

The Influence of Ethnicity in the Relationship between Sedentary Screen Time and Left Ventricular Mass: Insights from the MAG-SALVAGES

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Abstract

Background: The influence of race/ethnicity on the relationship between sedentary screen time and left ventricular mass has been recently suggested, but remains a subject of debate, and has never been explored in Africa. **Purpose:** To determine whether there is a racial/ethnic influence on the relationship between sedentary screen time and left ventricular mass in MAGhreb and Sub Saharan Africa Left-Ventricul ArGEometry Study (MAG-SALVAGES) participants. **Methods:** 100 blacks sub-Saharan African and 187 white Maghreb aged 18 - 55 years underwent an interview on their behavioral measures, physical activity and eating habits. Their left ventricular mass has also been measured by a resting transthoracic echography according to the American Society of Echography. Generalized linear models evaluated a test-for-trend across higher levels of sedentary screen time in progressive models with left ventricular measurements as dependent variables. The study population was stratified into quartiles of sedentary screen time (separately for whites and blacks) and examined the joint association of sedentary screen time and LVM within quartiles of physical activity. **Results:** Among White Maghreb, higher screen time was associated with smaller left ventricular mass ($P < 0.001$). This association persisted when adjusting for age, gender, heart rate, waist circumference, waist-to-hip ratio, systolic blood pressure QRS duration, TAPS and PAPS. Whereas, in blacks sub-Saharan African, the left ventricular mass was not associated with sedentary screen time. **Conclusions:** Sedentary screen time is associated with smaller left ventricular mass in White Maghreb, not in black sub-Saharan African. The lack of association in blacks supports a potential qualitative difference in the cardiovascular consequences of sedentary screen based behavior.

Keywords

Left Ventricular Mass, Sedentary, Ethnicity, White Maghreb, Black Sub-Saharan Africa

1. Introduction

Many of the modern diseases are corollaries of profound changes that accompanied the 45,000 years of evolution from *Homo sapiens sapiens*, to whom physical activity was the pledge of survival [1], to the today human who uses more neurons than muscles to live and survive, and therefore, has reduced physical activity and increased energy intake. Nowadays, humans have the unfortunate luck of having more opportunities for being sedentary. This is the so called sedentary behavior, which is defined as activities that do not increase energy expenditure substantially above the resting level such as sitting, watching TV, and playing PC/video games. This situation is known to be linked with increased cardiovascular disease morbidity and mortality. The majority of prospective studies of sedentary screen time (SST) has shown that greater sedentary time is associated with an increased risk of fatal and non-fatal CVD [2]-[9].

Sedentary behavior is responsible for the occurrence of several cardiovascular risk factors including obesity, insulin resistance, and high blood pressure. These factors in turn contribute to the occurrence of left ventricular hypertrophy (LVH). The left ventricular mass (LVM) correlates closely with the incidence of heart failure, stroke, coronary disease [10] and overall mortality [11]. So one pathway through which sedentary behavior may contribute to cardiovascular disease is through an impact on left ventricular mass. However the link between SST and LVM remains a controversial issue. Data from the National Health and Nutritional Examination Survey (NHANES) suggests that sedentary time is associated with cardiovascular risk factors and obesity in whites but not blacks [12]. Bethany *et al.* found that SST is associated with greater LVM in white not in Blacks [13]. This was an American cohort of Blacks and Whites. This issue has never been addressed in an African population.

2. Methods

2.1. Study Design

Study Population and Settings

The MAG-SALVAGES (MAGhreb and Sub-Saharan Africa Left-Ventricul ArGEometry Study) is a population-based survey conducted in Marrakech, Morocco, from November 2015 to January 2016. It recruited Black Sub-Saharan African (BSSA) and white Maghreb student population living in Marrakech.

2.2. Recruitment Strategy

2.2.1. Investigators

The investigation team consisted of senior residents of the Cardiology Unit of

Cady Ayyad University. The principal investigators (KPB and AS) introduced the study, explained the goals, described how the study was to be performed, and described the responsibilities of each investigator. The principal investigators attended staff meetings to discuss and answer any questions the investigator team had. A pre-test session was conducted asking a dozen students to evaluate the questionnaire, to test the appropriateness of the data collection sheet, and to assess the ability of the investigators to apply the protocol correctly.

2.2.2. Study Participants

The BSSA participants were all members of the The CESAM (Confédération' Etudiantset Stagiaires Africains de Marrakech). This is a cultural association that includes all BSSA students in Marrakech. It provided us with the names and addresses of BSSA students. Recruitment of Maghreb students was facilitated by the Secretary General of the Cady Ayyad University Students Office. Students were randomly chosen from the student's office and were invited to participate in the study.

2.2.3. Eligibility Criteria

The subjects recruited for the MAG-SALVAGES were asymptomatic students aged 18 years or older, regardless of their level of study (undergraduate, graduate, post-graduate, or doctoral). Participants with significant valvulopathy, who had poor echogenicity to the extent that echocardiographic parameters could not be measured, or who did not complete the planned investigations were excluded.

2.3. Data Collection

Interviews

Participants were interviewed using a questionnaire in a 20-minute session. Items asked included demographic characteristics (sex, age, ethnic group, and duration of residence in Marrakech for BSSA), lifestyle (diet, physical activity, smoking status, and alcohol intake), and personal medical history (hypertension, diabetes mellitus, hypercholesterolemia, and hyperuricemia). All these data were based on self-report. Participants were asked about their intake of fruits, vegetables, and fats, with regular consumption of fruits and vegetables defined as at least four days a week. Physical activity was assessed using the WHO/GPAQ [14]. The participants were categorized as either active or inactive based on whether they did or did not engage in moderate or vigorous exercise, with sedentary defined as sitting more than 7 hours daily. The categories for smoking were current smoker (defined as smoking at least one cigarette within the past month) or nonsmoker/former smoker (the latter defined as having quit smoking more than 3 month prior to the study). Alcohol consumption was categorized as excessive drinking (≥ 3 units/day for men and ≥ 2 units/day for women) or non-drinking/moderate drinking (≤ 2 units/day for men and ≤ 1 unit/day for women).

2.4. Clinical Examination

2.4.1. Physical Measurements

Participants were weighed without heavy clothing to the nearest 0.1 kg using a

digital impedancemeter scale. The same apparatus also provided body composition (fat mass (%), total body water (%), lean body mass (%), bone mass (kg), and daily energy expenditure (Kcal). Height was measured to the nearest 0.1 cm using a mounted stadiometer. Body mass index (BMI) was calculated as weight in kilograms (kg) divided by height in meters squared (m^2). Waist circumference (WC) was measured using a flexible tape measure, with the participant standing, and after gentle expiration, at a point midway between the lower costal margin and the upper border of the iliac crest. Hip circumference was measured at the widest point of the buttocks. The waist-to-hip ratio (WHR) and the waist-to-height ratio (WHeR) were calculated. Body surface area (BSA) was calculated $m^2 = 0.007184 \times \text{height (cm)}^0.725 \times \text{weight (kg)}^{0.425}$. Total obesity was defined as a BMI greater than $30.0 \text{ kg}/m^2$ and abdominal obesity as $WC \geq 102 \text{ cm}$ in males and $\geq 88 \text{ cm}$ in females.

2.4.2. Vital Signs

Sitting blood pressure (BP) was measured on the upper left arm non-invasively using an automated validated device (OMRON M6, HEM 7001E) with a cuff size appropriate for the arm diameter. Participants relaxed for 5 minutes in a sitting position, after which the BP was measured twice. A third measurement was required if the first two differed by at least 10 mmHg for systolic blood pressure (SBP) and/or 5 mmHg for diastolic blood pressure (DBP). The BP readings were averaged for analysis. The BP monitors were calibrated every morning against a standard mercury sphygmomanometer using a T-tube and applying static pressures ranging from 0 to 250 mmHg at 50-mmHg intervals. A device that deviated by 5 mmHg or more was replaced by a new one. Pulse pressure (PP) and mean arterial pressure (MAP) were calculated as follows: $PP = SPB - DBP$; $MAP = DBP + PP/3$.

2.4.3. ECG Measurements and Interpretation

A simultaneous 12-lead resting electrocardiogram (ECG) was recorded on an automated machine (EAS/OTE-ACTA Cardiograph, Italy) at a sampling frequency of 500 Hz over 10 s with a resolution of 5 mV and stored digitally.

To minimize inter or intraobserver variability and avoid variation in the amplitude and duration of waves and spaces from beat to beat, all ECGs were processed with the MEANS program (Welch Allyn, Inc. USA) to obtain ECG measurements and diagnostics interpretations.

2.4.4. Echocardiography Measurements

One or the other of the principal investigators performed echocardiography using an HD 15 Sonos 5500 (Phillips Medical Systems, Andover, MA, USA) ultrasound system equipped with 2.5, 3.5, and 5.0 MHz transducers. Three measurements were taken for each variable with the mean value used in analysis. Image was stored for subsequent validation by a team of three skilled training specialists of the CHU Mohammed VI echocardiography laboratory. Measurements were taken according to the 2015 American Society of Echocardiography and the European Association of Cardiovascular Imaging updated guidelines for cardiac

chamber quantification [15]. Two-dimensionally guided M-mode echocardiography was performed on a parasternal long-axis view. Interventricular septum (IVS) thickness in diastole (IVSd) in mm, left ventricular posterior wall (PW) thickness in diastole (LVPWd) in mm, and left ventricular end-diastolic diameter (LVEDd) in mm were measured at end-diastole at a level just below the mitral valve leaflets. Simultaneous ECG was used to correlate measurements with the cardiac cycle. Diastolic wall thickness was measured at the onset of the QRS wave. LVM was calculated according to the American Society of Echocardiography simplified cubed equation linear method using the following equation: $LVM \text{ (grams)} = 0.8 \times 1.04 \times [(LVEDd + IVSd + LVPWd)^3 - (LVEDd)^3] + 0.6 \text{ g}$. LVM was indexed by BSA and by height^{2.7}. LVM was considered normal when $\leq 115 \text{ g/m}^2$ or $\leq 48 \text{ g/m}^{2.7}$ in males and $\leq 95 \text{ g/m}^2$ or $\leq 44 \text{ g/m}^{2.7}$ in females. LVH was defined as LVM exceeding those values. The relative wall thickness (RWT) of the left ventricle (LV) was calculated as $(2 \times LVPWd)/LVEDd$. LV geometric patterns were defined as follows: normal geometry (normal LVM and $RWT \leq 0.42$), concentric remodeling (normal LVM and $RWT > 0.42$), concentric hypertrophy (LVH and $RWT > 0.42$), and eccentric hypertrophy (LVH and $RWT \leq 0.42$).

To analyze LV systolic function, the ejection fraction (stroke volume/diastolic volume $\times 100$), percentage of LV systolic shortening (%) ($[(\text{diastolic diameter} - \text{systolic diameter})/\text{diastolic diameter}] \times 100$) and cardiac output (stroke volume \times heart rate) were calculated. Stroke volume was calculated as $2\pi D/4 \times \text{velocity time integral}$, where D is the diameter of the aortic annulus measured in the left parasternal long-axis view at mid-systole from inner edge to inner edge.

The presence or absence of valve disease was detected by visual assessment in 2D and color Doppler in the left parasternal long-axis and apical four-chamber views.

2.4.5. Statistics

After encoding and validation, the data were entered in a computer using Epi-Info™ statistical software, version 7.1.2.0 (Atlanta, USA) (<https://www.cdc.gov/epiinfo/index.html>). Results for each BSSA were compared with two Maghreb subjects matched for age (± 1 year) and sex. Continuous variables are expressed as means and categorical variables as percentages. In order to compare means in independent samples, Student's t test or the Mann-Whitney test was used. Comparison of the means of three or more groups was performed with analysis of variance. The Tukey test for multiple comparisons was used to distinguish the different groups. For variables not fitting a normal distribution, the Kruskal-Wallis analysis of variance and the corresponding test of multiple comparisons were used. Pearson's correlation coefficient (r) was used to assess any significant association between two continuous variables. To compare proportions, the chi-square test or Fisher exact test was used. Frequency distributions of LVM dichotomized by ethnicity were constructed. Comparisons were made between BSSA and Maghreb for all parameters. When differences were observed on univariate analysis, the effect of potential confounders was studied by adjustment with multivariate linear regression. A significance

level of 5% was adopted. IBM SPSS version 21 (http://www.ibm.com/support/knowledgecenter/SSLVMB_21.0.0) was used for statistical calculations.

2.5. Ethics and Consent

This research was conducted in strict compliance with the recommendations of the Helsinki Declaration III. All respondents were briefed on the conclusions drawn from their investigations. Approval was obtained from the ethics committee of Cady Ayyad University. Each participant provided written informed consent.

2.5.1. Statistics

Participant characteristics according to SST were described using means and percentages as appropriate. Left ventricular measurements are presented as adjusted least squares means with 95% confidence intervals. Generalized linear models evaluated a test-for-trend across higher levels of sedentary screen time in progressive models with left ventricular measurements as dependent variables. Cutpoints for sedentary screen time categories were defined a priori to isolate extreme individuals (1 - 4 h, 5 - 9 h and ≥ 10 hour of screen time/day). We detected a significant interaction between race and sedentary time for LVM ($P = 0 < 0.001$), and thus report results separately by race. No gender interaction was detected for the relationship between sedentary time and LVM ($P = 0.184$).

To examine whether the association between SST and LVM was consistent across the range of leisure-time activity, the study population were stratified into quartiles of sedentary screen time (separately for whites and blacks) and examined the joint association of sedentary screen time and LVM within quartiles of physical activity.

2.5.2. Ethics and Consent

This Work Research has been conducted in strict compliance with the recommendations of the Helsinki Declaration III. The questionnaire was administered anonymously, and information obtained in the interview / anamnesis and clinical and paraclinical examination was transcribed into pre-established survey forms and pre-coded in compliance with the confidentiality and privacy of the participants. All respondents have been briefed on the conclusions drawn from their investigations.

Ethical approval was obtained from the ethics committees of Cady Ayyad University. Each participant provided written informed consent for his participation in the study.

3. Results

A total of 302 participants were initially recruited, 102 BSSA and 200 Maghreb. Thirteen participants were excluded because of poor echogenicity (three female Maghreb), significant valvular disease (four female Maghreb), refusal to undergo the ECG and echocardiography for modesty reasons (two female Maghreb), and failure to appear for the echocardiography (two male BSSA and two male Magh-

reb). The final analysis therefore comprised 289 participants, 100 BSSA and 189 Maghreb.

Overall, the rate of physical inactivity was higher in SSA (39%) than in Maghreb (24.9%) ($p = 0.018$). The rate of physical activity was higher in Maghreb (75.1%) than in SSA (61.0%) ($p = 0.015$). The rate of sedentary was similar in the two ethnic groups: 30.7% in Maghreb versus 29% in the SSA ($p = 0.801$) (**Table 1**). BSSA were significantly taller than the Maghreb. Maghreb had a greater mean BMI, WC, HC, SBP, PP, and fat mass than BSSA (**Table 2**).

Total and abdominal obesity were significantly more prevalent among Maghreb than among BSSA. QRS and QTc duration were the only ECG parameters that differed between the two populations, with a significantly longer average duration among Maghreb (**Table 3**). LVEDd was significantly higher among Maghreb than among BSSA, but this difference disappeared when indexed to BSA (**Table 3**). LVPWd was significantly greater among BSSA than among Maghreb. This difference persisted after adjustment for confounding factors (BMI, WC, HR, and fat mass). The differences observed for all other echocardiographic parameters were not statistically significant, including LVM for which the means of the two groups were similar regardless of the mode of Indexing.

Table 1. Characteristics of the study population as a whole and stratified according to ethnicity.

Variables	All participants n = 289	BSSA n = 100	Maghreb n = 189	P
Demographic characteristics				
Age (years)	29.8 ± 11.2	28.5 ± 10.7	30.4 ± 11.5	0.171
Gender				0.121
Male	173 (59.9)	65 (65.0)	108 (57.1)	
Female	116 (40.1)	35 (35.0)	81 (42.9)	
Place of birth				<0.0001
SSA	99 (34.4)	98(98.0)	1(0,5)	
Maghreb	189 (65.6)	2(2.0)	187(99.5)	
Life style characteristics				
Regular consumption of				
Fruits	162 (56.1)	39 (39.0)	123(65.1)	<0.0001
Vegetables	225 (77.9)	68 (68.0)	157(83.1)	0.005
Fats	276 (95.3)	93 (93.0)	183(96.8)	0.201
Smoking/Alcohol				
Currentsmoker	18 (6.2)	6 (6.0)	12 (6.3)	0.564
Excessive drinker	8 (2.8)	2 (2.0)	6 (3.2)	0.436
Physical activity				
Active	203 (70.2)	61 (61.0)	142 (75.1)	0.015
Inactive	86 (29.8)	39 (39.0)	47 (24.9)	0.018
sedentary	87 (30.1)	19 (29.0)	58 (30.7)	0.801

BSSA: Black Sub-Saharan African, SSA: Sub-Saharan Africa.

Table 2. Physical variables and cardiovascular risk factors of the study population as a whole and stratified according to the ethnicity.

Variables	All participants	BSSA	Maghreb	p
Weight(kg)	73.3 ± 14.9	72.2 ± 13.2	73.9 ± 15.8	0.368
Height (cm)	168.1 ± 9.8	169.7 ± 8.5	167.2 ± 10.3	0.039
BMI (kg/m²)	25.9 ± 5.5	24.5 ± 4.6	26.7 ± 5.7	0.001
WC (cm)	86.3 ± 14.5	82.4 ± 15.2	88.4 ± 13.7	0.001
HC (cm)	99.6 ± 10.6	96.3 ± 9.4	101.4 ± 10.7	<0.0001
WHR (cm)	0.87 ± 0.12	0.86 ± 0.17	0.87 ± 0.08	0.399
WHeR (cm)	0.45 ± 0.09	0.41 ± 0.06	0.50 ± 0.08	0.031
SBP (mmHg)	119.4 ± 15.1	116.6 ± 14.6	120.9 ± 15.2	0.020
DBP (mmHg)	77.2 ± 10.1	76.4 ± 10.4	77.6 ± 10.0	0.316
PP (mmHg)	42.2 ± 11.7	40.2 ± 11.1	43.3 ± 11.9	0.035
MBP (mmHg)	91.3 ± 10.7	89.8 ± 10.7	92.1 ± 10.6	0.084
HR (bpm)	72.7 ± 12.9	71.5 ± 12.0	73.4 ± 13.4	0.227
Fat mass (%)	20.9 ± 12.2	17.4 ± 9.2	22.8 ± 13.1	<0.0001
Lean mass (%)	29.6 ± 4.5	29.6 ± 4.3	29.6 ± 4.7	0.972
CVRF				
HTN	9 (3.1)	3 (3.0)	6 (3.2)	0.893
DM1	1 (0.3)	0 (0.0)	1 (0.5)	0.654
DM2	5 (1.7)	1 (1.0)	4 (2.1)	0.441
Total obesity	63 (21.8)	15 (15.0)	48 (25.4)	<0.0001
Abdominal obesity	64 (22.1)	14 (14.0)	50 (26.5)	0.013

BSSA: Black Sub-Saharan African, BMI: body mass index, WC: waist circumference, HC: hip circumference, WHC: waist-to-hipratio, WHeR = waist-to-height ratio, SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: pulse pressure, MBP: mean blood pressure, HR: heart rate, FM: fat mass, CVRF: cardiovascular risk factor, DM1: type 1 diabetes mellitus, DM2: type 2 diabetes mellitus.

Table 3. Electrocardiographic and echocardiographic characteristics.

Variable	All participants	BSSA	Maghreb	p
PR (msec)	145.9 ± 27.5	146.2 ± 23.2	145.8 ± 29.6	0.901
QRS (msec)	94.7 ± 23.2	90.2 ± 20.5	97.1 ± 24.2	0.016
QTc duration (msec)	401.5 ± 40.1	394.1 ± 33.6	405.4 ± 42.7	0.023
LVEDd (mm)	48.2 ± 4.8	47.1 ± 5.1	48.9 ± 4.6	0.004
LVEDd/BS (mm/m ²)	25.6 ± 6.0	26.2 ± 2.9	25.3 ± 7.2	0.218
LVEDs (mm)	30.3 ± 4.1	29.9 ± 4.2	30.6 ± 4.1	0.185
LVPWd (mm)	8.1 ± 1.3	8.3 ± 1.2	7.9 ± 1.3	0.011
IVSd (mm)	8.2 ± 1.3	8.4 ± 1.3	8.2 ± 1.3	0.187
LVM (g)	133.7 ± 36.1	132.7 ± 37.0	134.2 ± 35.7	0.726
LVM/height ^{2.7}	33.1 ± 9.6	32.1 ± 9.8	33.6 ± 9.5	0.185
LVM/BS (mg/cm ²)	73.0 ± 16.8	73.1 ± 17.8	72.9 ± 16.2	0.922
LVEF (%)	65.7 ± 7.7	65.3 ± 9.4	65.9 ± 6.6	0.526

BSSA: Black Sub-Saharan African. PR: PR interval. QRS: QRS duration. QTc: heart rate-corrected QT. LVEDd: left ventricular end-diastolic diameter. LVEDd/BS: left ventricular end-diastolic diameter indexed for body surface area. LVEDs: left ventricular end-systolic diameter. LVPWd: left ventricular posterior wall thickness in diastole. IVSd: Interventricular septum thickness in diastole. LVM: left ventricular mass crude. LVM/height^{2.7}: left ventricular mass indexed for height 2.7. LVM/BS: left ventricular mass indexed for body surface area. LVEF: left ventricular ejection fraction.

Median SST was 7.4 ± 3.7 (IQR 1.0, 17.0) hours/day among Maghreb and 7.4 ± 3.5 (IQR 1.0, 15, 0) among Blacks ($p = 0.976$). as shown in **Table 4**, in Maghreb, SST was significantly associated with age, gender, heart rate, visceral obesity, waist circumference, waist-to-hip ratio, systolic blood pressure, QRS duration, crude LVM (g), LVM indexed for height (LVMIH), LVM indexed for the body surface area (LVMBSA), LVM indexed for fat mass (LVMfm), tricuspid annular plane systolic excursion (TAPSE) and pulmonary systolic arterial pressure (PSAP). However, in Blacks, cigarette smoking and mean blood pressure (MBP) were the only parameter associated with SST. SST was not associated with any left ventricular parameter.

Table 4. Factors influenced by SST in univariate analysis.

Variables	BSSA			P	Maghreb			P
	1 - 4 h n = 22	5 - 9 h n = 49	≥ 10 h n = 29		1 - 4 h n = 46	5 - 9 h n = 85	≥ 10 h n = 58	
Gender				0.605				<0.0001
Male	14 (63.6)	30 (61.2)	21 (72.4)		23(50.0)	63 (74.1)	22 (37.9)	
Female	8 (36.4)	19 (38.8)	8 (27.6)		23 (50.0)	22 (25.9)	36 (62.1)	
HTN	5 (22.7)	7 (14.3)	5 (17.2)	0.961	13 (28.3)	18 (21.2)	10 (17.2)	0.277
Heartrate (bpm)	2 (9.1)	5 (10.2)	2 (6.9)	0.906	1 (2.2)	7 (8.2)	10 (17.2)	0.036
Obesity	11 (50.0)	24 (49.0)	20 (69.0)	0.206	33 (71.7)	59 (69.4)	26 (44.8)	0.005
Cigarette smoking	0 (0.0)	2 (4.1)	4 (13.8)	0.031	3 (6.5)	6 (7.1)	3 (5.2)	0.930
Alcoholintake	0 (0.0)	0 (0.0)	2 (6.9)	0.129	1 (2.2)	4 (4.7)	1 (1.7)	0.579
Age ans	31.2 ± 11.5	28.7 ± 11.1	26.2 ± 9.1	0.292	35.6 ± 11.9	32.4 ± 10.9	23.5 ± 8.3	<0.0001
IMC	23.6 ± 4.4	24.2 ± 4.3	25.6 ± 5.3	0.601	27.3 ± 5.5	27.3 ± 5.8	25.5 ± 5.6	0.117
TT Cm	85.3 ± 23.9	81.3 ± 12.5	82.2 ± 10.5	0.339	89.9 ± 11.4	91.1 ± 13.9	83.2 ± 13.7	0.002
WHiR	0.90 ± 0.33	0.85 ± 0.10	0.84 ± 0.06	0.629	0.89 ± 0.06	0.89 ± 0.08	0.83 ± 0.08	<0.0001
WHeR	0.50 ± 0.13	0.48 ± 0.08	0.48 ± 0.06	0.507	0.54 ± 0.09	0.54 ± 0.09	0.51 ± 0.09	0.129
PAS mmHg	113.5 ± 15.6	117.9 ± 14.9	116.8 ± 13.2	0.449	123.717	122.2 ± 14.6	116.8 ± 12.8	0.040
PAD mmHg	78.6 ± 8.9	76.2 ± 11.2	74.9 ± 10.0	0.871	79.1 ± 10.6	77.7 ± 8.8	76.3 ± 11.1	0.351
PAM	90.3 ± 10.2	90.1 ± 11.4	88.9 ± 10.2	0.035	93.9 ± 12.2	92.6 ± 9.3	89.8 ± 10.7	0.111
PP	34.9 ± 11.6	41.7 ± 11.2	41.9 ± 9.6	0.137	44.6 ± 12.1	44.5 ± 12.6	40.6 ± 10.4	0.108
Masse grasse	18.0 ± 6.2	18.7 ± 10.4	14.5 ± 8.3	0.902	25.1 ± 13.2	21.9 ± 12.7	22.3 ± 13.6	0.383
QRS duree	88.7 ± 17.5	91.1 ± 23.9	89.9 ± 16.7	0.843	101.8 ± 17.5	99.1 ± 31.3	90.6 ± 13.3	0.039
MVGg	136.6 ± 40.8	132.2 ± 37.7	130.6 ± 33.9	0.753	145.1 ± 34.2	144.6 ± 32.0	110.5 ± 30.7	<0.0001
MVGIt	33.1 ± 9.9	32.3 ± 10.6	31.0 ± 8.5	0.440	36.9 ± 9.2	34.8 ± 9.6	29.4 ± 8.1	<0.0001
MVG SC	76.4 ± 19.1	73.5 ± 18.8	70.0 ± 15.0	0.286	79.1 ± 16.1	76.2 ± 15.6	63.3 ± 12.8	<0.0001
MVG mgr	9.7 ± 3.9	9.2 ± 4.3	7.9 ± 3.5	0.072	7.8 ± 3.9	7.9 ± 4.0	7.2 ± 3.4	0.584
MVG mm	4.9 ± 1.5	4.5 ± 1.1	4.1 ± 0.9	0.809	5.0 ± 1.1	4.7 ± 1.1	3.8 ± 0.7	<0.0001
FEVG	64.6 ± 13.7	65.0 ± 6.9	66.2 ± 9.3	0.402	67.2 ± 5.9	65.2 ± 6.7	65.8 ± 6.9	0.258
EPR	0.34 ± 0.06	0.36 ± 0.06	0.37 ± 0.09	0.516	0.34 ± 0.06	0.34 ± 0.05	$.32 \pm 0.05$	0.141
Sa	15.9 ± 6.2	14.2 ± 1.9	14.4 ± 3.1	0.184	16.5 ± 3.4	14.9 ± 7.2	17.1 ± 3.8	0.577
TAPSE	26.3 ± 4.9	25.0 ± 3.5	24.1 ± 4.1	0.447	26.2 ± 4.1	23.9 ± 5.1	26.4 ± 8.9	0.039
SOG	20.8 ± 6.6	18.6 ± 5.4	20.6 ± 5.2	0.870	18.15	18.4 ± 3.1	21.5 ± 9.1	0.119
IMT mm	0.49 ± 0.11	0.48 ± 0.11	0.49 ± 0.14	0.447	$.47 \pm 0.12$	0.48 ± 0.14	0.49 ± 0.14	0.882
Glycémie	83.1 ± 23.8	88.8 ± 15.0	89.3 ± 14.4	0.693	88.5 ± 16.5	91.3 ± 11.5	97.7 ± 17.0	0.190
PAPS	21.1 ± 3.7	22.1 ± 5.4	22.0 ± 5.1	0.263	24.3 ± 4.9	21.9 ± 4.5	20.0 ± 4.3	<0.0001

In the Maghreb, there was a statistically significant association between SST and LVM with higher screen time being associated with smaller LVM ($P < 0.001$). After adjusting for the different confounding factors in multivariate analysis, the association between SST and LVM persisted in Maghreb (**Table 5**).

4. Discussion

This is, to our best knowledge, the first population-based study that addresses the issue of the interaction of ethnicity in the association between sedentary behavior and left ventricular mass in the African continent.

The main finding of this study is the existence of an association between sedentary screen time and LVM in the Maghreb, a white skin African ethnic group, in whom higher screen time is associated with smaller LVM, an association that did not emerge among Black sub-Saharan Africans.

The existence of an association between sedentary and left ventricular mass in the white race and the non-existence of it in the black race has recently been reported by Bethany *et al.* in the CARDIA study [13]. In the same study, Bethanie reported a higher screen time associated with larger LVM, whereas in the present study we found a higher screen time associated with smaller LVM. This inverse association between sedentary and LVM found in this study is consistent with the results reported by Jeroen *et al.* [16] which demonstrated for the first time that LV dimensions were smaller in a sedentary adults population with intellectual and concomitant physical disability compared to controls.

The cardiovascular consequences of sedentary would be related to cardiovascular risk factors including obesity and insulin resistance. However, the NHANES data showed the existence in the white race of an association between sedentary and cardiovascular risk factors, including obesity, which does not seem to exist in the black race [12]. This would explain the absence of association between sedentary and LVM observed in Black subjects recruited in this

Table 5. Factors influenced by SST in multivariate analysis.

	1 - 4 h n = 46	5 - 9 h n = 85	≥10 h n = 58	P
Age (years)	0.91 (0.84 - 0.97)	0.97 (0.91 - 1.03)	1.3 (1.11 - 1.38)	<0.001
Gender	6.5 (1.46 - 29.3)	5.5 (1.14 - 9.73)	7.3 (1.06 - 12.00)	0.024
Heart rate	5.3 (0.31 - 92.3)	6.6 (1.16 - 10.17)	8.6 (1.34 - 756)	0.005
Waist circumference (cm)	1.1 (0.94 - 1.2)	0.97 (0.89 - 1.07)	0.99 (0.87 - 1.14)	0.962
WHiR	0.12 (0.01 - 2.09)	18.0 (1.02 - 21.11)	83.3 (1.59 - 97.04)	0.006
SBP mmHg	1.1 (0.96 - 1.3)	0.96 (0.91 - 1.01)	1.03 (0.95 - 1.1)	0.504
QRS duration	2.1 (0.98 - 3.1)	1.01 (0.99 - 1.02)	3.03 (0.97 - 6.04)	0.872
LVM (g)	3.6 (1.93 - 5.97)	5.9 (1.91 - 11.03)	9.04 (1.95 - 13.13)	0.040
LVMIH	5.9 (1.94 - 8.38)	7.1 (1.86 - 9.19)	8.8 (1.62 - 11.10)	0.019
LVMBSA	3.9 (1.68 - 6.68)	5.1 (1.81 - 12.25)	7.15 (1.83 - 15.59)	0.034
TAPSE	0.95 (0.90 - 1.02)	1.1 (1.04 - 1.23)	0.95 (0.86 - 1.04)	0.021
PAPS (mmHg)	0.88 (0.8 - 1.01)	1.01 (0.93 - 1.08)	1.1 (1.02 - 1.26)	0.227

study and in that of Bethany. The pathophysiological explanation of this racial difference in the repercussion of sedentary in terms of cardiovascular risk factors remains to be elucidated. It would hide behind the complex entanglement of signaling pathways involved in the physiology of myocardial plasticity.

If the results of this study converge with those of Bethanie on the existence of an association between sedentary and LVM in Whites and not in Blacks, they diverge as to the meaning of this association. Indeed, Bethanie reports that higher sedentary screen time is associated with greater LVM [13], while we found the opposite: the higher the sedentary screen time, the smaller the LVM.

How can this divergence be explained? Presumably that everything depends on the complex interactions between the indirect reverberation of sedentary on LVM via cardiovascular risk factors that tend to cause myocardial hypertrophy, and direct repercussion by adaptation response of the myocardium to reduced load, to cause a myocardial atrophy, as demonstrated in bed rest or deconditioning studies [17] [18].

This study suffers from the weakness of being transversal and therefore unfit to postulate any causal link. Other studies are therefore needed to elucidate the cardiovascular impact of sedentary, since it is potentially modifiable.

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