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Jérémy Vanhelst[1-2], Laurent Béghin[1-2], Paul Stephen Fardy[3], Gilles Bui-Xuan[4], Jacques Mikulovic[5]

[1] Centre d'Investigation Clinique, CIC-9301-Inserm-CH&U, Lille, France

[2] Unité Inserm U995 & Université Lille Nord de France, Lille, France

[3] Department of Family, Nutrition, and Exercise Sciences (FNES), Queens College, Flushing, NY, USA

[4] ER3S, Université d'Artois, 59658 Villeneuve d'Ascq, France

[5] ER3S, EA 4110, ULCO, 59240 Dunkerque, France

Corresponding author: J. Vanhelst

Centre d'Investigation Clinique,

CIC-9301-Inserm-CH&U,

CHRU de Lille

59037 Lille Cedex

Tel: 03 20 44 61 26

Fax: 03 20 44 61 34

Email: jeremy.vanhelst@chru-lille.fr

Short title: Intervention program in obese youth

ABSTRACT

The aim of this study was to assess the effects of age and type of physical activity on anthropometric measures of obese youth participating in an intervention program. Subjects included 37 obese children (12.5 ± 2.9 yrs). The program consisted of a unique program of physical activity and health education. Assessments included body mass index, body composition, and ability to perform sport activities. Paired t tests were used to assess the effects of intervention and chi square was used to assess inter-action between measures. Findings suggest significant decrease in Z scores of Body Mass Index and an improvement of the ability to perform sport activities ($p < 0.05$). The effectiveness of the program has more impact on children than adolescents ($p < 0.05$). Improvements were greater in team vs. net sports ($p < 0.05$). Results show that intervention strategies have to be different according to the age in order to have a favourable effect on anthropometric characteristic and the consequences of obesity childhood and adulthood. The findings suggest that the intervention program was of greater benefit for children than adolescents.

Keywords: Rehabilitation, Pediatrics, Obesity, Physical activity, Strategies

Introduction

Pediatric obesity is alarming and epidemic problem in Western industrialized countries. Obesity in youth is associated with adverse health consequences in adults such as coronary heart disease, diabetes, and some cancers. Studies show that high normal weight in childhood predicts overweight or obesity as an adult and elevated Body Mass Index (BMI) in childhood predicted risk of hypertension in young adulthood (Dietz, 1998; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997; Filed, Cook, & Gillman, 2005). Other consequences of obesity include sleep apnea, orthopaedic complications, asthma, poor quality of life and hypertension (Wabitsch, Hauner, Heinze, Muche, Bockmann, & Parthon, 1994; Chin & Rona, 2001; Von Mutius, Schwartz, Neas, Dockery, & Weiss, 2001; Mcmurray, Harrell, Bangdiwala, Bradley, Denug, & Levine, 2002; Dahlberg, Bergkvist, Hekmat, & Svensson, 2008; Jasik & Lustig, 2008; Gozal & Kheirandish-Gosal, 2009).

Clinical interventions with differing methodologies have been developed to treat obesity. Physical activity training is regarded as an effective approach recognized for longterm weight maintenance (Van Dale, Saris, & Ten Hoor, 1990). Another successful strategy is restricting diet caloric intake (Epstein, Paluch , Beecher, & Roemmich, 2008).

Physical activity is widely recognized for its positive impact on health and important role in the prevention and treatment of chronic diseases such as obesity (Ekelund, Griffin, & Wareham, 2007; Pedersen & Saltin, 2006). Physical activity is represented by three components, the duration, the frequency and the intensity. Studies have shown that intensity, frequency and duration of activity are important factors in having a positive impact on childhood obesity (Atlantis, Barnes, & Singh, 2006; Horowitz & Klein, 2000; Achten, Gleeson, & Jeukendrup, 2002; Lazzer, Busti, Agosti, De Col, Pozzo, & Sartorio, 2007). However, to the best of our knowledge, there is no study assessing the effectiveness of the type of physical activity on obese youth. Such information would provide valuable information for successful program development.

The objective of this study was to assess the influence of age and type of physical activity on anthropometric measures of obese youth.

Participants and Methods

The current report is based on data derived from an intervention program on obese youth (Vanhelst, Marchand, Fardy, Zunquin, Loeuille, Renaut, *et al.,* 2010)**.** The aim of the program was to improve the health of obese youth by reducing obesity and improving cardiovascular health, physical fitness, sleep, and self-esteem. Data were collected during 2008 and 2010 in Northern France. In total, 37 obese youth ages 12.5 ± 2.9 yrs (18 girls and 19 boys) participated in the study. A detailed description of the program has been published elsewhere (Vanhelst, *et al.,* 2010). In summary, physical training consisted of many moderate to vigorous activities, including team and net sports, such as basketball, football, tennis, badminton, and handball. Physical activity consisted of 2-hour sessions once each week in a gymnasium for one year using the Conative Educational Model (Mikulovic, Bui-Xuan, & Marcellini, 2002; Bui-Xûan, 1999). The conative educational approach is based on the idea of conative curriculum which models a sense given by to one's actions (Bui-Xûan, 1999). Identifies five *impetus* which lead one's actions. This model allows the resarcher to identify conative stages through observation of child's practice, and to assess progress or evolution in the three components (structural, functional and technical) forming the model. The summation of these three components is called "guiding principle" which organize five conative stages, from novice (1) to expert (5) (Bui-Xûan, 1999). Subjects identify their stage and observe their progress in the practice of sport. Progress of the intervention program is associated with a teaching activity adapted to the stage that best encourages acquiring of new skills and progressing from one stage to the next. Subjects were evaluated individually and the activity program was adapted for each subject at the stage that met the subject's ability.

The aims and objectives were explained carefully to each subject. Written, informed consent was obtained from the children and their parents. The study was approved by the local ethics committee, and all procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008 and the European Good Clinical Practices and the European Good Clinical Practices and with the ethical standards of the sport and exercise science research (Béghin, Castera, Manios, Gilbert, Kersting, De Henauw, *et al.,* 2008; Harris & Atkinson, 2011).

Measurements

Measurements included age, height, weight, body mass index (BMI), body composition and ability to perform sport activities. Data were collected at baseline and at the end of one year.

Patients characteristics

Body mass was measured without shoes and heavy outer garments to the nearest 0.1 kg using an electronic scale (Oregon Scientific®, GA 101, USA). Height was measured without shoes to the nearest 0.1 cm using a standard physician's scale. Body Mass Index (BMI) was calculated by weight (kg)/height (m^2), and was converted to Z-score of BMI.

Total fat and fat free mass were assessed using bioelectrical impedance analysis (AKERN®, BIA101 AKERN, Italy). Following a 5 minute rest subjects were placed in a supine position with arms and legs in abduction between 30 and 40° from the trunk. Electrode tape, conductivity gel, and current electrodes were placed on the dorsal surfaces of the right hand

and foot at the distal metacarpals and metatarsals, respectively (Houtkooper, Going, Lohman, Roche, & Van Loan, 1992). Detector electrodes were applied at the right pisiform prominence of the wrist and between the medial and lateral malleoli at the ankle (Kushner & Schoeller, 1986). Subjects were instructed to avoid eating for two hours prior to testing. Shoes, socks, watches and jewelry were removed. Subjects were non hydrated and were requested to void the bladder prior to testing. Bio electrical impedance gives a value, expressed in resistance (R). This value is incremented in the equation of Houtkooper et al. to calculate fat mass, fat-free mass for all participants (Houtkooper, *et al.,* 1992).

Ability to perform sport activities (conative curriculum)

Conative curriculum is organized into five stages, from novice (1) to expert (5) in order to assess and observe the progress in the performance of sport (Vanhelst, Béghin, Fardy, Bui-Xuan, & Mikulovic, 2012). Ability to perform sport activities was assessed using scales developed for team sports, e.g. soccer, handball, basketball, and net sports, e.g. tennis, badminton, volleyball. The five levels in conative curriculum are described elsewhere (Vanhelst, *et al*., 2012).

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences, Windows 11.5 (SPSS Inc., Chicago, IL, USA), Excel 2003 (Microsoft Inc., Redmond, WA, USA) and Sphinx (Chavanod, France). Means were calculated at baseline and following intervention and were compared by paired *t* tests to assess the effects of the intervention program. Measures included Z-score of BMI, the age and the stage of conative curriculum. The chi square test was used to assess the interactions between these three variables during the intervention program. A p values $<$ 0.05 were taken to be significant with a 95% confidence interval.

Results

Subjects are described in Table 1. Significant improvements are observed between pre and post intervention for the Z score of BMI (Table 2). No significant difference was observed for change of body composition, i.e. fat and fat free mass. The conative curriculum of subjects increased significantly ($p < 0.05$). Thirty-five of thirty-seven subjects improved significantly in team sport ($p < 0.0001$) (Table 3). Compared to team sports, fewer subjects improved in net sports although gains were significant ($p < 0.05$) (24/37) (Table 3).

The mean ages where Z score of BMI decreased, stagnated, or increased was 12.3, 15.6 and 13.9, respectively. The effectiveness of the program on anthropometric measures was greater on children than adolescents. Best results were observed in subjects equal to or less than 12 years. 100% of obese youth aged less than 12 years improved Z score of BMI whereas 20% of subjects more than 12 years of age improved their Z score of BMI ($\chi_2 = 2.77$, df = 1, $p < 0.05$). 95% of obese youth 12 years of age or less improved the ability to perform team sports while 57.9% of subjects improved skills in net sports ($\chi_2 = 2.81$, df = 1, $p < 0.05$). 100% of obese youth aged more than 12 years of age improved the ability in net and team sports.

Discussion

Adolescence is a crucial period of life where lifestyle habits are established and persist until adulthood. The purpose of this study was to assess the influence of age and type of physical activity in obese youth participating in a rehabilitation program. Results suggest that there is a difference in the effectiveness of the program according to age and type of physical activity training. The program had more effect on improving team sports vs net sports and improvements in Z score of BMI were greatest for those subjects equal to or greater than 12 years.

Results from the present study showed that intervention was more beneficial for children 12 years of age or less vs children more than12 years old. The age associated with greatest change corresponds to puberty (Cheng, Buyken, Shi, Karaolis-Danckert, Kroke, Wudy, *et al.*, 2012). The effect of the pubertal development on physical changes, e.g. substrate oxidation, insulin resistance, vitamins, blood serum, BMI, adiposity has been well studied and should be taken into account in studies of overweight or obese youth (Brandou, Savy-Pacaux, Marie, Brun, & Mercier, 2006; Khadgawat, Thomas, Gahlot, Tandon, Tangpricha, Khandelwal D, *et al.*, 2012; Lewitt, Baker, Mooney, Hall, & Thomas, 2012 ; Molnar & Schutz, 1998). These studies concluded that pubertal status should be taken into account in studies of overweight or obese youth. Brandou et al showed that the influence of age on the ability to oxidize fat at exercise is explained by the pubertal increase in fat fee mass. Authors demonstrated in markedly obese children during puberty, the ability of fat free mass to oxidize fat at exercise decreases (Brandou, *et al.*, 2006). This conclusion may explain the difference between the two age categories. Even if obese youth increased fat free mass at the end of the intervention program, the improvement was not sufficient to overcome the effect of decreasing of fat oxidation by the fat free mass. Our results are in accordance with the studies showing the difficulty after puberty, to use fat oxidation to enhance lipolysis and diminish adipose tissue and the consequences of obesity (Molnar & Schutz, 1998; McMurray & Hosick, 2011; Brandou, *et al.*, 2006; Maffeis, Pinelli, & Schutz, 1995). However, we cannot completely confirm these conclusions because the program does not include data on the subjects' puberty stage. Other factors, such as daily physical activity, may also explain the improvement of anthropometric measures in children and not in adolescents. Knuth & Hallal (2009) showed that physical activity in youth decreased with increasing age, including a lower level of activity in physical education classes. In this program, whether children or adolescents, the time spent in moderate to vigorous physical activity during one week is not different (data not shown).

Another outcome of the present study was the necessity to differentiate the physical activity training according to the type of exercise. Adolescents improved their skills in team and net sports whereas children improved more in team v. net sports. No explanation on this topic is referenced in the literature. Perhaps there is less improvement in net sports because these activities, e.g. tennis, badminton, and table tennis have more complex movements than team sports. Results from our study on this topic are important in designing intervention programs for obese youth. Indeed, the intervention program has to be enjoyable in order to maintain interest and motivate subjects to adhere. The participant must never be in a failure situation which might lead to decreased activity. The child is positioned in a positive evolutionary dynamics in order to increase self-esteem that will lead a better management of overweight. Therefore, intervention strategies have to be different according to the age of the patient. Our results show that engaging in team sports has a greater impact on anthropometric measures and on the improvement on their ability for both age categories. Therefore team sports should be preferred for children. Net sports are better for adolescents than children.

The current study is unique in that it represents a 1-year health-wellness intervention program of physical activity for obese youth with a conative educational approach. The use of the conative curriculum permits subjects to be evaluated individually and to adapt the activity program according to the subject's ability. The study is limited because no control group was included. Future research could included a larger wide participants adding a control group.

In summary, results show that the intervention should take into account differences in age when designing intervention strategies for obese youth and adolescents. Team sports as a physical activity training intervention are more favourable than net sports for this age group.

The findings suggest also that the intervention program in obesity is more favourable for children (pre pubescent) than adolescents (post pubescent).

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Legends

Table 1. Physical characteristics of subjects (n = 37)

Table 2. Pre and Post intervention mean differences in Z score of BMI and the stage obtained in conative curriculum (n = 37)

Table 3. Evolution of participants after the intervention program (n = 37)

Table 1. Physical characteristics of subjects (n = 37)

	Boys	Girls
Number	18	19
Age (*yr*)	12.2 ± 2.8	12.7 ± 3.1
Weight (*Kg*)	79.5 ± 25.3	78.3 ± 26.8
Height (*cm*)	156.9 ± 15.9	155.3 ± 14.6
BMI (*Kg/m²*)	31.3 ± 6.1	31.1 ± 6.1

Table 2. Pre and Post intervention mean differences in Z score of BMI and the stage obtained in conative curriculum (n = 37)

	Pre intervention	Post intervention	Δ	Δ (%)
Z score of BMI	5 ± 1.9	4.5 ± 1.9*	- 0.4	- 8.7
Fat mass (*kg*)	39.1 ± 6.6	37.4 ± 6.4	- 1.7	- 4.3
Fat Free Mass (*kg*)	60.9 ± 6.6	62.6 ± 6.4	+ 1.7	+ 2.8
Conative Curriculum				
Team sport	1.3 ± 0.5	3 ± 0.5*	+ 1.7	+ 90
Net sport	1.3 ± 0.6	3 ± 0.7*	+ 1.7	+ 52.9

* $p < 0.05$

Table 3. Evolution of participants after the intervention program (n = 37)

	Decrease	Stagnation	Improvement
Team sport (n = 37)	0	2	35*
Net sport (n = 37)	0	13	24†

* $p < 0.0001$

† $p < 0.05$