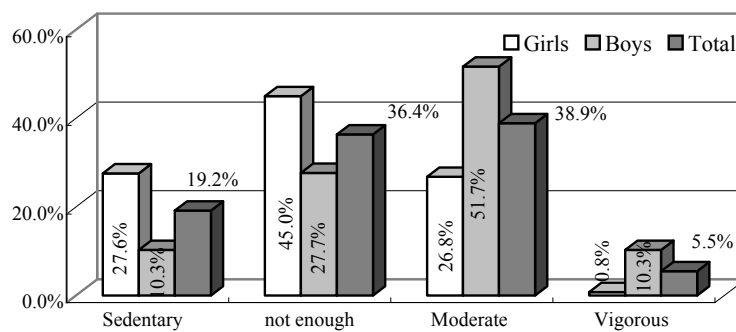
Children's television viewing time

Figure 4-4   Children's television viewing time among the 264 students

Some studies suggest that the decline of children's physical activity is associated with an increase of television viewing time. According to the self-report questionnaire, we found 67.4 percent of them watched at least two hours of television per day and 23.0 percent of them watched more than 4 hours per day (Figure 4-4).

Relationships between children's activity levels and some variables

Table 4-3   Correlation between MVPA and some variables among the 264 students

Items correlated with MVPA	Total (n=239)	All boys (n=116)	All girls (n=123)	B1 (n=43)	B2 (n=27)	B3 (n=46)	G1 (n=45)	G2 (n=33)	G3 (n=45)
Age	NS	NS	NS	-	-	-	-	-	-
Gender	-0.36***	-	-	-	-	-	-	-	-
BMI	NS	NS	NS	NS	NS	NS	NS	-0.33*	NS
Sum of SF	+0.23*	-0.17*	NS	-0.29*	NS	NS	NS	NS	NS
TV Time	NS	NS	NS	NS	NS	NS	NS	NS	NS
VO2 max	+0.41**	+0.27**	+0.30*	+0.28*	NS	+0.38**	+0.30*	NS	+0.34*
Physical fit	+0.30**	+0.26*	+0.31*	+0.33*	NS	+0.29*	+0.35*	NS	+0.34*
More items fit	+0.35**	+0.29*	+0.39**	0.30*	NS	+0.33*	+0.39*	NS	+0.55**
AC	+0.21*	NS	+0.24**	NS	NS	NS	NS	NS	+0.35*
AS	+0.24*	NS	+0.31**	NS	NS	NS	NS	+0.33*	+0.42**
UBS	+0.29**	+0.21*	+0.31**	NS	NS	+0.39**	+0.38*	NS	+0.34*
BC	NS	NS	NS	NS	NS	NS	NS	NS	NS
TES	NS	NS	+0.18*	NS	NS	NS	NS	NS	NS
OF	+0.21*	+0.24*	NS	+0.49**	NS	NS	NS	NS	NS

SF=Skinfolds; AF=Aerobic Capacity; AS=Abdominal Strength; UBS=Upper body strength; BC=Body Composition; TES=Trunk Extensive strength; OF=Overall Flexibility; B1=Boy(10-11yrs); B2=Boy(12-13yrs), B3=Boy(14-15yrs); G1=Girl(10-11yrs); G2=Girl(12-13yrs), G3=Girl(14-15yrs); NS: not significant; * p<0.05; **p<0.01; *** p<0.001.

The Pearson correlation coefficients between physical activity levels (MVPA) and variables among the 264 study subjects are presented in Table 4-3. We found that children's height and weight increases with age in both boys and girls. There was no age difference in MVPA and television viewing time in boys and girls. But children's MVPA was significant correlated with gender (r=0.36, p<0.001), which showed boys were significant more active than girls in MVPA. We found that children who regularly participate in MVPA significantly were physical fit in both boys and girl (r $_{boys}$ =0.26, p<0.05; r $_{girls}$ =0.31, p<0.05), and significant pass more health-related physical fitness items in FITNESSGRAM (r $_{boys}$ =0.26, p<0.05; r $_{girls}$ =0.31, p<0.05); Children who regular participate in MVPA also significantly improved the very important aerobic capacity (VO2 max) both boys and girls (r $_{boys}$=0.30, p<0.05; r $_{girls}$ =0.41, p<0.01), upper body strength (r $_{boys}$ =0.31, p<0.01; r $_{girls}$ =0.29, p<0.01), aerobic fitness for children (r $_{all}$ =0.21,

p<0.05; r_{girls} =0.24, p<0.01, boys was not significant); Children's MVPA significantly correlated with boys' flexibility (r_{boys} =0.24, p<0.01), girls' Abdominal Strength (r_{girls} =0.31, p<0.01) and trunk extensive strength (r_{girls} =0.18, p<0.05).

The two-way ANOVA was performed across height, weight, BMI, the sum of skinfold thicknesses, MVPA, and television viewing time to determine the effects of age and gender. Across these scales the age-by-gender interaction was statistically significant among height (F=3.016, p=0.012) and weight (F=2.923, p=0.014). We did not find a statistical significance in relation with BMI, sum of skinfold thicknesses, MVPA and television viewing time.

Children's knowledge about health, health-related physical fitness and exercise

One of the primary aims of this study was to determine the subjects' knowledge about health, objectives of the regular physical activity, and detail about health-enhancing physical activity (aerobic exercise).

According to the subjects' responses during the classes and on the questionnaire, we found most of children did not understand the concepts of health, health-related physical activity and skill-related physical fitness. On the question of "Do you know the concept of aerobic exercise?" we found most of them did not know the answer and did not know how to exercise aerobically.

Table 4-4　　Children's concept about aerobic exercise among the 264 students

Question: Do you know aerobic exercise?	Boys (131)	Girls (133)	Total (264)
Answer: I dont know	97.7%	91.0%	94.3%
Answer: I know a little or more	2.3%	9.0%	5.7%

Children's opportunities to practice aerobic exercise

According to the answers to the questions (figure 4-5) "What are the two sports you practice very often?" and "What are your two favorite sports?" we found the following ranking of sports activities children practice very often: Boys: football (73.3%), basketball (12.2%), track & field (12.2%), handball (10.0%), swimming (10.0%); Girls: football (60.6%). running (17.3%), gymnastics (15.4%), basketball (12.5%), volleyball (12.5%).

Because of limited playground and facilities, our subjects may not have opportunity to enjoy their favourite sports. We investigated their favourite sports in order to see the

difference between children sports that they practise very often and their favourite sports. We found the ranks of subject's favourite sports are: Boys: football (72.8%), basketball (20.7%), handball (10.9%), karate (10.9%) and volleyball (9.8%); Girls: football (49.2%), aerobics (23.7%), swimming (22.0%), basketball (19.5%) and volleyball (16.1%). If we exclude the football, which is the Portuguese national sport, we found that girls seemed to have less opportunity to practice their favourite sports, such as aerobics and swimming, which are not taught in school physical education classes.

Table 4-5   Children's favourite sports and the sports they play among the 264 students

	Boys						Girls				
	Sports like		Sports practise		Difference		Sports like		Sports practise		Difference
Football	72.8%	(1)	73.3%	(1)	0.5%		49.2%	(1)	60.6%	(1)	-11.4%
Basketball	20.7%	(2)	12.2%	(3)	8.5%		19.5%	(4)	12.5%	(5)	7.0%
Aerobics	0%	(15)	2.2%	(13)	2.2%		23.7%	(2)	10.6%	(7)	13.1%
Swimming	8.7%	(7)	10.0%	(5)	-1.3%		22.0%	(3)	15.4%	(3)	6.6%
Volleyball	9.8%	(6)	4.4%	(9)	5.4%		16.1%	(5)	12.5%	(5)	3.6%
Karate	10.9%	(4)	4.4%	(9)	6.5%		3.4%	(10)	1.0%	(13)	2.4%
Gymnastics	2.2%	(14)	4.4%	(9)	-2.2%		11.0%	(6)	15.4%	(3)	4.4%
Track and field	7.6%	(9)	12.2%	(3)	-4.6%		1.6%	(15)	1.9%	(11)	0.3%
Handball	10.9%	(4)	10.0%	(5)	0.9%		9.3%	(7)	4.8%	(10)	4.5%
Tennis	5.9%	(10)	4.4%	(9)	1.5%		3.3%	(12)	1.0%	(13)	2.3%
Skating	3.3%	(12)	2.2%	(13)	1.1%		2.5%	(13)	1.9%	(11)	0.6%
Running	4.3%	(11)	6.7%	(8)	-2.4%		3.4%	(10)	17.3%	(2)	-13.9%
Badminton	3.3%	(12)	0%	(15)	3.3%		1.7%	(14)	0%	(16)	1.7%
Bodybuilding	0%	(15)	0%	(15)	0%		0.8%	(16)	1.0%	(13)	-0.2%
Cycling	8.7%	(7)	8.9%	(7)	-0.2%		5.9%	(8)	9.6%	(8)	-3.7%
Others	12.0%	(3)	13.3%	(2)	-1.3%		4.2%	(9)	5.0%	(9)	0.8%

The number in () express the order of the selection among the children.

4.2 Effects of School Aerobic Exercise Intervention on Children's Health-Related Physical Fitness Among The 141 Portuguese Middle School Children.

A total of 141 children (62 boys and 79 girls, aged 10-15 yrs), from the sample 264 children, participated in the intervention study; The characteristics of the subjects in the experimental and control groups are described in Table 4-6 and Table 4-7.

Table 4-6   Characteristics of the 62 boys between experimental and control groups

Boy (62)	10-11 yrs		12-13 yrs		14-15 yrs	
Group (N)	Test (10)	Control (10)	Test (10)	Control (9)	Test (11)	Control (12)
Age	10.7±0.5	10.9±0.3	12.1±0.3	12.7±0.5	14.5±0.5	14.3±0.5
Height	144.7±3.6	148.3±6.4	161.9± 3.5	163.3±8.4	169.7±9.5	170.0±7.4
Weight	45.9±8.7	45.6±13.3	55.6±11.9	60.1±10.7	59.5±12.3	61.6±10.9
BMI	21.8±3.5	20.5±4.6	21.1±4.2	22.4±3.1	20.5±2.6	21.2±2.6

Table 4-7   Characteristics of the 79 girls between experimental and control groups

Girl (79)	10-11 yrs		12-13 yrs		14-15 yrs	
Group(N)	Test (12)	Control (13)	Test (14)	Control (13)	Test (14)	Control (13)
Age	10.9±0.3	10.7±0.5	12.4±0.5	12.2±0.4	14.4±0.6	14.1±0.6
Height	144.7± 7.1	146.1±8.4	156.1±4.4	153.7±4.3	160.0±4.4	162.2±8.0
Weight	42.5±13.3	43.5±10.8	48.9±8.8	48.8±5.7	51.5±4.7	55.6±8.8
BMI	20.3±5.7	20.2±3.9	20.0±3.1	20.7±2.8	20.1±1.9	21.1±2.8

The purpose of this study was to examine the health benefits of school-based aerobic exercise in school physical education. Table 4-8, Table 4-9, Figure 4-5 and Figure 4-6 show the results of FITNESSGRAM among 141 children in different groups.

We found in post-test that both boys and girls in the experimental groups had higher rate of physical fitness than those in control group. Girls in experimental groups scored a particularly high rate of physical fitness than girls in control groups. According to the results and our observation, we found a improvement in all girls' health-related physical fitness at all age groups and boy's health-related physical fitness in age groups 10-11 year and 12-13 year groups, but not at age group 14-15 year.

Table 4-8   FITNESSGRAM test between boys in experimental and control groups

Boy		Experimental Groups			Control Groups			EG Comparing with CG		
Age groups		2001	2002	Difference	2001	2002	Difference	2001	2002	Difference
10-11 yrs	6 items passed	10%	40%	30%	20%	10%	-10%	-10%	30%	40%
	5 items passed	40%	50%	10%	30%	30%	0	10%	20%	10%
12-13 yrs	6 items passed	10%	30%	20%	0	11%	11%	10%	19%	9%
	5 items passed	40%	60%	20%	22%	33%	11%	18%	27%	9%
14-15 yrs	6 items passed	27%	36%	9%	17%	33%	16%	10%	3%	-7%
	5 items passed	45%	81%	36%	50%	50%	0	-5%	31%	36%

6 or 5 item passed = passed 6 or 5 items in FITNESSGRAM

Figure 4-5   FITNESSGRAM test between boys in experimental and control groups
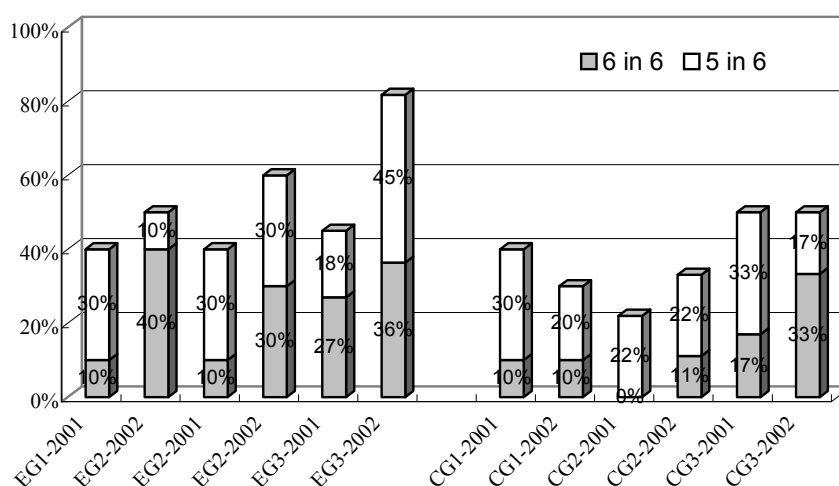
EG-experimental groups, CG-control groups

Table 4-9   FITNESSGRAM test between girls in experimental and control groups

Girl		Experimental Groups			Control Groups			Comparing between EG & CG		
Age groups		2001	2002	Difference	2001	2002	Difference	2001	2002	Difference
10-11yrs	6 items passed	0%	33%	33%	23%	8%	-15%	-23%	25%	48%
	5 items passed	17%	50%	33%	31%	46%	14	-16%	6%	22%
12-13 yrs	6 items passed	7%	29%	22%	15%	0%	-15%	-8%	29%	37%
	5 items passed	14%	50%	36%	61%	22%	-39%	-47%	28%	75%
14-15 yrs	6 items passed	14%	21%	7%	8%	8%	0	6%	13%	7%
	5 items passed	28%	57%	29%	62%	39%	-23%	-34%	18%	52%

6 or 5 items passed = passed 6 or 5 items in FITNESSGRAM

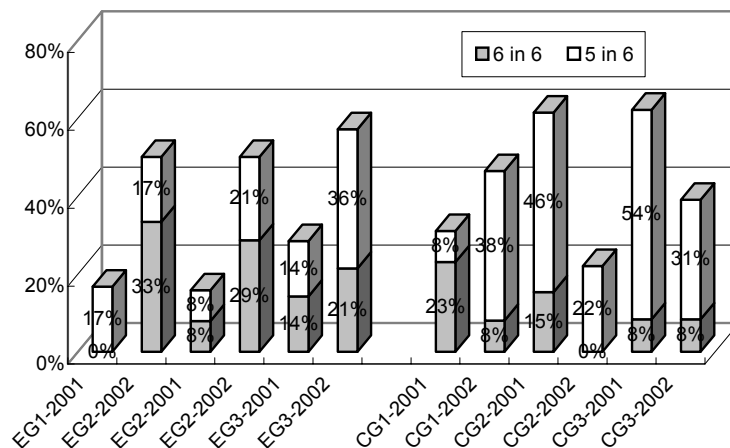Figure 4-6 FITNESSGRAM test between girls in experimental and control groups

EG-experimental group, CG-control group,

Health-related physical fitness items among the sample

Boys' characteristics in age group 10-11years can be seen in Table 4-10. In pre-test, we did not find significant difference between 2 groups in FITNESSGRAM. In post-test, boys in experimental groups made a significant improvement in the tests of Trunk Life, Curl-up, Push-up, boys in control groups made a significant improvement in the Curl-up test. We found that boys in experimental group had a significant improvement in One mile run test.

Table 4-10 Comparing health-related physical fitness items between boys in two groups in age group (10-11yrs)

Boy (10-11yrs)	Experimental Group(10)		Control Group(10)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	P_{E1-C1}	P_{E1-E2}	P_{C1-C2}	P_{E2-C2}	
Height (cm)	144.7 ± 3.6	1.489 ± 5.6	148.3 ± 6.4	152.0 ± 8.2	-	↑ **	↑ **	-	
Weight (kg)	45.85 ± 8.7	48.17 ± 7.7	45.6 ± 13.3	46.4 ± 9.2	-	-	-	-	
BMI (kg/m^2)	21.8 ± 3.5	21.7 ± 2.8	20.5 ± 4.6	20.0 ± 2.8	-	-	-	-	
Trunk Lift (cm)	29.1± 6.1	31.6 ± 5.7	32.7 ± 5.5	29.6 ± 4.4	-	↑ *	-	-	
Curl up (times)	25.5 ± 19.9	56.4 ± 21.1	19.3 ± 15.7	41.9 ± 23.6	-	↑ **	↑ *	-	
Push up (times)	7.0 ± 8.8	12.6 ± 11.2	6.7 ± 8.9	8.7 ± 6.9	-	↑ *	-	-	
Sit & Reach (cm)	17.3 ± 8.1	22 ± 5.4	17.0 ± 4.4	19.8 ± 3.7	-	-	-	-	
Triceps (cm)	15.4 ± 6.6	16.2 ± 6.6	15.9 ± 7.8	17.9 ± 6.3	-	-	-	-	
Calf (cm)	14.7 ± 8.8	15.8 ± 6.5	13.5 ± 7.5	17.2 ± 8.4	-	-	-	-	
Σ Skinfolds (cm)	30.1 ± 14.4	31.9 ± 12.9	29.4 ± 14.9	35.1 ± 14.3	-	-	-	-	
Body Fat (%)	23.5 ± 8.8	24.6 ± 7.9	23.0 ± 9.1	26.5 ± 8.8	-	-	-	-	
1 Mile (min)	9.3 ± 2.2	8.6 ± 1.4	9.7 ± 1.5	10.0 ± 1.6	-	-	-	#	
VO$_{2\ max}$ (ml/kg/min)	43.3 ± 5.3	44.2 ± 4.6	42.9 ± 5.6	42.0 ± 3.0	-	-	-	-	

Nearly to $p<0.05$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, ↑ good increase, ↓ bad increase.

Boys' characteristics in age group 12-13years can be seen in Table 4-11. In pre-test we only found a significant difference in the Push-up test which indicates that boys in the control group were significantly better than boys in experimental group. In post-test, boys in the experimental group made a significant improvement in Curl-up, Push-up and Sit and reach; boys in control group did not make any significant improvement in any test. Comparing the results of post-test between 2 groups, we did not find any significant difference in all tests between boys in the 2 groups. As there was a significant difference in Push-up between experimental and control groups before, it seemed that boys in the experimental group improve their upper body strength and endurance more effectively.

Table 4-11   Comparing health-related physical fitness items between boys in two groups in age group (12-13yrs)

Boy (12-13yrs)	Experimental Group(10)		Control Group(9)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	P_{E1-C1}	P_{E1-E2}	P_{C1-C2}	P_{E2-C2}	
Height (cm)	161.9 ±3.6	165.0 ± 4.2	163.3 ± 8.4	166.7 ± 8.4	-	↑ *	-	-	
Weight (kg)	55.6 ±11.9	58.5 ± 11.8	60.1 ± 10.7	64.7 ± 9.4	-	↑ **	-		
BMI (kg/m^2)	21.1± 4.2	21.5 ± 4.6	22.4 ± 3.1	23.3 ± 3.0	-	-	-	-	
Trunk Lift (cm)	31.3 ± 6.0	32.8 ± 5.9	29.9 ± 6.7	28.6 ± 6.2	-	-	-	-	
Curl up (times)	38.8 ± 24.9	62.8 ± 18.4	38.8 ± 12.4	50.6 ± 19.6	-	↑ **	-	-	
Push up (times)	2.2 ± 3.6	10.2 ± 7.2	7.4 ± 6.7	11.4 ± 6.9	*	↑ **	-	-	↑
Sit & Reach (cm)	17.8 ±6.1	22.9 ± 4.1	19.1 ± 6.7	20.2 ± 6.1	-	↑ *	-	-	
Triceps (cm)	14.2 ± 6.9	14.0 ± 7.5	16.7 ± 6.8	15.7 ± 4.9	-	-	-	-	
Calf (cm)	13.1 ± 7.3	12.8 ± 7.8	13.3 ± 5.7	13.8 ± 4.8	-	-	-	-	
∑ Skinfolds (cm)	27.3 ± 14.2	26.7 ± 15.2	30.0 ± 12.1	29.5 ± 9.6	-	-	-	-	
Body Fat (%)	22.2 ± 8.8	21.8 ± 9.4	23.4 ± 7.4	23.1 ± 5.9	-	-	-	-	
1 Mile (min)	8.6 ± 1.7	7.9 ± 1.4	9.3 ± 1.7	8.8 ± 1.4	-	-	-	-	
$VO_{2\,max}$ (ml/kg/min)	45.1± 6.5	46.3 ± 6.3	42.2 ± 5.8	42.3 ± 4.2	-	-	-	-	

Nearly to $p<0.05$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, ↑ good increase, ↓ bad increase.

Boys' Characteristics in age group 14-15years can be seen in Table 4-12. In pre-test, we only found a significant difference in the $VO_{2\,max}$, which shows boys in the control group scored significantly higher than boys in the experimental group. In post-test, boys in the experimental group made a significant improvement in Trunk Lift, Curl-up and Push-up. Boys in the control group made a significant improvement in Curl-up test. Comparing the results of post-test between experimental and control groups, we found a significant difference in Curl-up test. It appears that the intervention resulted in improvement of boys' abdominal strength and endurance in the experimental group.

Table 4-12   Comparing health-related physical fitness items between boys in two groups in age group (14-15yrs)

Boy (14-15yrs)	Experimental Group(11)		Control Group(12)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	P_{E1-C1}	P_{E1-E2}	P_{C1-C2}	P_{E2-C2}	
Height (cm)	169.7 ± 9.5	170.5 ± 8.1	170.0 ± 7.4	173.4 ± 6.5	-	-	↑ *	-	
Weight (kg)	59.5 ± 12.4	61.0 ± 10.8	61.6 ± 10.9	64.8 ± 10.9	-	-	-	-	
BMI (kg/m^2)	20.5 ± 2.6	20.8 ± 2.2	21.2 ± 2.6	21.4 ± 2.3	-	-	-	-	
Trunk Lift (cm)	29.7 ± 6.3	37.2 ± 11.3	31.8 ± 8.3	32.8 ± 8.7	-	↑*	-	-	
Curl up (times)	46.0 ± 19.4	70.5 ± 10.5	51.5 ± 20.6	56.3 ± 18.2	-	↑***	-	↑ **	↑
Push up (times)	11.2 ± 8.1	16.2 ± 4.7	9.9 ± 8.3	13.6 ± 9.8	-	↑ *	-	-	
Sit & Reach (cm)	22.9 ± 4.7	25.2 ± 5.2	20.3 ± 5.6	22.0 ± 4.2	-	-	-	-	
Triceps (cm)	10.4 ± 4.6	10.5 ± 3.9	11.2 ± 4.5	10.6 ± 3.8	-	-	-	-	
Calf (cm)	8.8 ± 2.9	9.1 ± 3.7	9.8 ± 4.7	10.5 ± 4.4	-	-	-	-	
Σ Skinfolds (cm)	19.2 ± 6.7	19.6 ± 7.5	21.0 ± 8.4	21.1 ± 7.9	-	-	-	-	
Body Fat (%)	16.8 ± 4.1	17.7 ± 5.0	17.9 ± 5.1	18.0 ± 4.8	-	-	-	-	
1 Mile (min)	7.4 ± 1.8	7.1 ± 0.9	8.4 ± 0.6	7.8 ± 1.5	-	-	-	-	
VO$_{2\ max}$ (ml/kg/min)	49.1 ± 4.7	49.3 ± 3.6	44.7 ± 2.6	46.1 ± 4.2	*	-	-	-	

Nearly to p<0.05, * p<0.05, ** p<0.01, *** p<0.001, ↑ good increase, ↓ bad increase.

Table 4-13   Comparing health-related physical fitness items between girls in two groups in age group (10-11yrs)

Girl (10-11yrs)	Experimental Group(12)		Control Group(13)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	P_{E1-C1}	P_{E1-E2}	P_{C1-C2}	P_{E2-C2}	
Height (cm)	1.447 ± 7.1	149.8 ± 6.4	146.1 ± 8.5	151.0 ± 8.3	-	↑ ***	↑ ***	-	
Weight (kg)	42.5 ± 13.3	44.8 ± 12.0	43.5 ± 10.8	47.2 ± 10.3	-	↑ ***	↑ ***	-	
BMI (kg/m^2)	20.3 ± 5.7	20.0 ± 5.0	20.2 ± 3.9	20.5 ± 3.3	-	-	-	-	
Trunk Lift (cm)	24.5 ± 6.9	29.8 ± 4.9	30.7 ± 4.5	33.2 ± 5.3	*	↑ **	-	-	
Curl up (times)	14.9 ± 11.3	52.8 ± 19.9	15.8 ± 9.9	45.0 ± 21.7	-	↑ ***	↑ ***	-	
Push up (times)	2.3 ± 3.3	7.3 ± 7.3	5.1 ± 6.4	7.6 ± 6.8	-	↑ *	-	-	
Sit & Reach (cm)	19.5 ± 3.9	26.5 ± 4.4	25.4 ± 5.0	23.2 ± 5.1	**	↑ ***	-	-	
Triceps (cm)	15.9 ± 5.3	16.1 ± 7.6	16.3 ± 6.4	18.8 ± 5.3	-	-	↓ *	-	
Calf (cm)	14.6 ± 8.9	15.4 ± 7.1	16.6 ± 5.9	20.5 ± 5.4	-	-	↓ **	#	
Σ Skinfolds (cm)	30.5 ± 13.6	31.5 ± 14.4	32.9 ± 12.2	39.3 ± 10.5	-	-	↓ **	-	
Body Fat (%)	23.7 ± 8.3	24.3 ± 8.8	25.2 ± 7.4	29.1 ± 6.4	-	-	↓ **	-	
1 Mile (min)	9.8 ± 1.4	9.8 ± 1.5	10.4 ± 2.3	10.9 ± 1.8	-	-	-	-	
VO$_{2\ max}$ (ml/kg/min)	42.7 ± 5.6	43.2 ± 6.3	42.9 ± 5.0	41.5 ± 3.7	-	-	↓ *	-	

Nearly to p<0.05, * p<0.05, ** p<0.01, *** p<0.001, ↑ good increase, ↓ bad increase.

Girls' characteristics in age group 10-11years can be seen in Table 4-13. In pre-test, we found a significant difference between 2 groups in Trunk Lift and Sit and Reach. In post-test, girls in experimental group made a significant improvement in Trunk Lift,

Curl-up and Sit and Reach; Girls in the control group made significant improvement in the Curl-up test, Also the Sum of Skinfolds, Skinfold of Triceps, Skinfold of Calf. Comparing the results of their post-test between 2 groups, we found girls in the experimental group had a significant improvement in skinfold test (Calf), which indicated that intervention is more effective in preventing an increase of calf skinfold.

Girls' characteristics in age group 12-13 years can be seen in Table 4-14. In pre-test, we found a significant difference in the Trunk Lift, Sit and Reach and One mile run between 2 groups. In post-test, girls in the experimental group made a significant improvement in Trunk Lift, Curl-up, Push-up and Sit and reach. Girls in the control group make some negative significant improvement in Sit and Reach, all skinfolds test and body fat. Comparing the post-test results between 2 groups, we found girls in the experimental made a significant improvement in Curl-up, time of One mile run, and $VO_{2\ max}$ than girls in the control group. There were some differences between girls in 2 and control groups in their pre-test, we found intervention made a significant improvement in Trunk Lift, Curl-Up, Sit & Reach, One Mile Run and $VO_{2\ max}$ for the girls in the experimental group.

Table 4-14   Comparing health-related physical fitness items between girls in two groups in age group (12-13yrs)

Girl (12-13yrs)	Experimental Group (14)		Control Group(13)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	$P_{E1\text{-}C1}$	$P_{E1\text{-}E2}$	$P_{C1\text{-}C2}$	$P_{E2\text{-}C2}$	
Height (cm)	156.1 ± 4.4	157.4 ± 4.2	153.7 ± 4.3	155.6 ± 3.8	-	-	↑ **	-	
Weight (kg)	48.9 ± 8.8	51.0 ± 8.2	48.8 ± 5.8	50.5 ± 5.1	-	↑ **	↑**	-	
BMI (kg/m^2)	20.0 ± 3.1	20.6 ± 3.0	20.7 ±2.8	20.9 ± 2.4	-	-	-	-	
Trunk Lift (cm)	29.1 ± 8.1	35.1 ± 8.4	34.7 ± 3.2	34.0 ± 5.9	*	↑ **	-	-	↑
Curl up (times)	38.9 ± 19.5	62.8 ± 14.7	38.4 ± 16.0	40.5 ± 17.1	-	↑ ***	-	↑ **	↑
Push up (times)	2.0 ± 3.7	7.7 ± 4.1	3.8 ± 3.8	4.6 ± 4.8	-	↑ **	-	-	
Sit & Reach (cm)	20.9 ± 4.3	24.4 ± 3.5	28.2 ± 5.6	25.1 ± 4.9	*	↑**	↓ *	-	↑
Triceps (cm)	15.1 ± 6.5	16.0 ± 6.3	16.5 ± 3.3	20.3 ± 4.9	-	-	↓ **	#	
Calf (cm)	15.0 ± 10.0	15.9 ±6.7	15.0 ± 4.2	18.5 ± 4.8	-	-	↓ **	-	
Σ Skinfolds (cm)	30.1 ± 15.9	31.9 ± 12.7	31.5 ± 6.9	38.8 ± 9.2	-	-	↓ **	-	
Body Fat (%)	23.4 ± 9.7	24.6 ± 7.7	24.3 ± 4.2	28.8 ± 5.6	-	-	↓ **	-	
1 Mile Run (min)	10.1 ± 1.7	8.7 ± 1.3	11.2 ± 0.8	11.5 ± 1.3	*	-	-	↑ ***	↑
$VO_{2\ max}$ (ml/kg/min)	42.8 ± 4.9	44.7 ± 4.7	40.2 ± 2.4	40.6 ± 2.9	-	-	-	↑ **	↑

Nearly to p<0.05, * p<0.05, ** p<0.01, *** p<0.001, ↑ good increase, ↓ bad increase.

Girls' characteristics in age group 14-15 years can be seen in Table 4-15. In pre-test, we only found a significant difference in Trunk Lift, which shows girls in the control group

scored significant higher than the girls in the experimental group. In post-test, girls in the experimental group made a significant improvement in Curl-up, Push-up, Sit & Reach, Skinfold (Calf), One Mile Run and $VO_{2\,max}$. Girls in the control group made a significant improvement in Curl-up and Skinfold (Calf). Comparing post-test between girls 2 groups, we found that girls in the experimental group made a significant improvement in Curl-up, Push-up, One Mile Run and $VO_{2\,max}$. The intervention did improve the girl's Trunk Lift, Curl-Up, Push-up, time in One Mile Run and $VO_{2\,max}$.

Table 4-15   Comparing health-related physical fitness items between girls in two groups in age group (14-15yrs)

Girl (14-15yrs)	Experimental Group(14)		Control Group(13)		Comparing Group E & C				Effect
	E1-2001	E2-2002	C1-2001	C2-2002	P_{E1-C1}	P_{E1-E2}	P_{C1-C2}	P_{E2-C2}	
Height (cm)	160.0 ± 4.4	160.1 ±3.7	162.2 ± 8.0	162.3 ± 6.3	-	-	-	-	
Weight (kg)	51.5 ± 4.7	50.6 ± 5.1	55.7 ± 8.8	55.1 ± 6.2	-	-	-	#	
BMI (kg/m^2)	20.1 ± 1.9	19.8 ± 1.6	21.1± 2.8	21.0 ± 2.7	-	-	-	-	
Trunk Lift (cm)	30.5 ± 4.3	34.1± 8.3	35.1 ± 6.7	34.7 ± 8.9	*	-	-	-	↑
Curl up (times)	38.1± 13.5	63.6 ± 13.7	32.5 ± 20.5	50.5 ± 17.9	-	↑***	*	↑ *	↑
Push up (times)	4.7 ± 5.4	10.9 ± 8.4	4.2 ± 5.6	3.1 ± 4.3	-	↑***	-	↑**	↑
Sit & Reach (cm)	22.5 ± 4.6	25.6 ± 3.9	25.1 ± 7.4	25.1 ± 7.6	-	*	-	-	
Triceps (cm)	17.4 ± 6.2	16.1 ± 5.1	16.6 ± 5.5	15.5 ± 3.5	-	-	-	-	
Calf (cm)	12.8 ± 4.1	15.1 ± 5.4	12.5 ± 5.6	15.0 ± 4.8	-	↓**	↓**	-	
∑ Skinfolds (cm)	30.2 ± 9.7	31.2 ± 10.2	29.1 ± 9.6	30.5 ± 7.1	-	-	-	-	
Body Fat (%)	23.5 ± 5.9	23.9 ± 5.5	22.9 ± 5.8	23.7 ± 4.4	-	-	-	-	
1 Mile (min)	9.8 ± 1.1	8.81 ±1.2	10.2 ± 1.3	10.8 ± 1.6	-	↑**	-	↑ **	↑
$VO_{2\,max}$ (ml/kg/min)	42.6 ± 2.2	45.1 ±2.8	41.3 ± 2.8	41.0 ± 2.9	-	↑**	-	↑ **	↑

Nearly to $p<0.05$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$, ↑ good increase, ↓ bad increase.

Table 4-16   Passing rate of FITNESSGRAM test in experimental and control groups

	N	All 6 items in HFZ			5 items in HFZ			Total 5 and 6 item in HFZ		
		2001	2002	+ OR-	2001	2002	+OR-	2001	2002	+OR-
All Boys-E	31	16.1%	16.1%	0%	25.8%	29.0%	3.2%	41.9%	45.1%	3.2%
All Boys-C	31	12.9%	12.9%	0%	22.6%	19.4%	-3.2%	35.5%	32.3%	-3.2%
All Girls-E	40	7.5%	27.5%	20.0%	12.5%	25.0%	12.5%	20.0%	52.5%	32.5%
All Girls-C	39	15.3%	5.1%	-10.2%	35.9%	30.8	-5.1%	51.2%	35.9%	-15.3%

HFZ=Healthy Fitness Zone

According to the results of our aerobic exercise intervention in school physical education (Table 4-16), we found that experimental group students, both boys and girls, significantly improved their health-related physical fitness, as compared to the children in

control groups. More children in the experimental groups achieved a healthy level and/or passed more items in the health-related physical fitness test (aerobic exercise is especially effective for older girls in experimental groups).

Stages of maturation on children's physical fitness

Descriptive statistics for physical characteristics, VO$_2$ max, and six items in FITNESSGRAM are presented in Table 4-16. As we did not receive permission to test children's maturity stage, only 39 Portuguese 8th grades from the sample 141 children were tested. We concluded that this sample was not big enough to weigh the difference, but we still found a significant difference between 8th grades in their maturity stages, for example, for boys from stage 2 to 5 and for girls from stage 3 to 5.

Table 4-17   The stages of maturity on 39 Portuguese 8th graders

Maturity stage	Boy(n=17)				Girl(n=22)		
	PH2(n=1)	PH3(n=3)	PH4(n=11)	PH5(n=2)	B3(n=4)	B4(n=11)	B5(n=7)
Age(yrs)	13.0±0	12.3±0.6	12.6±0.9	12.0±0	12.3±0.5	12.3±0.5	12.1±0.4
Height(cm)	146.0±0	154.0±13.9	163.8±4.2	163.5±14.8	155.7±5.1	158.8±3.0	154.9±4.6
Weight(kg)	54.5±0	50.8±16.1	59.7±9.3	57.0±11.3	43.5±5.7	52.5±5.0	52.8±6.5
BMI(kg/m^2)	25.6±0	21.1±3.6	22.3±3.3	21.2±0.4	17.9±2.3	20.8±1.7	22.0±2.4
Triceps(cm)	24.0±0	12.5±2.6	15.2±5.5	12.5±0.7	11.3±4.6	18.5±5.1	21.3±5.5
Calf(cm)	24.0±0	11.0±3.5	13.8±4.3	11.5±2.1	11.0±5.3	17.4±4.6	20.0±5.8
Sum of SK(cm)	48.0±0	23.5±5.3	29.0±9.6	24.0±2.8	22.3±9.5	35.9±9.1	41.3±10.6
% Fat	34.4±0	19.4±3.2	23.2±5.9	19.8±1.8	18.7±5.8	27.0±5.6	30.3±6.4
VO$_2$ max(ml/kg/min)	41.7±0	48.2±2.2	44.2±5.1	45.0±4.8	48.5±2.6	42.4±3.0	39.6±3.1
One mile run(min)	8.1±0	7.2±0.1	8.4±1.3	8.4±1.6	8.0±0.5	10.2±2.0	11.1±1.4
Push-up(times)	10.0±0	11.7±5.7	9.6±6.2	21.5±16.2	7.8±4.6	7.9±4.2	5.0±5.6
Curl-up(times)	75.0±0	46.0±20.9	55.2±22.4	60.0±21.2	70.0±10.0	56.9±15.9	38.6±14.4
Sit and Reach(cm)	15.0±0	26.7±2.3	21.1±4.2	16.5±9.2	24.5±4.7	24.4±3.8	25.9±2.9
Trunk Left(cm)	29.0±0	32. 7±9.0	30.1±7.4	31.5±13.4	41.5±8.8	34.4±5.7	30.7±3.9
MVPA(h/day)	2.0±0	2.3±0.6	2.8±1.1	3.5±0.7	2.3±0.5	2.1±0.8	2.3±0.5
TV Time(h/day)	2.0±0	3.3±1.5	3.7±1.3	3.0±0.0	2.8±1.7	4.0±1.2	3.3±1.6

Boy's maturity is based on pubic hair(PH); Girl's maturity is based on breast (B); SF=skinfolds

4.3 Children's physical activity levels during school physical education classes as measured by the heart rate monitor

Moderate-to-vigorous physical activity in physical education classes

HRMs were used to test children's physical activity levels in 7 different 90-minute physical education classes and 7 different 45-minute physical education classes. Descriptive statistics of the participants' characteristics, duration, and all heart rate measures are shown in Table 4-17 and Table 4-18. Figure 4-7 shows the curves of two children's heart rates in 90-minute co-educational physical education class.

Table 4-18   Subjects characteristics and heart rates in 90-minutes indoor physical education classes

| Total (n=14)	All (n=14)		Boy (n=7)	Girl (n=7)
	Mean (SD)	Min-Max	Mean (SD)	Mean (SD)
Age (yrs)	12.1 (0.4)	12.0-13.0	12.3 (0.5)	12.0 (0.0)
Height (m)	1.63 (0.1)	1.53-1.76	1.67 (0.1)	1.59 (0.1)
Weight (kg)	55.5 (10.7)	40.0-82.0	59.4 (12.6)	51.6 (7.3)
BMI (kg/m2)	20.8 (2.4)	17.1-27.4	21.1 (3.2)	20.4 (1.5)
HR Resting (bpm)	78.1 (4.4)	70-84	75.0 (4.1)	81.1 (2.0)***
Average HR in PE (bpm)	138.1 (21.4)	119-179	138.5 (22.5)	137.7 (22.0)
PE Actual Time (min)	61.2 (9.5)	49-82	63.6 (10.4)	58.7 (8.6)
Percentage of PE Actual Time (%)	68.0 (10.6)	54.4-91.1	70.6 (11.6)	65.3 (9.6)
Total PE time $\geq$ 140 bpm (min)	27.9 (23.9)	4.5-73.9	29.7 (23.7)	26.1 (25.8)
PPEST $\geq$ 140 bpm (%)	31.0 (26.5)	5.0-82.1	33.0 (26.3)	29.0 (28.6)
PPEAT $\geq$ 140 bpm (%)	42.6 (32.1)	9.2-96.0	44.5 (29.3)	40.7 (36.9)
Total PE time $\geq$ 160 bpm (min)	15.7 (20.4)	1.0-66.0	18.2 (23.1)	13.3 (18.8)
PPEST $\geq$ 160 bpm (%)	17.5 (22.6)	1.0-73.3	20.2 (25.7)	14.8 (20.8)
PPEAT $\geq$ 160 bpm (%)	23.2 (27.0)	1.6-80.5	26.3 (28.3	20.2 (27.5)
Total PE time $\geq$ 50% MHRR (min)	25.7 (23.8)	2.8-73.6	28.6 (24.2)	22.8 (25.0)
PPEST $\geq$ 50% MHRR (%)	28.5 (26.5)	3.1-81.8	31.7 (26.9)	25.3 (27.8)
PPEAT $\geq$ 50% MHRR (%)	38.9 (32.2)	5.6-89.7	42.7 (30.2)	35.2 (36.1)
Total PE time $\geq$ 60% MHRR (min)	18.4 (22.0)	1.5-70.7	21.2 (24.5)	15.5 (20.6)
PPEST $\geq$ 60% MHRR (%)	20.4 (24.4)	1.7-78.5	23.5 (27.2)	17.3 (22.9)
PPEAT $\geq$ 60% MHRR (%)	27.3 (29.2)	2.2-86.2	30.9 (30.2)	23.6 (30.1)
Total PE time $\geq$ 75% MHRR (min)	10.1 (17.3)	0-57.8	12.9 (20.9)	7.2 (13.9)
PPEST $\geq$ 75% MHRR (%)	11.2 (19.2)	0-64.2	14.4 (23.2)	8.0 (15.4)

PPEST: Percentage of PE Scheduled Time; PPEAT: Percentage of PE Actual Time; MHRR=Maximal Heart Rate Reserve

Table 4-19   Subjects characteristics and heart rates in 45-minutes indoor physical education classes

Items	All (n=14)		Boy	Girl
	Mean (SD)	Min-Max	Mean (SD)	Mean (SD)
Age (yrs)	12.4 (0.8)	11.0-13.0	12.7 (0.5)	12.1 (0.9)
Height (m)	1.58 (0.1)	1.51-69	1.61 (0.1)	1.55 (0.04)
Weight (kg)	60.0 (11.6)	43.0-75.0	59.4 (10.3)	60.6 (13.6)
BMI (kg/m2)	23.9 (3.7)	19.2-28.9	22.9 (2.9)	24.9 (4.3)
HR Resting (bpm)	78.1 (4.3)	70-82	75.1 (4.3)	81.1 (1.1)***
Average HR in PE (bpm)	140.5 (9.3)	124-159	141.2 (12.1)	139.7 (6.1)
PE Actual Time (min)	29.5 (3.6)	21.4-32.8	28.1 (4.5)	30.8 (2.0)
Percentage of PE Actual Time (%)	64.4 (8.0)	47.6-73.0	62.5 (9.9)	68.4 (4.5)
Total PE time $\geq$ 140 bpm (min)	14.4 (4.4)	7.8-20.7	14.2 (5.0)	14.6 (4.2)
PPEST $\geq$ 140 bpm (%)	32.0 (9.9)	17.2-45.9	31.6 (11.1)	32.4 (9.3)
PPEAT $\geq$ 140 bpm (%)	49.8 (17.2)	24.7-79.4	51.6 (19.0)	48.0 (16.4)
Total PE time $\geq$ 160 bpm (min)	6.7 (4.0)	2.3-14.1	8.3 (4.6)	5.0 (2.6)
PPEST $\geq$ 160 bpm (%)	14.8 (8.9)	5.2-31.3	18.5 (10.3)	11.1 (5.8)
PPEAT $\geq$ 160 bpm (%)	23.4 (14.8)	7.1-49.8	30.0 (16.7)	16.8 (9.6)
Total PE time $\geq$ 50% MHRR (min)	12.3 (4.6)	7.8-20.7	13.8 (5.3)	10.8 (3.6)
PPEST $\geq$ 50% MHRR (%)	27.3 (10.3)	17.2-45.9	30.7 (11.7)	24.0 (8.0)
PPEAT $\geq$ 50% MHRR (%)	42.8 (17.9)	26.3-77.4	49.8 (19.5)	35.7 (14.2)
Total PE time $\geq$ 60% MHRR (min)	7.9 (4.5)	3.1-16.9	10.1 (5.1)	5.7 (2.6)
PPEST $\geq$ 60% MHRR (%)	17.5 (10.1)	6.8-37.6	22.4 (11.4)	12.6 (5.7)
PPEAT $\geq$ 60% MHRR (%)	28.9 (16.0)	9.4-54.0	36.2 (17.5)	18.9 (9.6)
Total PE time $\geq$ 75% MHRR (min)	2.6 (2.1)	0.3-8.2	3.4 (2.8)	1.9 (0.8)
PPEST $\geq$ 75% MHRR (%)	5.7 (4.8)	0.6-18.2	7.5 (2.8)	3.9 (1.6)

PPEST: Percentage of PE Scheduled Time; PPEAT: Percentage of PE Actual Time; MHRR=Maximal Heart Rate Reserve.

Figure 4-7   The curves of two students´ heart rates in 90-minutes co-educated physical education class (basketball)
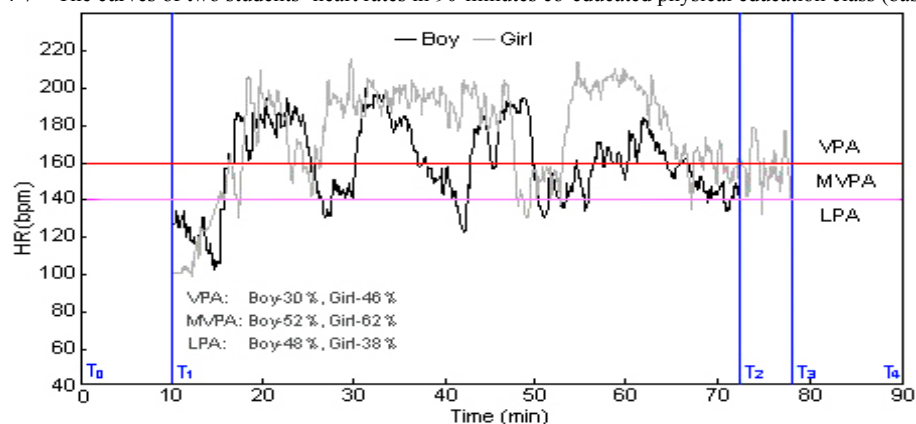
T_0-T_1: Time used in changing clothes; T_1 - T_2: Time that boy spent in PE class;
T_1-T_3: Time that girl spent in physical education class; T_2-T_4: Time that boy spent in taking bath and etc;
T_3-T_4: Time that girl spent in taking bath and etc.

The percentage of subjects in sustained periods with heart rate above 139 bpm, 159 bpm are presented in Table 4-19, Figure 4-8, and Figure 4-9.

Table 4-20   Percentage of subjects' sustained periods of MVPA and VPA in 90-min and 45-min PE classes

PA levels	Sustained period	Times	90-minute indoor PE			45-minute indoor PE		
			Total	Boy	Girl	Total	Boy	Girl
MPA	5 min period	0	50.0	42.9	57.1	35.7	28.6	42.9
(HR>139bpm)		1	14.3	14.3	14.3	42.9	28.6	57.1
		2	7.1	14.3	0	7.1	14.3	0
		3	28.6	28.6	28.6	14.3	28.6	0
	10 min period	0	64.3	57.1	71.4	78.6	57.1	100
		1	7.1	14.3	0	21.4	42.9	0
		2	7.1	0	14.3	0	0	0
		3	21.4	28.6	14.3	0	0	0
	20 min period	0	85.7	85.7	85.7	100	100	100
		1	7.1	0	14.3	0	0	0
		2	0	0	0	0	0	0
		3	7.1	14.3	0	0	0	0
VPA	5 min period	0	64.3	57.1	71.4	78.6	57.1	100
(HR>159bpm)		1	14.3	14.3	14.3	21.4	42.9	0
		2	7.1	14.3	0	0	0	0
		3	14.3	14.3	14.3	0	0	0
	10 min period	0	85.7	85.7	85.7	100	100	100
		1	0	0	0	0	0	0
		2	0	0	0	0	0	0
		3	14.3	14.3	14.3	0	0	0
	20 min period	0	85.7	85.7	85.7	100	100	100
		1	7.1	0	14.3	0	0	0
		2	0	0	0	0	0	0
		3	7.1	14.3	0	0	0	0

Figure 4-8   Children's sustained periods of physical activity in 90-minutes PE classes
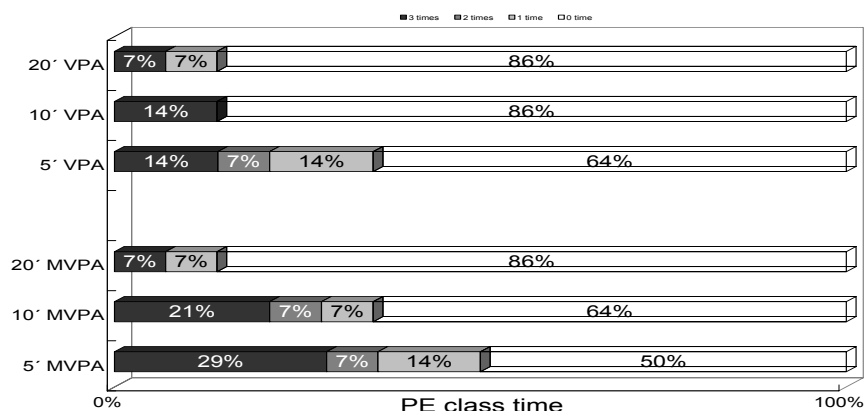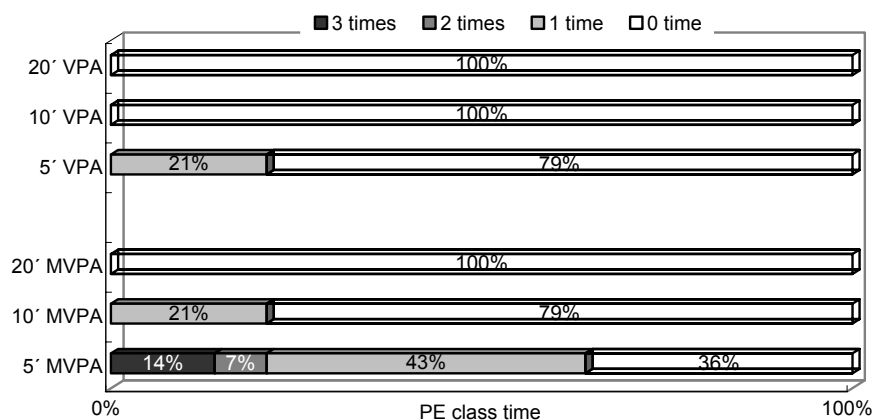

Figure 4-9   Children's sustained periods of physical activity in 45-minutes PE classes

Generally, we found that in the 90-minute indoor physical education classes, the scheduled class time was reduced to 61.2 minutes of actual class time. 31.0 % of class time was spent in changing clothes and taking showers. Subjects' average heart rate during actual class time were 138.1 bpm (beats per minute). The maximum time that children's heart rates above 139 bpm were 73.9 minutes, the minimum time was 4.5 minutes; the difference was 69.4 minutes. On average, subjects spent 27.9 minutes (42.6% of actual class time or 31.0% of schedule class time) with their heart rates above 139 bpm. A total of 57.1% of the boys and 42.9% of the girls achieved at least one five minutes period of continuous physical activity with their heart rate above 139 bpm. A total of 42.7 % of the boys and 28.6 % of the girls experienced at least one 10 minutes period of continuous physical activity with their heart rates above 139 bpm. 14.3 percent of the boys and girls

experienced at least one 20 minute period of continuous physical activity with their heart rates above 139 bpm respectively.

In the 45-minute classes, we found that the scheduled class time was reduced to 29.5 minutes of actual class time; subjects spent 35.6 % of class time changing clothes and taking showers. Subjects' average heart rates during their actual class time were 140.5 bpm. The maximum time that children's heart rates were above 139 bpm during was 20.7 minutes, the minimum time was 7.8 minutes; the difference was 12.9 minutes. On average, subjects spent 14.4 minutes (49.8% of actual class time or 32.0% of scheduled class time) with their heart rates above 139 bpm. A total of 71.4% of the boys and 57.1% of the girls achieved at least one five-minute period of continuous physical activity with their heart rates above 139, but only 42.7% the boys (no girls) experienced 10-minute period of continuous physical activity with their heart rates above 139bpm. No one experienced a single 20-minutes period of continuous physical activity with his or her heart rates above 139 bpm.