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ORIGINAL ARTICLE

Impact of the Traditional Game "Otsongui" (Apnea) on Spirometric, Cardiovascular Parameters and Body Composition in Overweight and Obese School Children

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Abstract

Otsongui" apnea game, practiced in an extracurricular context, on the health of overweight and obese school children. The experiment was based on a 12-week program, applied to a sample of 60 overweight and obese students (mean age: 18 years), randomly divided into two groups: an experimental group (EG) and a control group (CG), each composed of 30 participants. The assessments focused on spirometric, cardiovascular and body composition parameters, using a spirometer, the modified Luc Léger test and an impedance meter. The results reveal significant improvements in the students of the experimental group: reduction of BMI (29.43 ± 1.18 *vs.* 27.44 ± 0.17), improvement of respiratory function (FEV1: 75.90 ± 3.42 *vs.* 84.90 ± 3.42; FEF75: 0.71 ± 0.39 *vs.* 1.22 ± 0.39), improvement of time in the specific apnea test (58.01 ± 0.07 *vs.* 72.20 ± 0.08), increase of VO_2 max (28.46 ± 3.12 *vs.* 24.48 ± 3.15) and improvement of body composition (increase of muscle mass, decrease of fat mass and improvement of water mass).

These results highlight the value of traditional aquatic physical activities, such as the "Otsongui" game, in improving cardiorespiratory fitness and combating a sedentary lifestyle among young people. It is therefore recommended that their practice be encouraged in an educational or family setting.

Keywords

"Otsongui" Game, Spirometry, Body composition, Endurance

Introduction

Traditional Physical Activities (TPA), rooted in movement and spatial displacement, occupy an important place in our daily lives [1]. Regular physical activity is recognized as an essential lever for health promotion [2], while a sedentary lifestyle constitutes an independent risk factor [3]. Lung function, particularly FEV1, is a key indicator of respiratory and cardiovascular health, its reduction being linked to increased morbidity and mortality, particularly in cases of COPD [4]. A reduced forced vital capacity (FVC), even without airway obstruction, is an indicator of a restrictive lung profile and a predictor of mortality [4]. Pulmonary function tests, particularly spirometry, are essential to objectively assess respiratory health and detect possible physiological limitations [5]. These measures can predict morbidity and mortality in the general population [4,6]. The main parameters assessed in spirometry are FEV1, FVC and PEF. Their variability is strongly influenced by genetic and environmental factors, reflecting a marked heterogeneity between populations [6]. BMI is a global measure of body size, but does not distinguish between fat and lean mass or fat distribution. Excess weight can impair lung function by reducing compliance, limiting

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expiratory flow, and decreasing exercise capacity, due to mechanical overload related to fat accumulation [7].

Physical activity improves body composition by reducing fat mass and increasing lean muscle mass. It also strengthens respiratory muscles, reduces inflammation, and increases lung capacity [8] showed that obese children engaged in structured exercise programs saw their fat mass decrease, their muscle mass increase and their spirometric parameters (FEV1, FVC) improve, thus confirming the positive effects of exercise on respiratory function.

Whether in urban or rural areas, many extracurricular activities are practiced, particularly through traditional games such as "otsongui" (apnea game), common among students living near aquatic environments in the Republic of Congo. Very popular during the holidays, this recreational game is practiced daily without real attention paid to its physiological effects. However, regular physical activity is known for its health benefits. However, according to [9], lack of time remains a major obstacle to regular practice. Play is a central element in the educational process and overall development of children. In urban areas, particularly in the outlying neighborhoods of our African cities, many students walk long distances to school every day due to a lack of access to public transportation. This active travel contrasts with that of students living in more central areas, who primarily use buses or other motorized means.

Furthermore, the modern urban environment is fostering a growing sedentary lifestyle among young people. High exposure to screens, particularly television, smartphones and tablets, is now a worrying factor for public health. Recent studies confirm this observation: an American study [10] revealed that around two-thirds of adults spend more than two hours a day in front of the television, and nearly 50% devote more than one hour a day to using a computer outside of their professional activities.

Faced with this reality, it becomes relevant to question alternative practices such as traditional active games such as the apnea game "otsongui" which, although considered fun and recreational, could have beneficial effects on the physical and respiratory health of children. The central problem of this study is therefore to understand to what extent these extracurricular physical activities can compensate for the effects of a sedentary lifestyle and contribute to the harmonious physiological development of overweight and obese students.

Methodology

Field of investigation and participants

Our study will be experimental. The age of the subjects varies between eleven (18) years and twenty (20) years. They are selected in an extracurricular play situation in this aquatic environment.The population of our study consisted of 85 schoolchildren who live not far from the Djiri River. Apes randomization, a sample of 30 schoolchildren from the experimental group subjected to the "otsongui" water games and thirty (30) subjects from the control group having only the school physical activities of EPS. For reasons of efficiency of the experimental procedure the experimental group was subdivided into three subgroups of ten (10) subjects for better monitoring, all children granted by their parents (informed consent) and having respected the commitment protocol; all subjects who know how to float in the water.

Experimental procedure

Freediving exercises: consisting of a freediving relay race over a distance of 6 to 8 meters; filling a one-liter bottle underwater, maintaining apnea for as long as possible (individual record) (Table 1).

To solicit apnea through predominantly anaerobic activity, with a strong hypoxic constraint. It also solicits CO_2 tolerance, optimizes oxygen economy and induces adaptive bradycardia linked to the immersion reflex. Lipato has made it possible to combine mixed activity (aerobic/anaerobic), at moderate to sustained intensity. It develops resistance and cardiovascular capacity over a short period of time.

Materials

It consisted of: an impedance meter to assess body composition; a spirometer to Assess respiratory capacity before and after exercise; a two (2) meter height measuring rod

Stanley brand (Accuracy: 10 mm by default) for measuring height; individual cards for data collection, a stopwatch to determine the time during the stress test.

Anthropometric variables

Height: A 2 m Stanley measuring rod graduated from 0 to 200 cm was used to measure height in a standing position. The individual's stature was determined from the ground to the top of the skull (vertex).

Body mass index: Height and weight data were used to calculate the body mass index (BMI) (Table 2), which was the quotient of weight and the square of height in m. The body mass index is used to determine the nutritional status of the subject through the following formula:

With: $\mathbf{IMC} = \frac{\mathbf{P\ (Kg)}}{\boldsymbol{T^2\ (m)}}$

BMI: Body mass index in kg/m^2; T: Height in meters (m) and W: Weight in kilograms (kg)

Spirometric variables

A portable spirometer of the spirobank G type produced by "Medical International Research " was used to measure the pulmonary function parameters

Table 1: Daily program of the subjects subjected to the 12-week experiment of the aquatic game "otsogui" apnea of the schoolchildren of the experimental group.

Motor activities	Apnea	Lipato
Spot task time	30 to 45 seconds max	10 to 15 minutes max
Breaks	15 to 20 seconds max	4-5 min max
Volume of work	1h30 on average in 24 hours	45 min on average
Number of series	4 to 6 sets with 30s rest	4 to 5 sets with 30 seconds rest

Source: [11]

Table 2: Interpretation of the corpulence and nutritional status of the subjects.

Body mass index (BMI)	Interpretation
BMI > 40	Very severe obesity
35.00 < BMI < 39.99	Severe obesity
30.00 < BMI < 34.99	Moderate obesity
25.00 < BMI < 29.99	Overweight (excess weight)
18.50 < BMI < 24.99	Normal
15.00 < BMI < 18.49	Slight thinness
BMI < 15	Severe thinness

Source: WHO, 1995.

of the subjects .The spirometry test was performed to record the respiratory parameters. It is carried out as follows (Medical International Research; 201). This test is used before and after exercise.

Body composition variables

Body composition variables were measured using the TANITA BC-545N pedometer (JAPAN). It allows the following variables to be determined: weight; body fat; muscle mass; bone mineral mass; water mass.

By setting on the device, the date, month, day, hour and minutes of the study then, insert the personal data of the subject including age, sex, activity level, height and weight. After setting up the device, the researcher must place the device on a hard and flat surface with a minimal vibration level. The subject stands by placing the feet on the electrodes and holding the electrodes with both hands. In less than a minute a beep declares the end of the operation and all the results were displayed on the screen from the reading on the impedance meter table.

Cardiovascular variables

The assessment of cardiorespiratory endurance in the Luc Leger and Boucher shuttle running test made it possible to determine the VO2 $_{max}$ of the subjects before and after the "otsongui" games program.

A cassette radio with a suitable sound system of two speakers; a tape of the Luc Léger test; a handball court (Leger and Bouger, 1985). From the absolute value of VO $_2$ max, the VO_2 max in relation to the subject 's weight (expressed in liters per minute) is determined according to the following formula: VO_2 max (l/min) = VO_2 max (ml/kg/min) × Weight (kg): 1000. The specific apnea test which consisted of measuring the time taken for apnea in seconds using a stopwatch.

Results

Anthropometric characteristics

It is clear from table 3 that no difference is observed for any of the variables studied apart from the body mass index.

Spirometric (Table 4)

Body composition (Table 5)

Muscular endurance values (Table 6)

Examining Table 5 shows significant differences in $VO_{2\ max}$ and in relation to weight before and after.

Discussion

Our hypothesis is that the traditional physical activity of otsongu (apnea) improves spirometric, cardiovascular, and body composition values in schoolchildren. We have reached the following results:

Table 3: Anthropometric variables of overweight school girls before and after the program in the form of mean and standard deviation.

Anthropometric variables	Before (n = 30)	After (n = 30)	P
Age (years)	18.77 ± 2.69	18.77 ± 2.69	NS
Weight (kg)	83.90 ± 2.79	74.30 ± 2.19	< 0.05
Size (cm)	1.68 ± 0.12	1.68 ± 0.12	NS
BMI (kg/m²)	29.44 ± 1.18	27.91 ± 1.12	< 0.05

BMI: Body mass index; NS: non-significant difference; p < 0.05: significant difference;

Table 4: Shows the comparative values of spirometry of overweight schoolchildren before and after the aquatic activities program of the apnea game "otsongui" in the form of mean plus or minus standard deviation.

Spirometric variables	Before (n = 30)	After (n = 30)	p
FEV1 (%)	75.90 ± 13.42	89.90 ± 3.42	< 0.05
FEF 25	1.40 ± 0.93	1.46 ± 0.93	NS
FEF 75	1.22 ± 0.39	0.71 ± 0.39	< 0.05
FEF 25-75	1.05 ± 0.57	1.15 ± 0.57	NS

FEV1: percentage of forced expiratory volume in one second; FEF 25: Forced airflow in 25 thirds; FEF75: Forced airflow in 75 thirds; FEF 25-75: Forced airflow between 25 and 75 thirds; NS: non-significant difference; p < 0.05*: significant difference

Table 5: Shows body composition values compared before and after the program as mean plus or minus standard deviation.

Body composition variable	Before (n = 30)	After (n = 30)	P
MM (%)	60.08 ± 12.91	66.08 ± 11.92	< 0.05
MMO (%)	19.94 ± 1.62	19.74 ± 5.62	NS
MG (%)	47.97 ± 5.42	42.98 ± 5.40	< 0.05
MH (%)	5.30 ± 0.12	5.90 ± 0.14	< 0.05

Table 6: Shows the values of maximum oxygen consumption and weight-related values before and after the “otsongui” games program in the form of mean plus or minus standard deviation.

Variable of muscular endurance	Before (n = 30)	After (n = 30)	P
$\dot{V}O_2$ max (ml /kg.min^{-1})	24.56 ± 3.15	28.46 ± 3.12	< 0.05
$\dot{V}O2_{max}$ (l/min)	2.60 ± 1.16	4.02 ± 1.89	< 0.05
TSA(s)	58.01 ± 0.07	72.20 ± 0.08	< 0.05

VO_2 max: maximum oxygen consumption and TSA: specific apnea test

The results show a significant decrease in BMI in the participants of the experimental group, related to the intensity of the program based on the aquatic game "otsongui". This activity promotes high energy expenditure and beneficial physiological adaptations. As confirmed by [12], progressive training improves general physical condition. Although BMI is a good indicator, it remains incomplete without the analysis of body composition. Regular physical activity, in addition to preventing obesity, contributes to mental health, well-being and the prevention of chronic diseases, according to [13].

Analysis of Table 4 reveals a significant difference ($p < 0.05$) in forced expiratory flow at 75% (FEF75) in the experimental group (EG) subjects after exercise. FEF75, which represents the airflow expired when 75% of the forced expiratory volume (FEV1) is reached, is sensitive to changes in inspiratory and expiratory volumes. The observed improvement in FEF75 in the GE can therefore be explained by the joint increase in these volumes during exercise.

In contrast, although FEV1 values remained high after exercise in this group, a decrease in FEF75 was observed. This decrease could be related to the accumulation of residual air in the lungs, resulting from the high respiratory demand imposed by apnea exercise. This phenomenon is in agreement with the work of [14], which indicates that physical exertion leads to an increase in pulmonary ventilation in order to meet the increased oxygen demand and the elimination of CO_2 .These observations are also consistent with the results of [15], who found, in children aged 6 to 12 years, a temporary decrease in FEF75 after exercise, followed by a gradual return to baseline values. Their study, based on exercises such as running and swimming, highlights the impact of exercise on respiratory function in the short term.

Children with a history of asthma or allergies showed an even more marked decrease in FEF75, highlighting bronchial hypersensitivity to exercise. This increased sensitivity highlights the importance of regular monitoring of respiratory functions in children, especially those with respiratory pathologies. As highlighted by [16], fatigue following physical exertion can disrupt certain bodily functions such as breathing.

The results of our study also reveal a phenomenon of tracheobronchial collapse during forced expiration, due to excessive intrathoracic pressure, exceeding that of the bronchi. This phenomenon causes air retention (air trapping), thus reducing expiratory flow, as observed in certain post-exercise situations.Furthermore, our study confirms that high-intensity physical training significantly improves cardiorespiratory function in children. These observations corroborate the results of [17,18], according to which intense physical activity in adolescents leads to a more rapid improvement in muscle oxidative capacity, compared to moderate training. A meta-analysis involving adolescents aged 11 to 17 years also highlighted the superior effect of intensive exercise on improving cardiorespiratory functions.

The results of the study show significant changes in body composition in participants in the experimental group (EG) who followed a training program based on the aquatic game "otsongu" (apnea). After the exercise, significant differences were observed in muscle mass and water mass rates ($p < 0.05$), as well as a very significant difference in fat mass rate ($p < 0.05$). These transformations are attributed to the regular practice of the activity, demonstrating its beneficial effects, including a marked reduction in fat mass.

An increase in water mass in the GE participants, in contrast to the control group (CG), suggests better cellular hydration and optimized metabolic functioning. In subjects with initially high fat mass, the effects were more pronounced, confirming greater mobilization of lipids as an energy source.These results are consistent with those of [11], who demonstrated that regular practice of the traditional lipato game in children helps reduce the prevalence of overweight, [19] also observed notable improvements in body composition in children engaged in moderate to intense exercise programs such as swimming or running. In addition, [20] demonstrated that resistance exercises combined with aerobics contribute to the increase in muscle mass, the reduction of fat mass, and the improvement of spirometric parameters, notably forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), in obese adults.

The results of our study reveal a significant increase in VO_2 max, both in absolute value and in relative value to body weight, in the participants of the experimental group .This improvement can be attributed to the intensity and volume of the efforts made during the training sessions based on water play “otsongu” (apnea), which strongly solicit the aerobic system .These observations are consistent with data from the scientific literature. Indeed, studies have shown that in children, an exercise intensity greater than 80% of VO_2 max is necessary to expect progress, and an intensity between 90% and 120% of VO_2 max seems to

be optimal. However, the expected average progress, in terms of VO_2 max (approximately 8%), the increase in apnea time observed in the subjects is explained by the effectiveness of the training program based on the "otsongui" game. This program specifically mobilizes respiratory capacities through efforts in hypoxia, thus strengthening CO_2 tolerance and the efficiency of oxygen use.

Regarding apnea time, this improvement is correlated with the increase in VO_2 max values, a key indicator of aerobic capacity. A higher VO_2 max means that subjects are able to consume more oxygen during exercise, which is essential in apnea where oxygen management becomes critical. Furthermore, the increase in muscle mass observed in the experimental group promotes better use of oxygen in active tissues, which prolongs the possible duration of apnea. In short, the program allowed a synergistic physiological adaptation: improvement of cardiorespiratory function, optimization of muscle mass, and gain in respiratory efficiency, explaining the increased performance in apnea are lower than those that can be achieved in adults (20%).

Additionally, research has indicated that children demonstrate faster performance parameter recovery abilities than adults, allowing them to sustain intense efforts more efficiently [21].

Limitations of the Study

Our research has some limitations, including the lack of measurement of static lung volumes (total lung capacity, expiratory reserve volume) and additional body measurements. In addition, the influence of the aquatic environment on heart rate was not fully considered. Breath-hold exercises, although relevant, require rigorous supervision to avoid any risk of syncope. Finally, energy expenditure was not measured. Despite this, our results remain consistent with the literature and suggest a real improvement in VO_2 max through a combination of training intensity and adapted physiological responses in overweight and obese children.

Conclusion

Our hypothesis postulated that regular practice of this aquatic game leads to a significant improvement in spirometric, cardiovascular and body composition parameters in overweight and obese students. The results obtained confirm this hypothesis. Indeed, these results highlight the importance of extracurricular activities in improving physical fitness and in combating a sedentary lifestyle, which is responsible for much cardiovascular, metabolic and respiratory pathology. Therefore, we recommend that parents and supervisors encourage the participation of overweight and obese schoolchildren in these traditional practices of medium intensity and high volume of effort in an aquatic environment. Despite certain methodological limitations, notably the absence of data on energy expenditure.

Conflict of interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors contributed to this article and agree with the content and approved the final manuscript.

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