Research Square

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Sex-specific prevalence of coronary heart disease among Tehranian adult population across different glycemic status: Tehran Lipid and Glucose Study, 2008-2011

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Abstract

Background: Coronary heart disease (CHD) is one of the main causes of deaths. Alarmingly Iranian populations had a high rank of CHD worldwide. The current study aimed to assess the prevalence of CHD across different glycemic categories.

Methods: This study was conducted on 7,718 Tehranian participants (Men=3427) aged ≥ 30 years from 2008 to 2011. They were categorized based on glycemic status. The prevalence of CHD was calculated in each group, separately. CHD was defined as hospital records adjudicated by an outcome committee. The association of different glycemic categories with CHD was calculated using multivariate logistic regression, compared with normal fasting glucose /normal glucose tolerance (NFG/NGT) group as reference.

Results: The age-standardized prevalence of isolated impaired fasting glucose (iIFG), isolated impaired glucose tolerance (iIGT), both impaired fasting glucose and impaired glucose tolerance (IFG/IGT), newly diagnosed diabetes mellitus (NDM), and known diabetes mellitus (KDM) were 14.30% [95% confidence interval (CI): 13.50-15.09], 4.81% [4.32-5.29], 5.19% [4.71-5.67], 5.79% [5.29-6.28] and 7.72% [7.17-8.27], respectively. Among a total of 750 individuals diagnosed as cases of CHD (398 in men), 117 (15.6%), 453 (60.4%), and 317 (42.3%) individuals had history of myocardial infarction (MI), cardiac procedure, and unstable angina, respectively. The age-standardized prevalence of CHD for Tehranian population was 7.71% [7.18-8.24] in total population, 8.62 [7.81-9.44] in men and 7.19 [6.46-7.93] in women. Moreover, among diabetic participants, the age-standardized prevalence of CHD were 13.10 [9.83-16.38] in men 10.67 [8.90-12.44] in women, respectively, which were significantly higher than corresponding values for NFG/NGT and prediabetic groups. Across 6 levels of glycemic status, CHD was associated with IFG/IGT [odds ratio (OR) and 95% CI: 1.38 (1.01-1.89)], NDM [1.83 (1.40-2.41)], and KDM [2.83 (2.26-3.55)] groups, in the age and sex adjusted model. Furthermore, in the full-adjusted model, only NDM and KDM status remained to be associated with the presence of CHD by ORs of 1.40 (1.06-1.86) for NDM and 1.91 (1.51-2.43) for KDM.

Conclusion: The high prevalence of CHD, especially among diabetic populations, necessitates urgent implementation of behavioral interventions among Tehranian population, according to evidence-based guidelines for the clinical management of diabetic patients.

Background

Coronary heart disease (CHD) is one of the most common causes of deaths worldwide [1, 2]. Its global fatality rate increased from 7.3 million in 2007 to 8.93 million deaths in 2017 [1]. We previously reported that the overall prevalence of CHD was 21.8% (22.3% among women and 18.8% among men) in 1991-2001 among residents of Tehran, as a metropolitan city [3]. Also the incidence rate of CHD was 10.5 and 6.1 per 1000 person-years among men and women, respectively [4]. Importantly, over 40% of mortality among Tehranian adults aged ≥30 years, is attributed to cardiovascular disease (CVD) [5].

Type 2 diabetes mellitus (T2DM) is a major leading factor for CHD and its mortality [6, 7]. Beside the well-known association between diabetes and CVD, it was also shown that prediabetes status could lead to CHD and CVD [11, 12]. Based on national studies in 2011, about 11.4% and 14.6% of Iranian adults had diabetes mellitus (DM) and impaired fasting glucose (IFG), respectively. Furthermore, there was an alarming increase of 35.1% in the prevalence of DM from 2005 to 2011 [8]. A prediabetes tsunami, which included both impaired glucose tolerance (IGT) and IFG, was also reported among an Tehranian population, with ≥4% of adult individuals developing prediabetes each year [9].

The aim of the current study is to report the population-based prevalence of CHD among Tehranian adults, aged ≥30 years, according to their glycemic status in phase IV (2008-2011) of oldest cohort study in the Middle East and North Africa (MENA) region, the Tehran Lipid and Glucose Study (TLGS) [10].

Methods

Study design and population study

This study was performed within the framework of the TLGS, which is an ongoing community-based cohort study being conducted on a representative sample of citizens of Tehran. The TLGS aims at determining the prevalence and incidence of non-communicable diseases and their risk factors and also intended to prevent them by developing healthier life styles. Further details for the TLGS have been described before [10]. Briefly, after the first baseline examination (1999-2001), participants were followed-up until 2011. For this study, 8,400 individuals aged ≥30 years, participants of phase IV of TLGS (2008-2011), were enrolled. Firstly, we excluded 497 individuals whose glycemic status was not differentiable for us. Secondly, we excluded 177 subjects with missing data on covariates, including body mass index (BMI), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), systolic blood pressure (SBP), diastolic blood pressure (DBP), smoking status, and family history of CVD (considering overlap features between numbers). Finally, due to the lack of information on the outcome (CHD) assessment, 8 individuals were excluded and 7,718 participants remained for the analysis of the current study.

Clinical and laboratory measurements

Using structured questionnaires, a trained nurse collected data which included demographic data, past medical history, drug history, family history of CVD, education, smoking status, and levels of physical activity. Physical activity level was evaluated by the Modifiable Activity Questionnaire (MAQ), which assessed all three types of activities, including leisure time, job, and household activities in the past year [11]. Details of anthropometric and blood pressure (BP) measurements have been published previously [11]. BMI was calculated as weight divided by the square of the height (kg/m^2). After 12-14 hours overnight fasting, blood samples were collected between 07:00 AM and 09:00 AM and analyzed the same day. Except for those who had on glucose-lowering medications, a standard oral glucose tolerance test with 75 gr glucose was done for all participants. Fasting plasma glucose (FPG) and 2-hour post-challenge plasma glucose (2h-PCPG) were measured by enzymatic colorimetric glucose oxidase method; both inter-and intra-assay coefficient of variations were < 2.2%. More details of laboratory measurements have been published elsewhere [11].

Definition of terms

Participants were categorized into different groups as follows: Normal fasting glucose (NFG)/normal glucose tolerance (NGT), FPG < 5.6 and 2h-PCPG <7.7 mmol/L; isolated impaired fasting glucose (iIFG), 5.6 ≤ FPG ≤ 7 and 2h-PCPG <7.7 mmol/L; isolated impaired glucose tolerance (iIGT), 7.7 ≤ 2h-PG ≤ 11.1 and FPG <5.6 mmol/L; combined IFG and IGT (IFG/IGT), 5.6 ≤ FPG ≤ 7 and 7.7 ≤ 2h-PCPG ≤ 11.1 mmol/L [12]. Moreover, in the present study, prediabetes status was defined as the presence of IFG or IGT. Finally, newly diagnosed diabetes mellitus (NDM) was defined as FPG ≥ 7.0 or 2h-PCPG ≥ 11.1 mmol/L among those participants were not on glucose lowering medications and known diabetes mellitus (KDM) as subjects with positive history of taking any glucose

lowering medications. Hypercholesterolemia was defined as having TC≥ 5.2 mmol/L or use of lipid-lowering medications. Low HDL-C was defined as HDL-C< 1.036 mmol/L for men and <1.295 mmol/L for women, or taking lipid-lowering medications. Hypertension was considered as either SBP ≥140 mmHg or DBP ≥90 mmHg or the use of anti-hypertensive medications. Smoking status was defined as current, past, and never smoker. Education levels were classified as <6 years (reference group), 6–12 years, and >12 years. Low physical activity (inactive) was defined as not achieving a minimum score of 600 MET (metabolic equivalent task)-minutes per week [13]. Positive family history of premature CVD included any history of CHD/stroke in a male first-degree relative aged <55 years or female first-degree relative aged <65 years.

Definition of CHD

Details of the collection of outcome data have been reported elsewhere [11]. To summarize, each individual was under continuous surveillance for any medical outcome leading to hospitalization. As a part of the cohort data collection, a trained nurse called all participants annually and recorded any medical events experienced during the last year. Any reported event was followed-up by a home visit and collection of medical data from hospital by a trained physician. Collected data were evaluated by a consulting committee, the outcome committee, included a principal investigator, an internist, an endocrinologist, a cardiologist, an epidemiologist, and the physician who collected the outcome data and specific outcomes. Every confirmed event was considered as a non-communicable disease outcome based on ICD-10 criteria [11, 14]. In this study, CHD was selected from ICD-10 rubric I20-I25. CHD cases included [14-17]:

(1) Myocardial infarction (MI), included a) definite MI diagnosed by diagnostic electrocardiogram (ECG) and biomarkers (including CK, CK-MB, CK-MBm, troponin (cTn), and myoglobin), b) probable MI distinguished by positive ECG findings plus cardiac symptoms or signs and biomarkers showing negative or equivocal results.

(2) Cardiac procedure, defined as a) angiography proven CHD with a result of ≥ 50% stenosis in at least one major coronary vessel, b) history of angioplasty or bypass surgery.

(3) Unstable angina pectoris, who developed new cardiac symptoms or showed changing symptom patterns and positive ECG findings with normal biomarkers and admitted to coronary care unit (CCU).

Statistics

Baseline characteristics are presented as means ± standard deviations (SD), median (interquartile range) and number (frequency) as appropriate. ANOVA and Kruskal-Wallis tests were used for comparison of means and medians, respectively. Chi squared tests were applied for comparison of frequencies.

The crude and age-standardized prevalence (95% confidence interval: CI) were calculated for all glycemic status including NFG/NGT, iIFG, iIGT, IFG/IGT, NDM, and KDM. Regarding differences in the age distributions between the TLGS population from 2008 to 2011 and the Iranian census 2010 (supplementary Table 1), especially in the 30-39-year age-group and those aged ≥70 years, the age-standardized prevalence was reported, using the Iranian (Tehran province) census 2010.

We also examined the association of different glycemic status with prevalence of CHD, compared with NFG/NGT group (as reference). Using logistic regression analyses, odds ratios (ORs) for this association were calculated in 3 levels of adjustment: 1) without adjustment (crude OR); 2) age and sex adjustment; 3) full adjustment (adjusted for age, sex, BMI, hypercholesterolemia, low HDL-C, hypertension, family history of premature CVD, and smoking status).

Statistical analyses were done using STATA version 14. P-values < 0.05 were considered to be statistically significant.

Results

The study sample included 7,718 participants (men=3,427) aged ≥ 30 years [mean age (SD) 50.1 (13.2) years]. Sex-specific baseline characteristics across glycemic categories are shown in **Tables 1**. Generally, in comparison with the prediabetes and DM groups, participants with NFG/NGT had better cardiometabolic risk profiles, including age, BMI, waist to hip ratio, triglycerides, TC (only among women), SBP, and DBP. Furthermore, compared to the prediabetes and DM groups, participants with NFG/NGT had a better education status, lower prevalence of low physical activity (among women), and lower frequency of lipid-lowering and anti-hypertensive medications usage. Moreover, for the most of above mentioned factors, prediabetic participants were ranked between NFG/NGT and DM groups.

The crude and age-standardized prevalence of different glycemic status are illustrated in **Figure 1.** Among our total population, the age-standardized prevalence of iIFG, iIGT, IFG/IGT, NDM, and KDM were 14.30% (13.50-15.09), 4.81% (4.32-5.29), 5.19% (4.71-5.67), 5.79% (5.29-6.28), and 7.72% (7.17-8.27), respectively.

Totally, 750 individuals were diagnosed as cases of CHD. The crude and age-standardized prevalence of CHD for Tehranian population were 9.72% (95% CI: 9.06-10.38) and 7.71% (7.18-8.24), respectively. As is illustrated in **Figure 2**, from a total of 750 patients with CHD in this study, 117 (15.6%), 453 (60.4%), and 317 (42.3%) of them, had history of MI (definite and probable MI), cardiac procedure, and unstable angina, respectively. It should be notified that the total number of different type of CHD is over 750 (100%), considering that patients might have more than one type of CHD.

The sex-specific prevalence of CHD across glycemic categories is shown in **Table 2**. Among total age group, the crude prevalence of CHD was 11.61 (10.54-12.69) among men, which was significantly higher than the corresponding number among women. After age standardization, the prevalence decreased to 8.62 (7.81-9.44) among men and 7.19 (6.46-7.93) among women. Among diabetic participants, the age-standardized prevalence of CHD were 13.10 (9.83-16.38) in men and 10.67 (8.90-12.44) in women, respectively, which were significantly higher than corresponding values for prediabetes and NFG/NGT groups.

The prevalence and ORs of CHD across NFG/NGT (as reference group), iIFG, iIGT, combined IFG and IGT, NDM, and KDM groups are presented in **Table 3**. Accordingly, the highest and lowest crude prevalence of CHD were attributed to KDM and NFG/NGT, respectively. Moreover, among prediabetic groups, the prevalence of CHD was tended to be more prominent in the combined IFG and IGT. The age-standardized prevalence of CHD was estimated to be 6.39 (5.59-7.19), 6.52 (5.23-7.82), 7.00 (4.73-9.27), 8.04 (5.40-10.67), 8.74 (7.08-10.40), and 14.26 (10.73-17.79) among NFG/NGT, iIFG, iIGT, combined IFG and IGT, NDM, and KDM groups, respectively. After adjustment for age and sex, CHD was more likely to be associated with combined IFG and IGT, NDM, and KDM groups. Furthermore, in the full-adjusted model, NDM and KDM status remained to be significantly associated with the presence of CHD by ORs of 1.40 (1.06-1.86) for NDM and 1.91 (1.51-2.43) for KDM.

Discussion

In this population-based study conducted in 2008-2011, 14.30%, 4.81%, 5.19%, 5.79%, and 7.72% of Tehranian residents were found to be iIFG, iIGT, IFG/IGT, NDM, and KDM, respectively. Moreover, the age-standardized prevalence of CHD was about 7.7% among Tehranian residents. Generally, in comparison with women, men had higher prevalence of CHD. In addition, the age-standardized prevalence of CHD among diabetic participants was reported to be 13.1% in men and 10.7% in women. After age and sex adjustment, compared to NFG/NGT group, the presence of IFG/IGT, NDM, and KDM were significantly associated with higher prevalence of CHD. The associations were significant for NDM and KDM, even in the full-adjusted model.

Based on the current study, about 40% of Tehranian adults were in prediabetes or diabetes status in 2008-2011, which was higher than our previous finding in 1990-2001 (about 30%) [18]. National studies during 2005–2011 found about 35% of increase in DM prevalence and reach to 11.4% in 2011. Importantly, in this period, DM awareness improved and the nation-wide prevalence of NDM decreased from 45.7% to 24.7%. Additionally, the researcher found that about 14.6% of Iranian adults (15.4% among urban residents) were in IFG status in 2011 [8] which was comparable to our study.

In our previous study, using self-reported history of CHD, Rose angina, and ECG-defined ischemia for defining CHD, a 21.8% prevalence of CHD was reported for Tehranian adults in 1999-2001 [3]. The differences between the prior study and the current study might be attributable to the following factors. Firstly, in our previous report, the silent ischemia and positive history of Rose angina were considered as cases of CHD; however, we did not consider these soft criteria of CHD in the current study. Secondly, for history of CHD, in contrast to our original report, it was considered positive only when its hospital records were provided and then adjudicated by the outcome committee. Hence, in the current study, using the solid criteria for the definition of CHD led to underestimations for the prevalence of CHD.

It is important to note that due to different diagnostic criteria for CHD and different baseline characteristics of population study, comparing our results with other population-based studies is somewhat difficult. Abbasi et al. reported that among an Iranian population aged over 20 years, the national prevalence of self-reported CHD was 5.3% (5.6% among urban residents) in 2011 [19]; their values for prevalence of self-reported CHD were significantly lower than our reports. Compared to developed countries, data from the Quebec Integrated Chronic Disease Surveillance System (QICDSS) indicated that the age-standardized prevalence of CHD (CHD death not included) was 7.7% among a Canadian adults population in 2009/2010 [20], which was comparable to ours. The American Heart Association (AHA) reported that the prevalence of total CHD was 6.7% among US adults aged ≥20 years (7.4% for men and 6.2% for women) [21]. For the United Kingdom (UK), data from the Quality and Outcomes Framework (QOF) indicated that the prevalence of CHD remained constant at about 3% in England and 4% in Scotland, Wales, and Northern Ireland between 2004/2005 and 2014/2015 [22]. Additionally, the prevalence of CHD from national studies varied from 2% to 4% in India [23]. Furthermore, in Saudi Arabia, as a Middle Eastern country, the age-adjusted prevalence of CHD was reported to be 5.9% among men and 4.4% among women, aged 30-70 years [24]. Generally, it seems that the estimated prevalence of CHD among Tehranian population is higher than corresponding figures in US [21], UK [22], India [23] and, Saudi Arabia [24], an issue previously addressed in 2015 by Zhu et al. [25]. As we reported previously, modifiable risk factors, including diabetes, hypertension, smoking and dyslipidemia totally had population attributable fraction of 36.6% and 50.2% of incident CHD among male and female Tehranian population, respectively [4]. Other reasons that might justify the high prevalence of CHD among Tehranian population are related to impact of air pollution [26, 27] and stress [28], which are common in Tehran.

Focusing on diabetes status, a national study on Iranian diabetic patients aged ≥18 years, reported the crude prevalence of CHD to be 25.1% for men and 23.2% for women [29]; which were comparable to our findings (24.81% for men and 21.67% for women). Among diabetic populations of other countries, the age-standardized prevalence of CHD was found to be 4.43% and 4.76% among Chinese men and women with T2DM, respectively [30]. Moreover, the prevalence of CHD among Thai patients with diabetes was 3.54% in 2013 [31]. Additionally, among Swedish diabetic patients aged 45-74 years, the crude prevalence of CHD was reported to be 24.9% for men and 18.0% for women [32]. In addition, a significant racial difference was reported in the prevalence of CHD between White and African diabetic patients in a hospital-based study [33]. It has been suggested that there is also a racial susceptibility for CHD among diabetic patients, which could make Iranian diabetic patients more prone to developing CHD, compared to Asian, African, and European ethnicities. Furthermore, although CVD risk factors among Iranian diabetic populations have been controlled to some degree, during recent years, most diabetic participants still have uncontrolled CVD risk factors [34] which could also lead to high prevalence of CHD among our diabetic population.

In the current study, as expected, the significantly highest prevalence of CHD was found among participants with KDM. We also found that compared to NFG/NGT group, the presence of NDM status was associated with CHD [adjusted OR= 1.40 (1.06-1.86)]. We have previously reported that during a 7.6 years follow-up, Tehranian adults with NDM exhibited a CHD risk comparable to non-DM with a prior CHD [35]. In a cohort study, conducted on 271,174 patients with type 2 diabetes who were registered in the Swedish National Diabetes Register, it was shown that patients with type 2 diabetes who had five risk factors within the target ranges, appeared to have little or no excess risk of MI, in comparison with the general population [36]. Hence, we suppose that a tight control of all CVD risk factors among Iranian diabetic population should be considered in health policies to halt the increasing burden of CVD events. Also, regarding prediabetes status, a significant association was found between combined IFG/IGT and CHD, in the sex and age adjusted model. Furthermore, based on angiographic data, among a non-diabetic population, it was reported that participants with combined IFG and IGT had higher prevalence of significant CHD and higher severity of disease; however, there were no significant differences among subjects with NGT, i-IFG, and i-IGT [37].

The strengths of this study include adjudicated cases of CHD by an outcome committee and the determination of CHD prevalence across different glycemic status, using the glucose challenge test. Several limitations need to be acknowledged. First, our study shows an optimistic picture of CHD prevalence among our population since inclusion of subjects in an ongoing study can improve the level of attention paid to controlling their health risks (cohort effect). Therefore, the burden of CHD might be much higher in the context of the community. Second, this investigation was conducted among residents of Tehran as a metropolitan city. Hence, our results might not be generalizable to rural zones.

Conclusion

The high prevalence of CHD, especially among diabetic populations, necessitates urgent behavioral intervention to be aimed at halting obesity tsunami [38], hypertension [39], and physical inactivity [40] among Tehranian population, according to evidence-based guidelines for the clinical management of diabetic patients. Last but not least, the impact of environmental and psychosocial factors on CHD in Tehranians should be investigated in future studies.

Abbreviations

CHD: Coronary Heart Disease; CVD: Cardiovascular Disease; T2DM: Type 2 Diabetes Mellitus; DM: Diabetes Mellitus; IFG: Impaired Fasting Glucose; IGT: Impaired Glucose Tolerance; MI: Myocardial Infarction; ECG: Electrocardiogram; MENA: Middle East and North Africa; TLGS: Tehran Lipid and Glucose Study; MAQ: Modifiable Activity Questionnaire; BP: Blood Pressure; BMI: Body Mass Index; TC: Total Cholesterol; HDL-C: High Density Lipoprotein Cholesterol; SBP: systolic blood pressure; DBP: diastolic blood pressure; FPG: Fasting Plasma Glucose; 2h-PCPG: 2-hour Post Challenge Plasma Glucose; NFG: Normal Fasting Glucose; NGT: Normal Glucose Tolerance; iIFG: Isolated Impaired Fasting Glucose; iIGT: Isolated Impaired Glucose Tolerance; IFG/IGT: Combined IFG and IGT; NDM: Newly Diagnosed Diabetes; KDM: Known Diabetes Mellitus; Coronary Care Unit (CCU); SD: Standard deviations; CI: Confidence Interval; QICDSS: Quebec Integrated Chronic Disease Surveillance System; UK: United Kingdom; QOF: Quality and Outcomes Framework.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board (IRB) of the Research Institute for Endocrine Sciences (RIES), Shahid Beheshti University of Medical Sciences, and all participants provided written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Founding

No funding from any source was obtained for this study.

Author contributions

Study conception and design: S.S.M and F.H; Analysis and interpretation of data: M.H, D.P and F.H; Drafting of manuscript: S.S.M, H.G and F.H; Critical revision: S.S.M, A.G, H.G, F.A and F.H. All authors read and approved the final manuscript.

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Tables

Table 1. Baseline characteristics of participants across glycemic categories: Tehran Lipid and Glucose Study (phase IV: 2008-2011).

	Men				Women			
	NFG/NGT	Prediabetes (IFG or IGT)	DM	P-value*	NFG/NGT	Prediabetes (IFG or IGT)	DM	P-value*
Number of participants	1891	1000	536		2531	1040	720	
Continuous variables, Mean ± SD								
Age (year)	47.2 ± 12.8	53.6 ± 13.7	59.5 ± 12.6	<0.001	45.2 ± 11.5	52.8 ± 11.9	58.7 ± 10.7	<0.001
BMI (kg/m^2)	26.6 ± 4.0	28.0 ± 4.1	28.1 ± 4.1	<0.001	28.5 ± 4.7	31.4 ± 18	31.3 ± 5.6	<0.001
Waist to hip ratio ×100	95.9 ± 6.3	98.6 ± 5.7	100.6 ± 5.7	<0.001	90.7 ± 7.6	95.2 ± 7.4	99.2 ± 6.8	<0.001
SBP (mmHg)	117.1 ± 15.6	124.0 ± 18.3	130 ± 19.2	<0.001	111.9 ± 16.2	122.2 ± 19.5	129.8 ± 22.0	<0.001
DBP (mmHg)	78.9 ± 10.5	80.8 ± 10.8	82.3 ± 11.0	<0.001	74.7 ±10.4	78.4 ± 10.8	79.8 ± 11.6	<0.001
Total cholesterol (mmol/L)	4.9 ± 0.9	5.0 ± 1.0	4.8 ± 1.0	<0.001	5.0 ± 0.9	5.4 ± 1.0	5.3 ± 1.2	<0.001
HDL-C (mmol/L)	1.1 ± 0.2	1.1 ± 0.2	1.1 ± 0.2	0.109	1.3 ± 0.3	1.3 ± 0.3	1.2 ± 0.3	<0.001
Triglyceride (mmol/L)	1.5 (1.1-2.1)	1.7 (1.2-2.3)	1.8 (1.3-2.5)	<0.001	1.2 (0.9-1.7)	1.6 (1.2-2.2)	1.9 (1.4-2.8)	<0.001
Categorical variables, n (%)								
Smoking status				<0.001				0.382
Never	1055 (55.8%)	578 (57.8%)	303 (56.5%)		2403 (94.9%)	994 (95.6%)	690 (96.0%)	
Past	345 (18.2%)	227 (22.7%)	140 (26.1%)		45 (1.8%)	16 (1.5%)	15 (2.1%)	
Current	491 (26.0%)	195 (19.5%)	93 (17.4%)		83 (3.3%)	30 (2.9%)	14 (1.9%)	
Education level				<0.001				<0.001
<6 years	283 (15.0%)	256 (25.6%)	198 (36.9%)		578 (22.8%)	448 (43.1%)	450 (62.6%)	
6-12 years	1042 (55.1%)	524 (52.4%)	255 (47.6%)		1405 (55.5%)	491 (47.2%)	232 (32.3%)	
>12 years	566 (29.9%)	220 (22.0%)	83 (15.5%)		548 (21.7%)	101 (9.7%)	37 (5.1%)	
Low physical activity, yes	723 (39.6%)	401 (43.3%)	203 (41.6%)	0.169	620 (24.6%)	272 (26.6%)	259 (37.6%)	<0.001
Family history of premature	78 (4.1%)	43 (4.3%)	28 (5.2%)	0.543	160 (6.3%)	81 (7.8%)	47 (6.5%)	0.276

CVD, yes								
Lipid-lowering medication, yes	80 (4.2%)	96 (9.6%)	129 (24.1%)	<0.001	129 (5.1%)	131 (12.6%)	262 (36.4%)	<0.001
Anti-hypertensive medication, yes	126 (6.7%)	121 (12.1%)	148 (27.6%)	<0.001	194 (7.7%)	215 (20.7%)	317 (44.1%)	<0.001

Values are shown as Mean ± SD and number (%), for continuous and categorical variables, respectively; Triglycerides are given as median (interquartile range) due to skewed distribution.

* The comparison p-value between groups was calculated using ANOVA test for normal continues variables, chi-square test for categorical variables and kruskal wallis test for skewed variables.

BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; HDL-C: high density lipoprotein cholesterol; CVD: cardiovascular disease; NFG: normal fasting glucose; NGT: normal glucose tolerance; IFG: impaired fasting glucose; IGT: impaired glucose tolerance; DM: diabetes mellitus.

Table 2. Prevalence of coronary heart diseases across glycemic categories, by gender: Tehran Lipid and Glucose Study (phase IV: 2008-2011)

	Men			Women		
	Case/Total	Crude prevalence % (95% CI)	Age-standardized prevalence □ % (95% CI)	Case/Total	Crude prevalence % (95% CI)	Age-standardized prevalence □ % (95% CI)
NFG/NGT	139/1891	7.35 (6.17-8.53)	7.28 (6.06-8.49)	108/2531	4.27 (3.48-5.05)	5.71 (4.62-6.79)
Prediabetes (IFG or IGT)	126/1000	12.60 (10.54-14.66)	7.95 (6.55-9.36)	88/1040	8.46 (6.77-10.15)	6.62 (5.06-8.19)
DM	133/536	24.81 (21.15-28.47)	13.10 (9.83-16.38)	156/720	21.67 (18.65-24.68)	10.67 (8.90-12.44)
Total	398/3427	11.61 (10.54-12.69)	8.62 (7.81-9.44)	352/4291	8.20 (7.38-9.02)	7.19 (6.46-7.93)

□Age-standardized prevalence is calculated based on Iranian population distribution data from the National Consensus Bureau for Tehran province (2010).

NFG: normal fasting glucose; NGT: normal glucose tolerance; IFG: impaired fasting glucose; IGT: impaired glucose tolerance; DM: diabetes mellitus; CI: confidence interval.

Table 3. Prevalence and odds ratio of coronary heart diseases across glycemic categories: Tehran Lipid and Glucose Study (phase IV: 2008-2011)

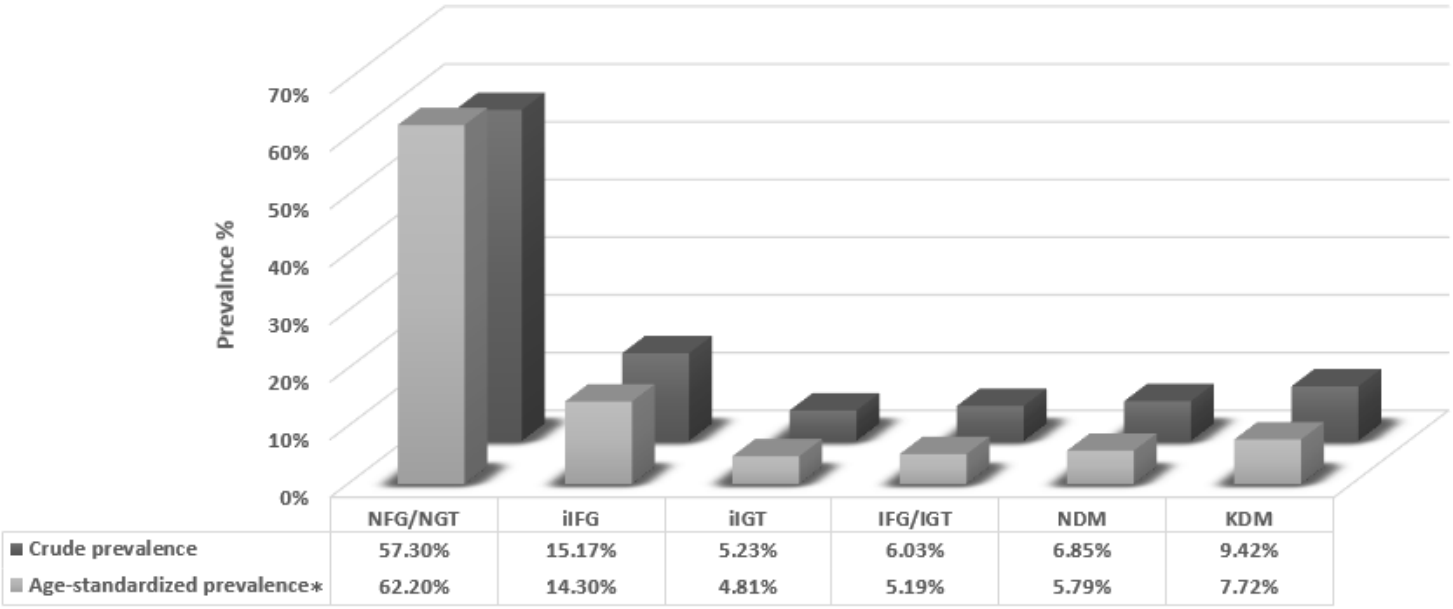
	Case/Total	Crude prevalence % (95% CI)	Age-standardized prevalence ▯ % (95% CI)	Crude odds ratio (95% CI)	Age and sex adjusted odds ratio (95% CI)	Full-adjusted odds ratio ▯ (95% CI)
NFG/NGT	247/4422	5.59 (4.91-6.26)	6.39 (5.59-7.19)	Reference	Reference	Reference
iIFG	105/1171	8.97 (7.33-10.60)	6.52 (5.23-7.82)	1.67 (1.31-2.11)	1.13 (0.88-1.45)	0.99 (0.76-1.27)
iIGT	45/404	11.14 (8.07-14.21)	7.00 (4.73-9.27)	2.12 (1.52-2.96)	1.17 (0.82-1.67)	0.95 (0.66-1.38)
IFG/IGT	64/465	13.76 (10.63-16.90)	8.04 (5.40-10.67)	2.70 (2.01-3.62)	1.38 (1.01-1.89)	1.07 (0.78-1.47)
NDM	98/529	18.53 (15.21-21.84)	8.74 (7.08-10.40)	3.84 (2.98-4.96)	1.83 (1.40-2.41)	1.40 (1.06-1.86)
KDM	191/727	26.27 (23.07-29.47)	14.26 (10.73-17.79)	6.02 (4.89-7.43)	2.83 (2.26-3.55)	1.91 (1.51-2.43)
Total	750/7718	9.72 (9.06-10.38)	7.71 (7.18-8.24)	_	_	_

▯Age-standardized prevalence is calculated based on Iranian population distribution data from the National Consensus Bureau for Tehran province (2010).

▯Adjusted for age, sex, BMI, hypercholesterolemia, low high-density lipoprotein cholesterol, hypertension, family history of premature cardiovascular disease, and smoking status.

NFG: normal fasting glucose; NGT: normal glucose tolerance; iIFG: isolated impaired fasting glucose; iIGT: isolated impaired glucose tolerance; IFG/IGT: both impaired fasting glucose and impaired glucose tolerance; NDM: newly diagnosed diabetes mellitus; KDM: known diabetes mellitus; CI: confidence interval.

Figures



	NFG/NGT	iIFG	iIGT	IFG/IGT	NDM	KDM
Crude prevalence	57.30%	15.17%	5.23%	6.03%	6.85%	9.42%
Age-standardized prevalence*	62.20%	14.30%	4.81%	5.19%	5.79%	7.72%

Figure 1

Prevalence of different glycemic status: Tehran Lipid and Glucose Study (phase IV: 2008-2011). Age-standardized prevalence is calculated based on Iranian population distribution data from the National Consensus Bureau for Tehran province (2010). NFG: normal fasting glucose; NGT: normal glucose tolerance; iIFG: isolated impaired fasting glucose; iIGT: isolated impaired glucose tolerance; IFG/IGT: both impaired fasting glucose and impaired glucose tolerance; NDM: newly diagnosed diabetes mellitus; KDM: known diabetes mellitus.

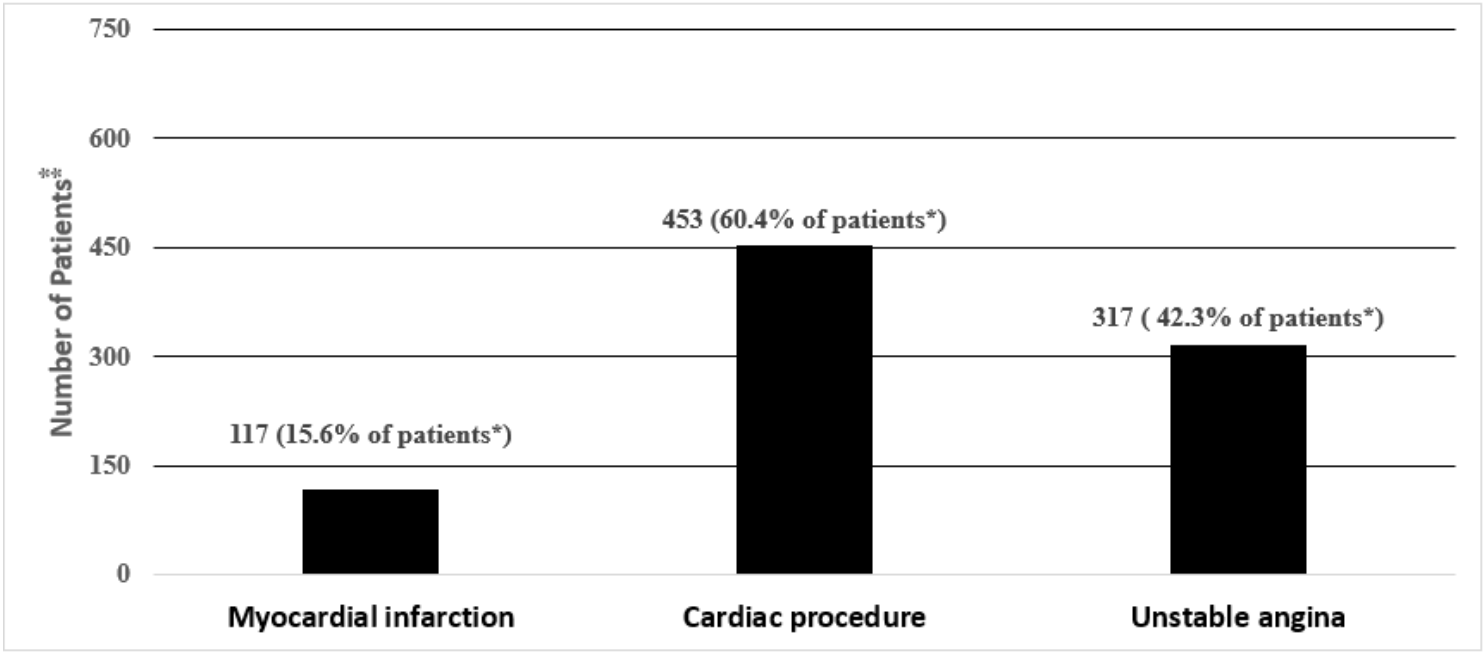


Figure 2

Number of patients across different types of coronary heart disease (CHD): Tehran Lipid and Glucose Study (phase IV: 2008-2011). percentage of each type were calculated only among 750 patients with positive coronary heart disease in our data set. The total number of different type of CHD is over 750 (100%), considering that patients might have more than one type of CHD. CHD events included cases of: (1) Myocardial infarction (MI), included a) definite MI diagnosed by diagnostic electrocardiogram (ECG) and biomarkers (including CK, CK-MB, CK-MBm, troponin (cTn), and myoglobin), b) probable MI distinguished by positive ECG findings plus cardiac symptoms or signs and biomarkers showing negative or equivocal results. (2) Cardiac procedure, defined as a) angiography proven CHD with a result of ≥ 50% stenosis in at least one major coronary vessel, b) history of angioplasty or bypass surgery. (3) Unstable angina pectoris, who developed new cardiac symptoms or showed changing symptom patterns and positive ECG findings with normal biomarkers and admitted to coronary care unit (CCU).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupTable1.docx