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Non-hemodynamic predictors of blood pressure in recreational sport practitioners in Cotonou, Benin Republic

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Abstract

Currently, there are evidences that regular physical activity is an efficient means to control high blood pressure. This cross-sectional study aims at identifying in subjects who exercise in non-institutional structures at Cotonou, the main factors that account for the inter-individual variations of the blood pressure. Four adiposity indexes, indirectly assessed VO_2max, atherogenous blood lipids, resting heart rate and blood pressure (SBP and DBP) were assessed in 120 recreational sport practitioners (RS), aged 13 to 52 years. The characteristics of the recreational sport practitioners and the history of cardiovascular disease were also assessed in all participants. Descriptive statistics (means ± standard error of the mean) were computed for all the variables. Pearson's coefficients of correlation were computed and a linear multiple regression was used to identify the best predictors of blood pressure. The results indicate that transportation by car or motorcycle and the length of daily walking less than 30 min correlated with high diastolic blood pressure. Age was an independent predictive variable of arterial blood pressure in this study sample ($R^2 = 0.095$, $p < 0.001$ for SBP; $R^2 = 0.18$, $p < 0.001$ for DBP). Together, and after adjustment for age, neck circumference and HDL-cholesterol were the most powerful predictors of the SBP ($R^2 = 0.14$, $p < 0.05$) and the sum of skinfold thickness along with the DBP ($R^2 = 0.21$, $p < 0.05$). It is concluded that exercises in non-institutional structures can be effective in managing hemodynamic health problems. However, this should be combined with meaningful dietary practices.

Keywords: Physical activity, blood pressure, obesity, hemodynamic predictors, non-institutional structures, Benin.

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Introduction

An individual's value of the blood pressure depends on the interactions between hemodynamic factors such as cardiac output, total peripheral resistance (Daniels et al., 1996) and non-hemodynamic factors such as age, sex, blood lipids, heredity, etc. The association among these various factors explains the inter-individual variance in the values recorded in a given population. These blood pressure values can rise abnormally at the level of an individual, or in a population, revealing a temporal arterial hypertension (AHT), i.e. a systolic pressure ≥ 140 mmHg and/or a diastolic pressure ≥ 90 mmHg (OMS, 1999) which become often persistent. The AHT affects 30% of men and 50% of the 65 to 75 years old women in the world, but it is currently observed in young individuals (OMS, 2005; Petrella, 1998). It is estimated that by 2025, a third of the world population will be hypertensive (He et al., 1994). The importance of this pathology related to cardiovascular conditions in Africa is well established (Agboton et al., 1987) and the AHT of an individual of black racial background has become an important public health problem (Aubry, 2003). Its risk factors that are non-modifiable (age, sex, heredity, etc.) and those that are modifiable through behaviour modification and/or the environment (excess consumption of salt, dyslipidemia, obesity, sedentariness, stress, tobacco use, etc.) are well known.

Among the primary and secondary therapeutic interventions for AHT and the prevention of its risk factors, the WHO (OMS, 1999) recommends firstly physical activity, especially aerobic exercises associated with a diet and personal hygiene. Indeed, aerobic exercise not only prevents against the disease in the long term, but also reduces in the short term, the systolic blood pressure from 4 to 9 mmHg in pre-hypertensive and hypertensive subjects (Padilla, Wallace & Park, 2005; Sallis et al., 1988).

The first fitness centres in Benin Republic were begun in Cotonou between 1980 and 1990 so that individuals can benefit from the hypotensive effect of regular physical activity. However, the high cost of the subscription to these centres and the prevalence of AHT, obesity and especially of their risk factors in the Beninese school population (Gouthon , Agbotan & Aremou, 2005), caused the proliferation of non-institutional structures of recreational sport (RS). The promoters of these structures are generally volunteers. Some of them do not have any formal education in the fitness field. Consequently, the exercises performed in these centres do not have the characteristics (intensity and load) necessary to ensure prevention against AHT and its risk factors like obesity and dyslipidemia (Hamer, 2006; Padilla et al., 2005; Cléroux & Lacourcière, 1991). Furthermore, the members of these non institutional structures are heterogeneous in terms of age, life style, motivation, ethnological and professionalism. These factors are likely to cause a great variability in the design and management of exercise programmes designed to manage AHT and its associated risk factors (Gratas-Delamarche & Delamarche, 1990; Klissouras, 1971).

A periodic assessment of the cardiovascular profile and the identification of the factors which are associated with the variability of blood pressure in this group of practitioners will be desirable in order to determine the effectiveness of the exercise programme performed. This type of assessment is common at exercise centres of a number of countries (Coetsee, 2003; Coetsee, 2002). However no study aimed at identifying the predictors of blood pressure among practitioners of recreational sports in Benin is available. The few studies on physical activities are rather interested in either the atherogeneous risk factors among students in formal settings (Gouthon et al., 2005), or in the determinants of blood pressure in sportsmen and women (Arèmou et al., 2007). The present study aims to fill this gap, and identify the best predictors of blood pressure in a group of recreational sports practitioners in Cotonou, Benin Republic.

Material and methods

Design of the Study

This is a descriptive and cross-sectional study, carried out in Benin Republic, from November 2006 to March 2007. All the participants gave their written consent, after being informed of the objectives and the procedures of the study which received the approval of the Scientific Council of the University of Abomey-Calavi.

Study sample

The target population consisted of all men and women who have a RS practice in Cotonou. The study involved seven non-institutional structures of practitioners who exercise at Cotonou during the weekends, at open spaces, the sport grounds of schools and at the esplanade of the National Stadium (*Stade de l'Amitié*). In fact, these structures are not recognised by the Benin Ministry of Homeland Security. These seven structures were chosen randomly (probabilistic method) based on the list of 35 structures identified in Cotonou. A non probabilistic and exhaustive sampling was then used at each of the seven structures, in order to select the participants who satisfied the criteria of inclusion. These criteria are: individuals should volunteer; be aged $\geq$ 13 years; be practising RS in one of the structures for at least six months; have not missed more than four consecutive weekly sessions during the last quarter of the year. The subjects taking medication for diabetes mellitus, AHT, and malaria were excluded from the study. The minimal sample size of 113 subjects was calculated, using the formula of Schwartz (1983) with an AHT prevalence of 8% and a Type I α error of 0.05. Finally, a total of 120 RS practitioners were enrolled in the study.

Measurements

Anthropometric measurements taken with standard equipment including SECA scales (calibrated to the nearest 0.1kg), stadiometer graduated to within 0.5 cm, Holtain Caliper skinfold thickness (to the nearest 2mm) and the subjects in light clothing without shoes. The skinfold thickness was measured according to the recommendations of Durnin and Rahaman (1967) and those of Fleta-Zaragozano (1999). Neck circumference was measured just on top of Adam's apple (Ben-Noun & Laor, 1983). Waist and hip circumferences were taken (within 1mm) with a tape measure, at the waist midway between the lowest rib and the iliac crest, and at the greater trochanter, respectively (Mac Dougall,Howard & Howard 1988). Heart rate monitors (Accurex Plus, Polar, Finland), and manual blood pressure monitors (Vasquez) were used to measure heart rate and blood pressure, respectively.

The Korotkoff I and Korotkoff V points were recorded as systolic blood pressure (SBP) and diastolic blood pressure (DBP), respectively. The blood lipid assessment was carried out, using the enzymatic and colorimetric method, using a spectrophotometer (Secomam S250).

VO_2max was measured indirectly in all the subjects, using the 20m shuttle run test of Léger and Lambert (1982).

Procedures for data collection

The data were collected only once on all the subjects, under the same conditions, i.e. by the same testers, using the same equipment, at the same days of the week and times of the day. Each anthropometric and cardiovascular parameter was measured three times consecutively and the average of the three measures was recorded. The measure of blood pressure was carried out early in the morning, before 9 hours, the subjects being at rest for at least 10 minutes. Blood sample (5 mL) was taken from the ante cubital fossa fold of the left elbow, in subjects after at least 12 hours fasting and refraining from intense physical activity for 36 hours.

Study variables

Assessment of the effects of recreational sports (RS) on the blood pressure is the main objective of this study. In this study, the term RS refers to regular exercising, with a utilitarian goal, i.e. exercising which aims at maintaining good health. In this context, the two groups of variables of the study are as follows: *Dependent variables*. These variables are the two principal components of blood pressure, i.e. systolic blood pressure (SBP) and diastolic blood pressure (DBP), with respective values higher than 140 mmHg and 90 mmHg considered as abnormal. These values correspond to the WHO lowest limits of AHT grade 1 (OMS, 1999). *Independent or predictive variables*. These variables are the characteristics of practitioners' physical activity, such as the seniority of RS practice (YP); the average distance covered per day by feet or bicycle (DFB) expressed in km; the usual movement patterns (MP), according to two modalities: by feet or bicycle, and by car or motorcycle.

The degree of obesity was indirectly assessed by the sum (SS) of four skinfolds thickness (bicipital, tricipital, subscapular, supra iliac), and by four adiposity indexes which are: body mass index (BMI), neck (NC) and waist (WC) circumferences, and the waist to hip ratio (W/H). BMI serves as an index of [general] body obesity; waist and neck circumferences, respectively as abdominal and trunk obesity. The W/H ratio accounts for the distribution of the corporal fat. Blood lipids (total cholesterol, HDL-cholesterol, LDL-cholesterol) and an index of fitness (indirectVO_2max) were also assessed. Taking into consideration the available data (Gibson, 2005; Ben-Noun & Laor, 2003; OMS, 1999; Boreham et al., 1993; Akplogan, Agbotan & Corneau, 1985), we consider abnormal, the following values of the study variables: BMI > 30 $kg.m^{2}$, NC > 34 cm for women and > 37 cm for men; SS > 140 mm for women and > 95 mm for men; WC > 80 cm for women and > 94 cm for men; W/H > 0.8 for women and > 1.0 for men; VO_2max < 35 $mL.kg^{-1}$ min^{-1} for women and < 40 $mL.kg^{-1}$ min^{-1} for men; total cholesterol (TC) > 2 g/L; LDL-cholesterol (LDL-C) > 1.6 g/L; HDL-cholesterol (HDL-C) < 0.40 g/L in men and women.

Statistical analysis

The data were processed with the Statistica software (Stat Soft Inc, 5.5version). The normality of the distribution and the equality of variance of the main variables were preliminarily assessed, using the Kolmogorov and Smirnov's test and the Levene's test, respectively. Descriptive statistics (mean ± standard error of the mean (SEM) were computed for all the variables. Pearson's coefficients of correlation were calculated, and a linear multiple regressions was used to identify the best predictors of blood pressure in the study sample. Only the independent (predictive) variables that significantly correlate to each component of the blood pressure ($p < 0.05$) were included in the models of the linear multiple regressions separately for SBP and DBP. The level of statistical significance of the tests and the coefficients of correlation was set at $p < 0.05$.

Results

The study sample includes 17.5% women and 82.5% men, with a sex ratio of 1/21. They have all attended primary school for at least six years and none of them had smoked before. On the whole, 42% of them exercise two hours or more per week and 39% have had a RS practice for more than five years (min = 6 months; max = 20 years). In 77.5% of the cases, the usual means of transportation is the car or motorcycle; but 63% of the subjects claimed that they commute by feet or by bicycle, more than 30 minutes per day. In this group, only 25% of the subjects have practised competitive sport for at least three years. Family history of cardiovascular disease is present in 37% of the subjects. The descriptive statistics for the other variables are presented Table 1.

Table 1: Physical characteristics of hypertension risk factors in recreational sport practitioners at Cotonou.

Variables	Women (N = 21) M ± SEM	Men (N = 99) M ± SEM	Whole sample (N = 120) M ± SEM
Age (years)	33.6 ± 2.4	34.5 ± 0.8	34.3 ± 0.7
Height (cm)	165.0 ± 0.9	173.1 ± 0.6	171.7 ± 0.6
Body mass (kg)	74.6 ± 2.7	75.5 ± 1.4	75.3 ± 1.3
Body mass index (kg/m²)	27.3 ± 0.9	25.0 ± 0.4	25.4 ± 0.4
Sum of skinfolds (mm)	80.7 ± 6.2	47.7 ± 2.3	53.5 ± 2.5
Waist circumference (cm)	87.7 ± 2.9	86.2 ± 1.1	86.4 ± 1.1
Waist/Hip ratio	0.8 ± 0.0	0.8 ± 0.0	0.8 ± 0.0
Neck circumference (cm)	33.9 ± 0.6	37.5 ± 0.2	36.9 ± 0.2
Resting heart rate (bpm)	74.9 ± 1.9	70.3 ± 1.0	71.1 ± 0.9
SBP (mmHg)	104.6 ± 4.1	107.0 ± 1.3	106.6 ± 1.3
DBP (mmHg)	65.9 ± 2.9	65.8 ± 1.3	65.8 ± 1.2
MAP (mmHg)	78.8 ± 3.2	79.8 ± 1.2	79.8 ± 1.1
Total cholesterol ($g.L^{-1}$)	1.9 ± 0.1	1.6 ± 0.1	1.7 ± 0.0
HDL-cholesterol ($g.L^{-1}$)	0.5 ± 0.0	0.4 ± 0.0	0.4 ± 0.0
LDL-cholesterol ($g.L^{-1}$)	1.2 ± 0.1	1.1 ± 0.0	1.1 ± 0.0
VO_2max ($mL.kg^{-1}.min^{-1}$)*	26.5 ± 0.7	37.9 ± 0.6	35.9 ± 0.7

SBP : systolic blood pressure; DBP : diastolic blood pressure; MAP : mean arterial pressure; N : sample size; M : mean value ; SEM : standard error of the mean; * maximal oxygen consumption indirectly assessed by the 20 m shuttle run test (Léger & Lambert, 1982).

Table 2: Prevalence of arterial hypertension and its risk factors in recreational sport practitioners in Cotonou (N = 120).

Arterial hypertension risk factors	Women (N = 21)	Men (N = 99)	Whole sample (N = 120)
Body mass index ≥ 30 kg/m²	6 **(28.5%)**	14 **(14.1%)**	20 **(16.6%)**
Sum of skinfolds ≥ 140 mm (♀) or ≥ 95 mm (♂)	1 (4.7%)	5 (5.1%)	6 (5%)
Waist circumference ≥ 80 cm (♀) or 94 cm (♂)	15 **(71.4%)**	25 **(25.2%)**	40 **(33.3%)**
Waist/Hip ratio ≥ 0.8 (♀) or ≥ 1,0 (♂)	15 **(71.4%)**	4 (4.0%)	19 **(15.8%)**
Neck circumference ≥ 34 cm (♀) or ≥ 37 cm (♂)	10 **(47.6%)**	52 **(52.5%)**	62 **(51.6%)**
Resting heart rate ≥ 100 bpm	0 (0%)	0 (0%)	0 (0%)
Systolic blood pressure ≥ 140 mmHg	1 (4.7%)	1 (1.0%)	2 (1.6%)
Diastolic blood pressure ≥ 90 mmHg	1 (4.7%)	2 (2.0%)	3 (2.5%)
Total cholesterol ≥ 2 $g.L^{-1}$	8 **(38.1%)**	14 **(14.1%)**	22 **(18.3%)**
HDL-cholesterol < 0.40 $g.L^{-1}$	1 (4.7%)	8 (8.1%)	9 (7.5%)
LDL-cholesterol ≥ 1.6 $g.L^{-1}$	3 **(14.2%)**	4 (4.0%)	7 (5.8%)
*Indirect VO_2max < 35 $mL.kg^{-1}.min^{-1}$ (♀) or < 40 $mL.kg^{-1}.min^{-1}$ (♂)	20 **(95.2%)**	59 **(59.5%)**	79 **(65.8%)**

*N : sample size ; values in the cases are absolute frequencies with percentages in the brackets; maximal oxygen consumption indirectly assessed by the 20 m shuttle run test (Léger & Lambert, 1982). ♀ : in women. ♂: in men.

Table 3 presents the correlations between SBP, and DBP and each predictive variable. It indicates that:

- none of the variables commonly associated with physical activity, has a significant correlation with SBP, but the usual movement patterns and the average length of walking or moving by bicycle per day, are correlated with DBP;

- all the anthropometric variables and blood lipids are significantly correlated with SBP ($p < 0.01$), except for SS ($r = 0.17$; $p = 0.054$). LDL-C is the only blood lipid that significantly correlates with DBP ($r = 0.26$; $p = 0.004$);

- HDL-C has a positive correlation with SBP;

- the correlation between indirect VO_2max and blood pressure (SBP and DBP) is negative but the coefficient of correlation is significant, only with DBP ($r = - 0.28$; $p = 0.001$).

Table 3: Coefficients of correlation between systolic and diastolic blood pressure and each of the predictive variables in recreational sport practitioner in Cotonou (N = 120).

Predictive variables	Systolic blood pressure		Diastolic blood pressure	
	R	p value	r	p value
Seniority in the practice (months)	-0.040	0.664	-0.064	0.485
Mean duration of RS practice per week (hours)	-0.05	0.517	-0.159	0.083
Usual movement patterns	-0.070	0.442	**-0.251***	0.006
Mean duration of walk or moving by bicycle	-0.153	0.095	**-0.192***	0.035
Age	**0.30***	0.001	**0.43***	0.0001
Body mass index	**0.27***	0.003	**0.35***	0.0001
Sum of skinfolds	0.17	0.05	**0.34***	0.0001
Neck circumference	**0.30***	0.001	**0.24***	0.007
Waist circumference	**0.29***	0.001	**0.39***	0.0001
Waist/Hip ratio	**0.26***	0.003	**0.31***	0.0001
Resting heart rate	0.001	0.99	-0.07	0.42
Total cholesterol	**0.21***	0.01	0.16	0.06
HDL-cholesterol	**0.21***	0.01	0.13	0.15
LDL-cholesterol	**0.22***	0.01	**0.26***	0.004
Indirect VO_2max *	-0.16	0.08	**-0.28***	0.001

RS: recreational sport; r : coefficient of correlation ; p value : level of signification ; * : coefficient of correlation significant for $\alpha = 5\%$. * indirect VO_2max : maximal oxygen consumption indirectly assessed by the 20 m shuttle run test (Léger & Lambert, 1982).

The variables (highlighted in Table 3) whose coefficients of correlation with SBP and DBP are statistically significant are plotted for the multivariate regression (Table 4). In this Table, age appears as an independent predictor of SBP (adjusted $R^2 = 0.08$) and DBP (adjusted $R^2 = 0.18$). After adjustment for ages (steps 2 and 3), the other significant predictors ($p < 0.05$) of SBP are NC at step 2 (adjusted $R^2 = 0.11$) and HDL-C at step 3 (adjusted $R^2 = 0.14$). The SS is the solely significant predictor of DBP (adjusted $R^2 = 0.21$).

Discussion

Prevalence of arterial hypertension risk factors

The results indicate that in our study sample, all the practitioners have exercised for at least six months, even if about half of them do not have more than two hours per week of recreational sport. They also indicate that despite this regular practice, the prevalence of obesity increased whatever is the criterion of reference, index of adiposity or distribution of body fat. The prevalence of the risk factors appears higher in women than in men. Nelson, Esler and Jennings (1986) observed after four weeks of exercise training (three sessions per week at 60 – 70% of VO_2max), a decrease of 9 and 11 mmHg, respectively for systolic and diastolic blood pressure.

Table 4: Results of the multivariate regression between each dependent variable (SBP and DBP) and hypertension risk factors in recreational sport practitioners at Cotonou (N = 120).

Variables	Steps	Independant variables	β Coefficients	Constants	Standard error of estimation	R^2	Adjusted R^2	P values
SBP	1	Age	0.309	88.97	13.78	0.095	0.088	0.0005
	2	Age	0.218	55.49	13.56	0.131	0.116	0.024
		NC	0.209					0.030
	3	Age	0.170	40.41	13.38	0.161	0.140	0.08
		NC	0.230					0.01
		HDL-C	0.180					0.04
DBP	1	Age	0.436	42.93	12.03	0.189	0.182	0.0001
	2	Age	0.354	41.73	11.79	0.22	0.210	0.0009
		SS	0.211					0.01

SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: waist circumference; NC: neck circumference; R^2: coefficient of determination; adjusted R^2: adjusted coefficient of determination; β : coefficient of regression; SS: sum of skinfolds.

However, this decrease was not followed by a body weight loss. Thus, as Hagberg (1990) pointed out, a decrease in arterial blood pressure after exercise training is not always correlated with body weight lost.

In a population constituted of slender subjects (30-36 years old) in south-western China, He et al. (1994) recorded an AHT prevalence of 2.7% to 6.1% in women. In this study, the authors found an annual increase of SBP in men (0.13 mmHg to 0.36 mmHg) and women (0.06 mmHg to 0.56 mmHg). In spite of the weight difference between this group and that of our study, the prevalence of AHT is comparable and age is equally involved in the increase of arterial blood pressure in the two studies.

Both the weak prevalence of AHT and low level of VO_2max unexpected in our study are in contradiction with the existing studies and could be explained as follows. Petrella (1998) noted that exercises of lowest intensities induce the greatest decrease of arterial blood pressure among hypertensive subjects involved in fitness programmes. Exercising at low intensity may induce a reduction in arterial blood pressure, but this training load is not enough to increase the maximal oxygen consumption (VO_2max). It is probably the case with the subjects in our study. The other possible reason is that the negative effect of a low aerobic fitness on the arterial blood pressure, particularly the systolic pressure, might be mediated by age (the first predictor in this study). As our subjects are relatively young (mean age = 34 years), the effects of the age are not perceptible even in the youngest of them. It is thus understood that the average systolic and diastolic blood pressures in our study are largely on this side of normal values proposed by the WHO, i.e. ≤ 139/89 mmHg (OMS, 1999).

A systematic recording of the data as each individual subscribes would have enabled us to assess the difference between these first values and those of this study, which were recorded after at least six months of practice.

Predictors of systolic and diastolic blood pressure

Our results show that neither the previous sport practices, nor the current recreational practices, influence to a significant degree, the arterial blood pressure in our study sample. It is possible that the current exercise workload is not enough to stimulate the physiological phenomena involved in the lipolysis, but the nature of the exercise bouts could also be evoked. Indeed, the training sessions consisting of three times out of the five, working for 40 to 45 minutes, of which a warm up of 15 min, muscular developement of the legs and trunk (20 to 30 repetitions) were followed by 25 to 30 min of walking or race. During these exercises, heart rate may increase within 110 to 145 beats per minute. In the other two groups, the sessions which lasted 60 minutes (in total) include a warm up of 15 min, and three sessions of 15 min football games. Due to the duration and intensity, heart rate may increase exponentially.

Contrary to our expectation, HDL-C presents a positive correlation with the arterial blood pressure. There is no obvious explanation for this result. VO_2max is not correlated with systolic blood pressure (SBP) but with diastolic blood pressure (DBP). These results do not agree with those of Dwyer and Jibbons (1994), Sallis et al. (1988), who recorded in children, a significant association between aerobic fitness and HDL-C on one hand and systolic and diastolic pressure on the other. The results also do not agree with those of Harshfield et al. (1990) who also observed in black teenagers, a significant correlation of VO_2max with arterial blood pressure (systolic and diastolic).

In the study by Dwyer and Jibbons (1994), body mass index (BMI) and VO_2max were the main determinants of the systolic blood pressure ($R^2 = 0.605$; $p < 0.07$; $R^2 = 0.315$; $p < 0.05$). Among the teenagers in Fripp and Hodgson (1985) study, the body mass index accounts for 37% and 35%, the variability of systolic and diastolic blood pressure, respectively. This contribution of the body mass index is more significant in this group of children than in our sample of adults aged 34.3 ± 0.7 years. The results of this study also support those of Arèmou et al. (2007) carried out on former sportsmen of Benin Republic. In that study, BMI was the only nonhemodynamic factor which contributed significantly (11%, p = 0.014) to the variability of the systolic blood pressure. After adjustment for age, body mass index and resting heart rate together accounted for 22% (p = 0.009) of the variability in the diastolic blood pressure. Our results corroborate those of Njelekela et al. (2003) in Tanzania who studied active older men aged 47 to 57 years. These authors observed that the main predictors of the blood pressure in men were body mass index and salt consumption. Agboton et al. (1987) had previously highlighted the important role of body mass and adiposity in the evolution of arterial blood pressure values throughout childhood in Beninese. The present data, pointed out the adiposity indexes (BMI, WC, NC, W/H ratio) as the main predictors of the arterial blood pressure, thus confirming the observations made in Beninese children. The results suggest that body mass, or simply adiposity, plays an important role in the variability of the arterial blood pressure among Beninese, irrespective of age.

In the present study, age is the only independent predictor of the arterial blood pressure (systolic and diastolic). The other nonhemodynamic parameters, i.e. neck circumference and HDL-C for the systolic pressure (R^2 = 14%) and the sum of skinfolds thickness for the diastolic pressure (R^2 = 21%) become significant predictors, after adjustment for age. Moreover, in the study sample, systolic and diastolic blood pressures do not have the same nonhemodynamic predictive ability. Although the hemodynamic factors studied in this research explain 86% and 79% variability in SBP and DBP respectively, there are other factors that were not studied in this research, yet they may be important. These include haematological parameters such as cardiac output and other hemodynamic parameters such as stroke volume, heart rate and total peripheral resistances (Daniels et al, 1996). Other nonhemodynamic factors, like heredity and dietary intake, are also likely to influence the values of the blood pressure components. The assessment of these factors in a study including the institutional structures of recreation and sport practises will permit the appreciation of their respective contributions to the variability of blood pressure. The results of this study suggest that recreation sport practitioners must exercise with more weekly frequency, at an intensity more favourable to weight loss, i.e. aerobic endurance. Moreover, the combination of this recreational sport practice with ideal diet has proved to be more effective in managing hemodynamic risk factors (Oladepo & Akinkugbe, 1995).

Measures to ensure reliability of the results and limitations of the study

Various precautions have been taken to guarantee the reliability of the data. One of these relates to the reduction of systematic and relative error, by using the same testers for the same subjects, as well as taking into account the average value of three measures for anthropometric and cardiovascular variables. The scrupulous observation of the instructions for the skinfold thickness measurement and blood lipids assessment, as they are standardized, ensures quality and reliable results.

The subjects included in this cross-sectional study are those who engage in recreational sports in non-institutional structures. This choice was guided principally by the increase in the number of these non-institutional structures for recreational sports in the urban environment, and secondly by the prevalence of hypertension and its associated risk factors in Beninese youth (Gouthon et al., 2005). In summary, the results of this study are valid for this population of recreational sport practitioners in non-institutional structures at Cotonou. The conclusions could not therefore be generalized to the users of specialized fitness centres, and to people leaving in the rural areas.

Conclusion

The results of the study have enabled us to appreciate the importance and effectiveness of non-institutional structures used by recreation sport practitioners for training and physical conditioning. These structures can be used for purposes that mitigate against the development of hemodynamic and haematological risk factors. The study has also enables us to understand the factors to focus, in order to improve blood pressure conditions. Among the hypertensive risk factors studied, the neck and the waist circumferences appeared as the best predictors of the systolic or diastolic blood pressure in the sample, in spite of their regular participation in recreational sports. It must be emphasized, however, that these data do not authorize the assessment of only waist and neck circumferences, as well as the decrease in their value following the exercise session. They are in themselves not sufficient to control arterial blood pressure. Other factors like age, diet and others hemodynamic parameters that are not included in this study, may be equally important. Future studies could include these factors among those to be studied. Finally, these results suggest, like those of Fripp and Hodgson (1985), that any improvement of the cardiovascular profile by the means of exercise training in unfit adults, is mediated by a preliminary loss of body fat.

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