Long sedentary time is associated with worsened cardiometabolic risk markers among working adults in Eastern Ethiopia

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Research Article

Keywords:

Posted Date: January 12th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1216972/v1

Abstract

This study aimed to examine the associations of sedentary time and cardiometabolic risk markers among working adults in Eastern Ethiopia. A cross-sectional study was conducted among 1,200 participants. Data were collected using the World Health Organization NCD STEPS survey instrument, and the sedentary behavior questionnaire. The biochemical parameters were analyzed by using the Mindray BS-200 chemistry analyzer. STATA version 16.1 software was used for analysis. The associations between sedentary time and cardiometabolic risk markers controlling confounders were examined using linear regression models. An adjusted coefficient (β) with the 95% confidence interval (CI) was used to report the results. P-value < 0.05 was considered for statistical significance. One hour per day increases in total sedentary time increases the average body mass index (β = 0.61kg/m^2: 95% CI: 0.49, 0.71), waist circumference (β = 1.48cm: 95% CI:1.14-1.82), diastolic blood pressure (β = 0.87mmHg: 95% CI: 0.56-1.18), systolic blood pressure (β = 0.95mmHg: 95% CI: 0.45, 1.48), triglycerides (β = 7.07mg/dl: 95% CI: 4.01-10.14), total cholesterol (β = 3.52mg/dl: 95% CI: 2.02-5.02), fasting plasma glucose (β = 4.15mg/dl: 95% CI: 5.31-4.98) and low-density lipoprotein cholesterol (β = 2.14mg/dl: 95% CI: 0.96-3.33). Long sedentary time is significantly associated with cardiometabolic risk markers. Interventions to reduce sedentary time to decreasing the risk of cardiovascular diseases among working adults.

Introduction

The majority of working adults waking time is spent being sedentary[1]. Sedentary behavior refers to an energy expenditure ≤1.5 metabolic equivalents while in a sitting or reclining posture during waking hours and not simply the absence of physical activity[2]. Sedentary time, which refers to the time spent watching television, reading, socializing, video game playing, listening to music, using a computer, and driving a car is becoming public health concern with significant risk for non-communicable diseases (NCDs)[2–4]. In many high-income countries working adults spend 50–66% of their work time sitting and accumulate additional sedentary time in leisure activities and commuting[5]. Although, evidence in low-income settings has shown the mean time spent sitting was 13.4 hours per day in working adults[6], sitting for prolonged periods becoming the major cause of mortality irrespective of the regular practice of physical activity[7].

NCDs, including cardiometabolic disorders, constitute a public health problem worldwide and represent one of the main sources of disease burden[8]. Increased magnitude of cardiometabolic risk markers, such as obesity, hyperglycemia, hypertension, and dyslipidemia become the leading causes of premature mortality[9].The increasing prevalence rates of cardiometabolic disorders have led to a worldwide focus on behavioral risk factors involved in the progression of this diseases[10].Modifiable risk factors such as sedentary behavior have been believed to be the major risk factors for the development of cardiometabolic disease[11].For example, the research identifies prolonged sedentary time as independent risk factors for cardiometabolic risk markers[12], such as obesity[3], increased waist circumferance[13], and risk of type 2 diabetes and cardiovascular diseases[8], and dyslipidemia in working adults[14], as well as premature mortality[3].

In low-income countries, sedentary time is increasing with emerging technological innovations and changes in working environments[6]. Increased technological innovation and labor-saving devices have led to changes in worker lifestyle with prolonged desk-based and reduced activity[6,15]. Therefore, working adults, especially office workers, have become the one at-risk population for sedentary time[16], with prolonged sitting and inactivity[6,17]. However, despite the high sedentary time in working adults, there is a paucity of research that examines the association between sedentary time and cardiometabolic risk markers in sub-Saharan Africa. Therefore, identifying the association between sedentary time and cardiometabolic risk markers has great implications for evidence-based health policy and helps design an effective, customized intervention and can encourage public health managers to review educational messages about sedentary time. Therefore, in this study, we evaluated the association between sedentary time and cardiometabolic risk markers among working adults in eastern Ethiopia.

Methods

Study settings

This study is part of a larger study on metabolic syndrome and NCD risk factors among working adults in Haramaya University, Eastern Ethiopia. Haramaya University, the second oldest university, is situated in East Hararghe Zone, Eastern Ethiopia. During the study period, the university has nine colleges, one academy, and one institute engaged in teaching, research, and community services with an overall of 7,176 employees. The majority of the employees were males (71.9%) and administrative staff (77.9%). The study was conducted among employees randomly selected from nine colleges, one institute, and one academy from December 2018 to February 2019.

Study design, population and sampling

A cross-sectional study design was used. We defined the target population of this study as working adults between 20 and 70 years of age in the university as the source of the population while working adults who stayed in the university for at least six months during the study period were the study population. Pregnant women were excluded. After getting the details of each Human Resources staff, a sampling frame was prepared and simple random sampling was used to select eligible participants. The sample size was calculated using the following assumptions, the standard deviation of clustered cardiometabolic risk marker score was 0.8, with the 95% confidence interval with 5% error margin, and 20% of the nonresponse rate using single population proportions[18]. For the second objective (associated factors) we used a double proportion formula to determine the sample size for significant factors reported in the previous study by considering the mean difference of body mass index was 1.3 $kg/m^2$with the power of 80%[19]. Finally, the sample size was calculated using Open Epi 3.1, having 894, but we recruited 1200 study participants. Thus, all the eligible working adults identified from the human resource database were included in the study to get a possible maximum sample size since the population was well defined (a complete sampling frame is available).

Data collection

Data were collected by using a structured questionnaire adapted from the WHO STEPwise to NCD risk factor surveillance through face-to-face interviews complemented with physical measurements and biochemical tests. A locally validated WHO STEPSwise questionnaire[20], and self-reported Sedentary Behavior Questionnaire[2], translated into the local language (Afan Oromo and Amharic) were used. The questionnaire was pretested on working adults in a public institution outside the study area. Trained experience data collectors in similar research area was conducted the interview, took anthropometric measurements, and appointed participants to draw venous blood. Blood sample was obtained as per the standard by trained medical laboratory technicians. The overall data collection process was closely supervised by the first author and master public health holder.

Variables and measurements

A six milliliters of venous blood sample were taken from each participant's antecubital arm in a sitting position after eight hours of fasting overnight strictly following infection prevention procedures.
The sample was directed into the sterile vacuum tube (Gel Clot Activator) and placed on the rack for 10-20 minutes to clot. Then it was centrifuged at 3,000 revolutions per minute to extract the serum and stored at -20°C for analysis. An extracted serum sample was used to analyze the lipid profile and blood glucose in the clinical chemistry laboratory of the Hiwot Fana Specialized University Hospital using the Mindray BS-200 chemistry analyzer (Shenzhen Mindray Bio-Medical Electronics Co. Ltd, China)[21].

Body mass index was calculated as weight in kilogram per height in meter squared as underweight (<18), normal (18.5–24.9), overweight (25.0 to 29.9), and obese (≥30) according to WHO criteria[21]. The participant's waist circumference was measured in centimeters at the midpoint of the line between the lower margin of the last palpable rib and the top of the hip bone using an inelastic measuring tape. Furthermore, blood pressure was measured after resting for at least five minutes using a validated digital measuring device (Microlife BP A50, Microlife AG, Switzerland). Measurement was carefully performed on a non-dominant hand while relaxing on a flat surface in a sitting position with the back supported. Then, three consecutive blood pressure measurements were made within five minutes and the average of the last two measurements was used[21].

Our main exposure was self-reported sedentary time. Sedentary time was assessed using a self-report questionnaire as a time spent for any duration (eg hour per day) or in any context in sedentary behaviors[22]. Participants were asked to report how much time they spend on leisure activities (watching television, playing video or computer games, listening to music, talking on the smartphone or texting, napping, socializing with friends and/or family activities, sitting during eating and drinking) or occupational activities (doing computer office work or paperwork, reading), and sitting in a car, bus, or other passive modes of transportation[23]. Accordingly, time spent on these activities for average weekdays and weekends was recorded. Finally, an estimated total sedentary time per day was calculated by summing up the average hours for all types of sedentary activities.[2,24] We categorized sedentary time into four quartiles as quartile one(≤4.33 hours per day),quartile two (4.34 to 5.71 hours per day), quartile three (5.72 to 7.27 hours per day), and quartile four (≥7.28 hours per day).[16] Furthermore, the items were grouped into two domain-specific: occupational and leisure sedentary time. Data collection methods for socio-demographic characteristics including sex, age, weight, height, educational status, ethnicity, religion, occupation, marital status and monthly salary have been collected based on the WHO STEP wise approach for NCDs surveillance in developing countries. Similarly, the measurement of behavioral variables such as smoking, alcohol drinking habits, Khat chewing and levels of physical activity have been collected according to WHO STEP wise approach[21].

Data management and analyses

All completed questionnaires were double entered into EpiData 3.1 and analyzed using STATA 16. Variables were described using proportion, mean, and quartiles as appropriate. After checking for multicollinearity by examining variance inflation factors, multiple linear regression analysis was used to test the associations between dependent variables (a number of cardiometabolic risk markers) and main independent variables (total, leisure, and occupational) sedentary time individually. Associations between outcomes and main independent variables were tested using linear regression as all outcomes were operationalized as continuous variables and also fulfill the assumption of a linear regression model. Visual inspection of P-P plots, histograms of standardized residuals, and scatter plots of standardized residuals against standardized predicted values indicated that assumptions of linearity and residuals were normally distributed and homoscedastic. Finally, we run nine multiple linear regression models to examine the associations between total, leisure, and occupational sedentary time and a number of cardiometabolic risk markers. The regression coefficient (β) along with the 95% CI was reported after adjusting for possible confounder covariates (sex, age, service year, educational level, monthly salary, occupation, marital status, alcohol consumption, khat chewing, physical activity, smoking, self-reported health status, depression), and a significant association was declared if the p-value was <0.05.

Ethical Approval

The study protocol was performed in accordance with the relevant guidelines and regulations. The study was approved by the Institutional Health Research Ethics Review Committee of Haramaya University, College of Health and Medical Sciences (Ref. No. IHRERC/196/2018). All study participants provided written informed consent. The identity of participants was not revealed, and an identification number was allocated. All methods used were also performed by the relevant guidelines and regulations.

Results

Of 1,200 sampled participants, 1,164 participated in the study (ie, response rate 97%). The mean age of the participants was 35 (±9.4) years and ranged from 20 to 70 years. Female participants account for 566 (48.6%), and older than 35 years account for 574 (47%). Two-third of participants were non-manual workers 755(64.9%) and have a college diploma or above education 734(63.5%).More than half of the participants were married 667 (57.3%) (Table 1).

Table 1 Socio-demographic characteristics of working adults in Eastern Ethiopia, 2019 (n= 1164).

Variable	Frequency	Percent
Sex		
Female	598	51.4
Male	566	48.6
Age in years		
18-34	617	53.0
≥35	547	47.0
Occupation		
Manual worker	409	35.1
Non-manual worker	755	64.9
Level of education		
Primary school (1-8)	193	16.6
Secondary school(9-12)	232	19.9
College and above(12+)	739	63.5
Service years in the university		
<5 years	492	42.3
5-10 years	394	33.8
10.1-15 years	148	12.7
>15 years	130	11.2
Marital status		
Single	427	36.7
Married	667	57.3
Divorced/widowed	70	6.0

Sedentary time

The mean self-reported sedentary time per day was 5.9 (±2.1) hours and ranged from 1.3 to 11.1 hours per day. Nearly one in three males 117 (29.1%), regular alcohol drinkers 171(30.9%), and *khat* chewers

126 (31.8%) constitute the fourth quartile of sedentary time. Further, the age group of 55 and above years 25(34.7%) and postgraduates 82(45.6%) were found in the fourth quartile of sedentary time (Table 2).

Table 2. Sedentary time quartiles by the background of study participants in Eastern Ethiopia, 2019 (n= 1164).

Variables	Quartile 1 (≤4.33 hr/day)	Quartile 2 (4.34-5.71 hr/day)	Quartile 3 (5.72-7.27 hr/day)	Quartile 4 (≥7.28 hr/day)
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Sex				
Male	104(17.4)	149(24.9)	171(28.6)	174(29.1)
Female	189 (33.4)	144 (25.4)	116 (20.5)	117 (20.7)
Age (years)				
18-24	24(30.0)	23(28.8)	21(26.2)	12(15.0)
25-34	114 (21.2)	144 (26.8)	155 (28.9)	124 (23.1)
35-44	86 (26.5)	80 (24.7)	71 (21.9)	87 (26.9)
45-54	49 (32.4)	33 (21.9)	26 (17.2)	43 (28.5)
55-64	20 (27.8)	13 (18.1)	14 (19.4)	25 (34.7)
Marital status				
Never married	82(19.2)	118(27.6)	130(30.5)	97(22.7)
Married	180 (27.0)	160 (24.0)	150 (25.5)	177 (26.5)
Divorced/ widowed	31 (44.3)	15 (24.4)	7 (10.0)	17 (24.3)
Educational status				
1-8 grade	103(53.4)	36(16.4)	19(9.8)	35(18.1)
9-12 grade	86 (37.1)	63 (21.2)	36 (15.2)	47 (20.3)
Undergraduate	95 (17.0)	159 (28.4)	178 (31.8)	127 (22.7)
Postgraduate	9 (5.0)	35 (19.4)	54 (30.0)	82 (45.6)
Occupation				
Non-manual work	105(13.9)	187(24.8)	232(30.6)	231(30.7)
Manual work	188 (46.0)	106 (25.8)	55 (13.8)	60 (14.7)
Monthly salary				
<2000 ETB	164(44.7)	86(23.4)	52(14.2)	65(17.7)
2,000-4,000 ETB	74 (22.6)	96 (29.3)	91 (27.7)	67 (20.4)
4,001-6,000 ETB	29 (17.3)	48 (28.6)	56 (33.3)	35 (20.8)

>6,000 ETB	26 (8.6)	63 (20.9)	88 (29.3)	124 (41.2)
Smoking status				
Never smoker	255(24.7)	267(25.8)	253(24.5)	258(25.0)
Former smoker	15 (20.8)	13 (18.1)	25 (34.7)	19 (26.4)
Current smoker	23 (39.0)	13 (22.0)	9 (15.3)	14 (22.7)
Khat chewing				
No/occasional	187(24.4)	208(27.1)	208(21.1)	165(21.4)
Frequent	106 (26.8)	85 (21.5)	79 (20.0)	126 (31.7)
Alcohol consumption				
Never /occasional	183(23.0)	159(26.0)	149(24.4)	120(19.6)
Regular	110 (19.9)	134 (24.2)	138 (25.0)	171 (30.9)
Physical activity				
<600 MET	112 (19.6)	160 (28.0)	154 (27.0)	145 (25.4)
600-2,999 MET	102 (27.8)	83 (22.6)	90 (24.5)	92 (25.1)
≥3,000 MET	79 (35.0)	50 (22.1)	43 (19.1)	54 (23.8)

Legends: ETB, Ethiopian Birr; MET, Metabolic Equivalent Minutes.

Mean cardiometabolic risk markers across the quartiles of sedentary time

Mean waist circumference, systolic and diastolic blood pressure, BMI, fasting plasma glucose, total cholesterol, LDL-c, and triglycerides were increased throughout the sedentary quartiles, while HDL-c decreased. For example, as presented in (Figure1), the mean values of triglycerides and fasting blood glucose increased from the first quartile to the fourth quartile of sedentary time (132.8 vs. 177 mg/dl) and (78.7 vs. 102.7 mg/dl), respectively (Figure 1).

Associations between sedentary time and cardiometabolic risk markers

According to multivariable linear regression model, one hour increase in sedentary time per day showed units increase in BMI (0.61 kg/m^2: β=0.61; 95% CI: 0.49, 0.71), waist circumference (1.4 cm: β=1.48; 95% CI: 1.14, 1.82), diastolic (0.87mmHg: β=0.87; 95% CI: 0.56, 1.18) and systolic blood pressure (0.95mmHg: β = 0.95; 95% CI: 0.45, 1.48), triglycerides (7.07mg/dl: β=7.07; 95% CI: 4.01, 10.14), total cholesterol (3.52 mg/dl: β= 3.52; 95% CI: 2.02, 5.02), fasting blood glucose (4.15 mg/dl: β=4.15; 95% CI: 5.31,4.98) and LDL-c (2.14 mg/dl: β=2.14; 95% CI: 0.96,3.33). Similar consistent associations were observed for leisure sedentary time, whereas occupational sedentary time were associated only with the body mass index, waist circumference, blood pressure, and fasting plasma glucose (Table 3).

Discussion

This is the first study attempt to estimate the associations of sedentary time with a number of cardiometabolic risk among working adults in Ethiopia. We found that the average sedentary time for work-related and personal activities among working adults per day was six hours. The results revealed that a longer time spent in total and leisure sedentary time was significantly associated with an increase in BMI, fasting plasma glucose, diastolic and systolic blood pressure, waist circumference, triglycerides, and LDL-c. However, occupational sedentary time was significantly associated with only BMI, fasting plasma glucose, diastolic and systolic blood pressure, and waist circumference after adjustment for covariates. These associations were significant even after adjusting for a range of demographic variables and covariates including age, sex, education, occupation, income, marital status, physical activity, smoking, khat chewing, smoking, alcohol use, fruits and vegetables consumption, depression and self-report health status.

In this study, we found that high levels of total sedentary time was significantly associated with a number of cardiometabolic risk markers, which coincides with previous evidence[25,26] regardless of physical activity and other potential confounders. Our finding is consistent with several cross-sectional studies[27,28], that have found a deleterious association with clustered cardiometabolic risk markers[14,19,27-30]. Moreover, evidence also showed sedentary time associated with fasting plasma glucose, triglycerides, and waist circumferences[31].This might be due to the extended period of sedentary time in and outside of the working area[23].Another consideration is that typical jobs in the study participants often more involve non-manual labor, thus resulting in less physical activity and high sedentary time[32].This can explain the positive effect of an increasing amount of sedentary time is associated with a reduction in lipoprotein lipase activity[33], which reduces the absorption of plasma triglycerides, particularly by the skeletal muscle, and fats are deposited in the vessels or adipose tissue and increase the plasma triglyceride levels[34].On the other, a decrease in skeletal muscle contractions from prolonged sedentary time may reduce the uptake of plasma triglycerides and free fatty acid into skeletal muscle through suppression of lipoprotein lipase activity[35], and reduction of plasma glucose uptake[36].

Contrary to previous studies, there was no evidence for the association between sedentary time and HDL-c[16]. This might be explained by methodological differences. For example, we measured the sedentary time of the last 7 days compared to Honda et al. which collected 28 days before data collection time[16], and previous studies were asked questions about the number of hours they spent sitting down (cumulative sitting time)[8]. As such, we may not capture the association between sedentary time and HDL-c in our study.

Leisure sedentary time was positively associated with BMI, diastolic and systolic blood pressure, LDL-c, triglyceride, and fasting plasma glucose in line with the previous studies[10,26,27]. However, these findings are inconsistent with prior studies[37,38].Epidemiological studies indicate mixed evidence on the association between leisure sedentary time and cardiometabolic risk markers. This might be related to the use of different measurement thresholds and diagnostic tools. Recent studies have shown the negative effect of watching television and working on the computer on cardiometabolic risk markers[18,38,39]. For example, long leisure sedentary time (3 or 4+ hours) could increase the risk of cardiometabolic risks regardless of physical activity in a working adult[26].

Fortunately, occupational sedentary time is not strongly associated with a set of cardiometabolic risk markers compared to leisure sedentary time, especially with lipid profiles (total cholesterol, triglycerides, LDL-c, and HDL-C). The results support previous study findings that occupational sedentary time is less harmful to cardiometabolic risk markers than leisure sedentary time[39,40]. However, as previously reported, we found that longer occupational sedentary time increased waist circumference[41], BMI, fasting plasma glucose, and triglycerides[42]. Some occupational categories demand more or less the same professionals to perform multiple activities/tasks, such as university employees[24].This inconclusive association between occupational sedentary time and cardiometabolic outcomes[43-45] could be partially explained by the cross-sectional nature of the study, which may not rule out the temporal relationship.

Self-report total, leisure, and occupational sedentary time appear to be associated with a number of cardiometabolic risk markers in working adults. Being an employee may increase social connection, which can lead to long sedentary time and fewer opportunities for physical activity. Thus, our findings suggest the need for intervention programs that focus on identified factors to improve cardiometabolic risk markers and prevent early cardiovascular disease and type 2 diabetes. Working adults who spent an excessive amount of time in sedentary advocate the need for increasing physical activity and decreasing sedentary time through systemic intervention in and out of work programs to reduce the incidence of cardiovascular diseases.

Limitations

This study relied on self-report data collected through interviews, which could be affected by the recall and social desirability biases. The study employed a cross-sectional study design which could not conclude causality and effects. Moreover, this finding may not be generalized to a broader Ethiopian population since our study participants were an employee of a specific organization. Furthermore, in this study, we did not include ecological environmental constructs, organizational policy, and physical environment that could affect the sedentary time of working adults.

Conclusions

This study contributes new evidence to the literature that sedentary time, specifically, total sedentary time, and leisure-time are associated with a number of cardiometabolic risk biomarkers. In this study, the mean cardiometabolic risk markers increased with increasing sedentary time. The total and leisure sedentary time was positively associated with fasting plasma glucose, body mass index, systolic and diastolic blood pressure, waist circumference, triglycerides, total cholesterol, and LDL-c. Whereas, occupational sedentary time a significant positive association with fasting plasma glucose, BMI, systolic and diastolic blood pressure, and waist circumference. Therefore, introducing interventions to reduce sedentary time and a regular screening system for cardiometabolic risk markers is essential to reduce the risk of cardiovascular disease among working adults. Further research is required to examine the association of sedentary time with cardiometabolic risk markers using prospective follow-up is essential to establish the temporal relationship.

Declarations

Data availability

The data are available from the corresponding author upon request.

Acknowledgements

The authors thank Haramaya University and the Addis Continental Institute of Public Health (ACIPH) for technical support. We also thank the study participants and data collectors for their willingness and unreserved contribution.

Author contributions

A.M. contributed to the design, proposal development, investigation, project administration, data analysis and interpreted the results, writing original drafts, and editing the manuscript. T.G. and K.T.R. contributed to the design, and interpretation of the results, and reviewed and edited the manuscript. Y.B. and A.W. contributed to the design of the study methodology, interpreted the results, and critically reviewed and edited the manuscript. All the authors read and approved the final manuscript for publication.

Competing interests

The authors declare no competing interests

Additional information

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Funding

This study was supported by Haramaya University (Grant # HURG-2017-02-02-05). The university has no role in the study design, data collection, analysis, manuscript writing, or publication.

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Figures

Figure 1

Legend: A) Waist circumference; B) Diastolic blood pressure; C) Triglycerides; D) HDL-c (High-Density Lipoprotein-cholesterol)

Legend: E) LDL-c (Low-Density Lipoprotein-cholesterol); F) Total cholesterol; G) Body Mass Index; H) Fasting Blood Glucose.

Q1: first quartile sedentary time; Q2: second quartile sedentary time; Q3: third quartile sedentary time; Q4: fourth quartile sedentary time.

Mean cardiometabolic risk markers across the quartiles of sedentary time among working adults in Eastern Ethiopia, 2019.