Effects Of Tsam-Tsam Transport By Bicycle On Cardiovascular, Anthropometric Indices And Energy Expenditure Among Transporters In The Congolese Basin

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Abstract: The objective of our study was to evaluate the cardiovascular variables, the energy expenditure and anthropometric parameters of the motor bike and pedal transporters. Our sample concerned 23 transporters whose average ages varied between 29.45 ± 5.05 years and 32 ± 7.40 years divided as follows: 11 pedal bicycle transporters (TVP) and 12 motor bicycle transporters (TVM). The measured variables are carried out transversely and classified into three categories: anthropometric, metabolic cardiovascular variablesThe results obtained show that the transport of tsam-tsam by pedal bicycle (TVP) presents significant adaptations on the cardiovascular indices [PAS (123.18 ± 2.68 Vs 146.08 ± 6.58) (mm Hg) ; PAD (76.27 ± 1.42 Vs 98.67 ± 6.14) (mm Hg); MAP (91.91 ± 1.53 Vs 114.47 ± 5.74) (mm Hg)], Anthropometric (61.96 ± 2.85 kgVs 79.02 ± 2.09 kg) including BMI (20.74 ± 2.01 kg / m2 Vs 26.71 ± 1.23 kg / m^2) and energy expenditure (4323.57 ± 60.48kcal Vs 126.79kcal). The data were entered on EPI Info version 5.1.0 and then processed using SPSS 23.0 software and Student's t test for unpaired series was used. Pedaling is a crucial factor for cycling. Indeed, it allows the preservation of lean mass, therefore avoiding overweight which would lead to overweight or even obesity. This is how the wish is that motor bike transporters (TVMs) should strengthen other daily activities to overcome overweight.

Keywords: Transport, Tsam-tsam, Bike, Cardiovascular, metabolic and Congolese

1. INTRODUCTION

Drum transport is a commercial activity practiced in the Republic of Congo decades ago. On the other hand, it is done on foot with calabashes by hawkers in shoulders. This activity is widely practiced in the northern part of the Congo, particularly in the Congolese basin, more precisely in the localities of Makoua and Owando. It also takes on a considerable scale in the Kouilou with black tip and the plateaus in Gamboma. This activity is a way of life to support the needs in the marketing of this local wine "Tsam tsam", made from date palm. Harvesters are in partnership with transporters in marketing. Once harvested in the places of production, the harvesters transport it to the point of exchange with the transporters. Nowadays, this activity is practiced using pedal bikes and motors, thus covering distances of approximately 60 to 70km from the marketing site. This transport by pedal or motorbike is a physical activity which induces physical effort, which physiologically presents modifications or adaptations of the organism during the transport of this wine. There fore, this daily practice for carriers is a physical activity of life. In light of the literature [1] reports that physical conditioning by intense activities is also a healthy lifestyle, also [2] note that physical activity has health benefits. Indeed, [3] have shown that the mortality rates of sedentary people are higher than those of active workers, many studies have specified its benefits in primary, secondary and tertiary prevention for different diseases. Physical activity is defined by the WHO as "any bodily movement produced by the contraction of skeletal muscles and increasing energy expenditure above rest expenditure" [4]. Physical activity has an energy cost which can be translated into quantifiable energy expenditure. Insufficient physical activity is considered a fundamental element in gaining weight over time and therefore an obstacle to preventing obesity. A report from the Kino-Quebec Scientific Committee entitled "Amount of physical activity required to gain health benefits" [5], makes an important link between the increase in the volume of physical activity and the health benefits. The report's conclusion can be summarized as follows: increased physical activity, however small, is good for health, especially for sedentary people. The more active the person, the better their health, regardless of age, gender, physical condition or current level of activity. Just as physical inactivity has been classified by the World Health Organization (WHO) as the leading cause of death from noncommunicable diseases after infectious diseases. It increases all causes of death, doubles the risk of cardiovascular disease, diabetes, obesity and increases the risk of colon cancer, high blood pressure, osteoporosis, lipid disorders, depression and anxiety. According to the WHO, 60-85% of the world's population in developed and developing countries has a sedentary lifestyle, making it one of the most serious public health problems of our era. Obesity will serve as a backdrop for this project to introduce physical activity that helps maintain quality of life. The transport of tsam-tsam is done in two stages, the first is that of the places of production to the places of trade and the second is that of the places of transaction to the various points of sale in the big cities. Previously, this step was done exclusively with pedal bikes regardless of the distance. Today with the modernization and the evolution of science, there has been the advent of motor bikes including "Jakarta". Thus, we notice that many carriers in order to win and save money, use motor bikes as pedal bikes. This allows them to work less and to gain a lot in terms of remuneration based on the number of container capacities to transport. It is in this perspective that we ask the fundamental question in terms of problematic summarized in the following way: what is the

impact of the transport of tsam-tsam by pedal bicycle and motor on the cardiovascular, anthropometric indices and energy expenditure with carriers? To answer this question, we formulated the following hypothesis: the mercantile activity of the transport of tsam-tsam by bicycle induces cardiovascular, anthropometric adaptations and a higher energy expenditure in pedal bicycle transporters than in bicycle transporters engine. The objectives assigned in this study are to evaluate the cardiovascular variables of transporters, to evaluate the energy expenditure of transporters and to measure the anthropometric parameters of transporters. This study aims and interests to show that the transport of tsam-tsam by motor bike, although it is beneficial from the commercial point of view but has drawbacks on the sanitary level. Material & methods

2.1 Experimental setting

Our study is a cross-sectional study carried out in Makoua and Owando in the bowl department, more precisely in the village of ADIBA and Ossangou during the month of August 2019.

2.2 Population

The target population of our study consisted of pedals and motor bikes from Tsam-Tsam.

2.2.1 Sample

Our sample was of 23 carriers distributed as follows: 11 pedal bicycle transporters and 12 motor bicycle transporters.

2.2.1.1 Inclusion criteria

Being a transporter of Tsam-Tsam by pedal bike (TVP) or by motor bike (TVM) over the same distance measured 60km from the point of sale; have the good will to cooperate.

2-1-2 Exclusion criteria

Be a transporter of Tsam-Tsam carrying out other activities; Be a carrier of Tsam-Tsam using mileage more or less than 60 km.

1. Material

The material which served us to carry out this study consisted of: a two (2) meter height rod of Stanley mark (Accuracy: 10 mm by default) to measure the size; one does not weigh anyone of the Omron brand (EU) calibrated in kilogram (kg) for weight measurement; a blood pressure monitor consisting of a cuff with a monogram for blood pressure; a heart rate monitor for the resting heart rate; an accelerometer for energyexpenditure and exercise heart rate; individual sheets for data collection.

2.2.1.2. Présentation of the variables

The measured variables are classified into three categories: anthropometric variables (height and weight), metabolic variables (energy) and cardiovascular variables (heart rate, blood pressure).

2.2.1.2.1 Anthropometric variables Size

Material:

A two (2) meter height rod from the Stanley mark (Accuracy: 10 mm by default).

Principle :

Measuring height consisted of determining the stature of the subjects. Technical: The subject was asked to stand barefoot on a flat and compact surface, in an upright position, looking towards the horizon of the ground, keeping the body straight and the arms stretched out along the body. The reference being the feet and vertex, the researcher placed the height rod behind the subject, compressed the subject's hair with a square (tip) fixed on the measuring rod graduated to the nearest centimeter. The individual's stature was determined from the ground to the top of the skull (vertex).

Weight measurement

Material:

An Omron (EU) brand bathroom scale.

Principle:

Weight measurement consisted of determining body mass. Technical The researcher placed the scale on a flat, solid surface and then asked the subject to stand upright and barefoot on the scale tray. The subject was instructed to direct his gaze to the horizontal of the ground. The value of body mass was measured in kilograms from the reading on the scale.

Body mass index

Height and weight data were used to calculate the body mass index (BMI) which was the quotient of weight and the square of height in m. The body mass index is used to determine and assess the subject's overweight or nutritional status. Its formula is as follows:

BMI: Body mass index in kg / m 2
T: Size in meter (m)
P: Weight in kilograms (kg)

$$IMC=\frac{P\ (Kg)}{T^2\ (m)}$$

Body mass index (BMI)	Interprétation
Si BMI >40	Very severe obesity
Si 35,00< BMI <39,99	Severe obesity
Si 30,00< BMI <34,99	Moderate obesity
Si 25,00< BMI <29,99	Overweight (overweight)
Si 18,50< BMI IMC <24,99	Normal
Si 15,00< BMI <18,49	Slight thinness
Si BMI < 15	Severe thinness

The equipment used to measure the heart rate of the effort was the accelerometer brand Garmin Forerunner R15 Quick Star (USA)

Principle:

These measures consisted of determining: the number of heartbeats during exercise; of the amount of energy supplied during exercise.

Technical:
Before beginning physical exertion, the subject wore a belt with sensors for cardiac and metabolic activities which were transmitted to a watch worn on the wrist. He was instructed to turn on his accelerometer and then press the exercise indicators trigger button until he observed the appearance of the heart that marked cardiac activity. At the end of the exercise, the administrator noted and recorded the value of the exercise heart rate, the and the energy expenditure of the subject.

2. STATISTICAL ANALYSIS

The data was entered on EPI Info version 5.1.0 and then processed using SPSS 23.0 software. The quantitative variables were expressed as an arithmetic mean accompanied by the standard deviation. The comparison of two means for the continuous variables before and after the experiment was carried out by the paired Student's t-test to examine the effect of pedaling on each parameter of interest in the carriers of the tsam tsam by bike. For the comparison of the same variable between pedaling and non-pedaling by Student's t-test for unpaired series was used. The only ones are fixed in the following ways: tc < 1.96, the difference was not significant; If tc> 1.96, the difference was significant ($p<0.05$); If tc ≥ 2.58, the difference was very significant ($p<0.01$); If tc ≥ 4 the difference was highly significant ($p<0.001$)

3.1 Anthropometric characteristics

The age, height, weight and body mass index (BMI) of pedal and motorbike transporters are presented in Table I as an average and standard deviation ($\bar{X} \pm \delta$).

Table 1: *Anthropometric variables of carriers*

Anthropometric variables	TVM (n=12)	TVP (n =11)	Significance	
			tc	p
Age (years)	32±7,40	29,45±5,05	0,97	NS
Size (m)	1,72±0,06	1,71±0,08	0,84	NS
Weight (kg)	79,02±2,09***	61,96±2,85	9,45	<0,001
BMI (kg / m^2)	26,71±1,23***	20,74±2,01	4,25	<0,001

Abbreviations: TVM: Motor bike transporters; TVP: Pedal bike carriers; NS: non-significant difference, $p<0.05$ *: significant difference, $p<0.05$; **: very significant difference, $p<0.01$; ***: highly significant difference, $p<0.001$.

The analysis of table I made it possible to show a non-significant difference between the values of age on the one hand and on the other hand a large significant difference between the values of height, weight and mass index body (BMI) of motor bicycle tsam-tsam transporters and pedal bicycle transporters.

3.2 Cardiovascular variables and expenditure and energy

Table 2 shows the resting heart rate (FCo), the effort heart rate (FCE), the maximum heart rate, the systolic blood pressure, the diastolic blood pressure, the average arterial pressure and the energy expenditure (DE) tsam-tsam transporters on motor bikes and pedal bikes in the form of mean and standard deviation ($\bar{X} \pm \delta$).

Table 2: *Cardiovascular variables and energy expenditure of carriers*

Cardiovascular variables and metabolic	TVM (n=12)	TVP (n=11)	Significance	
			tc	P
FCo (bpm)	86,25±5,79***	66,64±3,96	9,54	<0,001
FCE (bpm)	99,92±4,21	130,00±5,92***	13,54	<0,001
FC max (bpm)	188,00±7,40	190,55±5,05	0,97	NS
PAS (mmHg)	146,08±6,58***	123,18±2,68	11,1	<0,001
PAD (mmHg)	98,67±6,14***	76,27±1,42	12,29	<0,001
PAM (mmHg)	114,47±5,74***	91,91±1,53	13,13	<0,001
DE (kcal)	1632,14±37,64	4323,57±60,48***	126,79	<0,001

Abbreviations: TVM: Motor bike transporters; TVP: Pedal bike carriers; NS: non-significant difference, $p<0.05$; *: significant difference, $p<0.05$; **: very significant difference, $p<0.01$; ***: highly significant difference, $p<0.001$.

The results obtained made it possible to show that the max HR of pedal bicycle transporters and motor bicycle transporters were not significantly different ($p<0.05$). On the other hand, the FCo, FCE, PAS, PAD and PAM of pedal bicycle transporters and motor bicycle transporters were highly significant ($p<0.001$). In addition, the ED of pedal bicycle transporters and motor bicycle transporters was highly significant ($p<0.001$).

3 DISCUSSION

The work of this thesis was carried out with the aim of evaluating and comparing the effects of the transport of tsam-tsam by motor bike and pedal bike on the cardiovascular indices and energy expenditure among the carriers of this wine in the Congolese bowl. At the start of this study, we hypothesized below: the mercantile activity of tsam-tsam transport induces cardiovascular and metabolic adaptations that are important in pedal bicycle transporters

than in motor bicycle transporters. The verification of this hypothesis is made on a methodology adapted to the environment of the field of investigation and to the geomorphological context. The measurements and test have been validated by the scientific community. To test this hypothesis, we conducted a prospective cross-sectional study using research in Life and Health Sciences in general and exercise physiology in particular. The results obtained are no small consideration. The transport of tsam-tsam being a physical activity, its practice is determined by several factors including anthropometric characteristics. The results obtained show that motor bike and pedal bike carriers have statistically different values for age (32 ± 7.40 years vs. 29.45 ± 5.05 years), weight (79.02 ± 2.09kg vs 61.96 ± 2.85kg) and BMI (26.71 ± 1.23 kg.m-2 vs 20.74 ± 2. 01kg.m-^{2}). On the other hand, they present identical values concerning the size (1.72 ± 0.06 vs 1.71 ± 0.08) (table 1). The BMI values of these subjects make it possible to classify them among those with a normal nutritional state according to the classification of the WHO reported by [6]. These results show a tendency of overweight motor transporters. This difference in the body mass index is explained by the fact that with pedal bicycle transporters, the activity is very intense which makes it possible to burn fat while expending energy, on the other hand in transporters with motor bike the tendency of overweight is due to the slightest effort they provide therefore they accumulate a lot of reserves in the form of fats. Physical activity during leisure time was inversely associated with all-cause mortality among men and women of all age groups. An advantage was found of moderate physical activity during leisure time, with an additional advantage of sporting activity and cycling as a means of transport. [7], the caloric expenditure in cycling is approximately 400 to 600 kilocalories (kcal) per hour for a practice in excursion and 600 to 800 kcal per hour in competition. This expenditure will be a little more important in VTT (Mountain bike) than in road because more muscles work in this discipline. In the factors involving weight gain, it is necessary to emphasize the energy balance. A positive energy balance, that is, a food intake that exceeds energy expenditure, is the direct cause of weight gain [8]. The practice of physical activity therefore helps to preserve lean mass during weight loss with an energy restriction. These results also show that the transport of tsam-tsam by pedal bicycle plays a major role in weight maintenance. Indeed, pedaling induces cardiovascular adaptations and energy expenditure. This is explained by the fact that the results concerning the resting heart rates (FCo) show that the difference between the motor bike carriers and the pedal bike carriers is highly significant (86.25 ± 5.79 vs 66, 64 ± 3.96). The resting heart rate of pedal bicycle transporters who resemble trained athletes is explained by the fact that these transporters engage in significant physical activity daily with distances of 72 to 90km back and forth. This allows them to have a resting heart rate of about 66 beats per minute. In other words, pedal bicycle carriers by the impact of pedaling are similar to highly trained top athletes. The resting heart rate, which partly determines the general condition of the heart, generally ranges between 60 and 80 beats per minute [9]. What emerges from these results is that the resting heart rate of pedal bicycle carriers is under normal conditions. Therefore, their hearts are in good working order. On the other hand, that of motor bicycle transporters, which is above 86 beats per minute, proves that the heart is insufficiently active despite transport. For the frequency of effort (FCe), the results show that there is a significant difference between the transporters on motor bikes and those on pedal bikes (99.92 ± 4.21 vs 130.00 ± 5.92; $p<0.001$). These results show that during the transport of tsam-tsam, pedal bicycle transporters are subjected to intense activity which stimulates the heart in its functioning. Therefore, the heart being stressed during transport, this allows carriers to have a healthy heart in order to avoid cardiovascular disease. According to [10], subjects acquiring a sufficient level of physical activity have an improved prognosis on mortality or recurrence of cardiovascular events. Thus, their functional capacities are better which promotes a longer life expectancy in good conditions. If physical inactivity is an independent cardiovascular risk factor, on the other hand, physical activity has a positive effect on all of the modifiable risk factors. Physical activity is recommended for primary and secondary prevention in coronary artery disease, chronic heart failure and arteriopathy obliterating the lower limbs, but to date there are no significant data in favor of a direct action on the prevalence of stroke. The results show that there is no significant difference between motor bicycle and pedal bicycle carriers (188.00 ± 7.40 vs 190.55 ± 5.05; $p<0.05$). This is explained by the fact that they have almost the same average age. According to [11], the maximum heart rate is the maximum number of beats that a subject can not exceed regardless of his level of activity, that said that the maximum heart rate in practitioners of physical activity or in athletes does not depend on the activity or training, It varies according to age. Regarding systolic and diastolic blood pressure, the results show a highly significant difference between the data of motor bike carriers and those of pedal bike carriers (146.08 ± 6.58mmhg vs 123.18 ± 2.68mmhg ; $p<0.001$) for systolic blood pressure and (98.67 ± 6.14 mm Hg vs76, 27 ± 1.42; $p<0.001$). These results show that pedal bicycle carriers exhibit normal functioning of the heart. As a result, they are immune to cardiovascular disease and hypertension because blood pressure reflects the efficiency with which blood flows through the cardiovascular system. According to [10], physical activity reduces hypertension at rest or during exercise, with an average drop of 3.2 mm Hg of systolic pressure and 2.7 mm Hg of diastolic pressure. High blood pressure (hypertension) is defined by values of systolic blood pressure greater than 140mmHg and diastolic blood pressure greater than 90mmHg. In people with hypertension, physical activity decreases the systolic blood pressure by 11mmHg and the diastolic blood pressure by 8mmHg on average. The mechanisms of this decline are still incompletely known. It is notably enabled by a decrease in peripheral arterial resistance, a decrease in endothelial dysfunctions and neuro-hormonal abnormalities linked to hypertension and an increase in insulin sensitivity. The results obtained concerning mean arterial pressure (MAP) show a highly significant difference between motor bike transporters and those of pedal bike transporters, namely (114.47 ± 5.74mmHg vs 91.91 ± 1.53 mm Hg; $p<0.001$). This explains the proper functioning of the cardiovascular system of pedal bicycle carriers. Increasing physical activity and decreasing physical inactivity also have positive effects on blood pressure [12]. On the other hand, motor bike transporters, having less daily physical activity, they are comparable to semi-sedentary subjects. Consequently, their cardiac activity during transport does not have any beneficial effects because the volume and the intensity of muscular

work are low. Regarding energy expenditure (DE), the results in Table 2 show a highly significant difference between the energy expenditure of motor bicycle transporters and those of pedal bicycle transporters, namely (1632.14 ± 37.64Kcal vs 4323.57 ± 60.48Kcal; p<0.001). Indeed, pedaling on the hills and pushing the bike with load induces energy dependencies according to the needs of the activity of the pedal bike while on a motor bike, the transporter is practically like a sedentary. In addition, the distance between transaction locations which are 60 km or even 70 km apart, would influence this energy expenditure. Pedal bike carriers spend more ½ of energy than the motor bike (4323.57 ± 60.48Kcal Vs 1632.14 ± 37.64Kcal). This is explained by the muscular work which is more important in pedal bicycle carriers. Pedaling, which ensures the movement of the bicycle, involves the production of mechanical energy. Increasing physical activity is the only way to increase energy expenditure over which we can exercise some control [13]. This energy expenditure makes it possible to control the weight while increasing the energy expenditure thus favoring a balanced energy balance, an essential condition for maintaining lean mass and reducing fat mass. The transport of tsam-tsam being a physical activity, with effects which are favorable for the well-being of carriers in general and carriers of tsam-tsam on pedal bikes in particular. The results obtained during this study show that pedal bicycle transporters are subjected to extreme physical effort compared to motor bicycle transporters which are semi sedentary. As a result, motorbike tsam-tsam carriers are predisposed to overweight or even to the stage of obesity by the accumulation of energy reserves. Physical activity is a great way to increase daily energy expenditure and therefore contributes to maintaining a stable weight. According to some studies, physical activity may be effective in reducing the cardio-metabolic risk. Indeed, [14] demonstrated that physical fitness with low cardiorespiratory capacity were independently associated with risk factors for cardiovascular disease in adolescents aged 9-15 years. Another study investigating the effects of aerobic interval training for 3 months compared to a multidisciplinary approach of 12 months on risk factors for cardiovascular disease in 54 overweight and obese adolescents, it reveals that aerobic interval training is more effective than the multidisciplinary approach in improving the risk profile of cardiovascular disease in obese adolescents. The same authors pointed out, however, that to decrease the risk factors for cardiovascular disease, physical activity levels should be higher than the current international standards. Thus, in the prevention and fight against serious diseases, physical or sports activity is considered to be an a priori factor favorable to health. It is an important factor in preventing and fighting certain serious diseases. The work of [3] demonstrated that sedentary people were at a higher risk of mortality than physically active workers. Today, the numerous studies in this field agree to demonstrate that regular and moderate physical activity acts favorably on health, physical condition and improves the quality of life. Inactivity or insufficient activities are major elements in the development of cardiovascular and brain diseases [15]. Cardiovascular disease is the second leading cause of death in the world today. They become the leading cause of death from the age of 65. Physical activity, on the other hand, has a decisive action in the prevention and treatment of recent deaths [16]. Physical activity is now recommended in the field of cardiovascular diseases, both to prevent their occurrence and to limit the consequences when they are installed. Numerous studies have shown that physical training reduces morbidity and cardiac mortality by acting on risk factors such as lipid profile, blood pressure, coagulation and physiology of the vessel wall [17]. In this regard, the WHO reports that regular physical activity has a protective role in colon cancer in men and breast cancer in women. This reduction is around 60% when comparing subjects with significant physical activity compared to sedentary individuals.The glucose metabolism is increased and regulated during a regular and moderate effort, aerobic type, in the case of a suitable diet. Type 2 diabetes is a particularly explicit example, since physical activity alone can prevent its occurrence in almost 60% of cases in subjects with glucose intolerance. Muscle is the central element of all physical qualities because any physical exercise requires muscle function (walking, jumping, throwing, carrying, etc.), which is why cardiovascular function also depends on the level of physical activity. This vital function is complex. Physical activity therefore solicits this muscle and makes it progress. The more the heart muscle is developed, the more blood it sends out with each beat. Therefore, it beats slower at rest, it saves and tolerates efforts better.Physical activity is associated with a significant reduction in depressive and anxiety states in the population.

4 CONCLUSION

The purpose of this study was to assess the cardiovascular indices and the energy expenditure of tsam transporters. This corroborates the WHO definition, quality of life as "the perception that an individual has of his place in life, in the context of the culture, and the value system in which it lives, in relation to its objectives, expectations, standards and concerns ". The quality of life linked to health is therefore structured around three main dimensions : the physical or physiological dimension, the mental or psychological dimension and the social and environmental dimension. Regular physical activity contributes to the quality of life by acting on these different factors: satisfaction with the body, reduction in stress levels, positive emotional experiences through integration into the group or a positive outlook on the other, participation active in social life. tsam on motorbike and pedal. The results obtained show that the transport of tsam-tsam by pedal bicycle has significant adaptations on the cardiovascular indices and energy expenditure which is high during its practice, is a crucial factor for the preservation of lean mass, therefore avoiding overweight which leads to overweight and obesity. This type of transport indicates a healthy state of health therefore improves the quality of life of the practitioners. However, on motor bikes, carriers are exposed to overweight, hypertension and cardiovascular disease. The fight against physical inactivity is a real public health issue. Regular aerobic physical activity of medium intensity, and all the more so, high, as well as weight training exercises have a favorable effect on resting metabolism and prevent the reduction of lean mass linked to weight loss and to aging. Indeed, we suggest strengthening other activities for motor bike transporters to benefit from the quantity and volume benefits of activities on health and the quality of their lives.

REFERENCES

[1]. Kostrzewa-Nowak D, Nowak R, Jastrzębski Z, Zarębska A, Bichowska M, Drobnik-Kozakiewicz (2015). Effect of 12-week-long aerobic training programme on body composition, aerobic capacity, complete blood count and blood lipid profile among young men. Biochemia medica: Biochemia medica.; 25(1):103-113.

[2]. Baquet G, Van Praagh E, Berthoin S (2003). Endurance training and aerobic fitness in young people. Sports médicine ; 33(15) :1127-1143

[3]. Jackson Sutharsingh (2020). Effect of six weeks aerobic training on selected physical fitness variables among men students, International Journal of Physiology, Nutrition and Physical Education ; 5(1) : 52-53

[4]. Comité scientifique de Kino-Québec, CSKQ (1999). Quantité d'activité physique requise pour en tirer des bénéfices pour la santé : Avis du comité. Gouvernement du Québec : 15 Ministère de l'Éducation : 1-27.

[5]. Ewamela A., Empilo S., Ndebani F., Mankoko L., J. Bongbelé., (2006). Composition corporelle au cours d'un cross populaire en ambiance chaude et humide. Cahiers Africains de Recherche en Education 5 : 123-132, Paris : Le harmattan.

[6]. Andersen L.B. Et al. (2000). All-cause Mortality Associated with Physical Activity During Leisure Time, Work, Sports ans Cycling to Work, Arch. Intern. Med. Vol 160, June 12

[7]. Roy., R (2017) L'effet de la durée, l'intensité et la dépense énergétique de l'exercice sur la consommation d'oxygène post-exercice (EPOC) chez les adolescentes sédentaires

[8]. Cherifi Khalili., (2018). Variation de la fréquence cardiaque des judokas algériens au cours de la période compétitive (Cas des clubs CRBDB d'Alger et NRAS de Ghardaïa). P. 32

[9]. ANIS., J (2015). Analyse des freins à la prescription des activités physiques chez les médecins généralistes picards (Thèse-Université de Picardie Jules Verne UFR Médecine d'Amiens) ; p : 18-20

[10]. Catherine Maillard. (2017). La fréquence cardiaque : le meilleur atout santé du sportif''. Congrès de la Société Européenne de Cardiologie (ESC) Munich.

[11]. Véronique Julien (2015) Impact de l'activité physique combinée à une prise en charge multidisciplinaire sur la condition physique d'adolescents obèses (Mémoire- Faculté de médecine Université Laval Québec, Canada) :28-29.

[12]. Roseline Pompilus (2011). Détection des augmentations de 5 et de 10% de la dépense énergétique totale : comparaison des estimations de deux accéléromètres : p : 4-5

[13]. Andersen LB, Harro M, Sardinha LB, Froberg K, Ekelund U, Brage S and Anderssen SA. (2006) Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). Lancet ;368 : 299-304. [15] So HK, Sung RY, Li AM, Choi KC, Nelson EA, Yin J et al. TF Higher exercise frequency associated with lower blood pressure in Hong Kong adolescents : a population-based study Hum Hypertens. 2010 ; 24(10) :646-51

[14]. BIGOT., L (2008). Le sport, enjeu de santé publique, revue de presse.

[15]. Wilmore J.H D.L.Costill, D. L ., (2017). Physiologie du sport et de l'exercice, 6e édition, De Boeck Supérieur, Paris, Bruxelles.