Analysis of exercise training for treating obesity in children and adolescents: a review of recent programs

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Abstract

Physical activity is recognized as a basic component of the management of the obese child, but it is not clear which kind of intervention is the most efficient. The aim of this study is to evaluate the effect of prescribed exercise training in obese children. We reviewed 19 studies, 10 RCT and 9 observational studies, published in the last 5 years. In the majority of these studies obese children were treated as ambulatory patient, in tertiary centers. Only 2 studies described a community based program. In half of the studies, drop-out was not reported and the rate of attendance was rarely described. On the other hand, the content of each session was well described, but exercise training intensity was below international recommendations.
The analysis and interpretation of the current literature about exercise therapy in child obesity is difficult. The differences in program settings, in participant compliance and in measured outcomes, make the studies difficult to compare. Instead of focusing on intensity, program implementation should emphasize the special needs of obese children including their social background and the local network available.

Keywords: obesity, child, exercise training, physical activity, effectiveness

Résumé

L'activité physique est incontestablement l'un des piliers de la prise en charge des enfants obèses. Cependant, son efficacité demeure incertaine et la meilleure stratégie d'intervention reste à établir.
Le but de cette étude est d'évaluer l'effet des cours d'activité physique dans le traitement de l'obésité infantile. Nous avons revu la littérature spécifique de ces 5 dernières années. 19 études, 10 essais randomisés contrôlés et 9 études observationnelles, ont été retenues. La majorité des investigations ont été réalisées dans des centres tertiaires. Seules 2 études se sont intéressées à une approche communautaire. Dans la moitié de ces études, le nombre d'abandon n'était pas disponible. Le degré de participation était encore plus rarement rapporté. Si le contenu des cours était bien décrit, leur intensité était généralement en-dessous des recommandations internationales.
L'analyse et l'interprétation de la littérature récente, concernant l'effet thérapeutique de l'activité physique dans l'obésité infantile ne sont pas aisées. Les études sont difficilement comparables entre elles en raison du type de programme, de la compliance des enfants et de la mesure des résultats. Plutôt que de considérer l'intensité, la mise en place de programme d'activité physique devrait se centrer sur les besoins spécifiques des enfants obèses, de leur environnement socio-économique et des possibilités locales.

Mots clés: obésité, enfants, activité physique thérapeutique, exercice physique, efficacité

Introduction

Despite numerous guidelines and recommendations, daily management of the obese child remains a difficult task for treating physicians [1,2]. Physical activity is now admitted as being an integral element of pediatric obesity treatment, but it is not clear which intervention is the most efficient [3,4]. Physical activity is an extremely complex behavior that requires active involvement of the child and his family as well. It is influenced by personal, family and environmental factors [5] and each of these elements can be a potential barrier in preventing active participation of the child, therefore compromising a successful implementation of a program. These limitations are obvious for moderate-to-vigorous physical activity which is usually recommended for treating obese children [6]. In Europe, the reported prevalence of children spending more than 60 minutes a day in moderate-to-vigorous physical activity is very low. Only a quarter of European children did achieve this requirement [7,8,9]. To further complicate the assessment of physical activity in the management of pediatric obesity, several methodological biases make careful analysis and comparison difficult: the study designs, the assessment tools of physical activity and the goals of physical activity, (weight loss or prevention of weight gain) all differ in published reports [10,11]. The aims of this narrative study are therefore to evaluate the most recent studies that describe exercise training interventions and to find out which elements are more relevant in reducing weight in obese children and could be implemented in such programs.

Material and method

We searched Medline (via Pubmed) using the following keywords (free text): "exercise training" OR "exercise therapy" OR "physical activity" OR "physical fitness" OR "oxygen consumption" in combination with "obese children" OR "obese adolescents". There was no language limits. Age was limited to subjects under 18 years of age. Publications prior to 2010 have already been extensively reviewed [12–16], we therefore limited our review to studies published during the last 5 years, i.e. from January 1, 2010 to January 31, 2015. Only studies that clearly described the physical intervention used and session content were recorded.

Results

177 articles were found. After reading the title and the abstracts or the full texts, 19 articles met our criteria and were included [17–35]. The main characteristics of the 19 publications are summarized in table 1 and table 2. In 14 studies obese and overweight children were both enrolled. In 15 studies only obese or severely obese children were considered [18,19,21–22,26,28–29,33–35]. In 17 studies obesity and overweight were defined using the International Obesity Task Force criteria [36], whereas national standards [37] were used in 2 studies [24, 29]. Physical activity programs were performed mostly in tertiary centers except for 2 studies that reported the effectiveness of a physical activity program in the community [24,32]. In 4 studies, exercise training was provided during hospitalization in specialized centers, defined as an inpatient program [24,25,27,29]. The number of children enrolled was generally low, below 50. Only one study enrolled more than 100 children [16]. All but 2 studies had a control group [31,33]. When reported, the drop-out rate varied between 20% to 50% [20–22,24,30,33–35]. The rate of attendance reflecting participants' compliance to the program was detailed in 4 studies and varied from 87% to 94.5% (87%, 94.5%, 93%, 89% respectively) [20,22,30,31]. In about half the studies, exercise training alone was used [19,21–23,30–32,35]. In the remaining ones, dietary and exercise interventions were combined. Duration of the intervention greatly varied across studies, lasting from 3 to 12 months. 3 interventions only lasted less than 3 months [18,27,30]. Regarding the exercise prescription itself, the weekly time devoted was below 300 minutes, for programs longer than 3 months [17,19–26,28,29,31–35]. In 2 studies, exercise training time was greater than 300 min per week [18,27]. These more intense programs were provided as short interventions, i.e. less than 3 months. The content of sessions was well described in all studies and was supervised by a professional physical trainer. Most of the programs were based on aerobic endurance and provided a wide range of intensity levels, from 40% to 85% of maximal heart rate, corresponding to moderate-to-vigorous level [17–19,21–28,30,32–34]. 3 studies focused their intervention on higher exercise intensity or on interval training sets [20,31,35]. 3 other studies were obviously based on motor skills proficiency [25,31,33]. Outcomes were related to anthropometric or metabolic data rather than physical fitness results. Only 3 studies specifically assessed the effect of training on psychological parameters or psychosocial adjustment [20,29,30].

Table 1a: Characteristics of the studies

Author, (ref. number), year	Study design	Setting and Intervention type	Intervention length (months)	Patients description	Drop out (n)
Nemet. D. and al. (17) 2014	OBS	Ambulatory tertiary center Nutritional and PA interventions	12	Overweight and obese children n=147. 10. 7 ± 0.1 years BMI > P85 (26.1± 0.1Kg/m^2)*	NR
Ben Ounis O. and al. (18) 2010	RCT	Ambulatory tertiary center Nutritional and PA interventions	2	Obese adolescents n=14. 13.1 ± 0.8 years. BMI > P95 (31.1 ±1.1 Kg/m^2)*	NR
Zorba E. and al. (19) 2011	RCT	Ambulatory tertiary center PA intervention	3	Obese children n=40. 11 ± 1 years BMI> 30 Kg/m^2*	NR
Pescud. M and al. (20) 2010	RCT	Ambulatory tertiary center Nutritional and PA interventions	6	Overweight and obese children n=50. 9.7 ± 1.4 years BMI >P85 (24.7 ±6.8 Kg/m^2)*	19

Author, (ref. number), year	Study design	Setting and Intervention type	Intervention length (months)	Patients description	Drop out (n)
Racil G. and al. (21) 2013	RCT	Ambulatory tertiary center PA intervention	3	Obese girls n=22 15.9 ± 0.3 years. BMI > P97 (30.8 ± 1.6 Kg/m^2)*	2
Calcaterra V. and al. (22) 2013	OBS	Ambulatory tertiary center PA intervention	3	Obese children n=22. 13.2 ± 1.8 years BMI > P97 (32.9 ± 4.3 Kg/m^2)*	1
Vanhelst J. and al. (23) 2011	OBS	Ambulatory community PA intervention	12	Obese children n=37. 12.4 ± 2.9 years BMI > P97 (31.0 ± 5.9 Kg/m^2)*	NR
Van der Baan-Slootweg O. and al. (24) 2014	RCT	Inpatient tertiary center Nutritional and PA interventions	6	Severe obese children n=45. 13.8 ± 2.3 years BMI > 3sds (3.4 ± 0.4 Kg/m^2)**	11
D'Hondt E. and al.(25) 2011	OBS	Inpatient tertiary center Nutritional and PA interventions	6	Overweight and obese children n=36. 10.3 ± 1.4 years. BMI > P85 (29.1 ± 3.6 Kg/m^2)*	NR
Nemet D. and al. (26) 2013	RCT	Ambulatory tertiary center Nutritional and PA interventions	3	Obese children n=21. 10.5 ± 2.7 years. BMI = P 97.3 ± 2.1*	NR
Roberts Ch. and al. (27) 2013	OBS	Inpatient tertiary center Nutritional and PA interventions	0.5	Overweight and obese children n=19. 13.1 ± 0.5 years. BMI > P85 (33.6 ± 1.9 Kg/m^2)*	NR
Ackel-D'Elia C. and al. (28) 2014	RCT	Ambulatory tertiary center Nutritional and PA interventions	6	Obese adolescents. n=72. 16.5 ± 1.5 years. BMI > P95 (35.1 ± 3.9 Kg/m^2)*	NR
Verloigne M. and al. (29) 2011	OBS	Inpatient tertiary center Nutritional and PA interventions	10	Obese adolescents n=65. 15.1 ± 1.5 years. BMI > 2.3 sds (35.9 ± 5.7 Kg/m^2)**	NR
Wagener. T and al. (30) 2011	OBS	Ambulatory tertiary center PA intervention	2.5	Obese adolescents n=20. 14.0 ± 1.7 years. BMI > P95*	1
Morano M. and al. (31) 2012	OBS	Ambulatory community PA intervention	9	Obese children n=44. 9.2 ± 1.3 years. BMI > P95 (26.9 ± 3.7 Kg/m^2)*	NR
Park JH. and al. (32) 2012	RCT	Ambulatory tertiary center PA intervention	3	Overweight and obese children n=15. 12.1 ± 0.1 years. BMI > P85 (24.4 ± 0.4 Kg/m^2)*	NR
Steinberg N. and al. (33) 2013	OBS	Ambulatory tertiary center Nutritional and PA interventions	6	Obese children. n=29. 9.2 ± 2.1 years. BMI > P95 (24.4 ± 2.5 Kg/m^2)*	7
Prado D. and al. (34) 2010	RCT	Ambulatory tertiary center Nutritional and PA interventions	4	Obese children n=33. 10.2 ± 0.3 years BMI > P95 (30.6 ± 1.3 Kg/m^2)*	0
Corte de Araujo AC. and al. (35) 2012	RCT	Ambulatory tertiary center PA intervention	3	Obese children n=39. 10.4 ± 0.9 years. BMI > P95 (29.6± 4.0 Kg/m^2)*	9

BMI: body mass index, NR: not reported, OBS: observational study, RCT: randomized control trial, PAS: physical activity, SD: standard deviation.
* BMI according international standards (36) **BMI according national growth references (37).

Table 1b: Characteristics of interventions.

Author, (ref. number), year	Duration (months)	Description of intervention	Weekly time (min)	Reported intensity	Outcomes
Nemet D. and al. (17) 2014	12	aerobic training (50% team sports and 50% running games) coordination and flexibility exercises. Encourage participation and fun	120 (2×60)	As found in school physical activity lesson	Aerobic endurance VO_2max BMI
Ben Ounis O. and al. (18) 2010	2	running jumping balloon exercise	360 (4×90)	55% VO_2max	Aerobic endurance VO_2max BMI

Author, (ref. number), year	Duration (months)	Description of intervention	Weekly time (min)	Reported intensity	Outcomes
Zorba E. and al. (19) 2011	3	walking and jogging	135 (4×45)	60–65% max. HR	Metabolic parameters. BMI
Pescud M and al. (20) 2010	6	muscular strength training with progressive load. Program designed to be enjoyable	135 (3×45)	Increase the set of repetition maximum by a factor 3	Muscle power and endurance. Participation
Racil G. and al. (21) 2013	3	High vs low intensity Interval training specific work and stretching	180 (3×60)	80–110 % vs 70–80% MAS	Aerobic endurance MAS BMI
Calcaterra V. and al. (22) 2013	3	circuit-based aerobic exercises. Strength exercises for different muscular groups. various recreational sports	180 (2×90)	50–60% max HR	Drop-out aerobic endurance VO_2max BMI
Vanhelst J. and al. (23) 2011	12	moderate intensity games. progressive intensity to Increase adherence and fun	120 (2×60)	40–45% Vo_2max	BMI
Van der Baan-Slootweg O. and al. (24) 2014	6	Specific therapy based on postu-re, balance and coordination (Cesar Therapy)	180 (4×45)	Not reported	Metabolic parameter BMI
D'Hondt E. and al. (25) 2011	6	running swimming cycling and fitness training. Postural exer-cise and muscular strength	240 (4×60)	80% theoretical max. HR	Gross motor Coordination (body co-coordina-tion test for children)
Nemet D. and al. (26) 2013	3	50% aerobic activities. 50% strength and flexibility training. Games to encourage participation	120 (2×60)	As found in school PA lesson	Aerobic endurance VO_2max
Roberts Ch. and al. (27) 2013	0.5	gym based exercises, swimming, tennis	840 (7×120 or 7×150)	As found in school PA lesson	Metabolic parameters BMI
Ackel-D'Elia C. and al. (28) 2014	6	aerobic training (30 min running on treadmill) vs aerobic training and strength exercises for diffe-rent muscle groups vs Leisure activity, ball games.	180 (3×60)	VAT	leptin BMI
Verloigne M. and al. (29) 2011	10	Leisure physical activity level. Choice of activities to expe-rience success.	240 (4×60)	NR	Behavioural regulation in exercise questionnaire
Wagener T. and al. (30) 2011	2.5	danced-based exergame exercises	210 (3×40)	75% max. HR	Psychosocial adjustment perceived competence BMI
Morano M. and al. (31) 2012	9	aerobic exercise. Motor skill and strength training. to experience success and fun.	240 (2×120)	Progressive increase	Physical and skill competence (eurofit tests) Motivation
Park JH. and al. (32) 2012	3	aerobic exercise (30 min treadmill). Strength exercise	240 (3×80)	50–70% max. HR	Aerobic endurance VO_2max. Tests for muscle resistance endo-thelial progenitor cells
Steinberg N. and al. (33) 2013	6	aerobic activities. Strengthening for different muscle groups. Fle-xibility and coordination skills	120 (2×60)	As found in school physical activity lesson	Postural balance (posturographic assessment)
Prado D. and al. (34) 2010	4	50% walking and jogging on jogging track and 50% recreational games	180 (3×60)	VAT	Aerobic endurance VO_2max autonomic nervous system
Corte de Araujo AC. and al.(35) 2012	3	high and low intensity intermittent exercise. Endurance	120 (2×60)	80% max. HR	Aerobic endurance (intermittent endurance test) BMI

BMI: body mass index, max. HR: maximal heart rate, MAS: maximum aerobic speed, PA: physical activity, VAT: ventilator anaerobic threshold, NR: not reported.

Discussion

In this narrative review, we were able to carefully analyze the most important papers published over the last 5 years which describe the effectiveness of physical exercise in pediatric obesity programs. The variations in terms of duration of programs, settings, intensity levels and type of physical activity make comparison almost impossible. These differences make comparison between programs and evaluation of their results difficult and implementation potentially hazardous.
More specifically, we can make the following comments from a methodological point of view:

The duration and content of physical activity differed greatly from one study to another. In our review only short interventions achieved the recommended physical activity level. Most of the ambulatory programs, including moderate-to-vigorous intensity sessions, were still below the suggested physical activity levels [6,38,39,40], thereby questioning the effectiveness of these interventions [10,14]. To reach optimal level of physical activity, intensity can be increased and/or intermittent interval training can be incorporated into sessions; these options are closer to the spontaneous pattern of physical activity in childhood [41,42]. In general, high intensity training has been shown to bring greater enjoyment and to have good impact on physical fitness and anthropometric data [21,35,43,44].

As previously reported, few studies recorded the flow of participants, in particular the number of drop-outs. This poor reporting contrasts with the fact that many researchers indeed recognize the importance of long-term adherence to the program. Several authors emphasize the following aspects: to "encourage participation" [17], for the program to be "enjoyable" [20], for the need to be "designed for fun to increase adherence" [23,31] or to "experience success" [29]. There are many factors that can improve participants' adherence. Improving self-perceived physical ability is one of them and has been shown to be a good predictor of involvement in a future physical activity [31,45]. Social interaction during group sessions has also been highlighted as a determining factor in developing of a positive perception of physical activity. It decreases the feeling of "being insecure about appearance" and "not being good at" which are major barriers towards physical activity. Better self-motivation is likely to increase compliance to the programs [46,47]. In the same vein, socio-economic and family limitations can also impact the participation of the child and his family. Children from low backgrounds have been shown to have less access to sport, which explain more increase in difficulty to complete a program. Families with low incomes have more difficulty in affording a program and are more prone to drop out when enrolled [20,48,49]. Close interaction with the parents throughout the program to take into account their expectations increases adherence [50,51].

Beyond the mere physical activity, motor skills are also matter of interest in several studies [29,31]. Locomotion, object control and stability, representation of the fundamental movement skills, were shown to be good predictors of time spent daily in action. In healthy normal weight children, object control proficiency is well correlated to the time spent in moderate-to-vigorous physical activity time spent when they became adolescent [52]. Fundamental movement skills enable specialized sequences required to practice organized and non-organized physical activity [53]. Children with better motor skills have a better perception of their athletic competence and have more chance to be involved in sports during adolescence, increasing their level of physical activity [52,54,55]. On the other hand, children with developmental coordination disorder are prone to be obese although the causal effect of developmental coordination disorder and obesity remains a matter of discussion [56,57]. Overall, obese children show lower fundamental movement skills than their normal-weight peers [58,59,60]. In prospective studies, the diminished motor competence in obese children did not improve over time, contrary to their non-obese peers [61]. In opposition to gross motor competence, fine motor skills in obese children do not differ from their counterparts [62]. These data support the hypothesis that motor skills impairment in obese children bears a negative impact on self-perceived physical competence and could worsen their low participation in physical activities, thereby initiating a vicious circle.

Limitations

Excellent reviews on physical activity to treat pediatric obesity, including a Cochrane reviews were recently published [63]. We therefore limited our study to the last 5 years. Given the nature of our research, this cannot be considered as a systemic review. After carefully reading the conclusion of the Cochrane review [63] the inclusion of papers published prior to 2010 would not significantly alter our conclusions.

Conclusions

The analysis and interpretation of the current literature about exercise therapy to treat obesity show major differences between studies. In- or out-patient program settings, length of the program or of the sessions, compliance and measured outcomes make the studies difficult to compare and their success difficult to evaluate at the present time. To improve participants' compliance and finally program success, the special needs of the obese child, including his social background and the available local network, should be taken into account.

Acknowledgments, conflict of interest

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