

Original Article

Longitudinal study of physical fitness levels, BMI and childhood obesity in school context

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ABSTRACT

Martins, J.C., Honorio, S., Costa, A.M., Batista, M., & Cardoso, J. (2014). Longitudinal study of physical fitness levels, BMI and childhood obesity in school context. *J. Hum. Sport Exerc.*, 9(2), pp.645-655. This work is aimed at knowing the level of physical aptitude and its degree of association, regarding an urban and a rural area, in children from the primary education schools. The sample consisted of six schools from the primary education of the county of Fundão: Santa Teresinha school (a central school), and the schools of Valverde, Fatela, Enxames, Alcaria and Peroviseu (peripheral schools). The sample has been selected in order to have a certain number of pupils from a peripheral area and another one from a central area of the city. The total sample is represented by 161 pupils, 76 are female and 85 are male and they are aged between 6 and 10. 85 come from an urban area and 76 come from a rural area. The analysis of the physical aptitude had as a reference the battery *Prudential Fitnessgram* (2002). According to the results obtained in the anthropometry, boys and girls from rural areas are heavier and taller than the boys and girls from urban areas. Regarding the BMI and body fat, it is males in rural areas that show a higher number of pupils in the healthy zone. As far as females are concerned, it is the urban area that has more pupils in that zone. It was also noticed that there are a huge percentage of girls from the rural area in the thin zone. In the differentiation between genders, boys have better results in physical aptitude and obesity levels. Regarding the influence of the living area, there are obviously better results in the urban area than in the rural area. Our study reveals that there are significant differences in the physical aptitude tests when they were applied at two different moments. After the analysis and interpretation of the results, we can conclude that boys and girls coming from rural areas are taller and heavier than the ones from urban areas and that they exhibit a lower body mass index. When defining the percentage of subjects classified in the “healthy zone”, the BMI numbers in boys from rural areas that are in the healthy zone are higher than those of boys from urban areas. Regarding girls, the ones from urban areas as well as those from rural areas have almost the same percentage in the healthy zone. Concerning fat, it is males in the rural areas that have more pupils in the healthy zone. As for girls, the ones from the urban areas have better results in the three zones, being the healthy zone that has a higher percentage of girls. In the relationship between the genders, boys have better results in the levels of physical aptitude and obesity. In the relationship between the areas, the urban one shows better results. The existence of two periods of analysis allowed us to notice an improvement in all the tests. **Key words:** PHYSICAL ACTIVITY, URBAN AREA, RURAL AREA, CONTRAST URBAN-RURAL.

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INTRODUCTION

Relevance of the study

Currently, it is undeniable the dramatic increase in childhood obesity in urban areas, according to the World Health Organization (2003), exists today worldwide, about 17.6 million obese children under 5 years, which is problematic also extends to the age group of 6 to 11 years where, according to WHO, the prevalence of obesity has doubled since 1960. This reality, increasingly worrying, even led the WHO to understand this problem as an epidemic. And despite constantly conveyed information about this situation, are still underestimated their real consequences.

Reinforcing this idea, studies by Padez et al. (2004) and Martins, J. (2005) state that "a third of Portuguese children, between 7 and 9 years old is overweight, and some are pre-obese (20%) and other clearly obese (11%)."

Based on this fact we can identify, unsurprisingly, the practice of eating incorrectly and lack of physical activity, both by adults, particularly as the child population, the result of the current conditions of life, especially in urban areas, with housing cramped spaces and scarcity available time by parents to monitor their children, for example. Rite (2004) states that "errors are often caused by food stimuli irresponsible and unconscious adults for the child, they suggest consumption expropriated", becoming so essential to sensitize parents devastate the repercussions of obesity in children.

The urban-rural contrast may offer a chance to study about the quality of children's physical stamina, so it seems appropriate to know the fitness levels and their degree of association with the environment.

This study aims to verify the existence of statistically significant differences between children from the urban and rural areas, the levels of physical fitness and health, was used for this purpose to the Fitnessgram test battery and determining the percentage of fat mass.

Literature review

Obesity is defined as the excessive accumulation of fat mass resulting in increased body mass. This stems from an imbalance between energy intake and energy expenditure (Lahti-Koski, 2004; Malina 2001). From a pathophysiologic perspective, obesity is a metabolic disorder morphological and with a multifactorial etiology.

Childhood obesity is now considered a serious public health problem, mainly because:

- 1) If prolongs the life cycle up to adulthood (Guo et al., 2002; Goran, 2001; Kotani et al., 1997, Whitaker et al., 1997) being associated with morbid obesity independent of obesity in adults (Must et al., 1992);
- 2) If also associated with adverse consequences, such as hypertension, dyslipidemia, chronic inflammation, hyperinsulinemia and orthopedic problems (Srinivasan et al. 2002; Tounian et al. 2001; Fredman et al. 1999; Ferguson et al. 1998), and also psychosocial.

Obese children are regularly stereotyped as unhealthy, with little academic success, and socially maladjusted (Hill & Silver, (1995). The Low self-esteem and behavioral problems often associated with obesity (Strauss, (2000).

There have been some changes to physical fitness, resulting in a deterioration of the quality and style of life adopted. Thus, physical fitness individual represents an adaptive response to the environment, and some factors have a major influence on levels of physical fitness, among which are: 1st factors nature biocultural and social (habits, customs and traditions) and psychological (motivational in nature and predisposition); 2 - the conditioning socio - economic, Davis, (2000). We cannot forget also factors inherent to the persons himself, age, sex, maturational development, body composition, level of development of basic skills, health and nutrition status.

METHODS

Participants

Our sample consists of six schools of the primary teaching of basic education in Fundão : Santa Teresa school (Central School), Valverde, Fatela, Enxanes, Alcaria and Peroviseu (peripheral schools). The sample was selected in order to have a certain number of students in a more peripheral zone and another in a more central city.

In total, the sample is represented by 161 students of which 85 students are male and 76 female (present in our sample frame).

The sample for the central school is 85 students, 44 boys and 41 girls, in relation to the periphery of the sample schools is 76 students, of whom 41 are boys and 35 are girls.

The data collection was done in two different periods, the first data collection was carried out between 13 December 2009 and 20 January 2010 the second collection was performed 3 to 15 May 2010.

The students participated in the study freely and spontaneously and were previously educated about all the procedures that would be performed.

Table 1. Distribution of the sample by school, gender and ages

Schools	Gender	6 years		7 years		8 years		9 years		Total	
		M	F	M	F	M	F	M	F	M	F
Santa Teresinha		12	8	12	11	10	12	10	10	44	41
Valverde		-	-	-	-	4	6	5	5	9	11
Fatela		2	1	1	4	0	1	3	1	6	7
Enxanes		2	1	-	-	2	1	3	2	7	4
Alcaria		-	-	-	-	6	3	4	3	10	6
Peroviseu		-	-	-	-	4	2	5	5	9	7
Total										85	76
											161

RESULTS

The results suggest that boys and girls in rural areas are heavier and taller than the boys and girls from urban areas in the two periods. We also verified that BMI is higher in rural areas in both sexes in the 2nd time.

Table 2. Adjusted means and standard deviations of height and weight in the 1st and 2nd moments

		First Moment				Second Moment			
		Rural		Urban		Rural		Urban	
		M	dp	M	dp	M	dp	M	dp
Males	Weight	32	91	28.7	6	34	7.5	29.5	5.4
	Height	1.34	0.08	1.31	0.08	1.36	0.08	1.32	0.09
	BMI	17.7	3.3	16.7	3.5	19.1	2.7	16.8	2.9
Females	Weight	31.7	9.8	29.7	5.9	32.8	6.6	29.6	5.4
	Height	1.34	0.07	1.30	0.08	1.36	0.06	1.31	0.07
	BMI	17.65	2.8	17.6	3.7	18	2.5	17.2	2.6

Table 3. BMI distribution of the sample, in the category of "thinness", "healthy" and "needs improvement" defined by "cutoff" values published by the FITNESSGRAM, in the 1st and 2nd moments

Moments/Variables Fitnessgram	Environment	Thinness %		Healthy %		Needs improvement %	
		1st	2nd	1st	2nd	1st	2nd
		Males	Rural	21.9%	9.7%	51.2%	70.7%
	Urban	20.4%	27.2%	68.1%	54.5%	11.3%	18.1%
Females	Rural	37.1%	25.7%	48.5%	51.4%	14.2%	22.8%
	Urban	31.7%	41.4%	56.0%	51.2%	12.1%	7.3%

The results suggest that in the first moment, the urban environment presents a greater number of boys (68.1%) in the healthy zone the rural areas (51.2%). The rural focus the remaining subjects in the area of thinness and 21.9% in the area needs to improve 26.8%.

For the girls we have noticed that in the first moment, 56% of girls in urban areas are in the healthy zone and 31.7% in the area of thinness, as in rural areas 48.5% of girls are in the area of healthy and 37.1% in the zone of thinness, the remaining 14.2% is in need of improving area.

In the 2nd moment we see that the rural male presents a significant increase in the area of healthy 51.2% to 70.7%, with a significant decrease in the area of thinness. In the 2nd moment, in rural areas there is an increase in the area of thinness for the zone needs to improve, contrary to what happens in the urban environment, there is an increase in the area of thinness and a decrease in zones need to improve the zone of healthy there are no major changes from one moment to the next in two media under study.

Table 4. Distribution of sample FM, the category of "thinness", "healthy" and "needs improvement" defined by cutoff values published by the FITNESSGRAM, the 1st and 2nd moments

Moments/Variables Fitnessgram	Environment	Thinness %		Healthy %		Needs improvement %	
		1st	2nd	1st	2nd	1st	2nd
Males	Rural	9.7%	2.4	80.4%	80.4	9.7%	17.0%
	Urban	9.0%	11.3	75.0%	75.0%	15.9%	13.6%
Females	Rural	37.1%	22.8%	57.1%	65.7%	5.7%	11.4%
	Urban	7.3%	17.0%	52.9%	75.6%	9.7%	7.3%

The percentage of the results suggests that there are more boys in the rural area of healthy urban environment, to stress that this is repeated in the two periods, the area needs to improve is mainly represented by the urban boys with more or less 15 % in the two periods.

With regard to girls, we found that healthy zone is more representative in urban than in rural areas, at both times. Note that 37% of rural girls are in the area of thinness, that it repeats the second time.

In urban areas there is an increase in the area of thinness and decreases on the zone need to improve the 2nd moment. In rural areas from the 1st to the 2nd moment, there is an increase in the area of healthy and needs to improve zone.

Table 5. Adjusted means and standard deviations of physical fitness tests, results of MANOVA (Test Between-subjects effects) compared to gender (male and female) in the 1st and 2nd moments

		First moment					Second moment				
		Rural		Urban		P	Rural		Urban		P
		M	dp	M	dp		M	dp	M	dp	
Males	Léger test (come and go)	20	10	22	13	0.080	26.6	12.1	25.6	11.3	0.045
	Arm extension	8.34	4.6	9	6.3	0.011	9.5	5.1	13.5	9	0.115
	Sit and reach (left)	14	6	21	7	0.413	16.9	6.5	21	5.9	0.195
	Sit and reach (right)	14	6	20	6	0.208	17.7	6.5	21.4	5.9	0.549
	Abdominal	28	22	21	18	0.223	30.4	19.8	33.5	19.9	0.680
	BMI	17.7	3.3	16.7	3.5	0.864	19.1	2.7	16.6	2.9	0.995
	Fat mass	17.9	6.5	18.5	6.6	0.002	20.1	6.7	17.7	6.5	0.006
Females	Léger test (come and go)	17	10	18	12	0.080	23.6	10.9	20.4	11	0.045
	Arm extension	5.34	4	8	6	0.011	8.3	5.8	10.9	8.6	0.115
	Sit and reach (left)	16	6	22	7	0.413	19.8	6.4	20.8	6.1	0.195

Sit and reach (right)	16	6	21	6	0.208	19.5	6.6	20.9	5.9	0.549
Abdominal	18	11	25	21	0.223	27.2	16	34.1	23.9	0.680
BMI	17.6	2.8	17.6	3.7	0.864	18	2.5	17.2	2.6	0.995
Fat mass	20.2	6.0	22.4	5.4	0.002	22.8	7.6	20.9	5.9	0.006

After analyzing the values of physical fitness between the sexes, and the observation of the mean values for sex, we can see that there is a significant effect on testing extensions of arms and fat mass.

The boys have better results than girls in the extension of the arms and fat mass on the first moment. We also are boys and girls from urban areas to achieve better results in testing extensions of arms, as the test of fat mass, are the boys and girls from urban areas have a higher fat mass to the rural areas.

For the second moment, we find that there is a significant effect of gender on the shuttle test and fat mass, the boys are the best results in both tests. In the test shuttle both boys from urban as rural achieved the same result, the girls were in rural areas to achieve better performance. Regarding fat mass, was urban male and female having the best results.

Table 6. Mean and standard deviation of adjusted tests of physical fitness and obesity, results of MANOVA (Test Between-subjects effects) according to the environment (rural and urban), in the first and second moments

		First moment					Second moment				
		Urban		Rural		P	Urban		Rural		P
		M	dp	M	dp		M	dp	M	dp	
Males	Léger test (come and go)	20	10	22	13	0.292	25.6	12.1	25.6	11.3	0.372
	Arm extension	8.34	4.6	9	6.3	0.074	9.5	5.1	13.5	9	0.005
	Sit and reach (left)	14	6	21	7	0.000	16.9	6.5	21	5.9	0.012
	Sit and reach (right)	14	6	20	6	0.000	17.7	6.5	21.4	5.9	0.012
	Abdominal	28	22	21	18	0.979	30.4	19.8	33.5	19.9	0.126
	BMI	17.7	3.3	17.6	2.8	0.010	19.1	2.7	18	2.5	0.000
	Fat mass	17.9	6.5	18.5	6.6	0.152	20.1	6.7	17.7	6.5	0.038
	Léger test (come and go)										
	Arm extension	17	10	18	12	0.292	23.6	10.9	20.4	11	0.372
Males	Sit and reach (left)	5.34	4	8	6	0.074	8.3	5.8	10.9	8.6	0.005
	Sit and reach (right)	16	6	22	7	0.000	19.8	6.4	20.8	6.1	0.012

Abdominal	16	6	21	6	0.000	19.5	6.6	20.9	5.9	0.012
BMI	18	11	25	21	0.979	27.2	16	34.1	23.9	0.126
Fat mass	16.7	3.5	17.6	3.7	0.010	16.6	2.9	17.2	2.6	0.000
Léger test (come and go)	20.2	6.0	22.4	5.4	0.152	22.8	7.6	20.9	6.9	0.038

By analyzing the data resulting from the influence of the environment in relation to levels of physical fitness and obesity, we found that there is a significant effect on the first moment in testing flexibility (sit and reach left and right) as well as in IMC.

The urban environment presents better results than the rural areas, both in sitting and reaches the left and right, as the BMI.

With regard to the second time, the significant effect appears on the testing extensions, arms, sits and reaches left and right BMI and FM. At the first moment, is the urban environment with the best results in testing extensions of arms, sits and reaches the left and right, the weight / height (BMI) is also higher in urban areas relative to FM is higher in the middle rural.

In analyzing the results of the Paired Samples Test of repeated measures in both evaluation periods for the variables physical fitness and obesity, we found that there is a significant effect $p < 0.05$ shuttle tests, extension arms, sits and reaches right abdominal and BMI, so there is an improvement from one moment to the next in these tests, except for the sit and reach test left and fat mass.

Table 7. Adjusted means and standard deviations of physical fitness tests, Paired Samples Test results compared to the 1st and 2nd moments

	\bar{x}	s.d	P
Léger 1 – léger 2	-4,310	7,643	0,000
Arms extension 1 – Arms extension 2	-2,956	6,515	0,000
Sit and reach (left) 1 – Sit and reach (left) 2	-1,341	6,883	0,06
Sit and reach (right) 1 – Sit and reach (right) 2	-2	6,883	0,01
Abdominal 1 – Abdominal 2	-8,322	19,065	0,000
BMI 1 – BMI 2	-2,818	4,135	0,000
Fat mass 1 – fat mass 2	-0,531	4,571	0,142

The results obtained, show that there are differences from one moment to the next. Regarding BMI, Bouchard, et al (1997) states that this will increase during childhood, which was found in our study in both sexes.

Currently, the differences in living conditions in rural and urban areas are lower in the United States of America, Canada and Western Europe, but in countries like Poland, Romania and Greece these

differences exist, and residents of urban higher and heavier than the rural (Malina & Bouchard, 1991). The results of this study seem to indicate that both boys and girls in rural areas are taller and heavier at both times compared to urban areas.

In light of the results obtained shows that, although there are differences between urban and rural groups, these differences did not allow us to refute that physical growth is similar between those areas of residence. Rural and urban areas of this study seem to show little difference in quality of life in relation to nutrition, health care and other key aspects of growth.

Regarding the results of Fitnessgram program, we think that they are useful for students and teachers know the changes in %FM over time. Obesity is a health problem for children and adults. Childhood and adolescence are the best times of life to intervene at the behavioral level, preventing or counteracting the tendency to overweight (Epstein, 1990)

The patterns of healthy body composition were established for both the body fat percentage calculated from the triceps and skinfolds geminal as for BMI, calculated by measuring the weight and height. The reference values represent the boundaries of Zone Healthy Physical Fitness. Results above or below this zone must be examined, since these students have a greater potential to develop health problems related to their excess fat or skinny, Blair et al (1992).

The results obtained showed that in the first moment boys come from urban areas with the largest representation in the area of healthy (68.1%) and the remaining boys divided by the area of thinness 20.4% and 11 zone needs to improve, 3%, in the second moment there was a significant increase of the boys in the rural area of healthy, marking these a difference in this area. As for the girls noticed that the 1st moment is the urban environment to be more represented in the healthy zone, the zone of thinness has a significant% of girls of the two media. In the 2nd moment there is a uniform distribution in the area of healthy of the two media, there is a large increase in girls urban zone of thinness and a decrease in zones need to improve, yet rural decreased the area of thinness and increased area needs to improve.

In the area of residence and socioeconomic status appear to influence the growth of children and youth (Malina & Bouchard, 1991). Historically, was associated with the rural to higher values of height and weight, however, with the implement of living conditions in the urban environment this position was reversed.

The results of our study show that for the environment, the rural male is to get more students in the area of health, for the girls, is the urban environment to have more students in this area, we find that there is also a large percentage of students in the rural area of thinness.

In a study by Maia et al (2002), and a sample of 58 girls and 62 boys goes 4th year of 1st CEB two schools in the municipality of Vila Nova de Gaia, the female children showed lower levels of physical activity, especially at high intensity. Also a study by Faustino et al (2003), 18 boys and 20 girls from two schools of the primary school in Castelo Branco, the authors found better outcomes for male children. But, in contrast, Atkins (2001) found no significant differences between boys and girls.

Thus the analysis of the findings in all the tests, allow us to mention the performance increase in both moments of observation and there was a significant effect only in testing extensions of arms and fat mass, the 1st time, shuttle and fat mass, the 2nd time. Best results are evident in boys in testing extensions of arms and swinging. Regarding fat mass boys have lower results for girls at both times.

The level of urbanization seems to affect significantly the performances on the motor (Coelho and Silva et al., 2003; Rutenfranz et al., 1982). The greater or lesser access to facilities and conditions of systematic practice, socio-economic environments and familiar, the rhythms and spaces of life, the routines of movement and activity can be some of the reasons for the differences in motor performance of girls and boys rural and urban areas. If on one hand, is associated with rural social isolation scenarios, which hinder the development of the functional characteristics of children, is associated to urban leisure "anti-active." Coelho and Silva et al. (2003) believe that young people are the semi-urban benefiting from better spatial association between stimuli, distance from home to school, educational level of parents, type of dwelling and possession of material incentives for physical activity and sport in relation to young urban and rural environments.

According to the results of our study, we found that there is a significant effect on the 1st time in testing sit and reach left and right, and BMI, the 2nd time there is a significance test extensions of arms, sits and reaches the left and right BMI and MG.

There is an increase in performance from one moment to the next, best results being evident in urban than in rural areas. For the BMI is higher in urban areas, while the MG is higher in rural areas on both occasions, noted that in urban areas there is a decrease of MG from the first to the second moment.

According to Astrand (1996), it is essential to promote regular physical activity from childhood, so that a sedentary lifestyle is not established, contributing to the loss of quality of life, the natural aging process. Neto (1994) also says that regular physical activity helps with immense benefits for development, both in terms of physical growth and motor development of physical capabilities or creating new friendships and enhancement of self-esteem.

According to Nunes et al (2006), the purposes of education and Sports Physical activities consist mainly in developing the functional level of motor abilities of students, improving the performance of motor skills in different types of activities, combining their initiatives with the action of colleagues and applying the rules correctly; promoting the integral development of the student, favoring the strengthening of educational provision from an interdisciplinary and integrated with other school learning;

The results of our study show that there are significant differences from one moment to the next shuttle tests, extension arms, sits and reaches right abdominal and BMI, there was an improvement from one moment to the next.

CONCLUSIONS

After the analysis and interpretation of results arrived at the following conclusions:

- The boys had better results in levels of physical fitness and obesity, with only significant differences on tests of extension arms and fat mass on the first moment, Léger test and fat mass in the 2nd time.
- The average values related to the environment, tells us that the urban environment is to have better results.
- In the first moment there are significant differences in sit and reach test left and right, and BMI, the second moment there are significant differences in tests, sit and reach left and right arms extensions, BMI and FM.
- We found that children in urban areas have more flexibility, more power and are thinner.

- The existence of two stages of analysis enables us to verify that there is an improvement in all tests the second time.
- We found significant differences in tests, Léger, arms extension, sits and reaches right abdominal and BMI.
- No significant differences found in the tests: sit and reach left and fat mass.

REFERENCES

1. Atkins, P., & Jones, L. (2001) *Princípios de Química: Questionando a Vida Moderna e o Meio Ambiente* Bookman, Porto Alegre.
2. Blair, S.N., Kohl, H.W., Gordon, N. F. & Paffenberger, R. S. (1992). How much physical activity is good for health? *Annu Rev. Pub. Health*, 13, pp.99-126.
3. Blair, S.N. (1993). McCloy research lecture: physical activity, physical fitness and health. *Res. Quar. Exerc. Sport*, 64(4), pp.365-376.
4. Bouchard, C., Shephard, R., Stephens, T., Sutton, J. & McPherson, B. (1990). *Exercise, Fitness and Health: a consensus of current knowledge*. Human Kinetics. Champaign Illinois.
5. Bouchard, C., Malina, R., & Pérusse, L. (1997). *Genetics of fitness and physical performance*. Human Kinetics. Champaign Illinois.
6. Coelho e Silva, M., Sobral, F., & Malina, R. (2003). *Determinância sociogeográfica da prática desportiva na adolescência*. Coimbra: Centro de -Estudos do Desporto Infanto-Juvenil, Faculdade de Ciências do Desporto e de Educação Física, Universidade de Coimbra
7. Epstein, L.H., Valoski, A., Wing, R.R., & McCurdy, J. (1990). Teen-year follow-up of behavioral family-based treatment for obese children. *Journal of American Medical Association*, 265, pp.2519-2524.
8. Faustino, A.J., Pires, T.R., & Oliveira, V.R. (2003). *Os Efeitos da actividade física regular no desenvolvimento infanto juvenil*. Estudo no 1º ciclo do ensino básico, 2º ano de escolaridade.
9. Fergusson, M.A., Gutin, B., Owens, S., Litaker, M., Tracy, R.P., & Allison, J. (1998). Fat distribution and hemostatic measures in obese children. *American Journal Clinical Nutrition*. 67, pp.1136-1140.
10. Fitnessgram (1994). *The Prudential Fitnessgram Test Administrative Manual*. The Cooper Institute for Aerobics Research, Dallas, Texas.
11. Guo, S.S., Chumlea, W.C., & Roche, A.F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescents. *American Journal Clinical Nutrition*, 76, pp.653-658.
12. Maia, J., Magalhães, L., Silva, R., & Seabra, A. (2002) – Padrão de Actividade Física. Estudo em crianças de ambos os sexos do 4º ano de escolaridade. *Revista Portuguesa de Ciências do Desporto*, 2(5), pp. 47-57.
13. Malina, R. & Bouchard, C. (1991). *Growth, Maturation and Physical Activity*. Human Kinetics Publishers. Champaign, Illinois.
14. Martins, J. (2005), *Educação para a saúde e estilos de vida saudáveis. Estudo da aptidão física e saúde das crianças do 1º ciclo da cidade do Fundão*, ISBN972-99595-5-2; ED. CMF
15. Neto, C. (1994). A família e a institucionalização dos tempos livres. *Ludens*, 14(1), pp.5-10.
16. Padez, C., Fernandes, T., Mourão, I., Moreira, P., & Rosado V. (2004). Prevalence of Overweight and Obesity in 7-9-Year- Old Portuguese Children: Trends in Body Mass Index From 1970-2002. *American of Human Biology*, 16(6), pp.670-678.
17. Pangrazi, R.P., Corbin, C.B., & Welk, G.J. (1996). Physical fitness for children and youth. *Journal of Physical Education, Recreation and Dance*, 67(4), pp.38-43.

18. Rito, A.I.G. (2004). *Estado nutricional de crianças e oferta alimentar do pré-escolar de Coimbra, 2001. Enquadramento na saúde e nutrição/alimentação de Portugal*. Tese de Doutoramento. Escola nacional de Saúde Pública Sérgio Arouca da Fundação Oswaldo Cruz. Rio de Janeiro, Brasil.
19. Rutenfranz, J., Andersen, K., Seliger, V. & Masironi, R. (1982). Health standards in terms of exercise fitness of school children in urban and rural areas in various European countries. *Ann Clin Res.*, 14 (34), pp.33-6.
20. Williams, J.G. (1992). Effects of instructions and practice on ball catching skill: single-subject study of an 8-year-old. *Perceptual and motor skills*, 75, pp. 392-394.
21. WHO. (1998). *Report of a WHO consultation on obesity. Preventing and managing the global epidemic*. Geneva: World Health Organization.