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ORIGINAL ARTICLE

Comparison of physical activity level between overweight and non-overweight adolescent girls.

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Abstract

For the last three years Greece holds a dominant place among European countries on youth's obesity. Poor diet behaviour and physical inactivity are considered the key-factors for this epidemic expansion. The main purpose of this study was to examine physical activity (PA) level in overweight and non-overweight adolescent girls. Additional aims were to a) quantitatively describe the duration and intensity of PA on two weekdays and one weekend, and b) to compare PA level with the international guidelines of PA for health (Cavill, Biddle & Sallis, 2001). Forty two healthy adolescent girls living in two urban areas of Greece, aged 14 yrs (SD ±.8) participated voluntarily at the study; 22 were non-overweight (BMI 21.1, SD±1,2) and 20 were overweight or obese (BMI 27.5, SD±2,7). Their daily PA measured objectively by using the CSA 7164 accelerometer over a 4-day period (two weekdays and one weekend). For each day summary scores were calculated for: a) daily total PA, b) daily *moderate* PA (MPA) and c) daily *vigorous* PA (VPA). Compared to their non-overweight peers, overweight girls exhibited significantly lower daily accumulations of MPA and VPA for the weekdays and the weekend. A percentage of 76% of the non-overweight girls fulfilled the recommendation of the 60'min accumulated daily MVPA compared to 21% of their overweight peers. None of the participants accumulated substantial amount of VPA. These findings suggest that physical inactivity is one of the most important contributing factors to the increase of young girls' obesity in Greece. Efforts should be made to shift the sedentary-light activity to moderate, and to increase the time of involvement on PA over weekend days, especially for the overweight girls.

Key Words: Obesity, body mass index (BMI), Greece.

Introduction

During the last three decades obesity has reached an epidemic form worldwide across all age groups. According to WHO's estimatations, in 2005, approximately 1.6 billion people (15+) globally were overweight, and at least 400 million of them obese (WHO 2005). Regarding childhood obesity, the *International Obesity Task Force* found that globally one in ten children aged 5 – 17 was overweight whereas 2-3 % of them obese (IOTF, 2005). Even higher rates in childhood obesity were found in Europe where one in five children aged 7–11 were overweight and the prevalence ranged from 10–35%. In some European countries such as the Scandinavian countries the prevalence of childhood obesity was lower compared to Mediterranean countries; nonetheless, the proportion of obese children has been rising in both cases (Livingstone, 2001). In Greece both adult and childhood obesity has been now recognized as an epidemic problem, probably more important than in other European countries. The reasons for the obesity epidemic in the Greek population are not clear. Possible explanations could emerge from the delayed but sharp economic evolution which was paralleled by the abandonment of the traditional Mediterranean diet and the adoption of a sedentary lifestyle (Roditis, Parlapani, Tzotzas, Hassapidou & Krassas, 2009).

The global raise in young people obesity rates represents a critical public health problem. Overweight and obesity have significant impact on both physical (Must & Strauss, 1999; Daniels, 2006) and psychological health (Daniels, Arnett, Eckel, Gidding et al, 2005). Furthermore, childhood obesity is strongly linked with adult obesity (Whitaker, Wright, Pepe, Seidel & Dietz, 1997). However, the mechanism of obesity development is not fully understood and it is believed to be a disorder with multiple causes. According to Bouchard (2007), the potential contributors to this epidemic are grouped under four major headings: build environment, social environment, behaviour and biology. However, the modern youth lifestyle that is characterized by overeating, high level of inactivity and low level of PA is directly linked with the raise of overweight and

obesity worldwide (American Public Health Association, 2007). The steady decline in PA has heavily contributed to rising rates of obesity in young people.

Numerous studies in children and adolescents have shown that sedentary lifestyle and low levels of PA are associated with increased prevalence of obesity for both genders. Riddoch (2010), in his recent review of four large representative studies, concluded that large numbers of children are insufficiently active to achieve optimal health, including maintenance of a healthy weight. Young people, who are being driven to school and exhibited a low participation in sports and physical education (PE), are more prone to obesity than their active peers (Swinbug & Egger, 2002). In their study, Trost, Sirard, Dowda, Pfeiffer and Pate (2003) established that overweight preschool boys were significantly less active than their non-overweight peers. Similarly, overweight adolescent males exhibited significantly lower daily accumulation of total daily moderate/vigorous PA (MVPA) compared to their non-obese counterparts (Tzetzis, Kakamoukas, Goudas & Tsorbatzoudis, 2005).

The collection of national-level data on childhood obesity remains a research priority to enable comparisons across countries (Lobstein, 2010). In Greece there is little available data concerning the PA level of young females (Tzormpatzakis & Sleap, 2007). Therefore, the purpose of the study was to examine PA level in overweight and non-overweight adolescent girls. Additional aims were to a) quantitatively describe the duration and intensity of PA on two weekdays and one weekend, and b) to compare PA level of the above population, with the international guidelines of PA for health (Cavill, Biddle & Sallis, 2001).

Methods

Participants

Forty two healthy adolescent girls (14 yrs, SD ± .8) living in two urban areas of Greece were recruited from four public secondary schools. All participants and their guardians provided written consent to participate after a personal update meeting with the researchers. The participants filled out a written form with their personal data and those who had a medical condition that prevented them from participating in PA were excluded from the study. Initially 25 overweight/ obese girls with a Body Mass Index (BMI >25) were identified. Following, 25 non-overweight female classmates were randomly selected. Finally, the data of 42 girls (22 non-overweight and 20 overweight) were included in the study. The remaining 8 were exempted because either they did not respond to the data collection protocol or they were ill and therefore their typical PA was affected. All girls were of Greek nationality and did not participated in any organized form of sport. Only high school girls were selected because: a. in puberty there is an intense reduction in PA in comparison to boys (Caspersen, Perreira & Curran, 2000), and b. in puberty the interests of the two sexes regarding PA and sports are rather different (Avgerinos, 2002). In Table 1 the descriptive data of the participants are presented.

Table 1. Physical characteristics of the participants (M ± SD).

	Normal weight (n_1=22)	*Overweight (n_2=20)*
Age (years)	13,7±4 months	13,9 ±3 months
Height (m)	1,60±4,3cm	1,61±4,4cm
Weight (kg)	54,2±3,9	71,88±8,2
BMI (kg/m^2)	21,1±1,2	27,5±2,7

Instrumentation

Assessment of Physical Activity. The CSA *(Computer Science and Application Inc. 7164 Shalimar, Florida)* accelerometer was used to assess the PA of the participants. The CSA was designed to detect vertical acceleration of the body joints during movement while rejecting very low and high frequency vibrations (Welk, Corbin & Dale, 2000). The accerelometer measures the magnitude of

vertical acceleration known as "activity counts" over a user specified period of time-epoch (e.g. counts·min^{-1}). Further technical information can be found in previous studies (Freedson, Pober & Janz, 2005; Tzetzis, Kakamoukas, Goudas & Tsorbatzoudis, 2005). Seven CSA devices were used following a check for their credibility. Their batteries were replaced as well. A one-minute sampling interval was used in this study (Pate et al., 2003), for four consecutive days from 07:00-23:00 allowing in this way the recording of all activities of the girls. Based on the recording of the device the participant is characterized at the end of the measurement by an activity score expressed in *counts*. This was used in order to categorize the number of counts recorded each minute by the level of intensity (light, moderate and vigorous). Based on the regression equation by Freedson, Melanson and Sirard (1998) the rates of CSA <1952 counts.min^{-1}, 1953-5724 counts.min^{-1}, and >5725-9498 counts.min^{-1} were used to determine *light* (LPA), *moderate* (MPA) and *vigorous PA* (VPA) respectively. Despite the fact that CSA is a reliable and valid assessment instrument for PA, it cannot be used under water and is not reliable when the subject is engaged in activities such as biking, rowing, and weight lifting (Montoye, Kemper, Sarris & Washburn, 1996). None of the participants was engaged in such activities.

Participants weight status: Height and weight assessment were conducted in a private setting with girls dressed in light clothing. Weight was measured to the nearest 0.1 Kg with a calibrated mechanical scale (Seca Beam Balance 710). Height was measured to the nearest 1 cm, with the Seca Stadiometer 208. Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (Kg/ m^2). Participants were classified as overweight if their BMI was equal to or higher than the sex-and age-specific 85th percentile from the *Centers for Disease Control and Prevention'*s Growth Charts.

Procedures

All measurements were completed within the schools' environment. The collection of data was performed in spring during March, April and May. While the recording of PA took place the participants were not aware of the exact purpose of the study and were encouraged to continue their daily lifestyle. On a daily basis there was personal contact for the verification of the protocol. Both girls and their parents were trained for the proper repositioning of the instrument in case they needed to remove it. Every week the PA of all seven participants was assessed. The CSA device was put using a safety belt at the waist of each participant in a special case in order to be stable. Monitors were worn over the right hip, anterior to the iliac crest (Trost, McIver & Pate, 2005). Each girl wore a numbered accelerator for four consecutive days two of which were week days (Thursday-Friday or Monday-Tuesday) and a weekend in order to have a valid assessment of PA (Trost, Pate, Sallis & Taylor, 2000). Students adjusted the instrument each morning (approximately at 07:00) to their body and removed it before going to sleep (approximately at 23:00). The check for proper instrument placement was done each morning by the researchers at home (on weekends) or at school (on week days). The instrument could be removed from the participant's body only in case of entering in water (swimming pool or bath). In any other case of removing the instrument, the contestant was exempted from the procedure. In case of sickness the procedure was cancelled and repeated later. During data collection on weekdays all the girls participated at least in one scheduled physical education class at their school. During measurements weather conditions were also recorded in order to ensure that they were according to the season. No measurements were taken during rainy or cold days to avoid the negative effect on physical activity. At the end of the recording of the four days data of each instrument were saved on a computer separately for each participant.

Data reduction - Statistical Analysis

The participants' characteristics, age, height, weight and BMI were summarized using descriptive statistics. Activity countings for each minute interval were uploaded to a visual basic data reduction program for the determination of a) the total PA (in counts and min), b) the daily light PA (LPA) (min), c) the daily MPA (min), and d) the daily VPA (min) for each day. Differences in the PA variables were tested using *t-test* for independent samples. The homogeneity of variance was controlled by the Levene's test. Statistical significance was set at an alpha level of .05.

Results

In Table 2 are depicted the descriptive data of the total daily PA (in counts) for the non-overweight and the overweight participants respectively. Non-overweight girls accumulated each day significantly more PA than the overweight ($p<.001$).

Table 2: Descriptive data of the total daily PA for each day (in counts).

	Non-overweight (n_1=22)		Overweight (n_2=20)	
	M	SD	M	SD
Saturday	554142,6	198967,8	311427	153774,3
Sunday	491527,1	182371,2	269718,9	104112,9
Total Weekend	1045670,0	279888,3	581146,0	195418,6
Week Day 1	499335,9	189447,8	325635,4	91870,5
Week Day 2	487904,0	191723,8	360861,3	130965
Total weekdays	987240,0	288577,9	686496,7	173356,6

In Table 3 are depicted descriptive data and *t* values, of the mean daily MVPA (min.day^{-1}) for the weekdays and the weekend. The non-overweight girls were more active during the weekend days. Contrarily, the PA level of the overweight girls declined during the weekend and they accumulated statistically significant smaller amount of MVPA.

Table 3. Comparison (in minutes) of M&V PA level between the weekdays (mean) and the weekend (mean)

		Weekdays (mean PA of the 2 days)		Weekend (mean PA of the Saturday & Sunday)		$t_{(38)}$
		M	SD	M	SD	
Non-overweight (n_1=22)	MPA min.day^{-1}	82,0	23,9	89,9	34,8	5,542
	VPA.min.day^{-1}	4,2	5,2	5,0	5,9	3,265**
Overweight (n_2=20)	MPA.min.day^{-1}	48,1	25,1	37,0	25,7	6,670
	VPA.min.day^{-1}	0,8	1,0	0,7	1,4	2,914**

Significant difference between overweight and non-overweight girls at *<.05 and **<.001

In Table 4 are depicted descriptive data and *t* values, of the daily LMVPA (min.day^{-1}) for the weekdays and the weekend. Non-overweight girls accumulated statistical significant more MVPA than the overweight peers, both during the weekdays as well as the weekend. Furthermore, at all days of measurement, overweight girls were involved more time on sedentary or light physical activities compared to the non-overweight peers ($p<.001$).

Table 4. Group differences with respect to the PA variables (minutes.day^{-1} of involvement in LPA, MPA and VPA)

	Intensity of PA		Non-overweight (n_1=22) M	SD	Overweight (n_2=20) M	SD	$t_{(38)}$
PA at the weekdays (min.day^{-1})	LPA	Day-1	816,3	39,5	855,9	13,8	4,223**
		Day-2	810,9	45	846,3	36,6	2,723*
	MPA	Day-1	78,7	34	43,3	13,7	4,313**
		Day-2	85,3	41,7	52,9	36,6	2,604*
	VPA	Day-1	4,9	8,1	0,8	1,2	2,226*
		Day-2	3,7	5,7	0,7	0,8	2,291*
Mean PA at the weekdays (min.day^{-1})	LPA		813,6	42,3	851,1	25,2	4,7**
	MPA		82	23,9	48,1	25,1	4,504*
	VPA		4,2	5,2	0,8	1	3,053*
PA at the weekend (min.day^{-1})	LPA	Saturday	795,3	47	860,8	24,8	5,510**
		Sunday	814,9	44,3	863,7	27,2	4,792**
	MPA	Saturday	99	41,9	38,5	24,9	5,544**
		Sunday	80,7	42,8	35,5	26,5	4,008**
	VPA	Saturday	5,6	9,8	0,6	0,9	2,269*
		Sunday	4,3	6,2	0,7	1,8	2,481*
Mean PA at the weekend (min.day^{-1})	LPA		805,1	37,4	862,3	23,4	5,788**
	MPA		89,9	34,8	37	25,7	5,652**
	VPA		5	5,9	0,7	1,4	3,194**

Significant difference between overweight and non-overweight girls at *<.05 and **<.001

In Figures 1 and 2 are depicted diagrammatically the PA profile (counts.hour^{-1}) of the non-overweight and the overweight girls, over one weekday and one weekend day respectively. It was obvious that during the weekday the non-overweight girls were significant more active from their overweight counterparts both in school environment [8:00-14:00] (t=2.95, p<.05) and in after-school period [14:00-22:00] (t=2.95, p<.05).

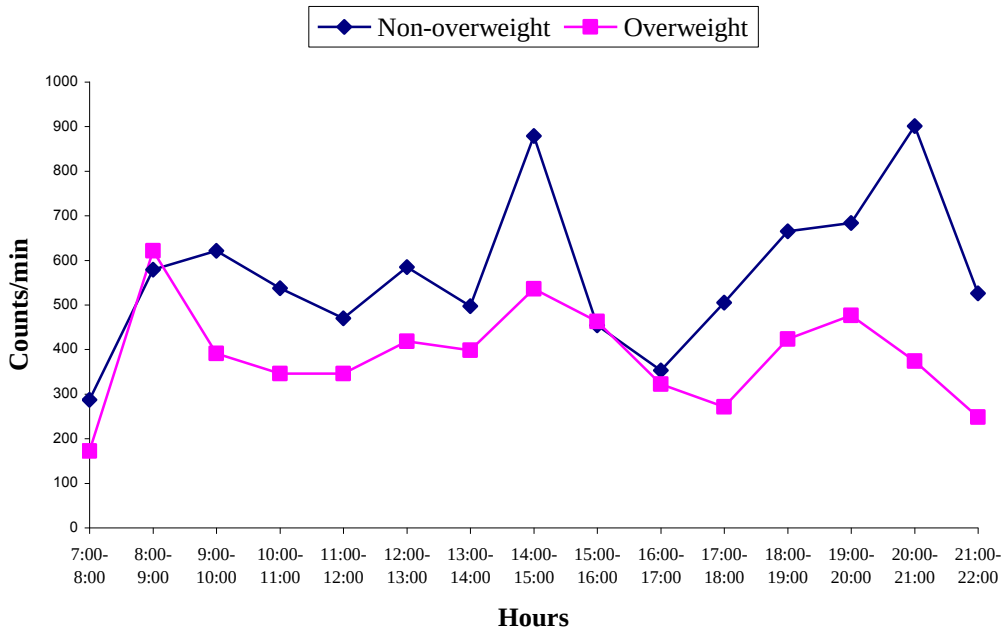

Figure 1. PA profile (counts.hour^{-1}) for the normal weight and overweight girls (mean values of the two weekdays).

Specifically, the non-overweight girls accumulated 33.7 (±15.4) min of MVPA within school environment, while their overweight counterparts accumulated 20.8 (±9.5) min. Similarly, during the after school period the non-overweight girls accumulated 52.4 (±19.5) min MVPA, while the overweight counterparts accumulated only 30.8 (±15.5) min (t=3.57, p<.001). During the weekend days the overweight girls exhibited a particularly sedentary behavior, while they had a minimum involvement in moderate intensity activities (see Figure 2). Specifically, the non-overweight girls accumulated a mean per day of 94.9 (±34.8) min of MVPA over the weekend, while the overweight girls accumulated a mean per day of 38.4 (±25.7) min.

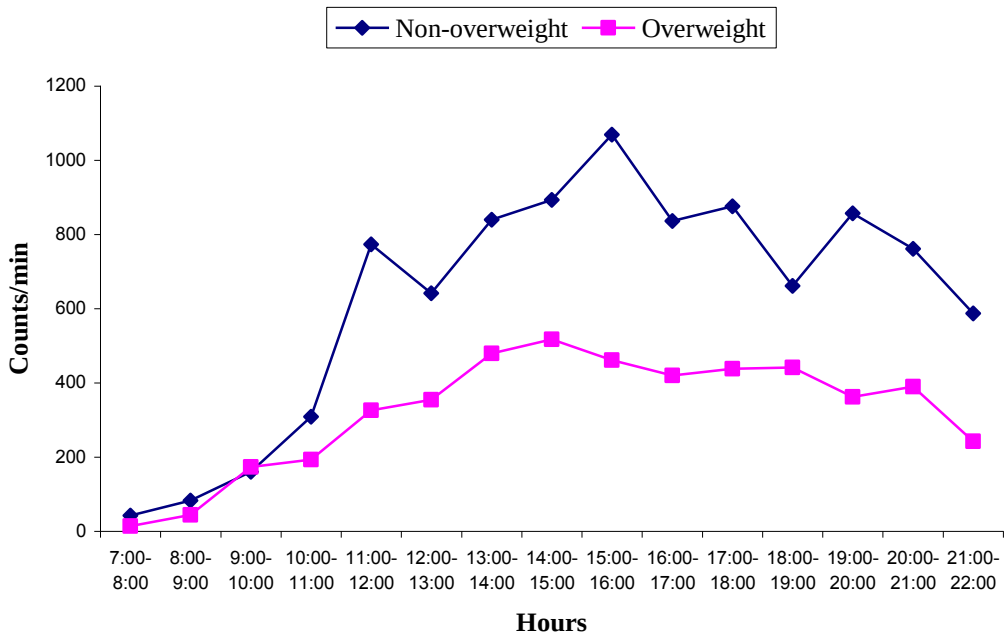

Figure 2. PA profile (counts.hour^{-1}) for the non-overweight and overweight girls (mean values of the weekend days).

Table 5 presents the percentage of the participants who accomplished the recommendation for the 60 min accumulated MVPA.day^{-1}. The majority of the overweight girls failed to fulfill PA requirements for a good health, both for the week days, as well as for the weekend.

Table 5: Percentage of the participants who accomplished the recommendation for the 60 min accumulated MVPA.day^{-1}.

Day of the week	Non-overweight >60 min	Overweight >60 min
Saturday	85%	15%
Sunday	70%	15%
Week day-1	75%	15%
Week day-2	75%	40%

Discussion

Although a direct causal link between PA and obesity is not clearly established, it is a fact that energy expenditure in daily life has been substantially decreased during the last decades (Fox & Hillsdon, 2007), fostereing sedentary habits. The major finding of this study was that overweight girls participated in significantly less PA than non-overweight both in weekdays and weekend. Furthermore, non-overweight girls accumulated significantly more MVPA regarding to their overweight peers. During the weekend the overweight girls had a particular sedentary behavior, while they were involved to a large extent of the day in low intensity activities. It is worth to note that low levels of PA during the weekend contribute to a state of positive energy balance and place overweight girls at high risk for further gains in adiposity. During all days of measurement, sedentary-LPA time was higher for overweight than for non-overweight girls. Therefore, it was not surprising that the majority of the overweight girls failed to accomplish PA requirements of 60 minutes.day^{-1} of MPA in order to gain health benefits. Furthermore, it was notable that all participants had minimal involvement in vigorous activity. These findings were consistent with previous studies conducted in Greece (Avgerinos, Argyropoulou, Almond & Mihalopoulou, 2000; Avgerinos, 2002; Tzetzis, Kakamoukas, Goudas & Tsorbatzoudis, 2005) and abroad (Gomez & Huffman, 2008; Trost, Sirard, Dowda, Pfeiffer & Pate, 2003).

During the resent years, the schools' role in the promotion of positive health behaviour and active lifestyle, has been well established. Furthermore, the school-environment has the potential to positively influence the habitual PA of the students by encouraging them to increase participation in extracurricular sports activities, by favouring active commuting to school, by providing exercise equipment and supervision during the school day, and by offering quality PE lessons (Trudeau & Shephard, 2005). However, the findings of this study concerning the PA level at school environment were disappointing and supported previous findings (Avgerinos & Vernadakis, 2005), suggesting that the low levels of PA may be associated with both personal motivational factors and contextual factors at schools such as absence of PA policy, lack of sport facilities and programs, and weaknesses on the implementation of the PE lesson.

The findings of this study indicated that there is an urgent need for a comprehensive program to cope with the problem of youth overweight, taking into account the various factors that contribute to this epidemic. Young people have been considered a "priority population" for intervention strategies since weight loss in adulthood is difficult (Bouchard & Katzmarzyk, 2010). Prevention might be achieved through a variety of interventions targeting built environment, PA and diet. These strategies could be initiated at home and in preschool institutions, schools, and

after-school services (IOTF, 2005). In Greece today the challenge is to identify obesogenic environments in order to intervene and promote healthier choices for young people. The implementation of sound health and PA school programs (such as increased sports participation and PE time) should be a priority. Similarly, adoption of more active modes of transportation to and from school should become a priority for the local authorities, parents and the community. Within the framework of this view, and taking into consideration their preferences and gender characteristics, special attention should be paid to the promotion of healthy and active lifestyle in the overweight youth (Avgerinos, Zetou & Vernadakis, 2006).

Despite the fact that the problem of the excess weight tends to become incontrollable, Greek governments have not yet taken any essential initiative to deal with it. It is a fact that the largest Greek cities have been developed in such way that have led people to sedentary habits. Moreover, it seems that this development has been imposed to people who are in an increased need for physical activity, such as children and elderly. Furthermore, the absence of leisure infrastructure and green areas have created an obesogenic environment which is characterised by low level of PA combined with high level of inactivity and overeating (Panagiotakos, Chrysohoou, Pitsavos, & Stefanadis, 2006; Roditis, Parlapani, Tzotzas, Hassapidou, & Krassas, 2009).

It is important to remind that the present research focused on the examination of moderate to vigorous intensity PA , that is directly linked with health benefits. However, obesity results from a chronic energy imbalance whereby intake exceeds expenditure (Ross & Janssen, 2007). Therefore, a thorough inspection of the participants' overall PA level - emphasizing on their involvement on sedentary and light activities – may reveal valuable information concerning differences in overall energy expenditure , which is associated closely to the overweight problem. Upcoming research should focus on this dimension of the youths' lifestyle since they spend hours in a daily base in front of screens (computers, electronic games, TV, mobile phones etc) and other passive leisure time pursuits (Papandreou, Malindretos & Rousso, 2010).

Conclusively, overweight girls participated in significantly less PA than non-overweight both in weekdays and weekend and they accumulated significant less MVPA than their non-overweight peers. These results suggest that a considerable percentage of overweight girls may be at risk for further increase in adiposity in virtue of their low levels of PA. However, the small size of the participants in this study warrants further consideration. While the research design of this study does not allow conclusions concerning cause and effect, the findings are consistent with the hypothesis that physical inactivity is a contributing factor to the development and maintenance of obesity.

References

American Public Health Association (2007). *Roots of the childhood obesity epidemic, Direct causes: Too much food, too little physical activity.* www.apha.ord/programs/resources/obesity/obesityrootdirect.htm?

Angerinos, A., Argiropoulou, E. C., Almond, L., & Michalopoulou, M. (2000). A new instrument for evaluating energy expenditure: convergent validity and reliability of the physical activity and lifestyle questionnaire (PALQ). *Athletic Performance and Health,* 4, 281-300.

Avgerinos, A.G. (2002). Lifestyle *and physical activity patterns of Greek children: The applicability of a school-based intervention program*. Doctoral Dissertation, Loughborough, UK.

Avgerinos, A.G., Zetou, E. & Vernadakis, N. (2006). Effects of school physical activity intervention programs. *Inquires in Sport & Physical Education,* 4 (2), 278-291.

Avgerinos, A. & Vernadakis, N. (2005). How active are elementary school children in the physical education lesson? Proceedings *2nd Forum of Hellenic Association of Physical Education,* (pp. 54-57). Halkidiki-Greece: Christodoulidis Press.

Bouchard, C. (2007). The biological predisposition to obesity: beyond the thrifty gene scenario [commentary]. *International Journal of Obesity,* 31, 1337-1339.

Bouchard, C. & Katzmarzyk, P.T (2010). Introduction. In Bouchard, C. & Katzmarzyk, P.T. (Eds.) *Physical Activity and Obesity.* (pp. 2-6). Champaign, IL: Human Kinetics Publishers, Inc.

Caspersen, C. J., Perreira, M. A., Curran, K. M. (2000). Changes in physical patterns in the United States, by sex and cross-sectional age. *Medicine and Science in Sports and Exercise*, 32, 1601-1609.

Cavill, N, Biddle, S. & Sallis, J.F. (2001). Health enhancing physical activity for young people: statement of the United Kingdom Expert Consensus Conference. *Pediatric Exercise Science*, 13:12-25.

Daniels, S.R. (2006). The consequences of childhood overweight and obesity. *The Future of Children,* 16 (1), 47-67.

Daniels, S.R., Arnett, D.K., Eckel, R.H., Gidding, S.S., Hayman, L.L., Kumanyika, S., Robinson, T.N., Scott, B.J., St Jeor, S. &Williams, C.L. (2005). Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment**.** *Circulation*, 111, 1999-2012.

Fox, K.B. & Hillsdon, M. (2007). Physical activity and obesity. *Obesity Reviews,* 8(1), 115-121.

Freedson, P., Pober. D., & Janz, K. F. (2005). Calibration of accelerometer output for children. *Medicine and Science in Sports and Exercise,* 37(11) Suppl:S523-30.

Freedson, P. S., Melanson, E. L., & Sirard, J. (1998). Calibration of the computer science and applications, Inc. Accelerometer. *Medicine and Science in Sports and Exercise, 30,* 777 – 781.

Gomez, P.G. & Huffman, G.F. (2008). Dietary Intake and Physical Activity of Overweight and Non-Overweight Hispanic Adolescents. The *FASEB Journal*, 22, 880.6. (http://www.fasebj.org/cgi/content/meeting_abstract/22/1_MeetingAbstracts/880.6).

International Obesity Task Force-IOTF, (2005). International Obesity Task Force: EU platform briefing paper. Brussels: European Commission. Available at: http://europa.eu.int/comm/health/ph_determinants/life_style/nutrition/documents/iotf_en.pdf

Livingstone, M.B. (2001). Childhood obesity in Europe: a growing concern. *Public Health Nutrition,* 4, 109-116.

Lobstein, T. (2010). Global prevalence of childhood obesity. In Bouchard, C. & Katzmarzyk, P.T. (Eds.) *Physical Activity and Obesity.* (pp. 57-60). Champaign, IL: Human Kinetics Publishers, Inc.

Montoye, H., Kemper, C., Sarris, W. & Wasburn, R. (1996). *Measuring physical activity and energy expenditure*. Champaign, IL: Human Kinetics.

Must, A. & Strauss, R.S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders,* 23(Suppl 2), S2-S11.

Panagiotakos, D.B., Chrysohoou, C., Pitsavos, C. & Stefanadis, C. (2006). Applied nutritional investigation Association between the prevalence of obesity and adherence to the Mediterranean diet: the ATTICA study. *Nutrition*, 22, 449–456

Dimitrios Papandreou, Pavlos Malindretos & Israel Rousso (2010). Risk factors for childhood obesity in a Greek paediatric population. *Public Health Nutrition,* 13(10), 1535–1539

Riddoch, C. (2010). The prevalence of children's physical activity. In Bouchard, C. & Katzmarzyk, P.T. (Eds.) *Physical Activity and Obesity.* (pp. 44-47). Champaign, IL: Human Kinetics Publishers, Inc.

Roditis, M.L., Parlapani, E.S., Tzotzas, T., Hassapidou, M. & Krassas, G.E. (2009). Epidemiology and Predisposing Factors of Obesity in Greece: From the Second World War Until Today. *Journal of Pediatric Endocrinology & Metabolism*, 22, 389-405.

Ross, R. & Janssen, I. (2007). Physical activity, fitness, and obesity. In Bouchard, C., Blair, S.N. & Haskell, W.L. (Eds.) *Physical Activity and Health,* (pp.173-189). Champaign, IL: Human Kinetics Publishers, Inc.

Swinburn, B. & Egger, G. (2002). Preventive strategies against weight gain and obesity. *Obesity Review,* 3, 289-301.

Tzetzis, G., Kakamoukas, V., Goudas, M. & Tsorbatzoudis, C. (2005). A Comparison of Physical Activity Patterns and Physical Self-Perception in Obese and non-Obese Children. *Inquiries in Sport & Physical Education*, 3(1), 29 – 39.

Tzormpatzakis, N. & Sleap, M. (2007). Participation in physical activity and exercise in Greece: a systematic literature review. *International Journal of Public Health,* 52, 360–371

Trost, S.G., Pate, R.R., Sallis, J.F., & Taylor, W.C. (2000). Using objective physical activity measures with youth: ho many days of monitoring are needed? *Medicine and Science in Sports and Exercise*, 32, 426-431.

Trost, S.G, Sirard, J.R., Dowda, M., Pfeiffer, K.A. & Pate, R.R. (2003). Physical activity in overweight and nonoverweight preschool children, *International Journal of Obesity,* 27, pp. 834–839.

Trost, S.G., McIver, K.L. & Pate, R. R., (2005). Conducting accelerometer based activity assessments in field – based research. *Medicine and Science in Sports and Exercise,* 37, 531 – 543.

Welk, G. J., Corbin, C. B., & Dale, D. (2000). Measurement Issues in the assessment of Physical activity in children. *Research Quarterly of Exercise and Sport* ,71, 59 – 73.

Whitaker, R.C., Wright, J.A., Pepe, M.S., Seidel, K.D. & Dietz, W.H. 1997).Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine*, 337, 869-873.

World Health Organization (WHO): Obesity and overweight, available at: www.who.int/mediacenter/factsheets/fs311/en/print.html (2005).

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