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

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Abstract

Otsongui "apnea game" is practiced in an extracurricular context on the health of overweight and obese schoolchildren. 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. Assessments were carried out 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 in BMI (29.43 ± 1.18 vs 27.44 ± 0.17), respiratory function (FEV1: 75.90 ± 3.42 vs 84.90 ± 3.42; FEF75: 0.71 ± 0.39 vs 1.22 ± 0.39), improvement in time in the specific apnea test (58.01 ± 0.07 vs 72.20 ± 0.08), increase in VO_{2max} (24.48 ± 3.15 vs 38.46 ± 3.12) and improvement in body composition (increase in muscle mass, decrease in fat mass, and improvement in 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 to encourage their practice in an educational or family setting.

Keywords

"Otsongui" Game, Spirometry, Body Composition, Endurance

1. 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 decrease is linked to accumulated 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 impairing compliance, limiting expiratory flow, and decreasing exercise capacity due to mechanical overload associated with fat accumulation [7].

Physical activity improves body composition, particularly 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), which are common among students living near aquatic environments in the Republic of the Congo. Very popular during the holidays, this recreational game is practiced daily without any 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% spend more than one hour a day 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 promoted as 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 include the effects of a sedentary lifestyle and contribute to the harmonious physiological development of overweight and obese students [11] [12].

2. Methodology

2.1. Field of Investigation and Participants

Our study will be experimental. The subjects' ages vary between eleven and twenty years. They are selected in an extracurricular play situation in this aquatic environment. The population of our study consisted of 85 adolescents who lived not far from the Djiri River. After randomization, a sample of 30 adolescents from the experimental group was subjected to the "otsongui" water games and thirty subjects from the control group had 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 subjects for better monitoring, all children granted by their parents (informed consent) and having respected the commitment protocol; all subjects knew how to float in the water.

2.2. Experimental Procedure

Freediving exercises consist of relay courses in freediving over a distance of 6 to 8 meters; filling a one-liter bottle underwater; and maintaining apnea for as long as possible (individual recording).

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

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

Source: Alongo *et al.* (2024) [1].

Physiological objectives require apnea through predominantly anaerobic activity, with strong hypoxic stress. It also requires CO_2 tolerance, optimizes the economy of oxygen and induces adaptive bradycardia through 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[1] (Table 1).

2.3. Materials

It consisted of: an impedance meter to assess body composition; a spirometer to assess respiratory capacity before and after exercise; a two-meter-high Stanley brand measuring rod (accuracy: 10 mm by default) to measure height; individual sheets for data collection; and a stopwatch to determine the time during the exercise test.

2.4. 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).

Height and weight data were used to calculate the body mass index (BMI), which is 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 using the following formula:

$$\text{BMI} = \frac{P(\text{kg})}{T^2(\text{m})}$$

with:

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

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

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 (2014) [13].

2.5. Spirometric Variables

A portable spirometer of the Spirobank G type, produced by Medical International

[1]Lipato is a traditional Congolese game, particularly popular in Brazzaville, which is played outdoors. It is a game of skill and pursuit where one player chases others by trying to tag them with their hand or a ball, and the tagged player then becomes the chaser.

Research, was used to measure the pulmonary function parameters of the subjects. Spirometry testing was performed to record respiratory parameters. It was performed as follows. This test was used before and after exercise.

2.6. Body Composition Variables

Body composition variables were measured using the TANITA BC-545N pedometer (Japan). It allowed the following variables to be determined: weight, fat mass rate, muscle mass rate, bone mineral mass rate, and water mass rate.

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

2.7. Cardiovascular Variables

The assessment of cardiorespiratory endurance in the Luc Léger and Boucher shuttle running test made it possible to determine the VO_{2max} of the subjects before and after the program of games based on "otsongui", a radio cassette with an adequate sound system of two speakers; a tape of the Luc Léger test; and a handball court (Léger & Bouger, 1980) [14]. From the absolute value of the VO_{2max}, the VO_{2max} in relation to the subject's weight (expressed in liters per minute) is determined according to the following formula: VO_{2max} (l/min) = VO_{2max} (ml/kg/min) × Weight (kg): 1000. The specific apnea test consisted of measuring the time taken to hold the breath, in seconds, using a stopwatch (**Tables 3-6**).

3. Results

3.1. Anthropometric Characteristics

Table 3. Anthropometric variables of overweight schoolgirls before and after the program, in the form of mean and standard deviation.

Anthropometric variables	Before	After	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/m^2)	29.44 ± 1.18	27.91 ± 1.12	<0.05

Abbreviations: BMI: Body mass index; NS: Non-significant difference; $p < 0.05$: Significant difference.

It is clear from **Table 3** that no differences are recorded for any of the variables studied, apart from the body mass index.

3.2. Spirometry

Table 4 shows that significant differences are observed in FEV1 and FEF75, while no notable differences are found in FEF25 and FEF25-75.

Table 4. Comparative spirometry values of overweight adolescents before and after the aquatic activities program of the apnea game "otsongui" in the form of average plus-or-minus deviation type.

Variable spirometry	Before	After	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 ± 0.19	1.91 ± 0.21	<0.05
FEF 25 - 75	1.05 ± 0.57	1.15 ± 0.57	NS

Abbreviations: 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.

3.3. Body Composition

Table 5 indicates significant differences in muscle mass, fat mass, and body water. However, no difference is observed in bone mineral mass throughout the program.

Table 5. Body composition values compared before and after the program as mean ± standard deviation.

Body composition variable	Before	After	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

Abbreviations: MM (%): Muscle mass percentage; MMO (%): Bone mineral mass percentage; MG (%): Fat mass percentage; MH (%): Water mass percentage; NS: Non-significant difference; $p < 0.05$: Significant difference.

3.4. Muscular Endurance Values

Table 6 highlights significant differences in nearly all the parameters measured during the program.

Table 6. Values of maximum oxygen consumption and values related to weight before and after the "otsongui" games program in the form of mean ± standard deviation.

Variable of muscular endurance	Before	After	P
VO_{2max} (ml/kg·min^{-1})	24.56 ± 3.15	38.46 ± 3.12	<0.05
VO_{2max} (l/min)	2.60 ± 1.16	4.02 ± 1.89	<0.05
TSA (s)	58.01 ± 0.07	72.20 ± 0.08	<0.05

Abbreviations: VO_{2max}: Maximum oxygen consumption; TSA: Specific apnea test.

4. Discussion

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

4.1. Anthropometry of Practitioners

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 "otsongui" water game. 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 [15].

4.2. Spirometry of Practitioners

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 expires 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 consistent with the work of other authors [16], who indicate that physical exertion leads to an increase in pulmonary ventilation in order to meet the accumulated oxygen demand and to eliminate CO_2. These observations are also consistent with the results of [17], who observed, in children aged 6 to 12 years, a temporary decrease in FEF75 after exercise, followed by a gradual return to initial values. Their study, based on exercises such as running and swimming, highlights the impact of exertion on respiratory function in the short term.

Children with asthma or allergy symptoms showed an even more marked decrease in FEF75, highlighting bronchial hypersensitivity to exercise. This sensitivity increases, highlighting the importance of regular monitoring of respiratory functions in children, particularly those with respiratory pathologies. As highlighted by [18], 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 that exceeds that of the bronchi. This phenomenon causes air retention (air trapping), thus driving 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 [19] [20], according to which intense physical activity in adolescents leads to faster muscle oxidative capacity compared with moderate training. A meta-analysis of adolescents aged 11 to 17 years has also highlighted the superior effect of intensive exercise on improving cardiorespiratory functions.

4.3. Body Composition of Practitioners

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 "otsongui" (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 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 traditional lipato play among children helps reduce the prevalence of overweight; [21] also observed notable improvements in body composition among children participating in moderate to intense exercise programs such as swimming and basketball [22]. Furthermore, [23] has 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, including forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), in obese adults; these results correspond to the studies of [24].

4.4. Muscular Endurance of Practitioners

The results of our study reveal a significant increase in VO_{2max}, 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 the volume of effort provided during training sessions based on the water game "otsongui" (apnea), which strongly stress 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_{2max} is necessary to hope for progress, and an intensity between 90% and 120% of VO_{2max} seems to be optimal. However, the expected average progress, in terms of VO_{2max} (approximately 8%), the increase in apnea time recorded 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 efficiency of oxygen use.

Regarding apnea time, this specific test is correlated with the increase in VO_{2max} values, a key indicator of aerobic capacity. A VO_{2max} higher 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: cardiorespiratory function, optimization of muscle mass, and gain in respiratory efficiency, resulting in accumulated apnea performance being lower than that we can reach 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 [25].

4.5. 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 taken into account. Apnea 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 allow for a real VO_{2max} measurement through a combination of intensity training and adapted physiological responses of overweight and obese children.

5. Conclusion

Our hypothesis postulated that the 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 sedentary lifestyles, which are responsible for many cardiovascular, metabolic, and respiratory pathologies. 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.

Authors' Contributions

All authors contributed to this article, agreed with its content, and approved the final manuscript.

Ethical and Safety Considerations

In order to receive authorization from the Ethics Committee and the Ministry of Secondary Education, it was necessary to create a Research Organization Committee to finalize the project and present it to these entities. This committee was composed of the researchers of the article, 3 members of the Laboratory of Physiology of Effort and Biomechanics, a general practitioner, and a nurse, under the supervision of the Laboratory coordinator. Subsequently, it was necessary to determine the sample and send a letter to the director of the chosen colleges to meet the inclusion criteria. For this, contacts were first made with the members of the Departmental Directorate of Sports and Physical Education of Brazzaville. Specific contacts were also made with the administrative authority of the selected school and with the parents (or guardians); to do this, the Organizing Committee had to hold meetings to explain the type of study, the objectives, and the rationale of the research. After receiving their favorable opinion (CERSSA on n˚ 001-23/MESRSIT/DGRST/CERSSA/25), the work was carried out with the students individually to comply with the instructions. The Organizing Committee was responsible for monitoring the stages of the work progress.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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