



Original Paper

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Acceptability, accessibility and effectiveness of a form of physical exercise session adapted to obese adolescents attending school in Brazzaville: Comparative study

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Received: 16-06-2023

Accepted: 26-09-2023

Published: 31-10-2023

ABSTRACT

The policy for the management of obese children in Congo is almost non-existent. The present study aims at determining the level of acceptability, accessibility and effectiveness of the form of physical exercise session best suited for the management of obese school children in Brazzaville. Methods: The present study was an intervention study, carried out with 23 overweight students from eight secondary schools in the city of Brazzaville. The participants were subjected to two physical exercise sessions (aerobics alone and then, aerobics and muscle strengthening) during one week. Data were collected using a questionnaire. The form of the session was considered acceptable if its assessment based on 6 items scored at least 13.6 out of a total of 17 points; accessible if its assessment based on 5 items scored 14.4 out of a total of 18 points. It was considered effective if it met 4 of the physiological criteria. The level of acceptability of the aerobics and muscle strengthening session was significantly higher than that of the aerobics session alone (14/23 or 61% versus 4/19 or 17%; $P = 0.03$). PCA identified two components (percent weight loss %PP and energy expenditure DE) in axis 1 that had a satisfactory loading factor of 0.70. The results of this study put the acceptability, accessibility and effectiveness of an intervention program based on aerobics and strength training. This program could be recommended as a non-pharmacological means in the management of an obese adolescent population.

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Keywords: Obesity, effectiveness, aerobic session, muscle strengthening, Republic of Congo.

INTRODUCTION

Obesity is defined as an abnormal or excessive accumulation of body fat that represents a health risk. It is caused by

ingesting more energy than is expended over a long period of time (Bahchachi et al., 2017). In recent decades, the prevalence of obesity and overweight has increased dramatically

worldwide in children and adults (Makoutode et al., 2017). World Health Organization (WHO) estimates that in 2011, there were 1 billion obese people over 20 years of age and 40 million children under 5 years of age worldwide. Global estimates of obesity prevalence among children and adolescents showed that about 124 million children and adolescents aged 5-19 years were obese and 213 million were overweight (Abarca-Gómez et al., 2017).

Obesity and overweight during adolescence are a concern because of their potential health impact (Musung et al., 2019; Noirez et al., 2019). It is furthermore established that 40% of children who are obese at the age of 17 years have a 5-fold higher risk of excess adiposity in adulthood with a high risk of obesity-related comorbidities (Ward et al., 2017). There is then a major risk of the obese child becoming an obese adult with various associated medical conditions (Kumar and Kelly, 2017) such as type 2 diabetes, high blood pressure, cardiovascular disease, osteoarthritis (Jurat et al., 2018).

Problems related to obesity are not only limited to health problems but also to psychological problems. Indeed, obese children develop increasingly sedentary habits due to a lack of confidence in their physical ability (Morano et al., 2019). The adoption of a new lifestyle with a change in eating habits and an increase in the level of physical activity is recommended for obese children. In this regard, WHO recommends a minimum of 60 minutes of moderate daily physical activity for children. However, it is difficult to observe a routine type of physical activity in obese children and adolescents. Therefore, in order to ensure a higher rate of applicability of the WHO recommendations for an active lifestyle in this population, an accessible, acceptable exercise program is needed.

Assessing the level of acceptability, accessibility and effectiveness is a practical way to subjectively identify the type of exercise best suited to obese children and adolescents. Due to the paucity of studies on the types of physical activity promotion intervention protocols in the management of

overweight and obese adolescents, this study was conducted to fill this gap. It aimed to assess the levels of accessibility, acceptability and effectiveness of a form of session adapted to overweight and obese pupils in schools.

MATERIALS AND METHODS

Study protocol

This is a before-and-after, here and there, intervention study conducted with overweight students in schools in Brazzaville. The participants were subjected to two physical exercise sessions during one week: the first, aerobics (alone) only, and the second, aerobics combined with muscle strengthening. The order of the sessions was drawn, at random and one week before the intervention. The acceptability and accessibility of the sessions were measured at the end of each session with a questionnaire submitted to the students, while effectiveness was assessed through anthropometric and biometric measurements taken before and after each form of session. Written consent was obtained from obese adolescents as well as from parents in accordance with the principles of the Declaration of Helsinki.

Participants

A total of 23 school-going adolescents were recruited from eight secondary schools in the three geographical areas of Brazzaville and took part in the study. These schools were selected on the basis of the following criteria: belonging to a geographical area of the city (north, south, centre), having a large number of adolescents to cover the required number for the age group studied, and being accessible to our interviewers. Subjects should meet the following inclusion criteria: be Congolese and enrolled in a secondary school in Brazzaville, be obese, between 14 and 18 years old, not suffer from a chronic disease, not have a malformation that could affect their body composition.

Measures

Data were collected using a questionnaire that consisted of three parts: the first part collected information on the socio-

demographic characteristics of the pupils surveyed, the second part included data on the acceptability and accessibility of the form, and the third part recorded the anthropometric and biometric data of the respondents. The questionnaire was submitted to 12 obese children as a pre-survey. This allowed to assess the sensitivity of the questions, the difficulties in understanding them and to retain the final versions. Cronbach's alpha coefficients were then calculated to assess the internal consistency of the questionnaire. The coefficients were $\alpha = 0.77$ for acceptability and $\alpha = 0.86$ for accessibility. It thus appeared that this questionnaire had a good level of internal consistency and could be considered valid, since α is greater than or equal to 0.70 each time.

The body mass index (BMI) was calculated as P/T^2 (P is weight in kilograms and T is height in metres) and the anthropometric weight status defined according to International Obesity Task Force (IOTF) standards for each subject (Bahchachi et al., 2017). The curve passing through BMI equal to 25 at the age of 18 years defines the threshold of overweight, obesity included (IOTF 25) and the percentile curve passing through BMI equal to 30 at the age of 18 years defines the threshold of obesity. The adolescent was considered obese if BMI > 95th percentile for subjects aged 13-17 years and BMI 30 for those aged 18 years. Rectal temperature was measured with a thermometer (Sejoy Hangzou, China). A 300 refractometer (Atago, Japan) was used to determine urine density from the samples collected. Geonote heart rate monitors (Decathlon, France) were used to measure heart rate. Subjective perception of effort was measured using the Borg perception scale. The weight and height of the respondents were measured in light clothing without shoes, using an automatic digital scale (Xiangshian, China) and a ZT-150A stadiometer (Perlong Medical Equipment, China) respectively. Energy expenditure was measured using a Garmin 15 accelerometer (USA).

Variables studied

Three composite variables were used in this study: the level of accessibility, the level of acceptability and the degree of effectiveness of the session.

Conceptual aspects of the variables

The variable acceptability of obese adolescents to the practice of a session form covered six components, namely: a) average duration of practice; b) weekly duration; c) long-term duration; d) content of the session form; e) feeling; and f) frequency of practice. The accessibility variable was assessed according to five items: a) location; b) proximity; c) environment; d) equipment; and e) instructor.

Each of the responses is coded from 0 to 4 according to the number of modalities contained in each component: the maximum level of acceptability is obtained by adding the maximum scores of the six components which gives a total of 17. The session is acceptable if the total score is ≥ 13.6 . For the score < 13.6 , the session is considered "not very acceptable". In relation to accessibility, the optimal level is obtained by adding the maximum scores of the components which gives a total of 18. The session is accessible, if the total score is ≥ 14.4 . It is less accessible when the total scores are < 14.4 .

The degree of efficiency is assessed according to: a) an exercise intensity between 70 and 85% of HRmax; b) a percentage weight loss $< 2\%$; c) an energy expenditure of 500 kcal to 650 kcal; e) a physiological index of thermal stress of 6 to 8 and a subjective perception of the Borg scale of 6 to 8. The session is said to be more effective when at least four of these components have retained normal values. Finally, the session is considered most appropriate for this population when at least two of the variables it covers (acceptability, accessibility and effectiveness) have the best modality.

Intervention protocol

Aerobic training session

The aerobic session lasted 75 minutes during which the participants worked at 65%

and 70% of the theoretical HRmax in the first phase and at 70% and 85% of the theoretical HRmax in the second phase. The session was divided into: 1) a grip in 5 min, 2) a warm-up in 15 min; 3) aerobics for 40 min; 4) a relaxation 10 min and 5) a return to calm and regaining control 5 min.

The warm-up part of this session consisted of cardiovascular activation, joint mobilization and muscle warm-up. It was carried out using fast walking, slow running and jumping exercises followed by stretching. The aerobic part included right and left set up, alternating, chase step, jumping jack, squats, power jack, pelvic limb swings and moves. For each exercise, participants performed in two sets of 30 repetitions with 20 seconds of recovery time between exercises. Aerobic capacity was energy-targeted during this session.

Aerobic Training Session and Strengthening of Muscles

Aerobics combined and strengthening of muscles lasted 1 hour and a half and consisted of six different parts, namely: 1) grip in 5 minutes, 2) warm-up in 15 minutes; 3) muscle strengthening in 30 minutes; 4) aerobics for 25 minutes; 5) relaxation for 10 minutes and 6) a return to calmness and regaining control for 5 minutes.

During the session, the subjects worked at 65-70% of the theoretical HRmax, then the intensity was slightly increased from 70%-85% of the theoretical HRmax.

During this session, the warm-up part focused on cardiovascular activation, joint mobilization and muscle warm-up. It was carried out using fast walking, slow running and jumping exercises followed by stretching.

The muscle strengthening sequence was organized in the form of a circuit. This circuit consisted of 12 workshops that can be grouped mainly into squats, push-ups, abdominals, sheathing and jumps. The squats, push-ups and abdominals were done in 2 series with 30 seconds of recovery. Each set consisted of 10 repetitions in the first phase, then 15 and 20 in the last phase. Sheathing was also performed in two separate series of 30 seconds of recovery.

The series consisted of 20 seconds of effort in the first part and 30 seconds in the second.

The aerobic sequence included right, left, alternating, set up, lunch, jumping jack, squats, power jack, pelvic limb swings and moves. These exercises were performed in two sets of 30 repetitions / exercise with 20 seconds of recovery in between.

During the cycle, improvements in aerobic capacity and strength endurance were aimed at the energy level and the muscle level respectively.

Statistical analysis

The data were entered using Epi-Info version 7 software and the analysis was performed with SPSS version 22 software. All quantitative variables were expressed as mean $\pm$ standard deviation and quantitative variables as absolute frequencies with corresponding percentages. The Kolmogorov-Smirnov test was applied to verify normality. Comparison of variables within each group was performed using analysis of variance with repeated measures followed by post-hoc testing when Anova was found to be statistically significant. Inter-group comparisons of relative changes in the variables after the intervention were performed using a one-factor analysis of variance followed by post-hoc testing when Anova was found to be statistically significant. Chi-square test followed by Cramer's V calculation to compare the proportions between aerobic session (alone) and aerobic session combined with strength training. The Kaiser-Meyer-Olkin (KMO) test was performed to determine the sampling equation and to interpret the relationship between different variables. Principal component analysis was used to transform the number of correlated variables into a smaller number of uncorrelated variables. The significance level for all tests was set at $P < 0.05$.

Ethical opinion and authorizations

The study protocol was approved by the Scientific Committee of the Higher Institute of Physical Education (ISEPS) of the Marien NGOUABI University of Brazzaville/Congo.

RESULTS

The subjects studied were on average 16.13 ± 1.14 years old with a mean height of 162.03 ± 3.72 cm and a body mass (BM) of 79.10 ± 6.91 kg. The mean resting heart rate (HRr) and rectal temperature (Trec) were respectively: 75 ± 4 bpm; $39.94 \pm 0.19^{\circ}\text{C}$ (Table 1).

The data recorded during the training sessions (Table 2), were higher at the aerobic and muscle strengthening session than at the aerobic session (alone) for Borg's subjective perception of exertion (PEF_{BORG}) ($P < 0.001$) and energy expenditure (DE) ($P < 0.001$) and percentage weight loss (%PP) ($P = 0.03$). Compared to the TSI, the score obtained from the aerobic session (alone) was comparable to that of the aerobic and muscle strengthening session (6.48 ± 0.56 versus 6.44 ± 1.01 ; $P = 0.03$). No differences were observed in the physiological parameters (Fc, HRmaxtheo, %HRmax, Trec).

The level of accessibility to the aerobic session alone and to the aerobic and muscle strengthening session was not significantly different (11/23 or 48% versus 12/23 or 52%; $P = 0.76$). On the other hand, the latter form of

session was significantly more acceptable to the subjects studied (4/23 or 17% versus 14/23 or 61%; $P = 0.03$). (Table 3).

Table 4 of the main components shows the most suitable exercise session model for obese students. The KMO value for the session indicated 0.49, which contributes to the 49% sample adequacy. Regardless of the form of session, PCA identified two components as the most important, with their higher (total) eigenvalues being greater than 1. In the present study, components with absolute values greater than 0.70 were normalized as cut-offs for selection as these values were relatively strong and stable indicating a high loading on the extracted factor. It was noted that two variables met the loading threshold of 0.70 for both proposed session forms (Table 4). These variables are then classified as an important component that is particularly necessary to identify the dominant physiological factor. There are two components in axis 1 that have a satisfactory loading factor of 0.70, these are % PP and DE which show a positive loading. This meant that each component was related to the type of exercise most suitable for all conditions of exercise efficiency.

Table 1: Anthropometric and physiological data measured at rest and at the end of each form of session among surveyed students (n = 23)

	AWA		AWST	
	Before	After	Before	After
BM (kg)	79.10 ± 5.91	78.07 ± 6.91	79.04 ± 5.58	77.75 ± 5.92
HR (bpm)	75 ± 4	$171 \pm 6^{***}$	74 ± 5	$175 \pm 5^{***}$
Trec ($^{\circ}\text{C}$)	36.94 ± 0.33	37.81 ± 0.28	36.80 ± 0.28	$37.80 \pm 0.49^{***}$
Urine density	1.012 ± 0.009	1.108 ± 0.08	1.014 ± 0.009	1.015 ± 0.11

The numbers in the boxes represent means $\pm$ standard deviations ($m \pm s$); SEAM: aerobic workout and strength training; SEA: aerobic workout alone; MC: body mass; Fc: heart rate; Trec: rectal temperature; *** difference between pre- and post-workout values at $P < 0.001$.

Table 2: Physiological values recorded during the aerobic session and the aerobic session associated with muscle strengthening (n = 23)

	AWA	AWST	p-value
EHR (bpm)	171 ± 6	175 ± 5	0.18
HRmaxthéo (bpm)	203.87± 1.14	203.87 ± 1.14	-
%HRmax (bpm)	84.11± 3.45	86.03 ± 2.80	0.12
Trec (°C)	37.81 ± 0.28	37.85 ± 0.51	0.41
DE (kcal)	420.01± 39.06	590.34 ± 39.06***	< 0.001
%PP (%)	1.30 ± 0.45	1.63 ± 0.62*	0.03
IPCT	6.48 ± 0.56	6.44 ± 1.01	0.76
PEF _{BORG}	13.17 ± 1.58	15.87 ± 1.05***	< 0.001

The numbers in the boxes represent means ± standard deviations (m ± s); AWA: aerobic workout alone; AWST: aerobic workout and strength training; EHR: exercise heart rate; % HRmax: percentage of maximum heart rate; Trec: rectal temperature; DE: energy expenditure; %PP: percentage weight loss; TSI: thermal stress index; PEF_{BORG}: subjective perception of effort; * difference between AWA and AWST data at P < 0.05; *** difference between AWA and AWST data at P < 0.001.

Table 3: Comparison between levels of accessibility and acceptability of aerobics alone and aerobics combined with strength training.

Variables	AWA	AWST	ddl	p-value	V de Cramer
Accessibility level					
- accessible	11 (48)	12 (52)	1	0.76	0.43
- less accessible	12 (52)	11 (48)	1		
Acceptability level					
- acceptable	4 (17)	14 (61)	1	0.03	0.44
- unacceptable	19 (83)	9 (39)	1		

AWA: aerobic workout only; AWST: aerobic workout and strength training; numbers in boxes represent numbers and percentages.

Table 4: Factor load after varimax rotation in PCA in study subjects.

Variables	AWST		AWA	
	Component 1	Component 2	Component 1	Component 2
ACPT	0.30	0.61	-0.11	0.59
ACSS	0.49	0.51	0.24	0.83
% PP	0.70	-0.48	0.19	-0.55
Urine density	0.43	-0.73	0.44	-0.16
IPCT	0.57	0.36	-0.71	-0.21
% HRmax	-0.01	0.56	0.59	-0.44
PEF _{BORG}	-0.05	0.54	0.75	0.05
DE	0.78	0.12	-0.64	0.21
Total	1,67	1,64	2,14	1,66
% variance	20.98	20.56	26.80	20.83
Cumulative %	20.98	41.55	26.80	47.64

AWA: aerobic workout alone; AWST: aerobic workout and strength training; ACPT: acceptability; ACSS: accessibility; % PP: percentage of weight loss; IPCT: physiological index of thermal stress; % HRmax: percentage of maximum heart rate; PEF_{BORG}: subjective perception of Borg's effort; DE: energy expenditure.

DISCUSSION

The objective of this study was to compare the effectiveness, acceptability and accessibility of aerobic sessions alone and aerobic sessions combined with strength training. This study is the first to evaluate the level of acceptability and accessibility of obese adolescents to a form of physical activity session. Moreover, the rigorous control of the proposed session forms, the CPA and the experimental protocol make it a solid study to increase knowledge regarding the promotion of physical activity among a population of obese school-aged adolescents. The main results of this study are as follows: a) exercise HR was higher during the aerobic session; b) weight change was greater at the end of the aerobic and strength training session; c) energy expenditure was greater at the end of the aerobic and strength training session; d) the level of acceptability of the aerobic and strength training session was higher than that of the aerobic session alone.

The average %HRmax data at the end of the different sessions suggest that the students in this study had a high level of investment in the aerobic session. Although these data are lower than the theoretical values expected for this age group, they are consistent with the value reported in one study as being associated in obese youth aged 11-16 years (Toulouse et al., 2020).

Obese adolescents have reduced aerobic capacity in walking and running, with faster attainment of exhaustion compared to healthy subjects (Ratel et al., 2006). This is explained by a low aerobic threshold, a higher heart rate during supramaximal effort and a higher outlook than for a healthy population when performing the same relative exercise (Pelegrini et al., 2014; Horia et al., 2018).

With regard to the variation in weight during the sessions, the data collected show that this variation was greater at the end of the aerobic and muscle strengthening session ($P < 0.05$). The results indicate that this group experienced a loss of body mass of 0.32 kg. This decrease in weight is justified by the fact that these students lost more water due to a high rate of perspiration during the effort following

the high intensity and pace of the effort during this session. The water status of the participants prior to the session may also be a factor in the loss of body mass in this group. Similar results were obtained in a study in which participants experienced a loss of body weight at the end of the exercise (Reale et al., 2018; Laurent et al., 2019). Water losses through sweating are in fact much lower than the 2% of body mass, considered to be the limit for inducing a decrease in physical performance capacity (Barley et al., 2019). Another conclusion is that this weight loss would be justified by the high energy expenditure recorded during the aerobic and muscle strengthening session.

Differences in the IPCT between the two sessions could be associated with the fact that the sessions were conducted at the same percentage of their maximum heart rate. The students included in this study expended more energy during the aerobic session associated with muscle strengthening.

Although rectal temperature increased during both sessions, the rectal temperature was on average slightly elevated at the end of the aerobic and strength training session than was observed after the other. This finding supports the hypothesis that the students were more physically active during the first session. In view of the training conditions of this study, i.e. with exposure temperatures often above 32°C and a relative humidity of up to 61%, it was to be expected that body temperatures close to 39°C would be recorded in these young people. In such a context of physical practice, thermolysis becomes indeed difficult and the body temperature tends to rise rapidly.

Contrary to expectations, the aerobics session combined with muscle strengthening was more accessible than aerobics alone. Our results are consistent with those of a study conducted with obese adolescents that showed the importance of enjoyment, feeling competent and proximity on adherence and maintenance of physical activity (Stuntz and Weiss, 2010). The most plausible explanation is that aerobics and strength training is an easily accessible game for young people because it is more attractive than aerobics alone. Moreover, the possibility of practicing it

in any location increases compliance and accessibility. In the literature, a study of 1281 Australians found that proximity to walking trails was associated with increased frequency of recreational walking (Duncan and Mummey, 2005). Another study found that accessibility to attractive and open environments in cities was associated with proximity to walking at least 6 times per week (Giles-Cort et al., 2004). It is highly likely that the students surveyed therefore have the facility to practice aerobics and strength training in a more accessible environment.

This study also assessed the level of acceptability of aerobics and strength training and aerobics alone among these students. The high level of acceptability of this form of aerobic and strength training session certainly represents an additional avenue for explaining the level of effectiveness of this form of training and the increase in the active level of the participants. The results obtained here are in line with those of a study that showed that active older women were more likely to opt for spontaneous active behaviours and that they were more deeply committed to an active lifestyle than sedentary ones (Kluge et al., 2002). Finally, other authors point out that obese adolescents show high levels of state anxiety and overall self-esteem when performing exercise at maximum intensity, and perceive continuous exercise as low motivation (Mercier et al., 2010). Thus, the high level of acceptability and accessibility allowed participants to have a positive commitment to the aerobic and strength training session.

Several methodological limitations of this study deserve to be listed. One limitation of this study is the small sample size, which does not allow for the possibility of generalizing the results to all obese adolescents aged 13 to 18 years. A second limitation of this study is the use of the questionnaire to assess the level of accessibility and acceptability. Indeed, the answers to the questions were self-reported by the students, which would increase the risk of bias. Another limitation was that the duration of the two proposed training program was not optimal. All effects reported in this study were based on this training duration,

which would not imply any explanation for a long-term intervention. Indeed, the desired test duration for physiological changes is at least 8 to 12 weeks. Therefore, it is unlikely that these limitations will significantly influence our findings.

Conclusion

The purpose of this study was to determine the most appropriate type of exercise session for the management of obese children. Taking into account the effectiveness, the high level of accessibility of the aerobic session associated with muscle strengthening compared to aerobic alone, the results obtained show that the first session is the most adapted for the management of this obese population. The results of the PCA confirm the higher effect of the aerobic session combined with muscle strengthening on the parameters of the components of DE, %PP, thus suggesting the significant values of these after this session. However, it would be necessary to determine the beneficial effects of an interventional program combining aerobics and muscle strengthening in obese people.

COMPETING INTERESTS

There is no competing interest between the authors.

AUTHORS' CONTRIBUTIONS

All the authors contributed to the realization of this work and to the preparation of the manuscript.

ACKNOWLEDGEMENTS

The authors would like to thank all those who participated in this research.

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