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Original Article

Relationship between sitting time and anthropometric indices: Findings of Yazd health study (YaHS)

Masoud Mirzaei^a, Maryam Askari^b, Nasim Namiranian^b, Hassan ali Mahmoudi Kohani^{b,*}^a Yazd Cardiovascular Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran^b Diabetes Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

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ABSTRACT

Background: The abnormal anthropometric indices are one of the main risk factors of the non-communicable diseases. The purpose of this study was to determine the relationship between sitting time and anthropometric indices.

Methods: This cross sectional analytic study was conducted on 10000 adult 20–69 years old residents of Yazd in 2013–2014. The anthropometric indices were measured according to the World Health Organization (WHO) standards and using the calibrated instruments. Data were analyzed by SPSS version 22. Statistical analysis were percentage, mean, standard deviation (SD), Chi-square test and Binary Logistic Regression (BLR). with significance level of 0.05.

Results: The findings showed that 49.9% of the participants were male. After the confounders adjustment, the Odds Ratio (OR) of abnormal waist to hip ratio (WHR) and sitting time was 0.7 (95% CI = 0.5–0.9) in people with daily sitting of 4–6 h at work ($p = 0.03$). The OR of abnormal waist to height ratio (WHtR) was 0.7 (95% CI = 0.5–0.9) in individuals with sitting of 1–3 h per day at work ($p = 0.02$). Furthermore, the OR of abnormal waist circumference (WC) and sitting time was 1.7 (95% CI = 1.0–2.8) in participants who were sitting 10 h or more per day at work ($p = 0.04$).

Conclusions: Decreased sitting time per day at work can prevent from abnormal WHR, WHtR and WC.

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1. Background

Physical inactivity is known as the fourth potential cause of death in the world. Low level of physical activity (PA) is responsible for incidence, approximately 30% of the ischemic heart diseases, 27% of diabetes, and 21–25% of the breast and colon cancers [1]. Many of the chronic diseases, such as coronary artery disease, stroke, hypertension, type 2 diabetes, and osteoporosis have been directly associated with physical inactivity [2,3]. Globally, 31.1% of adults are physically inactive; 33.9% of women and 27.9% of men [2,4]. The reduction of physical activity is partly due to the inactivity in leisure time and sedentary or inactive behaviors at work or at home [5].

Many epidemiologic evidences such as cross-sectional and prospective observational studies have shown that sedentary behaviors duration is a risk factor of non-communicable diseases (NCDs) [6,7].

Previous studies indicated a significant association between sitting time, health status, and diabetes biomarkers, especially obesity, 2-h glucose, lipid disorders, and impaired glucose tolerance [8]. According to the World Health Organization (WHO), about 13% of the world's adult population were obese in 2016 and the incidence of obesity doubled from 1975 to 2016 [9]. In Iran, according to the results of the STEPwise approach to Surveillance (STEPS) study in 2011, 48.2% of the participants (both genders) were overweight and 16.8% were obese. Moreover, a high prevalence of obesity and overweight was observed in the central regions of Iran, especially in the urban areas [10–12].

The abnormal anthropometric indices is one of the main risk factors for the incidence of NCDs [13]. On average, the life expectancy of obese people is six to seven years less than other individuals and this rate can reach up to 10 years in the people with

* Corresponding author. Diabetes Research Center, Talar-e-Honar Alley, Shahid Sadoughi Blvd., 8917693571, Yazd, Iran.

E-mail addresses: masoud_mirzaei@hotmail.com (M. Mirzaei), Askarim204@gmail.com (M. Askari), namiranian.nasim@gmail.com (N. Namiranian), a.mahmoodi@ssu.ac.ir (H. Mahmoudi Kohani).

body mass index (BMI) higher than 40 [14]. According to the WHO, anthropometric indices are the available and inexpensive way to evaluate the proportion, size, and body composition [15]. Although anthropometric indices may be less accurate in assessing body composition than more complex methods, they are applied as useful tools to examine the body composition changes over time in large studies due to their simplicity [16].

In addition to general obesity, abdominal obesity is also considered as an independent predictor of cardiovascular outcomes in epidemiological studies, which is defined using waist circumference (WC), hip circumference, waist to hip ratio (WHR), and waist to height ratio (WHtR) [17]. The most common criteria for determining the abdominal obesity is the size of the waist, which differs among various races and nationalities. For example, the recommended rates in Asia, South America, and Central America are 90 cm for men and 80 cm for women. However, considering the Chinese men and women, these rates are 85 cm and 80 cm, respectively [18].

One criterion in measuring physical activity is the duration of leisure time or the inactive time, which is known as sitting time. This situation usually occurs at work, leisure time and recreation, as well as the time of commuting with vehicles. Sedentary behaviors, such as watching television, using computers, sitting at work, or riding cars have significant association with on physical activity and health in the literature [19]. Abnormal anthropometric indices lead to increased risk of morbidity, mortality and burden of chronic disease. The aim of this study was to investigate the association of the sitting time at work, in vehicles, and home with anthropometric indices in Yazd city, Iran.

2. Methods

This population-based cross-sectional study was carried out using the data from Yazd Health Survey (YaHS) in 2013–2014. This study was conducted on 2% of the Yazd population, 10000 adults who were Yazd residents and aged between 20 and 69 years. Details of the study was published [20].

The inclusion criteria consisted of all the individuals aged 20–69 years, who were randomly selected, based on the location of residence using random cluster sampling. The exclusion criteria were: (1) having the same gender and being in the same age range for the individuals who lived in the same region; (2) having un-willingness to participate in the study; and (3) lack of cooperation in completing the questionnaire or giving the examinations after three visits to the place.

In order to collect the samples in this study, the multi-stage stratified sampling method was applied to prevent selection bias. In the first step, 200 clusters of 50 people were randomly selected from the regions of Yazd city. At the next stage, the main clusters were selected based on the list of households in 2014. Then, the questionnaires were completed by referring to the every other house on the right side of the selected house. The required information was collected by the YaHS questionnaire using interview method.

The two questions were used to calculate the sitting time in YaHS questionnaire: How much usually sitting time at home (at home)? How much usually sitting time at work, vehicle or car (at work)? PA was assessed using a short forms standard International Physical Activity Questionnaire (IPAQ). And categorised tree class consist Vigorous, Moderate and weak [21]. The anthropometric indices were calculated using the weight, height, and waist measures according to the standard criteria and by application of the calibrated measurement tools. BMI was defined as the ratio of weight (kg) to height (m) squared. Anthropometric indices were classified into two normal and non-normal categories for analysis.

According to the standard criteria presented by WHO, normal BMI was defined within the range of 19–24.9, normal WHR was ≤ 0.85 for women and ≤ 0.9 for men, normal WHtR was ≤ 0.48 for women and ≤ 0.52 for men, and normal WC was < 88 for women and < 102 for men [22].

Data were analyzed using SPSS version 20. Descriptive statistics were reported as percentage, mean, and standard deviation (SD) with the significant level of 0.05. Chi-square test was applied to compare the prevalence of anthropometric indices. Binary Logistic Regression (BLR) was applied to measure the effect of each variable as well as to eliminate the effect of confounders and their odds ratio (OR). 33 of the participants were excluded from this study due to missing in most variables. In this study, the confounding variables such as age, education, gender, physical activity, marital status, wake-up time, sleep duration, duration of watching television and video, health status, consumption of candy, sugar, and fried foods, occupation, working duration per day, the type of occupation, insurance, and smoking states were adjusted in all models. Moreover, in each model and for each anthropometric index, we adjusted the other three indicators and used the backward method.

3. Results

The total number of participants in this study was 10000, among whom 9967 people were included in the statistical analyses. Missing data in the variables of employment status and type of insurance, were 130 (1.3%) and 144 (1.4%) respectively. The findings showed that 50.6 % of the participants were female. It is worth noting that equal numbers of ten-year age groups were considered in this research. Most of the participants (29.7%) had diplomas and associate degree, 85% were married. Furthermore, 40.1% of the participants were employed (Table 1).

The mean BMI in the study population was 27.1 ± 5.0 , mean WC was 94.0 ± 13.2 , mean hip circumference was 101.9 ± 11.6 , and mean neck circumference was 37.6 ± 3.7 . The mean WHR and WHtR, as the indicators of abdominal obesity were 0.9 ± 0.01 and 0.5 ± 0.01 , respectively. This study showed that the mean of body fat and excess fat in participants were 32.4 ± 11.1 and 9.0 ± 4.4 , respectively.

The prevalence of abnormal BMI in people with sitting time of more than 10 h a day at home was 69%; whereas, this rate was 62.4% for the individuals who were sitting at work or in vehicles. The abnormal BMI rate for the people with sitting time of less than 1 h was 61% at home and 65.3% at work or in vehicles. Regarding the people with more than 10 h of sitting per day at home and at work or in vehicles, the abnormal BMI rates were 85.9 and 70.8%, respectively. Considering the individuals with the sitting time of less than 1 h a day at home and at work, the abnormal WHtR rates were 75.5 and 81.1%, respectively (Tables 2 and 3).

A regression model was developed for each of the dependent variables. So, a total number of eight regression models were designed. The OR of abnormal BMI in people who had sitting times for 10 h or more per day was $OR = 1.4$ (95% CI = 1.1–1.7), which was reduced to $OR = 1.0$ (95% CI = 0.5–1.7) after adjusting the confounding variables. However, the difference was not statistically significant. The OR of abnormal BMI in people who were sitting for 1–3 h a day at work was $OR = 0.7$ (95% CI = 0.6–0.8), but after adjusting the confounders this rate reached $OR = 1.2$ (95% CI = 0.9–1.5) and the difference was not significant. The OR of abnormal BMI in individuals who had sitting times of 4–6 h a day at work was $OR = 0.8$ (95% CI = 0.6–0.9). Regarding the multivariate regression, this rate increased to $OR = 1.3$ (95% CI = 0.9–1.7), but it was not statistically significant (Table 4).

The OR of abnormal WHR in people who were sitting at home for 4–6 h, 7–9 h, and 10 h or more per day in comparison with

Table 1
The baseline: Characteristics of Yazd Health Study Participants 2013–14.

Characteristics	Frequency	percentage	
Education	Lower middle school	2591	26.3
	Middle school & high school	2802	28.4
	Diplomas and associate degree	2932	29.7
	Bachelor's degree	1291	13.1
	Master's degree & higher	254	2.5
Gender	Male	4921	49.4
	Female	5046	50.6
Marital status	Married	8433	85.0
	Single	1054	10.6
	Widowed	380	3.8
	Divorced	56	.6
Employment status	Employed	3926	40.1
	Housewife	3825	39.1
	Unemployed	2039	20.8
Insurance	No insurance	23	.2
	Medical service	537	5.5
	Social security	1397	14.2
	Iranian national	6967	70.9
	Other	216	2.2

Table 2
Frequency (%) of categories anthropometric indices with time spent sitting at home^a.

		Sitting hours in home					
		1h>	1–3h	4–6h	7–9h	10h ≤	p-value
BMI	Normal N(%)	199(39.0)	779(39.6)	1148(38.0)	881(35.3)	577(31.0)	0.001>
	Abnormal N(%)	311(61.0)	1188(60.4)	1876(62.0)	1612(64.7)	1284(69.0)	
WHR	Normal N(%)	179(35.4)	611(31.3)	919(30.6)	653(26.3)	465(25.2)	0.001>
	Abnormal N(%)	326(64.6)	1342(68.7)	2084(69.4)	1829(73.7)	1382(74.8)	
WHtR	Normal N(%)	123(24.5)	500(25.5)	799(26.6)	517(20.8)	260(14.1)	0.001>
	Abnormal N(%)	379(75.5)	1460(74.5)	2204(73.4)	1963(79.2)	1587(85.9)	
WC	Normal N(%)	260(51.5)	1112(56.7)	1740(57.9)	1293(52.1)	700(37.8)	0.001>
	Abnormal N(%)	245(48.5)	849(43.3)	1267(42.1)	1189(47.9)	1151(62.2)	

^a chi-squared test.**Table 3**
Frequency (%) of categories anthropometric indices with time spent sitting at Work^a.

		Sitting hours in work					
		1h>	1–3h	4–6h	7–9h	10h ≤	p-value
BMI	Normal N(%)	1670(34.7)	1039(40.0)	326(40.4)	192(38.2)	64(37.6)	0.001>
	Abnormal N(%)	3146(65.3)	1561(60.0)	481(59.6)	310(61.8)	106(62.4)	
WHR	Normal N(%)	1246(26.0)	879(34.0)	286(35.8)	152(30.3)	45(26.8)	0.001>
	Abnormal N(%)	3538(74.0)	1705(66.0)	513(64.2)	349(69.7)	123(73.2)	
WHtR	Normal N(%)	906(18.9)	777(30.1)	232(29.0)	127(25.4)	49(29.2)	0.001>
	Abnormal N(%)	3882(81.1)	1807(69.9)	568(71.0)	373(74.6)	119(70.8)	
WC	Normal N(%)	2210(46.1)	1612(62.3)	532(66.4)	317(63.3)	95(56.5)	0.001>
	Abnormal N(%)	2585(53.9)	975(37.7)	269(33.6)	184(36.7)	73(43.5)	

^a Chi-squared test.**Table 4**
Association between BMI and sitting time at home and at work.

	Sitting time (hour)	OR Crude (CI)	p-value	OR Adjusted (CI)	p-value
Sitting Time at home [Regression Model 1 (Reg-M 1)]*	1>	1		1	
	1–3	0.9(0.7–1.1)	0.81	1.2(0.7–1.8)	0.39
	4–6	1(0.8–1.2)	0.64	1.4(0.9–2.2)	0.11
	7–9	1.1(0.9–1.4)	0.11	1.3(0.8–2.1)	0.15
	10≤	1.4(1.1–1.7)	0.001	1(0.5–1.7)	0.96
Sitting Time at work (Reg-M 2)	1>	1		1	
	1–3	0.7(0.7–0.8)	0.001	1.2(0.9–1.5)	0.05
	4–6	0.7(0.6–0.9)	0.002	1.3(0.9–1.7)	0.05
	7–9	0.8(0.7–1)	0.11	0.9(0.6–1.3)	0.81
	10≤	0.8(0.6–1.2)	0.42	1.1(0.7–1.9)	0.57

*Binary Logistic Regression.

those who were sitting for less than 1 h were OR = 1.2 (95% CI = 1.0–1.5), OR = 1.5 (95% CI = 1.2–1.8), and OR = 1.6 (95% CI = 1.3–2.0), respectively. The OR of abnormal WHR in people who were sitting at work for 1–3, 4–6, and 7–9 h in comparison with people who were sitting for less than 1 h per day were OR = 0.6 (95% CI = 0.6–0.7), OR = 0.6 (95% CI = 0.5–0.7), and OR = 0.8 (95% CI = 0.6–0.9), respectively. After adjusting for the confounders, the difference observed in the OR of the people with sitting duration of 4–6 h a day was significant: OR = 0.7 (95% CI = 0.5–0.9) (Table 5).

The OR of abnormal WHtR in people with daily sitting time of 10 h or more at home was OR = 1.9 (95% CI = 1.5–2.5). After adjusting for the confounding variables, this rate changed into OR = 1.6 (95% CI = 0.8–3.3), but the difference was not statistically significant. The OR of abnormal WHtR in people who were sitting for 1–3 h a day at work was OR = 0.5 (95% CI = 0.4–0.6). However, after adjusting for the confounding variables, this rate remained statistically significant as a protective factor with OR = 0.7 (95% CI = 0.5–0.9) (Table 6).

The OR of abnormal WC for people who were sitting for 10 h and more at home and at work were OR = 1.7 (95% CI = 1.4–2.4) and OR = 0.6 (95% CI = 0.4–0.8), respectively. After adjusting the confounders, sitting time at home was not significant, whereas sitting time at work was statistically significant OR = 1.7 (95% CI = 1.0–2.8) (Table 7).

4. Discussion

In our study, there was a statistically significant association between WHR, WHtR and WC with sitting time at work.

The results of this study showed that the prevalence of abnormal BMI and WHtR were higher in people with sitting time more than 10 h a day at home than the individuals with sitting time of less than 1 h at home. The OR of abnormal BMI in people who were sitting for 10 h or more at home per day was initially significant using the single-variable regression, but it was not significant after eliminating the confounding factors. The OR of abnormal BMI in individuals with 1–3 and 4–6 h of sitting position a day at work were also significant using the single-variable regression; however, it did not remain significant after adjusting for the confounders. Eriksen et al. [23] founded a positive and significant correlation between the sitting time at work and BMI in women.

The results of our study using the single-variable analysis indicated that the OR of an abnormal WHR increased significantly with an increase in the time of sitting at home. However, no significant result was observed after eliminating the confounding factors. The adjusted OR of the abnormal WHR was 27% less in people with sitting time of 4–6 h at work than the individuals with less than 1 h of sitting at work. A study by Fayaz et al. [24] showed a significant difference in WHR and body fat percentage of participants in terms

of their physical activity level. Furthermore, the level of physical activity was significantly correlated with the WHR and body weight.

According to our findings, the OR of abnormal WHtR increased with the increase of sitting time before adjustment of the confounders; this rate was almost two times significantly higher in people with daily sitting time of 10 h or more at home. After adjustment for the confounding variables, the increased OR was not statistically significant. The OR of abnormal WHtR in people with sitting time of 1–3 h at work per day reduced significantly by 27% after eliminating the confounding factors. However, this rate was not statistically significant in other categories of sitting time. We observed no association between work-related activity and obesity or overweight. A study by Wanner et al. [25] in Switzerland indicated that the amount of leisure time and severity of the physical activity were inversely associated with all the parameters of obesity, which is in agreement with our findings. However, they reported that the sitting time did not have any positive correlation with BMI, WHtR, or WC.

The OR of abnormal WC in people with daily sitting time of 10 h or more at work was 70% higher than those with daily sitting time of less than 1 h at work; this difference was statistically significant. A study carried out in Scotland found that the chance of developing abnormal BMI and WC was respectively 39 and 41% higher in people who were inactive and had sedentary behaviors at home [26].

One of the strengths of this study was its high sample size, accurate sampling, and consequently high power. And so this study has high generalizability. This research also enjoyed from application of trained questioners. Considering the limitations of this research, measurement of sitting time was interval variable. Furthermore, the participants' nutritional status, intake of energy, and their musculoskeletal disorders, which could reduce their mobility, were not investigated in the current study. Therefore, we suggest other researchers to design a cohort study, investigate individuals with normal anthropometric indices and sedentary lifestyles, and evaluate the incidence of obesity- and overweight-related consequences.

5. Conclusions

Physical inactivity is known as the fourth most common potential cause of death in the world. Our study showed that spending less time in sitting position at work prevented the abnormal WHR and WHtR. Furthermore, we also found that increase of the sitting time at work increased the WC. Therefore, time spent on inactive behaviors is considered as a potential risk factor for health outcomes. In this regard, we suggest people to devote more time for walking and physical activity during their working hours.

Table 5
Association between WHR and sitting time at home and at work.

	Sitting time (hour)	OR Crude (CI)	p-value	OR Adjusted (CI)	p-value
Sitting Time at home (Reg-M 3) ^a	1>	1		1	
	1–3	1.2(0.9–1.4)	0.07	1.1(0.7–1.7)	0.59
	4–6	1.2(1–1.5)	0.03	1(0.6–1.6)	0.76
	7–9	1.5(1.2–1.8)	0.001	1(0.6–1.7)	0.76
	10≤	1.6(1.3–2)	0.001	0.8(0.4–1.4)	0.46
Sitting Time at work (Reg-M 4) ^a	1>	1		1	
	1–3	0.6(0.5–0.7)	0.001	0.8(0.7–1.1)	0.29
	4–6	0.6(0.5–0.7)	0.001	0.7(0.5–0.9)	0.03
	7–9	0.80(0.66–0.98)	0.03	0.9(0.6–1.2)	0.58
	10≤	0.9(0.6–1.3)	0.83	1.2(0.7–2.1)	0.36

^a Binary Logistic Regression.

Table 6
Association between WHtR and sitting time at home and at work.

	Sitting time (hour)	OR Crude (CI)	p-value	OR Adjusted (CI)	p-value
Sitting Time at home (Reg-M 5) ^a	1>	1		1	
	1–3	0.9(0.7–1.1)	0.64	0.9(0.5–1.7)	0.99
	4–6	0.8(0.7–1.1)	0.32	0.9(0.5–1.5)	0.72
	7–9	1.2(0.9–1.5)	0.06	0.9(0.5–1.7)	0.92
	10≤	1.9(1.55–2.5)	0.001	1.6(0.8–3.3)	0.13
Sitting Time at work (Reg-M 6) ^a	1>	1		1	
	1–3	0.5(0.4–0.6)	0.001	0.7(0.5–0.9)	0.02
	4–6	0.5(0.4–0.6)	0.001	0.9(0.6–1.4)	0.95
	7–9	0.6(0.5–0.8)	0.001	1.1(0.7–1.7)	0.45
	10≤	0.5(0.4–0.7)	0.001	0.6(0.3–1.1)	0.15

^a Binary Logistic Regression.

Table 7
Association between WC and sitting time at home and at work.

	Sitting time (hour)	OR Crude (CI)	p-value	OR Adjusted (CI)	p-value
Sitting Time at home (Reg-M 7) ^a	1>	1		1	
	1–3	0.8(0.66–0.9)	0.03	0.8(0.5–1.4)	0.55
	4–6	0.7(0.64–0.9)	0.007	0.8(0.5–1.3)	0.47
	7–9	0.9(0.8–1.1)	0.80	0.6(0.3–1.0)	0.055
	10≤	1.7(1.04–2.4)	0.001	0.7(0.4–1.3)	0.39
Sitting Time at work (Reg-M 8) ^a	1>	1		1	
	1–3	0.5(0.4–0.5)	0.001	0.9(0.7–1.2)	0.74
	4–6	0.4(0.3–0.5)	0.001	0.9(0.7–1.3)	0.96
	7–9	0.4(0.4–0.6)	0.001	1.2(0.8–1.7)	0.20
	10≤	0.6(0.4–0.8)	0.008	1.7(1.0–2.8)	0.04

^a Binary Logistic Regression.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Yazd University of Medical Sciences on July 8, 2014 with the code of 17/1/73941. The participants were also asked to sign the informed consent forms.

Consent for publication

Not applicable.

Availability of data and material

The data underlying this study are owned by the Shahid Sadooghi University of Medical Sciences, Yazd, Iran. Each researcher can send professor Masoud Mirzaei an email to get the data. Email: masoud_mirzaei@hotmail.com.

Conflicts of interest

The authors declare that they have no competing interests.

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None.

Authors' contributions

Masoud Mirzaei designed the study and facilitated to access the data. Maryam Askari, Nasim Namiranian, Hassan ali Mahmoudi Kohani carried out the statistical analyzes. All authors participated in interpretation of the results. Maryam Askari and Hassan ali Mahmoudi Kohani wrote the first draft of the manuscript. Masoud Mirzaei and Nasim Namiranian edited the manuscript.

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Abbreviations

YaHS	Yazd Health Study
WHO	World Health Organization
SD	Standard Deviation
BLR	Binary Logistic Regression
Reg-M	Regression Model
OR	Odds Ratio
WHR	waist to hip ratio
WHtR	waist to height ratio
WC	waist circumference
NCDs	non-communicable diseases
STEPS	STEPwise approach to Surveillance
BMI	body mass index
at home	How much usually sitting time at home?
at work	How much usually sitting time at work, vehicle or car?
IPAQ	standard International Physical Activity Questionnaire
PA	physical activity

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dsx.2019.05.015>.

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