

# Number of parity/live birth(s) and cardiovascular disease among Iranian women and men: Results of over 15 years of follow-up.

**Seyyed Saeed Moazzeni**

Prevention of Metabolic Disorder Research Center

**Hossein Toreyhi**

Prevention of Metabolic Disorder Research Center

**Samaneh Asgari**

Prevention of Metabolic Research Center

**Fereidoun Azizi**

Research institute for Endocrine Science

**Fahimeh Ramezani Tehrani**

Reproductive Endocrinology Research Center

**Farzad Hadaegh** (✉ [fzhadaegh@endocrine.ac.ir](mailto:fzhadaegh@endocrine.ac.ir))

Prevention of Metabolic Research Disorder Center, Research institute for Endocrine Disorder, Shahid Beheshti University of Medical Science. <https://orcid.org/0000-0002-8935-2744>

---

## Research article

**Keywords:** Cardiovascular disease, Parity, Live birth, The Tehran Lipid and Glucose Study

**Posted Date:** October 30th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-24011/v2>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

---

**Version of Record:** A version of this preprint was published on January 7th, 2021. See the published version at <https://doi.org/10.1186/s12884-020-03499-2>.

# Abstract

**Background:** Most previous studies, conducted in non-Middle Eastern populations, have suggested that increase in the number of parity/live birth(s) leads to cardiovascular disease (CVD) development, although their findings were inconclusive on this issue for both sexes. Biologic and socioeconomic pathways were suggested to explain this association. We studied this issue among urban Iranian men and women.

**Methods:** In this population-based cohort study, included 3929 women and 2571 men aged  $\geq 30$  years, Data for number of parity/live birth(s) were obtained by standard questionnaire. Participants were then annually followed for CVD events. Multivariate Cox proportional hazard models were used to estimate hazard ratios (HRs), and 95% confidence intervals (CIs) for the number of parity/live birth(s) and other traditional CVD risk factors.

**Results:** During more than 15 years of follow-up, 456 and 524 CVD events have occurred among women and men, respectively. Among women, a J-shaped association was found between the number of live births and incident CVD with the lowest risk for women with 2 live births. Among women in multivariate analyses, each unit increase in parity had a HR of 1.05 (CI: 1.01-1.10) and having  $\geq 4$  parity was associated with a HR of 1.86 (0.97-3.56, p-value=0.061). Among men, in comparison with participants who had 1 child, multivariate HRs of having 2, 3 and  $\geq 4$  children were 1.97 (1.24-3.12), 2.08 (1.31-3.31) and 2.08 (1.30-3.34), respectively.

**Conclusion:** To the best of our knowledge, the current study is the first report of this issue in the Middle East and North Africa region, a region with high burden of CVD. It can now be suggested that the number of parity/live birth(s) is linked to CVD among the Iranian population, with this issue being more prominent among men. Further research is needed to support our results and clarify the pathways between the number of parity/live birth(s) and CVD development among Iranian populations by considering potential risk factors, especially psycho-socio-economic risk factors.

## Background

According to the latest GBD (Global Burden of Disease) data, cardiovascular disease (CVD) is the most common non-communicable disease, responsible for 17.8 million deaths in 2017[1]. Likewise, two consequences of CVD (stroke and coronary heart disease (CHD)) are the leading causes of mortality around the world[2, 3]. Statistics show that the effects of this phenomenon in the Middle East and North Africa (MENA) region are more prominent[2, 4]. In this region, Iran, while reporting modest mortality from CVD, is among the countries with the highest prevalence of CVD, with an approximate prevalence of 11% (7.7% for CHD) [2, 5].

In addition to traditional modifiable CVD risk factors such as obesity, hypertension, hypercholesterolemia, diabetes and smoking, it was shown that some reproductive factors can have a role in CVD development[6]. Pregnancy, as one of the most important events during a women's life, is associated with several cardiometabolic changes, including weight gain, dyslipidemia, increased plasma glucose and insulin resistance. While these kinds of changes are considered as normal physiological change, which are beneficial to both mother and fetus, they can also increase the prevalence of potential risk factors for CVD.

Additional stressors such as endothelial dysfunction, inflammation and hemostasis process during pregnancy may exacerbate this situation[7-9]. Results of previous studies on the association of parity (i.e., number of pregnancies reaching viable gestational age) and gravidity (i.e., number of times a woman is or has been pregnant, regardless of the pregnancy outcome) with the risk of CVD are inconclusive[9, 10]. Peters et al. showed that among 10 European countries, parous women had a 19% higher risk of CHD than nulliparous women; with this risk reaching up to 95% among women who had  $\geq 5$  children[10]. On the other hand, some others reported no significant association between parity and CVD[11-13]. Moreover, a J-shaped relationship was reported between parity and CVD among a Swedish female population, in which women with 2 births had the lowest risk of CVD, as compared with nulliparous and other parous women[8].

In addition to biomedical factors, some socioeconomic and lifestyle factors, which have a two-way causal relationship with the number of children (family size), can play a role in CVD development[14, 15]. These include social and economic characteristics, family and social supports, educational level, employment, income, lifestyle, and etc. This socioeconomic and lifestyle pathway is applicable not only to mothers, but also to fathers. A few previous studies examined the effect of the number of live births on CVD development among men; however, this issue is controversial among men as well[16, 17]. A large study conducted on a Chinese population reported that having more child was associated with CVD outcomes among men[17]. On the other hand, Eisenberg et al. found a negative association between the number of children and cardiovascular mortality among American men[16].

To the best of our knowledge, most previous studies related to these issues have been conducted in developed and Western countries and there is a lack of information on the effect of number of parity/live birth(s) on CVD development in the MENA region, a region with a high burden of CVD [2, 4]. The aim of the current study is to determine whether the number of parity/live birth(s) is an independent risk factor for incident CVD among Iranian women and men aged  $\geq 30$  years, over 15 years of follow-up. Data was collected from the oldest cohort of the MENA region, namely the Tehran Lipid and Glucose Study (TLGS).

## Methods

### *Study design and study population*

This study was conducted within the framework of TLGS, which is a community-based cohort study on a representative sample of residents of Tehran. TLGS pursues aims to determine the prevalence and incidence of non-communicable diseases and their risk factors and also prevent these diseases by advancing healthier lifestyles. TLGS enrollment has been conducted in two phases; phase one (January 31, 1999- July 03, 2001) and phase two (October 20, 2001- September 22, 2005). Data collection is planned to continue for at least 20 years at approximate 3-year intervals. More details of TLGS design and enrollment have been reported elsewhere[18].

5223 women and 4330 men aged  $\geq 30$  years (4459 women and 3468 men from phase I and 764 new women and 862 new men from phase II) were enrolled. Participants were excluded if they were single (194 women and 179 men), prevalent CVD cases (281 women and 318 men) and those with no live births (21 women and 8 men) leading to a total of 4727 women and 3825 men. Moreover, other exclusions included

those with missing data on the number of parity/live birth(s) (198 women and 1045 men), missing information on covariates including body mass index (BMI), fasting plasma glucose (FPG), total cholesterol (TC), systolic/diastolic blood pressure (SBP/DBP), education level, smoking status, family history of premature CVD, history of miscarriage, and history of oral contraceptive pill (OCP) use (198 women and 177 men, considering overlap features in the number of missing data between covariates). Also, subjects with no follow-up data (402 women and 32 men) were excluded. This left us with a total of 3929 women and 2571 men that were eligible for analysis.

### *Clinical and laboratory measurements*

A trained nurse collected data for demographic data, past medical history, drug history, family history of premature CVD, education level, marital status, smoking habits, and level of physical activity using a structured questionnaire. Questionnaires also included data on the history of miscarriage and the number of parity/live birth(s).

According to TLGS setting[18], measurements of weight and height were done with shoes removed and wearing light clothing. Weight was measured to the nearest 100 grams. Using a tape meter, the height of individuals was measured in a standing position. After a 15-min rest in a sitting position, two measurements of SBP and DBP were taken on the right arm. The mean of two measurements was defined as the subject's blood pressure (BP).

On the day of blood collection, after 12 to 14 hours of overnight fasting, a blood sample was collected between 7:00 and 9:00 AM from all participants in the TLGS research laboratory. Samples were analyzed on the same day. Details for laboratory measurements including FPG, TC, high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG) are published elsewhere[18].

### *Outcome assessment*

CVD data collection has been described in detail elsewhere[18]. Briefly, participants were interviewed by trained nurses through annual phone call for any cardiovascular events. Moreover, any reported event was followed-up by a trained physician through home visits and data collection from medical documents or death certifications (in case of mortality). Finally, the outcome committee which included an internist, an endocrinologist, a cardiologist, an epidemiologist, and other professionals when needed, evaluated the outcome data for this study and confirmed events. A CHD event included cases of definite myocardial infarction (MI) (diagnosed by electrocardiogram (ECG) and biomarkers), probable MI (positive ECG findings and cardiac symptoms plus missing biomarkers or positive ECG findings plus equivocal biomarkers), unstable angina pectoris (new cardiac symptoms or changing symptom patterns and positive ECG findings with normal biomarkers), angiographic-proven CHD, and cardiac death (any death in the hospital due to CHD based on the above-mentioned criteria, or sudden cardiac death caused by cardiac disease happening  $\leq 1$  hour after initiation of symptoms according to verbal autopsy files). CVD was considered as a composite measure of any CHD event, fatal or non-fatal stroke (defined as a new neurological deficit lasting  $\geq 24$  hour) and cerebrovascular death.

### *Definition of terms*

Type 2 diabetes mellitus (T2DM) was defined as FPG  $\geq 7$  mmol/L or use of glucose-lowering medications. Hypercholesterolemia was defined as TC  $\geq 5.18$  mmol/L or use of lipid-lowering medications. Hypertension was defined as either SBP  $\geq 140$  mmHg or DBP  $\geq 90$  mmHg or use of antihypertensive medications. Smoking status was categorized as current and former smokers versus never smokers. Education levels were categorized as having <6 years (reference group), 6–12 years, and >12 years of formal education. A 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. Low physical activity was defined as being physically active <3 days per week based on the TLGS using the Lipid Research Clinic (LRC) questionnaire for participants who were enrolled at phase I. Moreover, for participants who were enrolled at phase II, using the Modifiable Activity Questionnaire (MAQ), individuals with <600 MET (metabolic equivalent task-minutes per week) were considered as low physical activity group [18, 19]. Parity was considered as the number of live childbirth plus the number of stillbirth (defined as birth of an infant that died in the mother's uterus, after 20 weeks of gestation). A positive history of miscarriage was defined as the loss of an embryo or fetus before the 20th week of pregnancy.

### *Statistical Analyses*

All analyses were done separately for each sex. Baseline characteristics across the number of live births (1, 2, 3 and  $\geq 4$ ) are expressed as mean  $\pm$  standard deviation (SD) for continuous and number (%) for categorical variables. To compare baseline characteristics among different groups, ANOVA (or Kruskal–Wallis for skewed variables) and chi-square tests were employed for continuous and categorical variables, respectively.

In order to be able to capture a potential nonlinear association between the number of live births and incident CVD, univariate restricted cubic splines with 4 knots which defined the 5th, 25th, 75th, and 95th percentile, were used. This method enabled us to modify the model across the number of live births while considering a dose-response relationship [20]. Cox proportional hazard models were applied to evaluate the association of the number of parity/live birth(s) with incident CVD in 2 models: model 1 adjusted with baseline measurements of age; model 2 further adjusted with BMI, T2DM, hypertension, hypercholesterolemia, education level, smoking status, and family history of premature CVD for both sexes, as well as history of miscarriage and OCP use for women. The hazard ratios (HRs) and 95% confidence intervals (95% CI) were reported for the number of parity/live birth(s) and other risk factors. Time to event was defined by time of censoring or the event occurring, whichever came first. We censored participants in the case of other causes of death, leaving the district or being in the study until 20 March 2016, without any event. Moreover, we rerun our data analysis using age as time axis, rather than applied as a confounder in a sensitive analysis.

The proportionality in the Cox model was evaluated with the Schoenfeld residual test and generally, all proportionality assumptions were appropriate. Statistical analyses were performed using STATA version 14 (StataCorp LP, College Station, Texas), statistical software. P-values < 0.05 were considered statistically significant.

## **Results**

Baseline characteristics according to the number of live births are presented in **Table 1** for both sexes. Generally, among continuous variables cardiometabolic risk profiles became worse with increases in the number of live births. Thus, having more live births was associated with older age, higher BMI (only among women), increased BP and higher levels of FPG, TC, and TG (only among women). Similarly, among categorical variables, having more live births was associated with higher prevalence of T2DM, hypercholesterolemia, and hypertension as well as higher use of glucose-lowering, lipid-lowering (only among women) and antihypertensive medications. Furthermore, a positive history of miscarriage became more prevalent with increases in the number of live births. Finally, as the number of live births increased, the percentage of those with a higher degree of education levels decreased significantly.

Among women, incident CVD occurred in 456 (11.6%) women during a median (interquartile range: IQR) follow-up of 15.9 (11.7-16.5) years. Among men, the incident CVD occurred in 524 (20.4%) men during a median (IQR) follow-up of 15.7 (11.3-16.4) years.

As shown in Figure 1, we rejected the null hypothesis that CVD risk was a linear function of mean number of live births. Among women, the associations between the number of live births and the risk of incident CVD were J-shaped, so that the association of the number of live births with incident CVD appeared to decrease until the number reached two live births. After this point, the association appeared to rebound. Furthermore, the association was non-linear among men.

Multivariate HRs of incident CVD per additional live birth are shown in **Table 2** for both sexes. When live birth was adjusted with age in model 1, each additional live birth was associated with HRs of 1.07 [CI: 1.03-1.12] for women and 1.02 [0.97-1.08] for men, which were significant among women. However, after further adjustment in multivariate model 2, the HRs for each additional live births reached 1.04 [0.99-1.09] among women and 1.01 [0.95-1.07] among men.

Compared to women with 1 live birth in model 1, only women with  $\geq 4$  live births had an age-adjusted HR of 2.17 [1.18-4.00]; after more adjustment in model 2, the corresponding HR reached 1.72 [0.92-3.21, P-value = 0.087]. Among men, compared to those with 1 live birth, men with 2, 3, and  $\geq 4$  live births had a higher risk of incident CVD; the risks were significant in the full-adjusted model 2 by HRs of 1.97 [1.24-3.12], 2.08 [1.31-3.31], 2.08 [1.30-3.34], respectively. Importantly, beside the number of live births, traditional CVD risk factors including T2DM, hypertension, hypercholesterolemia, family history of premature CVD, former, and current smoking were significantly associated with incident CVD in model 2 (**Table 3**). Moreover, we conducted a similar analysis among men aged  $\geq 45$  years, who had the high probability to have completed family size (the average number of live births were 3.11 in men aged  $\geq 30$  years vs 4.07 for men aged  $\geq 45$  years). Similar to the men aged  $\geq 30$  years, among men older than 45 years, having  $\geq 2$  live births was associated with an increased CVD risk, with similar effect sizes, although the results did not reach to a significant level due to the limited sample size (**Supplementary Table 1**). However, there was no difference between the average number of live birth in women aged  $\geq 30$  years (2.46) vs aged  $\geq 45$  years (2.43).

Each unit increase in parity had an age-adjusted HR of 1.08 [1.04-1.13] among women in model 1; the HR remained at significant levels (1.05 [1.01-1.10]), even after further adjustment in multivariate model 2 (**Table 4**). In comparison with women with 1 parity, the age-adjusted HRs were 0.97 [0.47-2.00] and 1.41 [0.72-2.76]

among those with 2 and 3 parity, respectively. Moreover, having  $\geq 4$  parity had an age-adjusted HR of 2.34 [1.24-4.43] and after further adjustment in multivariate model 2, it also remained marginally significant (1.86 [0.97-3.56], P-value: 0.061). Importantly, beside the number of parity, traditional CVD risk factors including T2DM, hypertension, hypercholesterolemia, family history of premature CVD, and current smoking were significantly associated with incident CVD in model 2 (**Table 5**).

Compared to our main analysis (using follow-up time as the time axis), using age as the time axis yielded slightly lower effect sizes, but the results were overall similar and the 95% CIs overlapped; however, among women, the effect of parity as a continuous variable on incident CVD lost its significance in the sensitive analysis. (**Supplementary Table 2**).

## Discussion

This is the first population-based study conducted in the MENA region (a region with a high burden of CVD[4]) which examines the impact of the number of parity/live birth(s) on incident CVD events among both sexes during more than 15 years of follow-up.

Among women, the number of live births has a J-shaped association with incident CVD, with the lowest risk for those with 2 births. After adjustment for a wide series of important risk factors including age, T2DM, hypertension, hypercholesterolemia, smoking, and positive history of premature CVD -all of which remained significant risk factors in our analysis - each unit increase in parity was associated with a 5% higher risk of CVD events among women. Moreover, women with  $\geq 4$  parity had a more than 80% higher risk for incident CVD (marginally significant). Focusing on men, in comparison with participants who had 1 live birth, those with 2, 3, and  $\geq 4$  live births had about 100% higher risk for incident CVD in the presence of important traditional risk factors.

The findings of the current study about the association of parity number with incident CVD among women are consistent with a meta-analysis study on this issue by Li et al[9]. in which they found a non-linear J-shaped dose-response relationship between the number of parity and CVD among women. They also reported that each unit increase in the number of live birth led to a 4% increased risk of incident CVD; however, the authors showed significant high heterogeneity between studies ( $I^2=89.6\%$ ). In another meta-analysis[21], Lv et al. also found a similar J-shaped association between parity number and CVD mortality with the lowest risk for women with 4 live births. They also found that each live birth was associated with a 1% non-significant increased risk for CVD mortality ( $I^2 = 86.4\%$ ). It should be noted that the significant heterogeneity in these two meta-analyses[9, 21] could be related to different study populations, sample sizes and other epidemiologic aspects of studies. Marginally significant increased CVD risk for women with  $\geq 4$  parity in our results agrees with the findings of other studies[22, 23]. Furthermore, our findings are in line with some previous cohort studies on CVD morbidity and mortality risk assessment which show a J- or U-shaped association with the lowest risk for women with 2 live births or parity[8, 24]. However, in some others, there is no relation among women across the number of parity/live birth(s)[11, 13, 25] or their significance of association was lost after adjustment for other factors[12, 26, 27].

Although most of the previous studies on the current issue, focused only on women, the limited data on men was controversial as well[16]. Similar to the current report, Peters et al. reported that in comparison with Chinese men who had 1 child, men with  $\geq 2$  children and men with  $\geq 3$  children had a higher risk of incident CHD and stroke, respectively. Among Chinese men, they also showed that each additional child significantly increased the risk of CHD and stroke by 3% and 2%, respectively[17], although we did not find a linear relationship between the number of live births and incident CVD among Tehranian men. On the other hand, Eisenberg et al. found a negative association between the number of offspring and CVD mortality. Based on their report, each additional child decreased the risk of CVD mortality by 2% among American men[16]. Furthermore, some previous studies could not detect any significant association between the number of live births and CVD mortality and morbidity among men[28, 29]; however, some others reported a J- or U-shaped association among men which was similar to their female population study[24, 30].

A possible explanation for the association between parity and incident CVD in women is the biologic pathway. During pregnancy, some physiologic changes can have adverse effects for incident CVD which remained even after delivery, including weight gain, dyslipidemia, increased plasma glucose and insulin resistance as well as endothelial dysfunction and inflammatory and hemostatic processes[7-9]. In the light of multiple pregnancies, exposure time to these changes increased[9, 31]. This accumulative effect of repeating parity on traditional risk factors might be an important neglected residual confounding factor in the current study and similar researches in this field.

Beside the impact of the biologic pathway, psycho-socio-economic factors were reported to have a potentially important role in the pathway between number of children and CVD development in both parents[14, 15]. In a previous study on a Swedish population, Barclay et al. compared the effect of the number of live births on CVD mortality between adoptive and biologic parents[14]. They showed that CVD mortality is higher in biological parents than adoptive parents which means that the biologic pathway had inevitable effects for this issue. On the other hand, finding a U-shaped pattern in this study among adoptive male parents suggested that the biological pathway couldn't be the only explanation for their findings and the socioeconomic and lifestyle pathway should be considered as another explanation. Moreover, some previous studies[15, 17, 24] have found a similar pattern for men and women in their population study which confirmed the strong role of socioeconomic and lifestyle pathway. It should be considered that during our study recruitment period, the policy of the Iranian government was based on reducing population growth; so there was minimal economic support for Iranian parents[32]. Furthermore, according to the data of the statistical center of Iran in 2017, household income per capita reduced with increased family size [33] which means parents with more children might be under greater economic pressure. These economic problems could have adverse effects on socioeconomic status which can lead to CVD development through psychosocial factors (anxiety and depression development), using unhealthier diet, smoking initiation, limiting leisure-time physical activity, poor access to health care and little knowledge about diseases[34-36]. Since the head of the Iranian family is traditionally the father [37], the stronger effect of the number of children among men is expectable through the socioeconomic and life style pathway; the issue needs serious and deep investigations in future studies.

Although we couldn't find a strong protective role for childbearing in our data set, previous studies suggested that adult children may provide important social and financial support to their parents[14, 38]. These supports might be more important at older ages, where parents often need help for basic daily needs, accessing routine medical care, and prevention of social isolation[38]. Moreover, it was suggested that childbearing could cause developing a healthier lifestyle in parents[14, 38].

In addition to the CVD events, in previous studies, all-cause mortality[38, 39], diabetes[40], different types of cancer[41-43] were also found as medical outcomes influenced by childbearing. Therefore, it is not possible for us to accurately judge the ideal number of children in Tehran society. Moreover, in addition to the issue of the physical health of parents and families, other factors such as mental health, socioeconomic status, supports, employment, income, and life satisfaction should also be considered in the determination of the ideal children's number. Hence, it seems that due to the large differences in the mentioned factors in the community, it is better than talking about a fixed value of the ideal number of children for all families, the ideal number of children determined for each family individually, based on a predictive model including all the potential effective factors.

The strengths of the current study consist of addressing the effect of the number of parity/live birth(s) on CVD development among both sexes in the MENA region (a region with high burden of CVD) for the first time, with standardized measurements for assessment of traditional risk factors rather than relying on self-reported data and adjudicated CVD events. The current study was limited in several ways. First, potential risk factors were considered at the time of baseline phases and possible changes in risk factors as well as the number of parity/live birth(s), were not considered during the follow-up period. Second, the number of participants who hadn't had children was too low to permit us to compare the impact of nulliparity with ever parity. Third, we did not have access to valid data on participant job status, income, and diet which can clarify the socioeconomic and lifestyle pathway. Although we considered education status as a socioeconomic determinant, there was no strong relationship between education levels and economic status among Iranian population [44]. Fourth, some other reproductive factors of female participants such as breastfeeding, age at first and last live birth, age at menarche, and age at natural menopause were found to have roles in CVD development. However, for our female participants, these reproductive factors were not accessible to us, due to lack of data at the baseline recruitment. Finally, our population study included only residents of a metropolitan city and cannot be generalized to rural populations.

## Conclusion

To sum up, a J-shaped association was found between the number of live births and incident CVD among women. Moreover, for CVD events, besides the effects of traditional risk factors, each additional pregnancy increased the risk by 5%. We also found that women with  $\geq 4$  parity showed a marginally significant increased risk. Among men, those with only 1 child had the lowest risk of CVD events. It can be suggested that the number of parity/live birth(s) is linked to CVD among the Iranian population, with this issue being more prominent among men. Further research is needed to support our results and clarify the pathways between the number of parity/live birth(s) and CVD development among the Iranian population by considering potential factors, particularly psycho-socio-economic factors.

## Abbreviations

GBD: Global Burden of Disease; CVD: Cardiovascular Disease; CHD: Coronary Heart Disease; MENA: Middle East and North Africa; TLGS: Tehran Lipid and Glucose Study; BMI: Body Mass Index; FPG: Fasting Plasma Glucose; TC: Total Cholesterol; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; OCP: Oral Contraceptive Pill; BP: Blood Pressure; HDL-C: High-density Lipoprotein Cholesterol; TG: Triglycerides; MI: Myocardial Infarction; ECG: Electrocardiogram; T2DM: Type 2 Diabetes Mellitus; LRC: Lipid Research Clinic; MAQ: Modifiable Activity Questionnaire; MET: Metabolic Equivalent Task-minutes per Week; HR: Hazard ratio; 95% CI: 95% Confidence Interval; IQR: Interquartile Range.

## 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. All methods were done in accordance with the relevant guidelines and regulations.

### 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.

### Funding

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: S.A and F.H; Drafting of manuscript: S.S.M, H.T, S.A and F.H; Critical revision: S.S.M, H.T, S.A, F.A, F.R.T and F.H. All authors read and approved the final manuscript.

### Acknowledgements

The authors would like to express their appreciation to the TLGS participants and staff for their kind cooperation. The authors also wish to acknowledge DR. Laleh Rashidian for critical editing of English grammar and syntax of the manuscript.

## Authors' information

<sup>1</sup>Prevention of Metabolic Disorders Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

<sup>2</sup>Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

## References

1. Roth GA, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, Abdela J, Abdelalim A: **Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017.** *The Lancet* 2018, **392**(10159):1736-1788.
2. Roth GA, Johnson C, Abajobir A, Abd-Allah F, Abera SF, Abyu G, Ahmed M, Aksut B, Alam T, Alam K *et al*: **Global, Regional, and National Burden of Cardiovascular Diseases for 10 Causes, 1990 to 2015.** *Journal of the American College of Cardiology* 2017, **70**(1):1-25.
3. Johnson CO, Nguyen M, Roth GA, Nichols E, Alam T, Abate D, Abd-Allah F, Abdelalim A, Abraha HN, Abu-Rmeileh NM: **Global, regional, and national burden of stroke, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016.** *The Lancet Neurology* 2019, **18**(5):439-458.
4. Turk-Adawi K, Sarrafzadegan N, Fadhil I, Taubert K, Sadeghi M, Wenger NK, Tan NS, Grace SL: **Cardiovascular disease in the Eastern Mediterranean region: epidemiology and risk factor burden.** *Nature reviews Cardiology* 2018, **15**(2):106-119.
5. Moazzeni SS, Ghafelehbashi H, Hasheminia M, Parizadeh D, Ghanbarian A, Azizi F, Hadaegh F: **Sex-specific prevalence of coronary heart disease among Tehranian adult population across different glycemic status: Tehran lipid and glucose study, 2008–2011.** *BMC public health* 2020, **20**(1):1510.
6. Peters SA, Woodward M: **Women's reproductive factors and incident cardiovascular disease in the UK Biobank.** *Heart (British Cardiac Society)* 2018, **104**(13):1069-1075.
7. Ogunmoroti O, Osibogun O, Kolade OB, Ying W, Sharma G, Vaidya D, Michos ED: **Multiparity is associated with poorer cardiovascular health among women from the Multi-Ethnic Study of Atherosclerosis.** *American journal of obstetrics and gynecology* 2019, **221**(6):631.e631-631.e616.
8. Parikh NI, Cnattingius S, Dickman PW, Mittleman MA, Ludvigsson JF, Ingelsson E: **Parity and risk of later-life maternal cardiovascular disease.** *American heart journal* 2010, **159**(2):215-221. e216.
9. Li W, Ruan W, Lu Z, Wang D: **Parity and risk of maternal cardiovascular disease: A dose–response meta-analysis of cohort studies.** *European journal of preventive cardiology* 2019, **26**(6):592-602.
10. Peters SA, van der Schouw YT, Wood AM, Sweeting MJ, Moons KG, Weiderpass E, Arriola L, Benetou V, Boeing H, Bonnet F *et al*: **Parity, breastfeeding and risk of coronary heart disease: A pan-European case-cohort study.** *European journal of preventive cardiology* 2016, **23**(16):1755-1765.
11. Colditz GA, Willett WC, Stampfer MJ, Rosner B, Speizer FE, Hennekens CH: **A prospective study of age at menarche, parity, age at first birth, and coronary heart disease in women.** *American journal of*

- epidemiology* 1987, **126**(5):861-870.
12. Jacobsen BK, Knutsen SF, Oda K, Fraser GE: **Parity and total, ischemic heart disease and stroke mortality. The Adventist Health Study, 1976-1988.** *European journal of epidemiology* 2011, **26**(9):711-718.
  13. Chang HS, Odongua N, Ohrr H, Sull JW, Nam CM: **Reproductive risk factors for cardiovascular disease mortality among postmenopausal women in Korea: the Kangwha Cohort Study, 1985-2005.** *Menopause (New York, NY)* 2011, **18**(11):1205-1212.
  14. Barclay K, Kolk M: **Parity and Mortality: An Examination of Different Explanatory Mechanisms Using Data on Biological and Adoptive Parents.** *European journal of population = Revue europeenne de demographie* 2019, **35**(1):63-85.
  15. Magnus MC, Iliodromiti S, Lawlor DA, Catov JM, Nelson SM, Fraser A: **Number of Offspring and Cardiovascular Disease Risk in Men and Women: The Role of Shared Lifestyle Characteristics.** *Epidemiology (Cambridge, Mass)* 2017, **28**(6):880-888.
  16. Eisenberg ML, Park Y, Hollenbeck AR, Lipshultz LI, Schatzkin A, Pletcher MJ: **Fatherhood and the risk of cardiovascular mortality in the NIH-AARP Diet and Health Study.** *Human reproduction (Oxford, England)* 2011, **26**(12):3479-3485.
  17. Peters SA, Yang L, Guo Y, Chen Y, Bian Z, Millwood IY, Wang S, Yang L, Hu Y, Liu J *et al.*: **Parenthood and the risk of cardiovascular diseases among 0.5 million men and women: findings from the China Kadoorie Biobank.** *International journal of epidemiology* 2017, **46**(1):180-189.
  18. Azizi F, Ghanbarian A, Momenan AA, Hadaegh F, Mirmiran P, Hedayati M, Mehrabi Y, Zahedi-Asl S: **Prevention of non-communicable disease in a population in nutrition transition: Tehran Lipid and Glucose Study phase II.** *Trials* 2009, **10**:5.
  19. Committee IR: **Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-short and long forms.** [http://www ipaq ki se/scoring pdf](http://www.ipaq.ki.se/scoring/pdf) 2005.
  20. Royston P, Sauerbrei W: **Multivariable modeling with cubic regression splines: a principled approach.** *The Stata Journal* 2007, **7**(1):45-70.
  21. Lv H, Wu H, Yin J, Qian J, Ge J: **Parity and cardiovascular disease mortality: A dose-response meta-analysis of cohort studies.** *Scientific reports* 2015, **5**:13411.
  22. Zhang X, Shu X-O, Gao Y-T, Yang G, Li H, Zheng W: **Pregnancy, childrearing, and risk of stroke in Chinese women.** *Stroke* 2009, **40**(8):2680-2684.
  23. Dior UP, Hochner H, Friedlander Y, Calderon-Margalit R, Jaffe D, Burger A, Avgil M, Manor O, Elchalal U: **Association between number of children and mortality of mothers: results of a 37-year follow-up study.** *Annals of epidemiology* 2013, **23**(1):13-18.
  24. Barclay K, Keenan K, Grundy E, Kolk M, Myrskylä M: **Reproductive history and post-reproductive mortality: A sibling comparison analysis using Swedish register data.** *Social science & medicine (1982)* 2016, **155**:82-92.
  25. Gallagher LG, Davis LB, Ray RM, Psaty BM, Gao DL, Checkoway H, Thomas DB: **Reproductive history and mortality from cardiovascular disease among women textile workers in Shanghai, China.** *International journal of epidemiology* 2011, **40**(6):1510-1518.

26. Koski-Rahikkala H, Pouta A, Pietilainen K, Hartikainen AL: **Does parity affect mortality among parous women?** *Journal of epidemiology and community health* 2006, **60**(11):968-973.
27. Vladutiu CJ, Meyer ML, Malek AM, Stuebe AM, Mosher A, Aggarwal S, Kleindorfer D, Howard VJ: **Racial differences in the association between parity and incident stroke: Results from the REGARDS Study.** *Journal of stroke and cerebrovascular diseases: the official journal of National Stroke Association* 2017, **26**(4):749.
28. Ness RB, Cobb J, Harris T, D'Agostino RB: **Does number of children increase the rate of coronary heart disease in men?** *Epidemiology (Cambridge, Mass)* 1995:442-445.
29. Dekker J, Schouten E: **Number of pregnancies and risk of cardiovascular disease.** *The New England journal of medicine* 1993, **329**(25):1893.
30. Jaffe DH, Eisenbach Z, Manor O: **The effect of parity on cause-specific mortality among married men and women.** *Maternal and child health journal* 2011, **15**(3):376-385.
31. Sanghavi M, Kulinski J, Ayers CR, Nelson D, Stewart R, Parikh N, de Lemos JA, Khera A: **Association between number of live births and markers of subclinical atherosclerosis: The Dallas Heart Study.** *European journal of preventive cardiology* 2016, **23**(4):391-399.
32. Abbasi-Shavazi MJ, McDonald P, Hosseini-Chavoshi M: **The fertility transition in Iran**, vol. 75: Springer; 2009.
33. Statistical-center-of-Iran: **NATAYEGE AMARGIRI AZ HAZINE VA DARAMADE KHANEVARHAYE SHAHRI SALE 1396.** 2017.
34. Clark AM, DesMeules M, Luo W, Duncan AS, Wielgosz A: **Socioeconomic status and cardiovascular disease: risks and implications for care.** *Nature reviews Cardiology* 2009, **6**(11):712-722.
35. Williams J, Allen L, Wickramasinghe K, Mikkelsen B, Roberts N, Townsend N: **A systematic review of associations between non-communicable diseases and socioeconomic status within low- and lower-middle-income countries.** *Journal of global health* 2018, **8**(2):020409.
36. Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, Quyyumi AA, Taylor HA, Gulati M, Harold JG *et al*: **Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions.** *Circulation* 2018, **137**(20):2166-2178.
37. Aghajanian A: **Family and family change in Iran.** *Fayetteville: Fayetteville State University* 2001.
38. Högnäs RS, Roelfs DJ, Shor E, Moore C, Reece T: **J-curve? A meta-analysis and meta-regression of parity and parental mortality.** *Population Research and Policy Review* 2017, **36**(2):273-308.
39. Zeng Y, Ni Z-m, Liu S-y, Gu X, Huang Q, Liu J-a, Wang Q: **Parity and all-cause mortality in women and men: A dose-response meta-analysis of cohort studies.** *Scientific reports* 2016, **6**:19351.
40. Guo P, Zhou Q, Ren L, Chen Y, Hui Y: **Higher parity is associated with increased risk of type 2 diabetes mellitus in women: a linear dose-response meta-analysis of cohort studies.** *Journal of diabetes and its complications* 2017, **31**(1):58-66.
41. Wu Q-J, Li Y-Y, Tu C, Zhu J, Qian K-Q, Feng T-B, Li C, Wu L, Ma X-X: **Parity and endometrial cancer risk: a meta-analysis of epidemiological studies.** *Scientific reports* 2015, **5**:14243.
42. Lambe M, Hsieh C-c, Chan H-w, Ekblom A, Trichopoulos D, Adami H-O: **Parity, age at first and last birth, and risk of breast cancer: a population-based study in Sweden.** *Breast cancer research and treatment*

1996, **38**(3):305-311.

43. Zhu J, Zhu X, Tu C, Li YY, Qian KQ, Jiang C, Feng TB, Li C, Liu GJ, Wu L: **Parity and thyroid cancer risk: a meta-analysis of epidemiological studies.** *Cancer medicine* 2016, **5**(4):739-752.
44. Falahati A, Fatahi S, Goli Y, Goli S: **TAGHAZAYE TAHSILAT VA BARAVORD SAHME TAHSILAT DAR NABARABARI DARAMAD.** *MODELSAZI EGHTESSADI* 1396, **1396**(37).

## Tables

**Table 1. Baseline characteristics according to the number of live births among women and men: Tehran Lipid and Glucose Study, Iran, 1999-2016.**

| Number of Live births                 | Women        |              |              |              | P-value* | Men          |              |              |              | P-value* |
|---------------------------------------|--------------|--------------|--------------|--------------|----------|--------------|--------------|--------------|--------------|----------|
|                                       | 1            | 2            | 3            | 4 ≤          |          | 1            | 2            | 3            | 4 ≤          |          |
| Number of participants                | 305          | 906          | 906          | 1812         |          | 376          | 770          | 576          | 849          |          |
| <b>Continuous variables, Mean ±SD</b> |              |              |              |              |          |              |              |              |              |          |
| Age (year)                            | 38.2 ± 9.6   | 38.8 ± 7.5   | 44.0 ± 9.2   | 54.0 ± 9.9   | <0.001   | 37.3 ± 8.0   | 41.6 ± 7.7   | 48.7 ± 9.2   | 58.8 ± 9.2   | <0.001   |
| BMI (kg/m <sup>2</sup> )              | 27.0 ± 4.3   | 27.6 ± 4.6   | 28.7 ± 4.5   | 29.6 ± 4.7   | <0.001   | 26.1 ± 4.0   | 26.0 ± 3.6   | 26.3 ± 4.0   | 26.4 ± 3.8   | 0.214    |
| SBP (mmHg)                            | 112.0 ± 16.2 | 112.6 ± 14.7 | 118.5 ± 17.4 | 129.3 ± 21.9 | <0.001   | 115.5 ± 14.7 | 115.9 ± 15.4 | 120.3 ± 18.1 | 128.6 ± 20.7 | <0.001   |
| DBP (mmHg)                            | 74.6 ± 9.8   | 75.9 ± 9.7   | 78.7 ± 10.5  | 81.3 ± 11.0  | <0.001   | 77.0 ± 11.0  | 77.0 ± 10.5  | 79.0 ± 11.5  | 80.2 ± 11.9  | <0.001   |
| FPG (mmol/L)                          | 5.2 ± 1.6    | 5.1 ± 1.3    | 5.4 ± 1.6    | 6.1 ± 2.5    | <0.001   | 5.2 ± 0.9    | 5.2 ± 1.2    | 5.6 ± 1.9    | 5.9 ± 2.2    | <0.001   |
| Total cholesterol (mmol/L)            | 5.2 ± 1.1    | 5.4 ± 1.1    | 5.6 ± 1.1    | 6.0 ± 1.3    | <0.001   | 5.2 ± 1.1    | 5.3 ± 1.1    | 5.4 ± 1.1    | 5.4 ± 1.1    | 0.002    |
| HDL-C (mmol/L)                        | 1.2 ± 0.3    | 1.2 ± 0.3    | 1.1 ± 0.3    | 1.2 ± 0.3    | 0.349    | 1.0 ± 0.3    | 1.0 ± 0.2    | 1.0 ± 0.3    | 1.0 ± 0.2    | 0.128    |
| Triglycerides (mmol/L)                | 1.37 (1.10)  | 1.45 (1.05)  | 1.70 (1.21)  | 1.97 (1.31)  | <0.001   | 1.82 (1.42)  | 1.82 (1.27)  | 1.84 (1.44)  | 1.85 (1.29)  | 0.811    |
| <b>Categorical variables, n (%)</b>   |              |              |              |              |          |              |              |              |              |          |
| Smoking status                        |              |              |              |              | <0.001   |              |              |              |              | <0.001   |
| - Never                               | 281 (92.1)   | 834 (92.1)   | 854 (94.3)   | 1676 (92.5)  |          | 188 (50)     | 391 (50.8)   | 302 (52.4)   | 483 (56.9)   |          |
| - Former                              | 6 (2.0)      | 12 (1.3)     | 9 (1.0)      | 66 (3.6)     |          | 39 (10.4)    | 121 (15.7)   | 81 (14.1)    | 165 (19.4)   |          |
| - Current                             | 18 (5.9)     | 60 (6.6)     | 43 (4.7)     | 70 (3.9)     |          | 149 (39.6)   | 258 (33.5)   | 193 (33.5)   | 201 (23.7)   |          |
| Education level                       |              |              |              |              | <0.001   |              |              |              |              | <0.001   |
| - Illiterate/primary school           | 56 (18.4)    | 144 (15.9)   | 334 (36.9)   | 1442 (79.6)  |          | 41 (10.9)    | 96 (12.5)    | 154 (26.7)   | 521 (61.4)   |          |
| - Below diploma/diploma               | 182 (59.7)   | 655 (72.3)   | 526 (58.1)   | 346 (19.1)   |          | 253 (67.3)   | 505 (65.6)   | 302 (52.4)   | 268 (31.6)   |          |
| - Above diploma                       | 67 (22.2)    | 107 (11.8)   | 46 (5.1)     | 24 (1.3)     |          | 82 (21.8)    | 169 (21.9)   | 120 (20.8)   | 60 (7.1)     |          |
| Low physical activity, yes            | 192 (63.0)   | 560 (61.8)   | 622 (68.7)   | 1283 (70.8)  | <0.001   | 273 (72.6)   | 574 (74.5)   | 408 (70.8)   | 585 (68.9)   | 0.083    |
| T2DM, yes                             | 15 (4.9)     | 33 (3.6)     | 66 (7.3)     | 316 (17.4)   | <0.001   | 11 (2.9)     | 30 (3.9)     | 64 (11.1)    | 117 (13.8)   | <0.001   |
| Hypercholesterolemia, yes             | 146 (47.9)   | 471 (52.0)   | 560 (61.8)   | 1347 (74.3)  | <0.001   | 187 (49.7)   | 410 (53.2)   | 321 (55.7)   | 497 (58.5)   | 0.022    |
| Hypertension, yes                     | 27 (8.9)     | 115 (12.7)   | 196 (21.6)   | 744 (41.1)   | <0.001   | 52 (13.8)    | 109 (14.2)   | 130 (22.6)   | 281 (33.1)   | <0.001   |

|                                      |              |               |               |               |        |              |               |              |              |        |
|--------------------------------------|--------------|---------------|---------------|---------------|--------|--------------|---------------|--------------|--------------|--------|
| Family history of premature CVD, yes | 55<br>(18.0) | 172<br>(19)   | 165<br>(18.2) | 322<br>(17.8) | 0.896  | 60<br>(16.0) | 126<br>(16.4) | 80<br>(13.9) | 98<br>(11.5) | 0.031  |
| Glucose-lowering medication, yes     | 7<br>(2.3)   | 16<br>(1.8)   | 24<br>(2.6)   | 182<br>(10.0) | <0.001 | 3<br>(0.8)   | 15<br>(1.9)   | 15<br>(2.6)  | 52<br>(6.1)  | <0.001 |
| Lipid-lowering medication, yes       | 7<br>(2.3)   | 20<br>(2.2)   | 33<br>(3.6)   | 144<br>(7.9)  | <0.001 | 6<br>(1.6)   | 10<br>(1.3)   | 14<br>(2.4)  | 22<br>(2.6)  | 0.236  |
| Antihypertensive medication, yes     | 12<br>(3.9)  | 41<br>(4.5)   | 61<br>(6.7)   | 330<br>(18.2) | <0.001 | 5<br>(1.3)   | 17<br>(2.2)   | 22<br>(3.8)  | 56<br>(6.6)  | <0.001 |
| OCP use, yes                         | 18<br>(5.9)  | 90<br>(9.9)   | 63<br>(7.0)   | 43<br>(2.4)   | <0.001 | -            | -             | -            | -            | -      |
| History of miscarriage, yes          | 75<br>(24.6) | 292<br>(32.2) | 314<br>(34.7) | 776<br>(42.8) | <0.001 | -            | -             | -            | -            | -      |

BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; FPG: fasting plasma glucose; 2h-PCPG:2-hour post-challenge plasma glucose; HDL-C: high density lipoprotein cholesterol; T2DM: type 2 diabetes mellitus; CVD: cardiovascular disease; OCP: oral contraceptive pill. Values are shown as Mean  $\pm$ SD and number (%), for continuous and categorical variables, respectively; for TG values are shown as Median (interquartile range).

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

**Table 2. Multivariate hazard ratios (HR) and 95% confidence intervals (CI) of incident CVD per additional live birth among women and men: Tehran Lipid and Glucose Study, Iran, 1999-2016.**

|   | Women               |         |                     |         | Men                 |         |                     |         |
|---|---------------------|---------|---------------------|---------|---------------------|---------|---------------------|---------|
|   | Model 1             |         | Model 2             |         | Model 1             |         | Model 2             |         |
|   | HR (95% CI)         | p-value |
| <b>Live birth (per each additional)</b> | 1.07<br>(1.03-1.12) | 0.002   | 1.04<br>(0.99-1.09) | 0.094   | 1.02<br>(0.97-1.08) | 0.474   | 1.01<br>(0.95-1.07) | 0.714   |
| <b>Age (year)</b>                       | 1.07<br>(1.06-1.08) | <0.001  | 1.05<br>(1.03-1.06) | <0.001  | 1.06<br>(1.05-1.07) | <0.001  | 1.06<br>(1.05-1.07) | <0.001  |
| <b>BMI (kg/m<sup>2</sup>)</b>           |                     |         | 1.01 (0.99-1.03)    | 0.404   |                     |         | 1.01<br>(0.99-1.04) | 0.219   |
| <b>T2DM, yes</b>                        |                     |         | 2.37 (1.92-2.91)    | <0.001  |                     |         | 2.41<br>(1.92-3.01) | <0.001  |
| <b>Hypertension, yes</b>                |                     |         | 1.84 (1.49-2.26)    | <0.001  |                     |         | 1.55<br>(1.28-1.88) | <0.001  |
| <b>Hypercholesterolemia, yes</b>        |                     |         | 1.82 (1.38-2.41)    | <0.001  |                     |         | 1.49<br>(1.24-1.79) | <0.001  |
| <b>Low physical activity, yes</b>       |                     |         | 1.12 (0.91-1.39)    | 0.282   |                     |         | 1.03<br>(0.85-1.26) | 0.735   |
| <b>Education level</b>                  |                     |         |                     |         |                     |         |                     |         |
| Illiterate/primary school               |                     |         | Reference           |         |                     |         | Reference           |         |
| Below diploma/diploma                   |                     |         | 0.78 (0.59-1.03)    | 0.084   |                     |         | 1.14<br>(0.92-1.41) | 0.229   |
| Above diploma                           |                     |         | 0.67 (0.34-1.32)    | 0.248   |                     |         | 0.96<br>(0.71-1.29) | 0.772   |
| <b>Smoking status</b>                   |                     |         |                     |         |                     |         |                     |         |
| Never                                   |                     |         | Reference           |         |                     |         | Reference           |         |
| Former                                  |                     |         | 1.09 (0.71-1.69)    | 0.693   |                     |         | 1.27<br>(1.01-1.59) | 0.044   |
| Current                                 |                     |         | 1.65 (1.09-2.50)    | 0.018   |                     |         | 1.60<br>(1.30-1.96) | <0.001  |
| <b>FH of premature CVD, yes</b>         |                     |         | 1.61 (1.31-1.99)    | <0.001  |                     |         | 1.32<br>(1.04-1.68) | 0.023   |
| <b>History of miscarriage, yes</b>      |                     |         | 1.18 (0.98-1.42)    | 0.088   |                     |         |                     |         |
| <b>OCP use, yes</b>                     |                     |         | 0.48 (0.20-         | 0.109   |                     |         |                     |         |

---

BMI: body mass index; T2DM: type 2 diabetes mellitus; OCP: oral contraceptive pill; CVD: cardiovascular disease; FH: family history

Model 1: Adjusted with age.

Model 2: for women: Adjusted with Age, BMI, T2DM, hypertension, hypercholesterolemia, education status, smoking status, family history of CVD, history of miscarriage, and OCP use; for men: Adjusted with age, BMI, T2DM, hypertension, hypercholesterolemia, education status, smoking status and family history of CVD.

---

**Table 3. Multivariate hazard ratios (HR) and 95% confidence intervals (CI) of incident CVD according to the number of live births among women and men: Tehran Lipid and Glucose Study, Iran, 1999-2016.**

|                                   | Women            |         |                  |         | Men              |         |                  |         |
|-----------------------------------|------------------|---------|------------------|---------|------------------|---------|------------------|---------|
|                                   | Model 1          |         | Model 2          |         | Model 1          |         | Model 2          |         |
|                                   | HR (95% CI)      | p-value |
| <b>Number of Live births</b>      |                  |         |                  |         |                  |         |                  |         |
| 1                                 | Reference        |         | Reference        |         | Reference        |         | Reference        |         |
| 2                                 | 0.89 (0.44-1.80) | 0.752   | 0.86 (0.43-1.73) | 0.676   | 2.00 (1.26-3.16) | 0.003   | 1.97 (1.24-3.12) | 0.004   |
| 3                                 | 1.57 (0.83-2.97) | 0.162   | 1.42 (0.75-2.70) | 0.279   | 2.25 (1.42-3.58) | 0.001   | 2.08 (1.31-3.31) | 0.002   |
| ≥ 4                               | 2.17 (1.18-4.00) | 0.012   | 1.72 (0.92-3.21) | 0.087   | 2.20 (1.37-3.52) | 0.001   | 2.08 (1.30-3.34) | 0.002   |
| <b>Age (year)</b>                 | 1.07 (1.06-1.08) | <0.001  | 1.04 (1.03-1.06) | <0.001  | 1.05 (1.04-1.06) | <0.001  | 1.05 (1.04-1.06) | <0.001  |
| <b>BMI (kg/m<sup>2</sup>)</b>     |                  |         | 1.01 (0.98-1.03) | 0.613   |                  |         | 1.01 (0.99-1.04) | 0.270   |
| <b>T2DM, yes</b>                  |                  |         | 2.37 (1.93-2.91) | <0.001  |                  |         | 2.37 (1.89-2.96) | <0.001  |
| <b>Hypertension, yes</b>          |                  |         | 1.83 (1.49-2.25) | <0.001  |                  |         | 1.56 (1.29-1.90) | <0.001  |
| <b>Hypercholesterolemia, yes</b>  |                  |         | 1.80 (1.37-2.38) | <0.001  |                  |         | 1.47 (1.22-1.77) | <0.001  |
| <b>Low physical activity, yes</b> |                  |         | 1.13 (0.91-1.40) | 0.266   |                  |         | 1.04 (0.85-1.26) | 0.728   |
| <b>Education level</b>            |                  |         |                  |         |                  |         |                  |         |
| Illiterate/primary school         |                  |         | Reference        |         |                  |         | Reference        |         |
| Below diploma/diploma             |                  |         | 0.86 (0.64-1.14) | 0.284   |                  |         | 1.14 (0.93-1.41) | 0.211   |
| Above diploma                     |                  |         | 0.79 (0.40-1.57) | 0.503   |                  |         | 0.96 (0.71-1.29) | 0.771   |
| <b>Smoking status</b>             |                  |         |                  |         |                  |         |                  |         |
| Never                             |                  |         | Reference        |         |                  |         | Reference        |         |
| Former                            |                  |         | 1.11 (0.71-1.71) | 0.653   |                  |         | 1.27 (1.01-1.60) | 0.039   |
| Current                           |                  |         | 1.68             | 0.014   |                  |         | 1.60             | <       |

|                                    |                     |        |                     |       |
|------------------------------------|---------------------|--------|---------------------|-------|
|                                    | (1.11-2.55)         |        | (1.30-1.97)         | 0.001 |
| <b>FH of premature CVD, yes</b>    | 1.62<br>(1.32-2.00) | <0.001 | 1.33<br>(1.05-1.69) | 0.020 |
| <b>History of miscarriage, yes</b> | 1.17<br>(0.98-1.41) | 0.090  |                     |       |
| <b>OCP use, yes</b>                | 0.50<br>(0.20-1.22) | 0.126  |                     |       |

BMI: body mass index; T2DM: type 2 diabetes mellitus; OCP: oral contraceptive pill; CVD: cardiovascular disease; FH: family history.

Model 1: Adjusted with age.

Model 2: for women: Adjusted with Age, BMI, T2DM, hypertension, hypercholesterolemia, education status, smoking status, family history of CVD, history of miscarriage, and OCP use; for men: Adjusted with Age, BMI, T2DM, hypertension, hypercholesterolemia, education status, smoking status and family history of CVD.

**Table 4: Multivariate hazard ratios (HR) and 95% confidence intervals (CI) of incident CVD per additional parity among women: Tehran Lipid and Glucose Study, Iran, 1999-2016.**

|                                     | Model 1          |         | Model 2          |         |
|-------------------------------------|------------------|---------|------------------|---------|
|                                     | HR (95% CI)      | p-value | HR (95% CI)      | p-value |
| <b>Parity (per each additional)</b> | 1.08 (1.04-1.13) | <0.001  | 1.05 (1.01-1.10) | 0.028   |
| <b>Age (year)</b>                   | 1.07 (1.06-1.08) | <0.001  | 1.05 (1.03-1.06) | <0.001  |
| <b>BMI (kg/m<sup>2</sup>)</b>       |                  |         | 1.01 (0.99-1.03) | 0.415   |
| <b>T2DM, yes</b>                    |                  |         | 2.36 (1.92-2.90) | <0.001  |
| <b>Hypertension, yes</b>            |                  |         | 1.84 (1.49-2.26) | <0.001  |
| <b>Hypercholesterolemia, yes</b>    |                  |         | 1.82 (1.38-2.41) | <0.001  |
| <b>Low physical activity, yes</b>   |                  |         | 1.12 (0.91-1.39) | 0.285   |
| <b>Education level</b>              |                  |         |                  |         |
| - Illiterate/primary school         |                  |         | Reference        |         |
| - Below diploma/diploma             |                  |         | 0.79 (0.59-1.05) | 0.100   |
| - Above diploma                     |                  |         | 0.68 (0.34-1.34) | 0.267   |
| <b>Smoking status</b>               |                  |         |                  |         |
| - Never                             |                  |         | Reference        |         |
| - Former                            |                  |         | 1.09 (0.71-1.69) | 0.686   |
| - Current                           |                  |         | 1.65 (1.09-2.51) | 0.017   |
| <b>FH of premature CVD, yes</b>     |                  |         | 1.62 (1.31-1.99) | <0.001  |
| <b>History of miscarriage, yes</b>  |                  |         | 1.17 (0.97-1.41) | 0.091   |
| <b>OCP use, yes</b>                 |                  |         | 0.48 (0.20-1.18) | 0.108   |

BMI: body mass index; T2DM: type 2 diabetes mellitus; OCP: oral contraceptive pill; CVD: cardiovascular disease; FH: family history.

Model 1: Adjusted with age.

Model 2: Adjusted with age, BMI, T2DM, hypertension, hypercholesterolemia, education level, smoking status, family history of CVD, history of miscarriage, and OCP use.

**Table 5: Multivariate hazard ratios (HR) and 95% confidence intervals (CI) of incident CVD according to the number of parity among women: Tehran Lipid and Glucose Study, Iran, 1999-2016.**

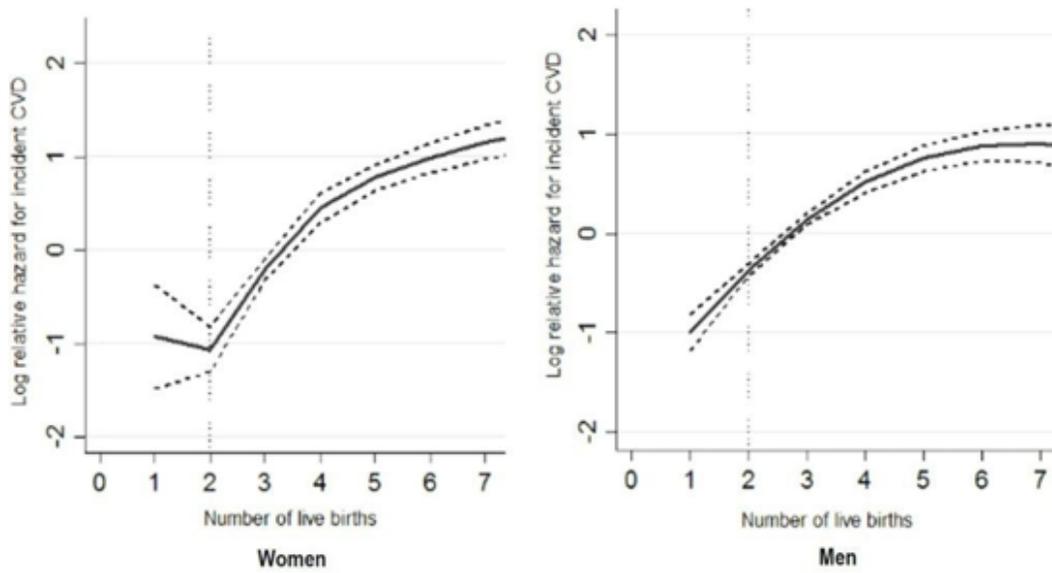
|                                    | Model 1          |         | Model 2          |         |
|------------------------------------|------------------|---------|------------------|---------|
|                                    | HR (95% CI)      | p-value | HR (95% CI)      | p-value |
| <b>Number of parity</b>            |                  |         |                  |         |
| 1                                  | Reference        |         | Reference        |         |
| 2                                  | 0.97 (0.47-2.00) | 0.931   | 0.93 (0.45-1.93) | 0.855   |
| 3                                  | 1.41 (0.72-2.76) | 0.315   | 1.32 (0.67-2.60) | 0.417   |
| ≥ 4                                | 2.34 (1.24-4.43) | 0.009   | 1.86 (0.97-3.56) | 0.061   |
| <b>Age (year)</b>                  | 1.07 (1.06-1.08) | <0.001  | 1.04 (1.03-1.06) | <0.001  |
| <b>BMI (kg/m<sup>2</sup>)</b>      |                  |         | 1.00 (0.98-1.03) | 0.647   |
| <b>T2DM, yes</b>                   |                  |         | 2.36 (1.92-2.90) | <0.001  |
| <b>Hypertension, yes</b>           |                  |         | 1.82 (1.48-2.24) | <0.001  |
| <b>Hypercholesterolemia, yes</b>   |                  |         | 1.80 (1.36-2.38) | <0.001  |
| <b>Low physical activity, yes</b>  |                  |         | 1.13 (0.91-1.40) | 0.255   |
| <b>Education level</b>             |                  |         |                  |         |
| Illiterate/primary school          |                  |         | Reference        |         |
| Below diploma/diploma              |                  |         | 0.87 (0.65-1.15) | 0.321   |
| Above diploma                      |                  |         | 0.79 (0.40-1.58) | 0.510   |
| <b>Smoking status</b>              |                  |         |                  |         |
| Never                              |                  |         | Reference        |         |
| Former                             |                  |         | 1.11 (0.71-1.71) | 0.649   |
| Current                            |                  |         | 1.67 (1.10-2.53) | 0.016   |
| <b>FH of premature CVD, yes</b>    |                  |         | 1.62 (1.32-2.00) | <0.001  |
| <b>History of miscarriage, yes</b> |                  |         | 1.17 (0.97-1.41) | 0.092   |
| <b>OCP use, yes</b>                |                  |         | 0.49 (0.20-1.20) | 0.121   |

BMI: body mass index; T2DM: type 2 diabetes mellitus; OCP: oral contraceptive pill; CVD: cardiovascular disease; FH: family history.

Model 1: Adjusted with age.

Model 2: Adjusted with age, BMI, T2DM, hypertension, hypercholesterolemia, education level, smoking status, family history of CVD, history of miscarriage, and OCP use.

## Figures



**Figure 1**

Restricted cubic spline curve for association (95% confidence interval) of the number of live births with incident cardiovascular disease (CVD) among Tehranian women and men: Tehran Lipid and Glucose Study, Iran, 1999-2016.

## Supplementary Files

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

- [SupplementaryTable2.docx](#)
- [SupplementaryTable1.docx](#)