Original Article

The effects of physical program on brachial arterial stiffness, heart rate, and other cardiovascular risk factors among executives with metabolic syndrome in Kinshasa, DR Congo

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ABSTRACT

Much attention has been directed toward lifestyle modifications as effective means of reducing cardiovascular disease (CVD) risk. In this present study, physical activity has been studied because of its well-known effects on metabolic syndrome (METS) and CVD. The study sought to evaluate the impact of short-term regular and moderate exercise program on risk factors associated with CVD among executive professionals. All 21 executives enrolled were inactive males, diagnosed with METS, and aged 54.4 ± 7.1 years (range 37–62 years). Of the participants, 14.3% were smokers and 57.1% had excessive alcohol intake. Physical activity significantly decreased abdominal obesity, arterial stiffness, and hypertension rates 3 months' post-intervention. There was also significant effect of moderate physical activity on the mean levels of waist circumference, heart rate, systolic blood pressure, diastolic blood pressure, and peripheral arterial stiffness.

Key words: Arterial stiffness, Cardiovascular diseases, Metabolic syndrome, Intervention study, Physical activity.

INTRODUCTION

Physical inactivity (sedentary lifestyle) is well established as a risk factor for obesity (or overweight), type 2 diabetes mellitus (T2DM), atherosclerosis, and cardiovascular diseases (CVDs) including arterial hypertension, coronary heart disease (CHD), stroke, and peripheral artery disease (1-3). Longitudinal studies have reported 2 times higher risk for premature death in the presence of sedentary lifestyle in developed settings (4).

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However, epidemiologic studies have shown that regular physical activity assists in reducing the risk factors for CHD, T2DM, hypertension, overweight, dyslipidemia, and CVD independently to other risk factors in both young and adult individuals as well as extending life expectancy with CVD (5-11). Only few data have reported no effect of long-term physical activity on the glycemic control in diabetics (12).

With globalization, epidemiologic, demographic, and nutritional transitions (13), non-communicable diseases including CVD and T2DM, will increase so rapidly in Sub-Saharan Africa as epidemic cause of the global burden of diseases by 2020 (14). In the Democratic Republic of Congo (DRC), Central Africa, CVD, T2DM, metabolic syndrome (METS), obesity, and arterial hypertension, and physical inactivity constitute a real problem from general, hospital, and workplaces population (15-20).

In the Metropolitan area of Kinshasa, the capital of DRC, the physical demands at the National Company for Electricity Supply (NCELS), in particular, as well as in the general population, have decreased significantly. In Kinshasa, 39–60.2% individuals do not experience some degree of breathlessness in their daily domestic work, leisure times, and office work (16,20). However, there are no data about the physical management of CVD risk factors (obesity, hypertension, heart rate, and arterial stiffness) among urban executives of the NCELS who remain seated for more than 10 hours per day in their offices at the headquarter in Kinshasa, DRC.

The study aimed to determine the level of cardiometabolic risk and whether regular physical training should be considered an effective antiatherogenic therapy independent of pharmacological treatments among sedentary executives in NCELS. Its first specific objective was to evaluate the impact of short-term regular and moderate exercise program on levels of body mass index (BMI), waist circumference (WC), serum total cholesterol (TC), heart rate, fasting plasma glucose (FPG), systolic blood pressure (SBP), diastolic blood pressure (DBP), and brachial pulse pressure (PP). Second, the study sought to investigate the decrease in the rates of total obesity, abdominal obesity, abdominal obesity, arterial stiffness (subclinical atherosclerosis), arterial hypertension, and glycemia.

MATERIALS AND METHODS

The study was a short-term follow-up and intervention program with a pre-test and post-test design. The study was conducted from June 6 to October 19, 2005, at the occupational medicine of the NCELS, Kinshasa town, DRC. The NCELS was considered for the study for multiple reasons which included epidemic rates (>60%) of total obesity and hypertension (Longo Mbenza, unpublished data). In addition, the Occupational Medicine Service of NCEALS also had no active physical education program in place. The study protocol was approved by the Ethics Committee of the Kinshasa University School of Medicine. After obtaining authorizations from the NCEALS authorities, campaigns of information and sensitization of target population, and written consent of participants in May 2005, the study was conducted according to the Helsinki Declaration II.

Target population and sampling

Figure 1 presents the target population from the NCEALS. The study was especially designed for staff including senior and deputy executives because METS is commonly diagnosed among black African executives (21). Sedentary executives (≥10 h in sitting position) were invited to participate in physical activity intervention program which lasted for 3 months and took place 3 times a week for 40–60 min per session. This program was run during the working time at 14H30–15H30 by a registered physiotherapist (KL). Exclusion criteria consisted of the history of anti-lipid medication or any other drug interfering with lipid and glucose metabolism renal or thyroid dysfunction, stroke, myocardial infarction, and inflammatory.

The intervention program discussed with the participants and included activities that interested them such as dancing, walking, and jogging for aerobic exercises, strength, and flexibility exercises. Thus, the intervention consisted of moderate-to-vigorous activities for at least 40 min of the time according to the United States center for Disease control and prevention (DCP) guide for moderate-vigorous physical activity (22).

The intervention program included, therefore, exercise training of moderate intensity requiring a metabolic equivalent task (MET = energy expenditure) score of 3.0–6.0 (23). The energy expenditure during rest corresponds to one MET.

Data collection

After informed and written consent from participants, an administered structured and standardized questionnaire elicited information on age, gender, executive rank, family and personal medical history, and levels of physical activity (sedentary/inactive vs. active). Executives seated more than 10 hours were asked the amount of time they spent on average per week on each of the following physical activities: Walking, jogging, running, cycling, and activities during work and leisure times: Inactive without increase in respiratory frequency and heart rate during the recommendation from the centers for DCP and the American college of sports medicine (3) and WHO/STEP approach (24). The reproducibility and validity of the physical activity questionnaire were ensured by the significant simple correlation coefficient r = 0. 85 ($P < 0.0001$) between physical activity reported on 1-week recalls and that reported on the questionnaire.

Pre- and post-intervention measurements of weight, height, WC, TC, heart rate, FPG, high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), SBP, DBP, and PP were performed using the same procedures and regularly calibrated instruments. Body weight in light clothes was measured to the nearest 0.1 kg using a Soehnle scale (Soehnle-Waagen, Gmbh CO, Murrhard, Germany), and height was recorded to the nearest 0.5 cm using portable locally manufactured stadiometer. Participants stood upright on a flat surface without shoes, with the back of the heels, and the occiput on the stadiometer. BMI was calculated as weight divided by height squared (kg/m^2). WC was measured after gentle expiration between the lower rib margins and the iliac crest to the nearest millimeter using a flexible tape, with

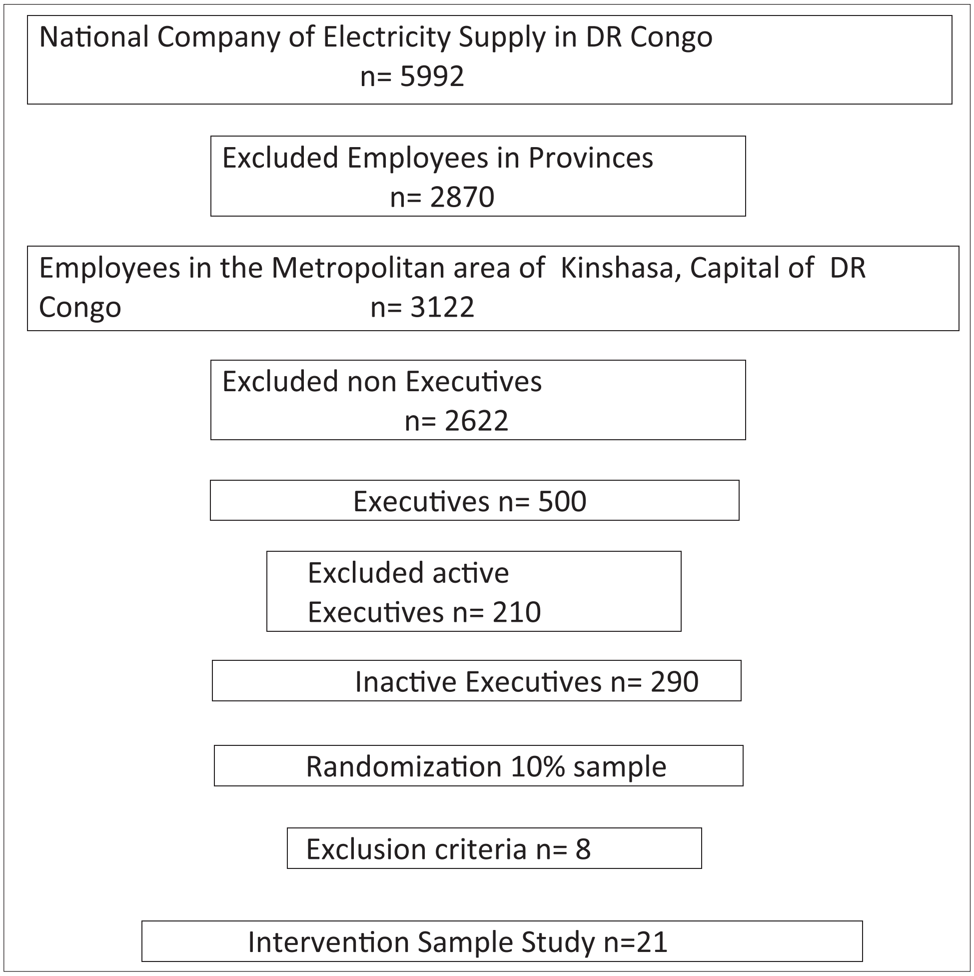

Figure 1: Methodology of probabilistic sampling design.

participants standing with their heels together. Standardized protocols were used to measure body weight, height, and WC (25-27) with appropriate validation and quality-control procedures.

SBP and DBP were with the seated participants elbow flexed at the heart level according to the American Heart Association (28) and using a standard mercury sphygmomanometer. Three blood pressure measurements were taken at intervals longer than 2 min after the participants had been sitting for at least 30 min. SBP and DBP were defined as the average of the last two measurements with the 1st and 5th Korotkoff phases, respectively.

Participants were instructed and encouraged not to eat after 19:00 in the evening before the laboratory measurements. Overnight 12 h - fasting blood was drawn between 7:00 and 9:00 AM for the determination of FPG using hexokinase-glucose-6-phosphate-enzymatic reaction, serum TG, TC, and HDL-C using standard methods (29) at LOMO Medical Central Laboratory with inter- and intra-assay coefficients of variation <2%.

Definitions

Using International Diabetes Federation (IDF) criteria (30), METS was diagnosed in participants who had FPG ≥5.6 mmol/L, abdominal obesity (WC ≥94 cm in men and WC ≥80 cm in women), HDL <1.03 mmol/L in men and <1.29 mmol/L in women, SBP ≥130 mmHg, DBP ≥85mmHg, and TG >1.7 mmol/L. Total obesity (overweight/obesity) was defined by BMI ≥25kg/m² (27).

Dysglycemia included impaired fasting glucose with FPG ≥5.6 mmol/L and <7 mmol/L and T2DM in known diabetics or FPG >7 mmol/L (31). Hypertension was defined by SBP ≥140 mmHg and/or DBP ≥90 mmHg or a treatment diagnosis of hypertension (32). Brachial (peripheral) arterial stiffness (subclinical atherosclerosis) was defined by PP (SBP-DBP) ≥60 mmHg (33).

Dyslipidemia included low HDL-C and high TG according to IDF criteria, TC ≥5.2 mmol/L, and low-density lipoprotein-cholesterol ≥2.6 mmol/L or the use of lipid-lowering drugs (34). A frequency rate of METS ≥50% meant a higher cardiometabolic risk for the study population.

Table 1 : Impact of physical activity of moderate intensity on established risk factors for coronary heart disease

Variables of interest	Pre-intervention	Post-intervention	*P* value
Total obesity	15 (71.4)	13 (61)	NS
Abdominal obesity	14 (66.7)	6 (28.6)	<0.0001
Dyslipidemia	11 (52.4)	8 (38.1)	NS
Dysglycemia	13 (61.9)	8 (38.1)	NS
Arterial stiffness or subclinical atherosclerosis	10 (47.6)	3 (14.3)	<0.0001
Arterial hypertension	21 (100)	7 (30)	<0.0001

NS: >0.05

Statistical analysis

Data were reported as numbers and proportions (%) for categorical variables and means ± standard deviation for continuous variables. Student's paired *t*-test was used within the study population for comparisons of means between pre- and post-intervention. To evaluate the clinical significance of change over time in mean measurements obtained at baseline and 3 months after intervention, findings were also interpreted in terms of effect size, comparing baseline versus 3-month follow-up data. Effect size values were calculated according to Hedges team models (35) as (Y2-Y1)/Sp2 where Y1 = pre-test mean, Y2 = post-test mean, Sp2 = PLACE VIDE POUR L EQUATION, n1 = number of participants at pre-test, n2 = number of participants at post-test, and S21 = pre-test variance, S22 = post-test variance.

The differences between proportions (%) at pre-intervention and post-intervention were evaluated using a McNemar's test. The magnitude of decrease in rates of hypertension, total obesity, abdominal obesity, arterial stiffness (subclinical atherosclerosis), dysglycemia, and dyslipidemia was evaluated as (X2-X1)/X1 where X1 = proportion of each CVD risk factor at baseline and X2 = proportion of each CVD at post-intervention.

$P < 0.05$ was considered for statistical significance. Statistical analysis was conducted using the Statistical Package for the Social Sciences for Windows Version 15 (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Of 29 eligible executives, 8 were excluded and 21 (response rate of 72%) participated in the study with complete data. All 21 executives were inactive males (100%), diagnosed with METS (100%), and aged 54.4 ± 7.1 years (range 37–62 years). Among the participants, 14.3% (n = 3) and 57.1% (n = 12) were smoking cigarette and had excessive alcohol intake, respectively. Table 1 summarizes significant differences in the decrease in abdominal obesity, arterial stiffness, and hypertension rates between pre-intervention and post-intervention, but no significant effect of moderate physical activity on total obesity, dyslipidemia, and dysglycemia, respectively.

Table 2 : Mean values of coronary heart disease risk factors

Variables of interest	Before	After	*P* value
BMI (kg/m²)	27.7±4.6	27±4.7	NS
WC (cm)	99.5±18.6	91.9±12.2	<0.0001
FPG (mmol/L)	4.8±1.5	4.6±1.6	NS
TC (mmol/L)	5.3±1.3	4.8±0.6	NS
Heart rate (bpm)	85.7±8.7	64.8±11.7	<0.05
SBP (mmHg)	145±12.2	131.1±8.6	<0.0001
DBP (mmHg)	93.4±11.4	145.9±12.2	<0.0001
Brachial pulse pressure	53.6±9.9	48.2±8.4	<0.0001

BMI: Body mass index, WC: Waist circumference, FPG: Fasting plasma glucose, TC: Total cholesterol, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Physical activity with moderate intensity after 3 months reduced significantly the mean levels of WC, heart rate, SBP, DBP, and peripheral arterial stiffness (Table 2).

Multiple studies have evaluated the effect of physical activity on various aspects of health. Although physical activity is known to have its benefits, it is unclear as to what amount of physical activity is the most advantageous. Several studies correlated leisure-time physical activity levels to incidence of CVD and/or mortality (36-40).

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