Diabetes & Metabolic Syndrome: Clinical Research & Reviews 14 (2020) 1391–1397

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

# Dietary habits and the 10-year risk of overweight and obesity in urban adult population: A cohort study predicated on Yazd Healthy Heart Project

Mohammadtaghi Sarebanhassanabadi [a], Manijeh Shahriari Kalantari [b, *], Paolo Boffetta [c, d], Omid Beiki [e, f], Mohammadreza Pakseresht [g], Nizal Sarrafzadegan [h], Masoud Mirzaei [a], Alexander Kraemer [i], Seyedmostafa Seyedhosseini [a], Shahriar Mali [a], Seyedeh Mahdieh Namayandeh [a], Seyed Kazem Razavi [a], Mohammad Reza Alipour [a], Mahmood Emami [a], Mostafa Shokati Ahmad Abad [j], Habib Allah Hosseini [a], Amin Salehi-Abargouei [k, l]

[a] Yazd Cardiovascular Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[b] Department of Nursing, school of Medicine, Islamic Azad University, Yazd, Iran
[c] Tisch Cancer Institute, Icahn School of Medicine at Mount Sinai, New York, NY, 10029, USA
[d] Department of Medical and Surgical Sciences, University of Bologna, Bologna, Italy
[e] Department of Clinical Neuroscience, Karolinska Institute, Stockholm, Sweden
[f] Department of Epidemiology, Kermanshah University of Medical Sciences, Kermanshah, Iran
[g] Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, Alberta, Canada
[h] Isfahan Cardiovascular Research Center, Cardiovascular Research Institue, Isfahan University of Medical Sciences, Isfahan, Iran
[i] School of Public Health, Department of Public Health Medicine, University of Bielefeld, Germany
[j] Critical Care Department, Nursing and Midwifery Faculty, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[k] Nutrition and Food Security Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[l] Department of Nutrition, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

ARTICLE INFO

*Article history:*
Received 17 December 2019
Received in revised form
13 July 2020
Accepted 15 July 2020

*Keywords:*
Dietary habits
Overweight
Obesity
Incidence

ABSTRACT

*Background and objective:* Overweight and obesity are thought to be associated with increased risk of chronic disease in the Middle East. The present study aimed to determine the association between dietary habits and the incidence of overweight and obesity in urban adult population in the central part of Iran after a 10-year follow-up.

*Methods:* This cohort study was initiated with 2000 participation aged 20–74 years from Yazd city in Iran based on Yazd Healthy Heart Project (YHHP). The participants without overweight and obesity at the baseline of the study were followed up to 10 years. Demographic data, anthropometric measurements, behavioral and metabolic risk factors of cardiovascular diseases and dietary habits were assessed at baseline and phase II.

*Results:* After a 10-year follow up, 516 non-overweight and 1068 non-obese participants were included for the final analysis. Once adjustments were made for all potential confounders including age, sex, smoking, economic status, physical activity and education, it was identified that lack of weight control increased the risk of obesity (hazard ratio; 95% CI) in total population (1.9; 1.06, 3.4), as well as the risk of

* Corresponding author. , Postal code: 8917945556,
*E-mail addresses:* mtsareban@gmail.com (M. Sarebanhassanabadi), m_kalan13@yahoo.com (M. Shahriari Kalantari), paolo.boffetta@mssm.edu (P. Boffetta), omid.beiki@ki.se (O. Beiki), mpakseresht@ualberta.ca (M. Pakseresht), nsarrafzadegan@gmail.com (N. Sarrafzadegan), mirzaeim@mailfa.com, mmirzaei@ssu.ac.ir (M. Mirzaei), alexander.kraemer@uni-bielefeld.de (A. Kraemer), m.seyedhossaini@gmail.com (S. Seyedhosseini), malishahriar4@gmail.com (S. Mali), drnamayandeh@gmail.com (S.M. Namayandeh), razavi822@gmail.com (S.K. Razavi), dralipour53@yahoo.com (M.R. Alipour), emami.mahmood@yahoo.com (M. Emami), mostafa.shokati@gmail.com (M.S. Ahmad Abad), drhahosseini@gmail.com (H.A. Hosseini), abargouei@gmail.com (A. Salehi-Abargouei).

https://doi.org/10.1016/j.dsx.2020.07.024

overweight (2.39; 1.07, 5.27) and obesity (2.65; 1.13, 6.25) in men. Moreover, consumption of mayonnaise increased the 10-year risk of overweight in women (6.09; 1.2, 30.99).
*Conclusions:* As revealed by the present study, unhealthy dietary habits can increase the incidence of overweight and obesity in central part of Iran. Therefore, changing the lifestyle appears to be urgent in reducing the risk of overweight and obesity.


## 1. Introduction

Obesity and overweight are assumed to be serious public health problems in the world. As defined by the World Health Organization (WHO), 25≤ body mass index (BMI) < 30 and BMI ≥30 kg/m2 are the features that represent overweight and obesity, respectively [1]. WHO has recognized obesity as a disease the prevalence of which is augmenting globally and its health care costs are estimated over 215 billion dollars per year in the United States [2]. In a systematic review study, the prevalence of obesity in Iranian population has considerably increased since 2005 with regard to age and gender [3]. The incidence of overweight and obesity are different in various areas of Iran emanating from sociocultural diversities and the like. Predicated on WHO reports, the prevalence of overweight as for the Iranian women and men has been reported 70% and 54%, respectively [4]. Also, a study on Tehranian people in Iran revealed the rate of obesity reaching 31.3% for the whole population, and respectively 23.4% and 38.1% for men and women [5]; for another part of Iran, i.e., Isfahan, however, it leveled at 13.2% and 32.9% for the genders [6].

Obesity and overweight are associated with increased risk of chronic diseases including hypertension, hyperlipidemia, cardiovascular disease, diabetes and some cancers [7,8]. Obesity is most often triggered by environmental (e.g; food availability and quality), physiologic (e.g; sex, age), genetic and social factors [9]. Dietary habits are regarded as an important behavior that can boost the risk of obesity [8]. They are considered as the habitual decisions to choose food [10]. Consumption of high-fat *vs* low-fat meat, low-fat *vs* high-fat dairy product, type of cooking such as frying or boiling food, and consumption of salad and mayonnaise as adding dressings to foods are examples of dietary habits [10].

An unhealthy dietary pattern, including high consumption of fat, sugar, fast foods, low consumption of fibers and shunning breakfast can be associated with overweight and obesity [11,12]. The results of a study indicated that the likelihood of obesity is lower with a healthy diet containing fruits and vegetables [13]. Another study conducted in Iran reported that inappropriate dietary habits are widespread in the Iranian populations [14].

Some studies have appraised association between dietary habits and prevalence of obesity [11,15]. The study of Hanley et al. revealed the prevalence of obesity being related to food intake and food composition [1]. In addition, the results of a cross-sectional inquiry in Iran indicated an association between fast food consumption and the risk of abdominal obesity in young adults [16]. And in a study by Groholt and et al., findings revealed a relation between consumption of breakfast and BMI concluding that obesity and overweight stand higher in individuals who fail to eat any breakfast [17].

Some surveys have assessed the prevalence of obesity in Iran [4,18], designing, however, no prospective outlook around the impact of dietary habits on the incidence of the disease. The aim of the present study was, therefore, to identify the association between dietary habits and the incidence of overweight and obesity in urban adult population in central part of Iran after a 10-year follow-up.

## 2. Materials and methods

### 2.1. Study population

This cohort study commenced with 2000 urban residents aged 20–74 years from Yazd city in Iran in 2005–2006 as Yazd Healthy Heart Project (YHHP); they were selected using cluster random sampling method. After about 10 years and for repeating measurements, the participants were invited once more during 2015–2016. Details of the project protocol have been reported in previous studies [15,19].

At the baseline of the study, all the participants with no signs of overweight (n = 810 out of 2000) and obesity (n = 1602 out of 2000) were followed-up for 10 years. After repeated measurements at the end of the follow-up, 63.7% (n = 516) and 66.7% (n = 1068) of the participants were found to be overweight or obese respectively; attrition occurred for the rest of the participants during the program.

### 2.2. Data collection

When the study was initiated, several variables including demographic data (age, sex and education), anthropometric measurements, physical activity, economic status, smoking and dietary habits were collected based on face-to-face interview and questionnaire. Variables such as economic data, physical activity and education were categorized into low, moderate and high level subgroups [15,19]. Further, other risk factors such as systolic and diastolic blood pressure, fasting blood glucose, triglycerides, total and HDL-cholesterol and waist circumference were gathered at the baseline during 2005–2006. All measurements were carried out using standard methods and calibrated devices [15,19]. Repeated measurements of all variables were performed in 2015–2016. According to WHO definition, 25 ≤ BMI<30 and BMI ≥30 kg/m$^2$ levels were considered as the features of overweight and obesity, respectively [20].

### 2.3. Assessment of dietary habits

In the first phase of study, dietary habits data were collected during 2005–2006 through a dietary habit questionnaire designed by some expert nutritionists. It included 16 items such as eating habits for salad, mayonnaise, high salt food, high fat meat, poultry and dairy, canned or fast food and cooking methods all having a two-option response (yes/no) [15].

## 3. Statistical analysis

SPSS version 19 (IBM Corporation, New York, USA) was used to analyze the data. Independent Student *t*-test was used to compare the means of quantitative variables, and chi-square test was employed to compare categorical variables between the overweight/non-overweight and obese/non-obese groups at the first phase. To find associations between dietary habits and the risk of overweight and obesity, Cox proportional hazard regression

**Table 1**
Baseline characteristics of study population between two groups of overweight/non-overweight and obese/non-obese in total population.

| Variable | overweight | | | obesity | | |
|---|---|---|---|---|---|---|
| | non-overweight n = 810 | Overweigh n = 1168 | p-value | non-obesity n = 1602 | Obesity n = 376 | p-value |
| Age | 47.09 ± 17 | 49.7 ± 13.7 | <0.0001 | 48.3 ± 15.5 | 50.08 ± 13.5 | 0.02 |
| Weight | 61.5 ± 9.4 | 77.1 ± 11 | <0.0001 | 67.6 ± 11.2 | 84 ± 11.27 | <0.0001 |
| Systolic blood pressure (mmHg) | 124.9 ± 15.4 | 130.3 ± 15.4 | <0.0001 | 127.5 ± 15.8 | 130.8 ± 14.5 | <0.0001 |
| Diastolic blood pressure (mmHg) | 80.6 ± 8.6 | 83.8 ± 8.7 | <0.0001 | 82.07 ± 8.9 | 84.3 ± 8.4 | <0.0001 |
| Fasting glucose (mg/dL) | 96.9 ± 42.8 | 106.9 ± 46.9 | <0.0001 | 101.6 ± 42.6 | 107.9 ± 44.9 | 0.01 |
| Triglyceride (mg/dL) | 149.8 ± 92.8 | 193 ± 113.4 | <0.0001 | 171.1 ± 109.01 | 192.9 ± 99.4 | <0.0001 |
| HDL-cholesterol (mg/dL) | 54.2 ± 14.6 | 53.7 ± 12.9 | 0.37 | 53.8 ± 13.6 | 54.4 ± 13.9 | 0.42 |
| Waist circumference (cm) | 84.6 ± 9.5 | 99.7 ± 9.8 | <0.0001 | 90.5 ± 10.7 | 106.2 ± 9.6 | <0.0001 |
| Sex (%) | | | | | | |
| Male | 60.7 | 42.1 | <0.0001 | 55 | 27.4 | <0.0001 |
| Female | 39.3 | 57.9 | | 45 | 72.6 | |
| Smokers (%) | 76.8 | 86.3 | <0.0001 | 80.3 | 91.5 | <0.0001 |
| Economic Status (%) | | | | | | |
| Low | 33.2 | 29.4 | 0.01 | 30.5 | 33.1 | 0.75 |
| Moderate | 43.1 | 37.5 | | 40.3 | 37.4 | |
| High | 23.7 | 33.1 | | 29.1 | 29.4 | |
| Physical activity (%) | | | | | | |
| Low | 65.3 | 70.9 | 0.09 | 68.2 | 70 | 0.86 |
| Moderate | 29.6 | 24.8 | | 27 | 25.7 | |
| Vigorous | 5.1 | 4.3 | | 4.7 | 4.3 | |
| Education (%) | | | | | | |
| Low | 57.7 | 62.7 | 0.02 | 58.8 | 68.5 | <0.0001 |
| Moderate | 31.4 | 29.4 | | 31.1 | 26.1 | |
| High | 11 | 8 | | 10.1 | 5.4 | |

[a]Values are mean ± standard deviation, otherwise indicated.

**Table 2**
The risk of overweight based on dietary habits in the total population (n = 516).

| Risk factors | Crude hazard ratio | Adjusted hazard ratio (Model I)[a] | Adjusted hazard ratio (Model II)[b] |
|---|---|---|---|
| Weight control program (no) | 1.02 (0.76–1.37) | 1.09 (0.81–1.48) | 1.61 (0.81–3.2) |
| Being on a special diet (no) | 1.04 (0.76–1.44) | 0.91 (0.64–1.29) | 1.38 (0.65–2.93) |
| Eating salad (no) | 1.25 (0.88–1.77) | 1.33 (0.93–1.89) | 1.68 (0.78–3.64) |
| Consuming mayonnaise (yes) | 1.19 (0.86–1.64) | 1.1 (0.79–1.54) | 1.05 (0.55–1.99) |
| Salt intake with food when eating (yes) | 1 (0.75–1.34) | 0.9 (0.66–1.22) | 1.17 (0.63–2.2) |
| Remove of poultry skin (no) | 0.87 (0.53–1.43) | 0.87 (0.53–1.43) | 0.71 (0.27–1.9) |
| High-fat dairy (yes) | 0.97 (0.7–1.33) | 0.94 (0.68–1.3) | 0.64 (0.32–1.26) |
| Attention to food labels (no) | 0.99 (0.75–1.31) | 1.07 (0.8–1.43) | 1.26 (0.7–2.25) |
| Eating food out of home (yes) | 1.1 (0.81–1.49) | 0.97 (0.7–1.35) | 1.2 (0.66–2.19) |
| Canned food (yes) | 0.61 (0.28–1.31) | 0.65 (0.3–1.42) | 0.49 (0.58–4.22) |
| Fast foods (yes) | 1.06 (0.73–1.54) | 0.87 (0.55–1.36) | 1.22 (0.47–3.2) |
| Fried food (yes) | 0.84 (0.63–1.11) | 0.76 (0.57–1.02) | 0.41 (0.22–0.76) |
| Boiled food (no) | 0.85 (0.64–1.14) | 0.77 (0.57–1.04) | 0.38 (0.2–0.72) |
| High-fat meat (yes) | 1.01 (0.73–1.41) | 0.97 (0.69–1.35) | 0.86 (0.44–1.68) |
| special measuring cup for adding oil (no) | 1.2 (0.89–1.63) | 1.14 (0.84–1.56) | 0.92 (0.46–1.84) |
| special measuring cup for adding salt (no) | 1.17 (0.85–1.63) | 1.14 (0.82–1.58) | 1.01 (0.48–2.13) |

[a] Model I: Adjusted for age and sex.
[b] Model II: Adjusted for age, sex, smoking, economic status, physical activity, and education.

model was used for total population as well as men and women separately. The risk of overweight and obesity was assessed crudely as models I (adjusted for age and sex) and II (adjusted for age and sex, smoking, economic status, physical activity, and educational level). In this study, the statistical level of <0.05 was considered as significant.

## 4. Results

The mean (±standard deviation) age of the non-overweight and non-obese participants at the baseline was 47.09 ± 17 and 48.3 ± 15.5 respectively as shown in Table 1. Significant differences were observed between overweight and obese people compared with their counterparts in terms of age, sex, systolic and diastolic blood pressure, fasting blood sugar, triglyceride, and waist circumference. The study population was categorized based on education, economic and physical activity levels. Education and economic conditions exhibited significant differences between the two groups of overweight and non-overweight. Table 2 reveals the risk of developing overweight based on dietary habits in the total population after approximately a 10-year follow-up. In model II, once adjustments were made for all potential confounders, namely sex, age, smoking, economic status, physical activity, and educational levels, the risk of overweight decreased significantly in participants who failed to consume both boiled foods [hazard ratio (HR) = 0.38, 95% confidence interval (CI): 0.2–0.72] and fried foods (HR = 0.41, 95% CI: 0.22–0.76) (Table 3).

The risk of developing obesity based on dietary habits in the total population is set out in Table 3. In model II, the risk of obesity rose in the participants who had no body weight control program (HR = 1.9, 95% CI: 1.06–3.4). Moreover, in those who were not on a special diet (e.g; diabetic or hypertensive diet), the risk lowered

**Table 3**
The risk of obesity based on dietary habits in the total population (n = 1068).

| Risk factors | Crude hazard ratio | Adjusted hazard ratio (Model I)[a] | Adjusted hazard ratio (Model II)[b] |
|---|---|---|---|
| Weight control program (no) | 1.24 (0.9–1.72) | 1.21 (0.87–1.68) | 1.9 (1.06–3.4) |
| Being on a special diet (no) | 0.59 (0.43–0.81) | 0.52 (0.37–0.73) | 0.36 (0.20–0.65) |
| Eating salad (no) | 1.41 (0.98–2.04) | 1.37 (0.94–2) | 1.75 (0.79–3.89) |
| Consuming mayonnaise (yes) | 0.75 (0.52–1.07) | 0.69 (0.47–1) | 0.48 (0.25–0.91) |
| Salt intake with food when eating (yes) | 0.85 (0.59–1.21) | 0.80 (0.55–1.17) | 1.34 (0.72–2.5) |
| Remove of poultry skin (no) | 0.81 (0.45–1.47) | 0.86 (0.48–1.56) | 0.65 (0.23–1.83) |
| High-fat dairy (yes) | 1.32 (0.93–1.87) | 1.39 (0.98–1.98) | 1.3 (0.70–2.4) |
| Attention to food labels (no) | 0.99 (0.72–1.37) | 1.05 (0.75–1.47) | 0.89 (0.48–1.66) |
| Eating food out of home (yes) | 1.04 (0.74–1.45) | 0.99 (0.69–1.4) | 1.45 (0.76–2.76) |
| Canned food (yes) | 0.95 (0.35–2.6) | 0.96 (0.35–2.62) | 1 (0.2–5.11) |
| Fast foods (yes) | 0.91 (06–1.4) | 0.83 (0.52–1.34) | 1.08 (0.47–2.5) |
| Fried food (yes) | 0.71 (0.51–0.99) | 0.69 (0.49–0.99) | 0.87 (0.46–1.64) |
| Boiled food (no) | 0.71 (0.50–0.99) | 0.68 (0.47–0.97) | 0.86 (0.45–1.62) |
| High-fat meat (yes) | 0.69 (0.44–1.06) | 0.67 (0.43–1.04) | 0.48 (0.2–1.15) |
| special measuring cup for adding oil (no) | 1.29 (0.92–1.8) | 1.24 (0.89–1.74) | 0.65 (0.32–1.35) |
| special measuring cup for adding salt (no) | 1.39 (0.99–1.97) | 1.37 (0.96–1.93) | 0.65 (0.29–1.47) |

[a] Model I: Adjusted for age and sex.
[b] Model II: Adjusted for age, sex, smoking, economic status, physical activity, and education.

**Table 4**
The risk of overweight based on dietary habits in men and women.

| Risk factors | Men (n = 326) | | | Women (n = 190) | | |
|---|---|---|---|---|---|---|
| | Crude hazard ratio | Adjusted hazard ratio (Model I)[a] | Adjusted hazard ratio (Model II)[b] | Crude hazard ratio | Adjusted hazard ratio (Model I)[1] | Adjusted hazard ratio (Model II)[2] |
| Weight control program (no) | 1.22 (0.83 −1.8) | 1.29 (0.87–1.92) | 2.39 (1.07–5.27) | 0.77 (0.49 −1.2) | 0.88 (0.55–1.4) | 0.83 (0.24–2.9) |
| Being on a special diet (no) | 1 (0.65–1.54) | 0.9 (0.57–1.41) | 1.21 (0.53–2.73) | 1.15 (0.71 −1.88) | 0.90 (0.52–1.56) | 1.99 (0.25–16.06) |
| Eating salad (no) | 1.39 (0.88 −2.2) | 1.45 (0.91–2.31) | 1.69 (0.69–4.16) | 1.08 (0.63 −1.84) | 1.19 (0.7–2.05) | 1.89 (0.3–11.67) |
| Consuming mayonnaise (yes) | 1.06 (0.71 −1.61) | 1 (0.65–1.53) | 0.74 (0.35–1.56) | 1.58 (0.92 −2.71) | 1.44 (0.83–2.48) | 6.09 (1.2–30.99) |
| Salt intake with food when eating (yes) | 0.95 (0.66 −1.38) | 0.87 (0.59–1.28) | 1.31 (0.65–2.63) | 1.15 (0.71 −1.86) | 0.93 (0.55–1.56) | 0.85 (1.85–3.93) |
| Removing of poultry skin (no) | 0.8 (0.42 −1.52) | 0.79 (0.41–1.5) | 0.46 (0.1–2.01) | 0.97 (0.44 −2.13) | 1 (0.46–2.19) | 1.69 (0.34–8.32) |
| High-fat dairy (yes) | 0.98 (0.66 −1.44) | 0.96 (0.65–1.42) | 0.51 (0.24–1.11) | 0.95 (0.53 −1.7) | 0.88 (0.49–1.6) | 2.15 (0.35–13) |
| Attention to food labels (no) | 1.1 (0.76 −1.58) | 0.97 (0.61–1.53) | 1.24 (0.63–2.42) | 0.86 (0.55 −1.34) | 1.17 (0.81–1.71) | 1.67 (0.5–5.59) |
| Eating food out of home (yes) | 1.13 (0.76 −1.69) | 1.02 (0.66–1.57) | 1.36 (0.66–2.79) | 1.09 (0.68 −1.74) | 0.89 (0.53–1.47) | 0.99 (0.27–3.61) |
| Canned food (yes) | 0.64 (0.25 −1.6) | 0.67 (0.27–1.7) | 0.47 (0.05–4.13) | 0.57 (0.14 −2.43) | 0.67 (0.16–2.86) | – |
| Fast food (yes) | 1.19 (0.75 −1.9) | 1.13 (0.63–2.02) | 2.02 (0.68–6.04) | 0.91 (0.49 −1.72) | 0.61 (0.29–1.26) | 0.25 (0.02–3.88) |
| Fried food (yes) | 0.75 (0.52 −1.08) | 0.68 (0.46–1) | 0.33 (0.15–0.7) | 1.02 (0.65 −1.6) | 0.93 (0.59–1.48) | 0.75 (0.18–3.12) |
| Boiled food (no) | 0.74 (0.51 −1.08) | 0.67 (0.46–0.99) | 0.28 (0.13–0.61) | 1.09 (0.69 −1.72) | 0.97 (0.61–1.56) | 1.01 (0.24–4.21) |
| High-fat meat (yes) | 1.18 (0.79 −1.76) | 1.15 (0.77–1.73) | 0.99 (0.49–1.99) | 0.77 (0.42 −1.41) | 0.67 (0.37–1.23) | – |
| Using special measuring cup for adding oil (no) | 1.02 (0.69 −1.52) | 0.98 (0.65–1.46) | 0.84 (0.39–1.83) | 1.57 (0.99 −2.54) | 1.49 (0.92–2.42) | 1.06 (0.23–4.95) |
| Using special measuring cup for adding salt (no) | 1.04 (0.68 −1.58) | 1.01 (0.67–1.55) | 1.4 (0.29–6.71) | 1.44 (0.86 −2.41) | 1.38 (0.82–2.3) | 0.9 (0.37–2.19) |

[a] Model I: Adjusted for age.
[b] Model II: Adjusted for age, smoking, economic status, physical activity, and education.

significantly compared to those with a special diet (HR = 0.36, 95% CI: 0.2–0.65). In addition, consumption of mayonnaise reduced the risk of obesity (HR = 0.48, 95% CI: 0.25–0.91) in total population.

In regard with gender, refusing to use boiled food and fried food decreased the risk of overweight in men but not in women (Table 4). Further, the risk of overweight escalated in men who had no body weight control program (HR = 2.39, 95% CI: 1.07–5.27); in women, however, this was not the case. Additionally, the risk of overweight turned out to be significantly higher in women who consumed mayonnaise (HR = 6.09, 95% CI: 1.2–30.99).

Table 5 illustrates the risk of obesity based on dietary habits in men and women. An increment in the risk of obesity was observed in men participants who had no body weight control program (HR = 2.65, 95% CI: 1.13–6.25) but not in women. In addition, for women who were not on a special diet, the risk declined significantly (HR = 0.26, 95% CI: 0.11–0.61). Finally, consumption of

**Table 5**
The risk of obesity based on dietary habits in men and women.

| Risk factors | Men (n = 621) | | | Women (n = 447) | | |
|---|---|---|---|---|---|---|
| | Crude hazard ratio | Adjusted hazard ratio (Model I)[a] | Adjusted hazard ratio (Model II)[b] | Crude hazard ratio | Adjusted hazard ratio (Model I)[1] | Adjusted hazard ratio (Model II)[2] |
| Weight control program (no) | 1.28 (0.75–2.16) | 1.31 (0.77–2.22) | 2.65 (1.13–6.25) | 1.08 (0.72–1.64) | 1.12 (0.73–1.73) | 1.1 (0.44–2.75) |
| Being on a special diet (no) | 0.63 (0.38–0.96) | 0.49 (0.28–0.85) | 0.54 (0.21–1.34) | 0.64 (0.42–0.96) | 0.56 (0.36–0.87) | 0.26 (0.11–0.61) |
| Eating salad (no) | 1.41 (0.74–2.68) | 1.48 (0.78–2.8) | 2.11 (0.67–6.63) | 1.21 (0.77–1.9) | 1.26 (0.79–2.01) | 1.66 (0.5–5.52) |
| Consuming mayonnaise (yes) | 0.75 (0.43–1.3) | 0.73 (0.44–1.22) | 0.33 (0.12–0.9) | 0.73 (0.44–1.19) | 0.73 (0.44–1.22) | 0.69 (0.28–1.73) |
| Salt intake with food when eating (yes) | 1.3 (0.78–2.17) | 1.16 (0.68–1.99) | 1.54 (0.6–3.97) | 0.64 (0.38–1.1) | 0.61 (0.35–1.05) | 1.54 (0.63–3.76) |
| Removing of poultry skin (no) | 0.73 (0.29–1.84) | 0.73 (0.29–1.83) | 0.35 (0.05–2.65) | 0.85 (0.37–1.96) | 0.85 (0.37–1.96) | 0.71 (0.16–3.11) |
| High-fat dairy (yes) | 1.57 (0.93–2.65) | 1.46 (0.86–2.48) | 0.94 (0.39–2.26) | 1.34 (0.83–2.15) | 1.34 (0.83–2.16) | 1.73 (0.69–4.34) |
| Attention to food labels (no) | 1.02 (0.61–1.68) | 1.1 (0.66–1.86) | 0.81 (0.33–1.98) | 0.97 (0.64–1.48) | 1.01 (0.65–1.58) | 0.81 (0.3–2.1) |
| Eating food out of home (yes) | 0.98 (0.58–1.65) | 0.85 (0.49–1.47) | 1.4 (0.56–3.52) | 1.14 (0.74–1.77) | 1.11 (0.7–1.76) | 1.29 (0.5–3.25) |
| Canned food (yes) | 0.73 (0.17–3.07) | 0.81 (0.19–3.4) | 0.18 (0.02–1.87) | 1.15 (0.28–4.77) | 1.16 (0.28–4.79) | 0.69 (0.05–9.33) |
| Fast food (yes) | 1.92 (0.61–2.34) | 0.9 (0.41–1.95) | 0.85 (0.22–3.32) | 0.76 (0.43–1.35) | 0.75 (0.4–1.39) | 1.62 (0.52–5.05) |
| Fried food (yes) | 0.93 (0.56–1.54) | 0.8 (0.47–1.37) | 1 (0.39–2.53) | 0.63 (0.39–1) | 0.58 (0.36–0.95) | 0.79 (0.33–1.86) |
| Boiled food (no) | 0.84 (0.51–1.4) | 0.71 (0.41–1.22) | 0.94 (0.37–2.4) | 0.67 (0.42–1.07) | 0.62 (0.38–1.01) | 0.85 (0.36–2.03) |
| High-fat meat (yes) | 0.51 (0.24–1.08) | 0.48 (0.23–1) | 0.29 (0.06–1.31) | 0.91 (0.53–1.57) | 0.89 (0.51–1.54) | 0.68 (0.22–2.07) |
| Using special measuring cup for adding oil (no) | 1.43 (0.85–2.42) | 1.33 (0.78–2.29) | 1.03 (0.39–2.74) | 1.19 (0.77–1.83) | 1.18 (0.76–1.82) | 0.43 (0.14–1.34) |
| Using special measuring cup for adding salt (no) | 1.45 (0.84–2.5) | 1.38 (0.8–2.39) | 0.86 (0.3–2.47) | 1.36 (0.87–2.13) | 1.36 (0.87–2.13) | 0.33 (0.07–1.43) |

[a] Model I: Adjusted for age.
[b] Model II: Adjusted for age, smoking, economic status, physical activity, and education.

mayonnaise lowered the risk of obesity in men (HR = 0.33, 95% CI: 0.12–0.9).

## 5. Discussion

In this cohort study conducted on Iranian adult population after a 10-year follow up, some significant associations were observed between dietary habits and risk of overweight and obesity. We detected that lack of weight control program is associated with increased risk of overweight and obesity. The risk of obesity decreased in participants who failed to have a special diet in both total population and women. Also consumption of mayonnaise increased the risk of overweight only in women.

In the current study, the risk of obesity significantly increased in participants who failed to have a weight control program in total population; similar result was also obtained for men. Some researchers have demonstrated that having a weight control program can lower the risk of obesity [21] and lack of weight control program, low physical activity and lack of calorie-controlled diets can trigger the risk of the disease [22]. Furthermore, the current study proved the risk of overweight growing significantly in men who are at a loss to have a weight control program. A study conducted on university students from 23 countries indicated that fewer men make attempts to control their weight and thus pay less attention to have a weight control schedule compared with women [23]. Additionally, other studies indicated that women show more interest to observe a weight control planning [24].

In our study, the risk of obesity decreased significantly in participants who were not on a special diet in total population, and specifically among women. Likewise, similar to the current study, our previous probe identified a significant decrease in the risk of metabolic syndrome for individuals who failed to observe a special diet [15]. It appears that the subjects who keep a special diet would likely face some problems such as diabetes and hypertension and might not completely follow their special diet during the study. Therefore, unexpected weight gain among those with a special diet could be partly related to their underlying disorders. However, some studies report that observing special diets such as low fat and high fiber food items can contribute to weight loss [25]. Results of a meta-analysis study revealed a low-carbohydrate diet being associated with decreasing body weight and body fat mass [26]. And a meta-analysis of randomized controlled trial also demonstrated that a very low-carbohydrate diet can lead to a higher reduction in body weight [27].

An unexpected result of our study was that consumption of boiled foods fails to significantly lower the risk of overweight in total population and lack of using boiled foods induces a significant decreased risk of overweight in men. The consumption of some other unhealthy dietary habits might be one of the reasons for the unexpected results. Therefore, correlation between dietary factors is highly critical to interpret the results and using a scoring system for dietary habits might be a good benchmark to solve the problem [28]. Further, other mechanisms underlying BMI changes should be accommodated to interpret the results [29]. Contrary to our findings, however, a study detected that healthy cooking methods such as boiling of foods is significantly associated with a decrease in the risk of overweight in adolescents [30]. Moreover, a study in India concluded that glycemic index (GI) value and carbohydrates are

significantly lower in boiled foods and GI lower value is related with reduced risk of diabetes mellitus. Another research reported that diabetes mellitus can led to elevated risk of obesity and overweight [31]. Still another study demonstrated the relationship between high-GI and carbohydrates in dietary and increased overweight [32].

According to our results, the risk of overweight increased significantly in women who consume mayonnaise. Alike our investigation, a cross-sectional study conducted on Iranian women concluded that unhealthy dietary patterns containing mayonnaise of higher fat can trigger BMI and weight gain [33]. In addition, a study performed in Lebanon proved that a western pattern diet comprising different compositions such as mayonnaise and high fat elements can contribute to a higher risk of overweight [34]. Result of another inquiry revealed high cholesterol in egg yolk and mayonnaise exerting an influence on overweight, obesity as well as other diseases [35]. After an 8-year follow up, a prospective cohort study also reported that consumption of high fat foods in overweight women can engender higher weight gain [36]. Moreover, using high fat food substances such as fast foods can be principle factor behind increased waist circumstance as well as BMI [37].

As far as our knowledge is concerned, this study is the first cohort conducted to verify the effect of dietary habits on the incidence of overweight and obesity in Iranian adult population. Also there are several limitations that need to be acknowledged in this research: First, respectively 36.3% and 33.3% of non-overweight and non-obese participants were failed to end with the study after repeated measurement. Second, the accurate time of overweight and obesity incidence was unclear conditioned by re-evaluations of the participants being performed after about 10 years. Third, we could not exert a proper control on the lifestyle of the participants during the follow up period, therefore, many variables including smoking, dietary habits, and physical activity might have been changed during the period of the research. Further, other mechanisms underlying BMI changes could have been considered to interpret the results. Fourth, in terms of bias, the correlation between dietary factors could be accommodated as a critical aspect to interpret the results.

In conclusion, dietary habits can change the risk of overweight and obesity in Iranian adults at the central part of Iran. Therefore, dietary habit changes are advised so as to reduce the risk of the problems mentioned. The fact that this study has approached the issue with a novel perspective can hardly be denied. However, to generalize the findings for other Iranian adults, more investigations are recommended to be performed in other parts of Iran.

## Funding

This study was supported by Shahid Sadoughi University of Medical Sciences in Yazd, Iran and Iran National Science Foundation (INSF).

## Ethical approval

The Ethical Committee of Shahid Sadoughi University of Medical Sciences in Yazd, Iran approved the study (Ethical Code: IR.SSU.MEDICINE.REC.1397.186).

## Informed consent

Informed consent was obtained from all the participants during the entire phase of the study.

## Declaration of competing interest

On behalf of all the authors, the corresponding author states that there is no conflict of interest.

## References

[1] Rapando C, Wakhu F. Feeding Habits associated with overweight and obesity amongst secondary School students in Private and Public schools in Langata Nairobi Kenya. Int J Sci Res Publ 2017;7:498–505.
[2] Singh K, Shen B-J. Abdominal obesity and chronic stress interact to predict blunted cardiovascular reactivity. Int J Psychophysiol 2013;90:73–9.
[3] Jafari-Adli S, Jouyandeh Z, Qorbani M, Soroush A, Larijani B, Hasani-Ranjbar S. Prevalence of obesity and overweight in adults and children in Iran; a systematic review. J Diabetes Metab Disord 2014;13:121.
[4] Najafipour H, Yousefzadeh G, Forood A, Karamouzian M, Shadkam M, Mirzazadeh A. Overweight and obesity prevalence and its predictors in a general population: a community-based study in Kerman, Iran (Kerman coronary artery diseases risk factors studies). ARYA atherosclerosis 2016;12:18.
[5] Hosseinpanah F, Mirbolouk M, Mossadeghkhah A, Barzin M, Serahati S, Delshad H, et al. Incidence and potential risk factors of obesity among Tehranian adults. Prev Med 2016;82:99–104.
[6] Sarrafzadegan N, Talaei M, Sadeghi M, Mohammadifard N, Lotfizadeh Dehkordi M, Esmaillzadeh A, et al. Determinants of weight change in a longitudinal study of Iranian adults: Isfahan Cohort Study. Arch Iran Med 2014;17:539–44.
[7] Demirci N, Demirci PT, Demirci E. The effects of eating habits, physical activity, nutrition knowledge and self-efficacy levels on obesity. Univ J Edu Res 2018;6:1424–30.
[8] Ardekani MS, Salehi-Abargouei A, Mirzaei M, Fallahzadeh H, Nadjarzadeh A. Dietary habits in association with general and abdominal obesity in central Iran: results from Yazd health study (YaHS). Diabetes & metabolic syndrome: Clinical research & reviews. 2018.
[9] Razzoli M, Pearson C, Crow S, Bartolomucci A. Stress, overeating, and obesity: insights from human studies and preclinical models. Neurosci Biobehav Rev 2017;76:154–62.
[10] Mobarakeh ZS, Mirzaei K, Hatmi N, Ebrahimi M, Dabiran S, Sotoudeh G. Dietary habits contributing to breast cancer risk among Iranian women. Asian Pac J Cancer Prev 2014;15:9543–7.
[11] Hamam FA, Eldalo AS, Alnofeie AA, Alghamdi WY, Almutairi SS, Badyan FS. The association of eating habits and lifestyle with overweight and obesity among health sciences students in Taif University, KSA. J Taibah Univ Med Sci 2017;12:249–60.
[12] Garcia-Continente X, Allué N, Pérez-Giménez A, Ariza C, Sánchez-Martínez F, López M, et al. Eating habits, sedentary behaviours and overweight and obesity among adolescents in Barcelona (Spain). Anales de Pediatría (English Edition) 2015;83:3–10.
[13] Bimbo F, Bonanno A, Viscecchia R. Adult obesity, food access, and eating habits in Italy: an empirical analysis. Br Food J 2015;117:1689–705.
[14] Mirzaei-Alavijeh M, Karami-Matin B, Matin AK, Mahboubi M, Aghaei A, Jouybari TA. Dietary habits among Iranian families. Int J Adv Biotechnol Res 2017;8:315–20.
[15] Sarebanhassanabadi M, Mirhosseini SJ, Mirzaei M, Namayandeh SM, Soltani MH, Pakseresht M, et al. Effect of dietary habits on the risk of metabolic syndrome: Yazd Healthy Heart Project. Publ Health Nutr 2018;21:1139–46.
[16] Bin Zaal A, Musaiger A, D'Souza R. Dietary habits associated with obesity among adolescents in Dubai, United Arab Emirates. Nutr Hosp 2009;24:437–44.
[17] Grøholt E-K, Stigum H, Nordhagen R. Overweight and obesity among adolescents in Norway: cultural and socio-economic differences. J Publ Health 2008;30:258–65.
[18] Rahmani A, Sayehmiri K, Asadollahi K, Sarokhani D, Islami F, Sarokhani M. Investigation of the prevalence of obesity in Iran: a systematic review and meta-analysis study. Acta Med Iran 2015:596–607.
[19] Sarebanhassanabadi M, Mirhosseini SJ, Mirzaei M, Namayandeh SM, Soltani MH, Pedarzadeh A, et al. The incidence of metabolic syndrome and the most powerful components as predictors of metabolic syndrome in Central Iran: a 10-year follow-up in a cohort study. Iran Red Crescent Med J 2017;19.
[20] Rapando C, Nyagero J, Wakhu F. Feeding Habits associated with overweight and obesity amongst secondary School students in Private and Public schools in Langata Nairobi Kenya.
[21] Nam J-H. Effect of weight control program on obesity degree and blood lipid levels among middle-aged obese women. Kor J Food Nutr 2006;19:70–8.
[22] Williams CL, Strobino BA, Brotanek J. Weight control among obese adolescents: a pilot study. Int J Food Sci Nutr 2007;58:217–30.
[23] Wardle J, Haase AM, Steptoe A. Body image and weight control in young adults: international comparisons in university students from 22 countries. Int J Obes 2006;30:644.
[24] Stigler MH, Arora M, Dhavan P, Shrivastav R, Reddy KS, Perry CL, et al., Stigler, Melissa H Arora, Monika Dhavan, Poonam Shrivastav, Radhika Reddy, K Srinath Perry, Cheryl L. Weight-related concerns and weight-control behaviors among overweight adolescents in Delhi, India: A cross-sectional study. Int J

Behav Nutr Phys Act 2011;8:9.
[25] Lindström J, Peltonen M, Eriksson JG, Louheranta A, Fogelholm M, Uusitupa M, et al. High-fibre, low-fat diet predicts long-term weight loss and decreased type 2 diabetes risk: the Finnish Diabetes Prevention Study. Diabetologia 2006;49:912–20.
[26] Hashimoto Y, Fukuda T, Oyabu C, Tanaka M, Asano M, Yamazaki M, et al. Impact of low-carbohydrate diet on body composition: meta-analysis of randomized controlled studies. Obes Rev 2016;17:499–509.
[27] Bueno NB, de Melo ISV, de Oliveira SL, da Rocha Ataide T. Very-low-carbohydrate ketogenic diet v. low-fat diet for long-term weight loss: a meta-analysis of randomised controlled trials. Br J Nutr 2013;110:1178–87.
[28] Sarebanhassanabadi M, Mirhosseini SJ, Mirzaei M, Namayandeh SM, Soltani MH, Salehi-Abargouei A. The association between a dietary habits score and the risk of metabolic syndrome: a cohort study. Clin Nutr 2020;39:282–90.
[29] Sarebanhassanabadi M, Mirhosseini SJ, Mirzaei M, Namayandeh SM, Soltani MH, Pedarzadeh A, et al. Association between dietary habits and changes in cardiometabolic risk factors in the patients with metabolic syndrome: a 10-year follow-up study. Prog Nutr 2019;21:348–58.
[30] Kramer RF, Coutinho AJ, Vaeth E, Christiansen K, Suratkar S, Gittelsohn J. Healthier home food preparation methods and youth and caregiver psychosocial factors are associated with lower BMI in African American youth. J Nutr 2012;142:948–54.
[31] Bahado-Singh P, Wheatley A, Ahmad M, Morrison ESA, Asemota H. Food processing methods influence the glycaemic indices of some commonly eaten West Indian carbohydrate-rich foods. Br J Nutr 2006;96:476–81.
[32] Murakami K, Miyake Y, Sasaki S, Tanaka K, Arakawa M. Dietary glycemic index and glycemic load in relation to risk of overweight in Japanese children and adolescents: the Ryukyus Child Health Study. Int J Obes 2011;35:925.
[33] Rezazadeh A, Rashidkhani B. The association of general and central obesity with major dietary patterns of adult women living in Tehran, Iran. J Nutr Sci Vitaminol 2010;56:132–8.
[34] Naja F, Hwalla N, Itani L, Karam S, Sibai AM, Nasreddine L. A Western dietary pattern is associated with overweight and obesity in a national sample of Lebanese adolescents (13–19 years): a cross-sectional study. Br J Nutr 2015;114:1909–19.
[35] Ma Z, Boye JI. Advances in the design and production of reduced-fat and reduced-cholesterol salad dressing and mayonnaise: a review. Food Bioprocess Technol 2013;6:648–70.
[36] Field AE, Willett WC, Lissner L, Colditz GA. Dietary fat and weight gain among women in the Nurses' Health Study. Obesity 2007;15:967–76.
[37] Rouhani MH, Mirseifinezhad M, Omrani N, Esmaillzadeh A, LJJoo Azadbakht. Fast food consumption, quality of diet, and obesity among Isfahanian adolescent girls. 2012. p. 2012.