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Gender disparities in the association between age at first marriage and chronic diseases: evidence from the Azar cohort study

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Abstract

Background The role of age at first marriage in chronic disease risk remains understudied, and evidence on its association with chronic health outcomes in men and women is limited. We therefore examined the relationship between age at first marriage and the risk of chronic diseases among adult men and women in the Azar cohort.

Methods This cross-sectional study used data from 13,326 participants in the Azar Cohort, which evaluates risk factors for chronic non-communicable diseases (NCDs) in northwest Iran. A structured questionnaire captured demographic variables, age at first marriage, medical history, and personal habits. Based on age at first marriage, participants were classified into two groups: under 18 years (child marriage) and 18 years or older (adult marriage).

Results Among 13,326 participants, the prevalence of child marriage was 26.36%. Women constituted a larger share of the child marriage group than men (46.6% vs. 3.6%; $P < 0.001$). In men, child marriage showed no association with NCDs except for obesity (Odds ratio [OR]: 1.43) and multimorbidity (MM) (OR: 1.41). In women, marriage before 18 years was associated with higher odds of diabetes (OR: 1.25), hypertension (OR: 1.37), cardiovascular disease (OR: 1.67), stroke (OR: 1.84), depression (OR: 1.35), obesity (OR: 1.50), and MM (OR: 1.53). Notably, the highest odds occurred for stroke.

Conclusion Child marriage was associated with obesity and MM in men, and with diabetes, hypertension, cardiovascular disease, stroke, depression, obesity, and depression in women. These results indicate a need for tailored health interventions for people affected by child marriage, particularly women. Longitudinal follow-up is recommended to assess causality.

Keywords Child marriage, Diabetes, Hypertension, Obesity, Chronic diseases

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Introduction

Chronic diseases are the leading cause of premature mortality in adults [1] and have become a global public health problem due to lifestyle changes [2]. According to the World Health Organization (WHO), 80% of deaths from chronic diseases occur in low- and middle-income countries (LMICs) [3]. Cardiovascular diseases, cancers, chronic respiratory diseases, diabetes mellitus, and hypertension are among the most common chronic diseases [4–6]. Among potential risk factors for non-communicable diseases (NCDs), the role of age at marriage, particularly child marriage, and the plausible pathways linking it with NCDs remain understudied. Child marriage is defined as marriage before the age of 18 years [7], an estimated 700 million people have experienced it globally, with about 15 million new cases each year, mostly in developing countries [8, 9]. Factors that can lead to early marriage include poverty, place of residence, natural disasters, low education level, unemployment, geographical and social isolation, emigration, and culture [10–14].

Recent studies have reported associations between child marriage and chronic conditions. Women who married as children had higher risks of anemia and obesity [15, 16]. Some surveys reported an inverse association between child marriage in women and the risk of hypertension and type 2 diabetes [17–20]. and, in some analyses, maternal mortality [21]. Vikram et al. reported that marriage before 18 years was associated with high blood pressure, diabetes, heart disease, asthma, and thyroid disorders in women [22]. Because early marriage is more common among women, few studies have examined its consequences in men. One cohort study found that men who first married at a younger or older age had higher odds of cardiovascular disease (CVD) and cancer. In contrast, age at first marriage was not associated with CVD or cancer risk in women [23]. Another cohort study reported that later marriage was associated with lower mortality risk in older men, although this association was not significant in older women [24].

Given these inconsistent findings, clarifying the effect of age at first marriage on the risk of chronic disease is necessary to inform healthcare providers about highly vulnerable populations. Moreover, most studies worldwide have focused on women. To the best of our knowledge, limited evidence addresses the association between age at first marriage and chronic health outcomes in both men and women in LMICs, and no study has examined this association in Iran. Therefore, this study investigated the association between age at first marriage and the risk of chronic diseases among adult men and women in the Azar cohort.

Methods

Study design and setting

This cross-sectional study used data from the Azar cohort, a component of the large PERSIAN (Prospective Epidemiological Research Studies in Iran) cohort [25, 26]. Tabriz University of Medical Sciences surveyed from September 2014 to January 2017 in the Shabestar region of East Azerbaijan Province. The Ethics Committee of Tabriz University of Medical Sciences approved the study protocols (IR.TBZMED.REC.1403.416). All participants provided written informed consent before enrolment. The Azar Cohort collected data from 15,006 participants, yielding a 93% response rate. Further cohort details appear in the published profile article [27].

Participants who had never been married, those who had experienced multiple marriages, as well as individuals who were divorced or widowed, were excluded from the study. This exclusion was based on the potential for these individuals to have encountered unique life stressors associated with divorce, abandonment, or widowhood. Finally, we omitted the subjects from the analysis who had any missing values in the outcome variables. Final analysis was performed on 13,326 subjects (Fig. 1).

Data collection

Trained interviewers collected data through face-to-face interviews using standardized questionnaires. Collected variables included demographic characteristics, physical activity, socioeconomic status, medical history, and smoking status. All data were recorded on a smart website, and the English language version has been uploaded as a supplementary file.

Independent variable

The independent variable was age at first marriage, classified into two categories: under 18 years and 18 years or older.

Dependent variables

The main outcomes were non-communicable diseases (NCDs) and multimorbidity (MM). We examined ten conditions: hypertension, diabetes, cardiovascular disease (CVD), stroke, depression, non-alcoholic fatty liver disease (NAFLD), cancer, thyroid disorders, chronic obstructive pulmonary disease (COPD), and obesity. We defined MM as the concurrent presence of two or more chronic conditions [28]. Trained physicians asked participants: "Have you ever been diagnosed by a doctor with any of the listed diseases?" An affirmative response indicated the presence of that condition.

We grouped additional variables into four domains: individual socio-demographic factors, physical activity, lifestyle risk factors, and residential location.

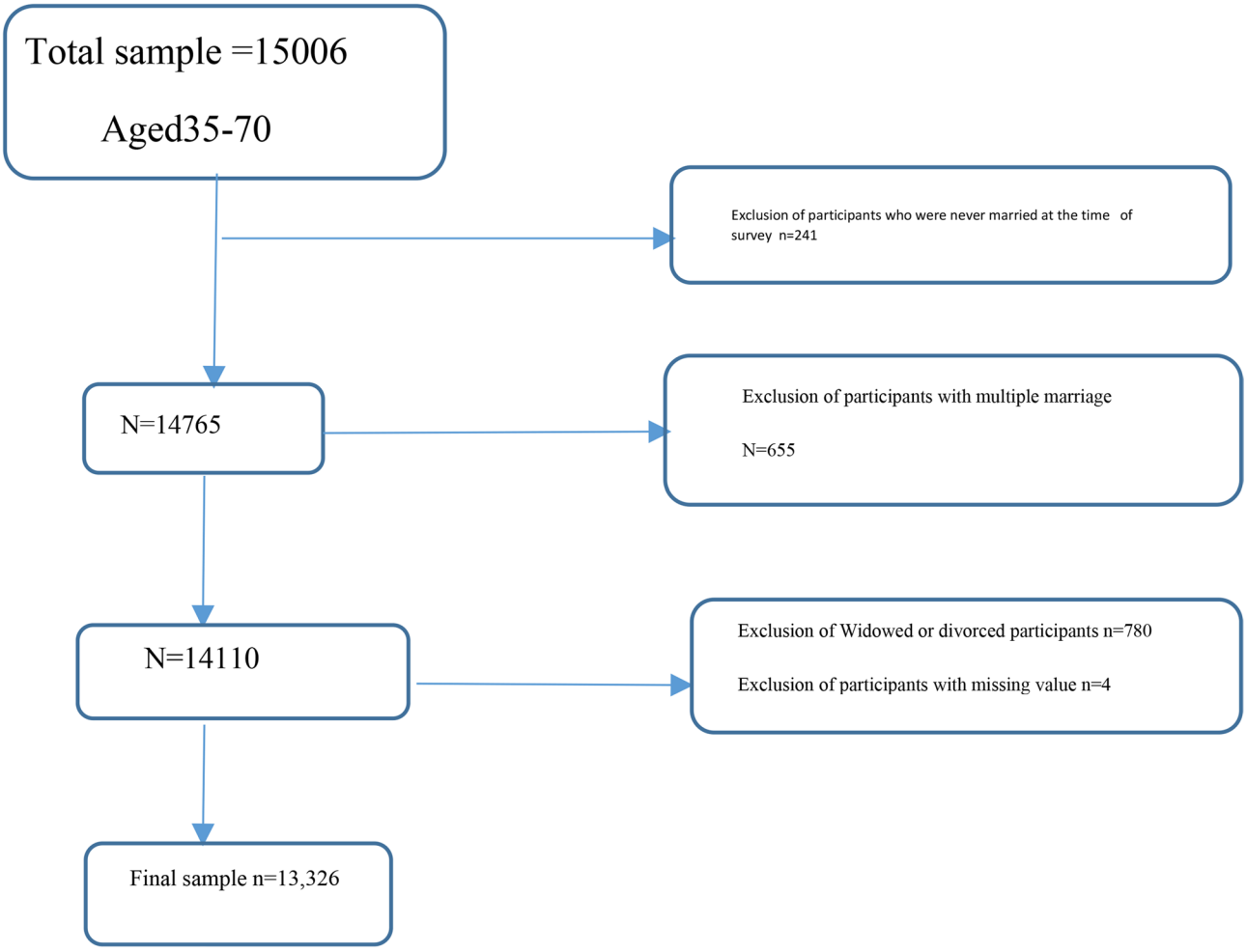

Fig. 1 Flowchart of the study sample

Socio-demographic variables included current age, educational attainment, marital status (never married, married, divorced, widowed), and number of marriages.

We assessed socioeconomic status (SES) using an asset-based approach with multiple correspondence analysis (MCA). Data on housing conditions (e.g., number of rooms, ownership status) and ownership of durable goods (e.g., vehicle, television, and dishwasher) contributed to an SES score for each participant. We then derived a Wealth Score Index (WSI) from the MCA and classified it into quintiles.

Using the physical activity questionnaire, we calculated metabolic equivalent of task (MET) scores. Each MET reflects energy expenditure relative to body weight. We then categorized MET values into tertiles [29, 30].

This study defines a current smoker as an individual who consumes cigarettes or other tobacco products daily. An ex-smoker refers to an individual who previously smoked either daily or occasionally but no longer smokes. Non-smokers are defined as individuals who have never engaged in smoking.

Anthropometric measurements

Trained staff measured participants' height and weight according to the PERSIAN Cohort protocol. Body mass index (BMI) was calculated as weight (kg) divided by height (m^2). BMI was used to assess the nutritional status. Obesity was defined as BMI ≥ 30 kg/m^2 [31].

Statistical analysis

This study assessed normality using the Skewness and Kurtosis indices. Since all quantitative variables exhibited a normal distribution, the data are presented as mean ± standard deviation (SD). Qualitative variables are reported as frequency and percentage. All dependent variables (chronic diseases) were dichotomous, and logistic regression was used to assess the association with age at first marriage, classified as under 18 years (child marriage) and 18 years or older (adult marriage). The group married at 18 years or older served as the reference. Regression analyses are presented in three models: Model 1 (unadjusted), Model 2 (adjusted for age, gender [if applicable], residence region, and smoking status), and

Table 1 Comparison of demographic characteristics, anthropometric measurements, and chronic diseases in the studied groups

	First marriage age (years)		
	Adult marriage ≥ 18	**Child marriage < 18**	***P**
	(*n* = 9813)	**(*n* = 3513)**	
	N(%)	N(%)	
Residential regions			< 0.001
Urban residents	7040 (71.7)	2268 (64.6)	
Rural residents	2773 (28.3)	1245 (35.4)	
Education levels			
Illiterate	1040 (10.6)	983 (28)	
Primary school	3627 (37)	1611 (45.9)	
Diploma	3950 (40.3)	895 (25.5)	
University	1196 (12.2)	24 (0.7)	
BMI classification (Kg/m2)			< 0.001
Underweight	71 (0.7)	13 (0.4)	
18.5–24.9 normal weight	2352 (24)	400 (11.4)	
25–29.9.9 over weight	4241 (43.2)	1265 (36.0)	
≥ 30 obese	3149 (32.1)	1835 (52.2)	
Physical activity level (¶METs)			< 0.001
Low	3111 (31.7)	1173 (33.4)	
Moderate	2910 (29.7)	1525 (43.4)	
High	3792 (38.6)	815 (23.2)	
Quintiles of wealth index			< 0.001
1 (poorest)	1919 (19.6)	856 (24.4)	
2	1823 (18.6)	905 (25.8)	
3	1792 (18.3)	639 (18.2)	
4	2115 (21.6)	632 (18)	
5 (richest)	2164(22.1)	481(13.7)	
Current smoking status			< 0.001
non smoker	3380 (68.1)	3321 (94.5)	
Ex-smoker	1083 (11)	64 (1.8)	
smoker	2050 (20.9)	128 (3.6)	
Age classification (years)			< 0.001
35–45	4076 (41.5)	1157 (32.9)	
46–55	3287 (33.5)	1264 (36)	
56–70	2450 (25.0)	1092 (31.1)	
Common chronic diseases			
Hypertension	1547 (15.8)	993 (28.3)	< 0.001
Diabetes	980 (10.0)	515 (14.7)	< 0.001
Cancers	41 (0.4)	29 (0.8)	0.004
Fatty liver	428 (4.4)	217 (6.2)	< 0.001
Stroke	62 (0.6)	40 (1.1)	0.003
CVD	430 (4.4)	187 (5.3)	0.02
COPD	298 (3.0)	165 (4.7)	< 0.001
Thyroid disorder	643 (6.6)	491(14)	< 0.001
Depression	1270 (12.9)	909 (25.9)	< 0.001
Number of chronic Diseases			< 0.001
0–1	7678 (78.2)	2047 (58.3)	
≥ 2	2135 (21.8)	1466 (41.7)	
	mean ± SD	**mean ± SD**	**P
Age (years)	48.79 ± 9.039	50.48 ± 9.03	< 0.001
Height (cn)	164.92 ± 9.30	156.67 ± 6.74	< 0.001
Weight (kg)	76.60 ± 13.67	75.27 ± 13.34	< 0.001

Table 1 (continued)

	First marriage age (years)		
	Adult marriage ≥ 18	**Child marriage < 18**	***P**
	(*n* = 9813)	**(*n* = 3513)**	
Waist circumference (cm)	93.93 ± 11.11	95.29 ± 11.09	< 0.001
BMI (kg/m^2)	28.17 ± 4.59	30.65 ± 5.04	< 0.001

CVD: Cardiovascular diseases, *COPD:* Chronic obstructive lung diseases

*P: Chi-Sqaure

**P: Independent –t-test

Model 3 (adjusted for age, gender [if applicable], residence region, physical activity [METs], and WSI). Stata version 14 was used to generate figures showing age-specific predicted probabilities of NCDs by child marriage status (based on Model 1).

Results

Of the 13,326 participants, the prevalence of child marriage was 26.36%. The proportion of women in the child marriage group was significantly higher than that of men (46.6% vs. 3.6%; $P < 0.001$).

General characteristics of the participants

As shown in Table 1, participants in the child marriage group, compared with those in the adult marriage group, had lower educational attainment, higher obesity, and lower physical activity ($P < 0.001$). Moreover, the prevalence of all NCDs was significantly higher in the child marriage group than in the adult marriage group ($P < 0.05$). To clarify the findings, Table 2 presents the variables stratified by gender. The main difference between men and women was the prevalence of NCDs. The frequency of chronic diseases was more pronounced among women who experienced child marriage, whereas similar patterns did not appear in men.

Findings of the association between child marriage and NCDs

In the total sample, binary logistic regression showed that all NCDs were associated with child marriage. After adjustment for confounders (age, gender, residential region, physical activity level, and WSI), several associations changed. In particular, the positive associations for COPD, thyroid disorders, and cancer were no longer significant after adjustment (Table 3).

After controlling for confounders, we found no association between child marriage and NCDs in men, except for obesity and MM. Men who married before 18 years had higher odds of obesity (OR: 1.43; 1.07–1.90) than those who married at 18 years or older (Table 3).

In contrast, women who married before 18 years had increased odds of several conditions, including diabetes [OR: 1.25 (1.08–1.46)], hypertension [OR: 1.37 (1.21–1.55)], CVD [OR: 1.67 (1.27–2.20)], stroke [OR: 1.84 (1.00–3.37)], depression [OR: 1.35 (1.20–1.51)], obesity [OR: 1.50 (1.36–1.65)], and MM [OR: 1.53 (1.38–1.70)]. The highest odds were observed for stroke [OR: 1.84 (1.00–3.37)].

Based on Model 1, Fig. 2 shows the predicted probability of NCDs across age categories by age at first marriage. Across all ages, the child marriage group had higher predicted probabilities than the adult marriage group. The largest differences appeared for hypertension, diabetes, obesity, thyroid disorders, depression, and MM, with the gap becoming more evident around ages 46–55.

Discussion

Globally, child marriage is more prevalent among women than men; consequently, most research focuses on its prevalence and risk factors in women. Nonetheless, child marriage has also been reported among boys in several countries. Both genders face risks associated with child marriage, but biological, physiological, and social differences can lead to distinct consequences for each sex [32–34]. A review of the existing literature also shows limited research on the association between child marriage in men and the prevalence of NCDs. In this context, the present study analyzed the association between age at first marriage and chronic diseases, accounting for gender differences. To our knowledge, this is the first study to evaluate the association between child marriage and NCDs in both genders.

In this study of 13,326 participants, the prevalence of child marriage was 26.36%. Gender-specific analysis showed a significantly higher prevalence in women than in men (46.6% vs. 3.6%). Gaston et al. examined the prevalence of child marriage among men using data from 89 countries and reported regional variation: the highest rate occurred in the Central African Republic (27.9%), followed by Latin America and the Caribbean (8.3%) and East Asia and the Pacific (5.9%); the lowest rates were observed in the Middle East and North Africa, and in Eastern Europe and Central Asia [35].

Among women, reported prevalence ranges from 18.3% to 69% across different populations [16, 19, 22, 34, 36, 37]. The substantial variation observed across countries compared with our findings may reflect differences

Table 2 Comparison of demographic characteristics, anthropometric measurements, and chronic diseases in the studied groups by gender

	First marriage age (years)			First marriage age (years)		
	Adult marriage ≥ 18	Child marriage < 18	*P	Adult marriage ≥ 18	Child marriage < 18	*P
	Male			Female		
	N (%)	N (%)		N (%)	N (%)	
Number of participants	6054	229		3759	3284	
Residential regions			< 0.001			< 0.001
Urban residents	4293 (70.9)	122 (53.3)		2747 (73.1)	2146 (65.3)	
Rural residents	1761 (29.1)	107 (46.7)		1012 (26.9)	1138 (34.7)	
Education levels			< 0.001			< 0.001
Illiterate	478 (7.9)	51 (22.3)		562 (15)	932 (28.4)	
Primary school	2185 (36.1)	128 (55.9)		1442 (38.4)	1483 (45.2)	
Diploma	2602 (43.0)	46 (20.1)		1348 (35.9)	849 (25.9)	
University	789 (13)	4 (1.7)		407 (10.8)	20 (0.6)	
BMI classification (Kg/m2)			0.003			< 0.001
Underweight	62 (1.0)	5 (2.2)		9 (0.2)	8 (0.2)	
18.5–24.9 normal weight	1695 (28)	43 (18.8)		657 (17.5)	357 (10.9)	
25–29.9.9 overweight	2747 (45.4)	106 (46.3)		1494 (39.79)	1159 (35.3)	
≥ 30 obese	1550 (25.6)	75 (32.8)		1599 (42.4)	1760 (53.6)	
Physical activity level (¶METs)			0.09			0.89
Low	1856 (30.7)	59 (25.8)		1255 (33.4)	1114 (33.9)	
Moderate	1197 (19.8)	40 (17.5)		1713 (45.6)	1485 (45.2)	
High	3001 (49.4)	130 (56.8)		791 (21)	685 (20.9)	
Quintiles of wealth index			< 0.001			< 0.001
1 (poorest)	996 (16.5)	71 (31)		923 (24.6)	785 (23.9)	
2	1158 (19.1)	69 (30.1)		665 (17.7)	836 (25.5)	
3	1123 (18.5)	39 (17)		669 (17.8)	600 (18.3)	
4	1259 (20.8)	26 (11.4)		856 (22.8)	606 (18.5)	
5 (richest)	1518 (25.1)	24 (10.5)		646 (17.2)	457 (13.9)	
Current smoking status			< 0.001			0.13
non smoker	2953 (48.8)	78 (34.1)		3727 (99.1)	3243 (98.8)	
Ex-smoker	1074 (17.7)	47 (20.5)		9 (0.2)	17 (0.5)	
smoker	2027 (33.5)	104 (45.4)		23 (0.6)	24 (0.7)	
Age classification (years)			< 0.001			< 0.001
35–45	2220 (36.7)	45 (19.7)		1856 (49.4)	1112 (33.9)	
46–55	2067 (34.1)	105 (45.9)		1220 (32.5)	1159 (35.3)	
56–70	1767 (29.3)	79 (34.5)		683 (18.2)	1013 (30.8)	
Common chronic diseases						
Hypertension	864 (14.3)	45 (19.7)	0.02	683 (18.2)	948 (28.9)	< 0.001
Diabetes	612 (10.1)	32 (14)	0.05	368 (9.8)	483 (14.7)	< 0.001
Cancers	19 (0.3)	3 (1.3)	0.01	22 (0.6)	26 (0.8)	0.29
Fatty liver	243 (4)	9 (3.9)	0.94	185 (4.9)	208 (6.3)	0.01
Stroke	46 (0.8)	5 (2.2)	0.01	16 (0.4)	35 (1.1)	0.002
CVD	344 (5.7)	18 (7.9)	0.16	86 (2.3)	169 (5.1)	< 0.001
COPD	166 (2.7)	6 (2.6)	0.91	132 (3.5)	159 (4.8)	0.005
Thyroid disorder	124 (2)	3 (1.3)	0.43	519 (13.8)	488 (14.9)	0.20
Depression	473 (7.8)	17 (7.4)	0.82	797 (21.2)	892 (27.2)	< 0.001
Number of chronic Diseases			0.005			< 0.001
0–1	5009 (82.7)	173 (75.5)		2669 (71)	1874 (57.1)	
≥ 2	1045 (17.3)	56 (24.5)		1090 (29)	1410 (42.9)	
	mean ± SD	mean ± SD	**P	mean ± SD	mean ± SD	**P
Age (years)	49.89 ± 9.16	52.83 ± 8.57	< 0.001	47.01 ± 8.51	50.32 ± 9.04	< 0.001
Height (cn)	170.19 ± 6.67	169.38 ± 6.46	0.06	156.44 ± 6.11	155.79 ± 5.80	< 0.001
Weight (kg)	79.53 ± 13.59	81.20 ± 14.10	0.06	71.88 ± 12.41	74.85 ± 13.19	< 0.001

Table 2 (continued)

	First marriage age (years)			First marriage age (years)		
	Adult marriage ≥ 18	Child marriage < 18	*P	Adult marriage ≥ 18	Child marriage < 18	*P
	Male			Female		
	N (%)	N (%)		N (%)	N (%)	
Waist circumference (cm)	95.27 ± 11.09	97.60 ± 11.52	0.002	91.93 ± 10.81	95.13 ± 11.05	< 0.001
BMI (kg/m^2)	27.43 ± 4.25	28.27 ± 4.52	0.003	29.37 ± 4.85	30.81 ± 5.04	< 0.001

CVD: Cardiovascular diseases, *COPD:* Chronic obstructive lung disease

*P: Chi-Sqaure

**P: Independent –t-test

in socioeconomic conditions, cultural norms, measurement approaches, and data sources.

The first factor may relate to differences in the age ranges studied; some studies classify participants as 18–49 years, while others include those aged 18 years and older. In the present study, the age range was 35–70 years. A second factor is the country in which the survey was conducted, since some countries, particularly in sub-Saharan Africa and South Asia, report the highest prevalence of child marriage globally [38]. A final factor concerns the rural-to-urban composition of the study population. For example, in the study by Mim et al., nearly 70% of participants resided in rural areas, where child marriage is substantially more common than in urban areas [37]. In contrast, only 30% of our sample lived in rural areas. In Iran, the documented rate of child marriage is 1 in 10 girls overall, compared with 1 in 5 girls in rural areas [39].

Overall, after adjustment, the odds of chronic diseases, including hypertension, diabetes, CVD, stroke, depression, and MM, increased with child marriage. After stratifying by gender, the pattern changed. In men, the associations became non-significant after controlling for confounders, whereas in women, they remained significant even after adjustment.

These findings align with studies that reported a significant relationship between child marriage and NCDs [19, 20, 22, 40, 41]. Datta et al. analyzed nationally representative data on Indian women and observed that the risks of hypertension and diabetes increased by 1.29 and 1.23 times, respectively, among those married in early adolescence [19]. Another study found that child brides had a 1.5-fold higher risk of developing hypertension in young adulthood compared with women who married in adulthood [40]. Vikram et al. also reported increased likelihoods of hypertension, diabetes, asthma, and thyroid disorders associated with child marriage [22].

Hypertension and diabetes are major contributors to CVD, the leading cause of premature mortality worldwide [42]. In our study, women who married as children had a significantly higher risk of chronic diseases. These conditions contribute to increased premature mortality [43]. Health policymakers should introduce targeted programs for this group across the life course. Our findings, consistent with prior research, indicate that the risk of chronic disease in women married as children rises in adulthood. Moreover, despite the high prevalence of these conditions, survey data show that most women with hypertension do not receive appropriate treatment [40]. As noted, the higher disease burden among women who experienced child marriage likely reflects intersecting social, biological, and psychological factors. Early marriage often disrupts education and economic participation and reinforces dependence and vulnerability, which can harm health [32, 34]. Early and repeated pregnancies raise the risks of obstetric complications, reproductive morbidity, and nutritional deficits, intensifying long-term health vulnerabilities [44–46]. Child marriage has also been linked to depression, anxiety, and trauma, and the chronic stress associated with these conditions can worsen both physical and mental illness [47].

Despite a global decline in child marriage rates, including in Iran, this issue remains a significant concern. The government should implement stricter laws to prevent child marriage. Families, particularly in rural areas, also need education about the health consequences of child marriage, including reduced quality of married life and undernutrition in children under five years of age [48]. Prior studies show that child marriage in women correlates with poorer psychological well-being and higher rates of depression [41, 49]. In this study, the odds of depression among women who married as children were 31% higher than among those who married as adults, reinforcing previously reported reductions in quality of life.

An intriguing finding of this study is that, overall, participants of both genders showed higher odds of obesity after adjustment; the odds were 1.5 times greater in the child marriage group than in the adult marriage group. Consistent with these results, Datta et al. reported adjusted odds of obesity of 1.5 (CI: 1.3–1.7) among women who married as children compared with those who married as adults, after controlling for socio-demographic factors [16].

The high prevalence of obesity and other NCDs in this population, particularly among women, may stem

Table 3 The association between age at first marriage and chronic diseases by gender

	Model 1			Model 2		Model 3	
		OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Common chronic diseases	**First marriage age (years)**						
Diabetes	**Child marriage < 18**	1.54(1.38–1.73)	< 0.001	1.28 (1.11–1.47)	0.001	1.26 (1.10–1.45)	0.001
	Adult marriage ≥ 18	reference					
Hypertension	**Child marriage < 18**	2.10 (1.92–2.30)	< 0.001	1.37 (1.22–1.53)	< 0.001	1.36 (1.21–1.52)	< 0.001
	Adult marriage ≥ 18	reference					
CVD	**Child marriage < 18**	1.22 (1.02–1.46)	0.02	1.53 (1.21–1.92)	< 0.001	1.55 (1.23–1.96)	< 0.001
	Adult marriage ≥ 18	reference					
Stroke	**Child marriage < 18**	1.81 (1.21–2.70)	0.004	1.83 (1.09–3.08)	0.02	1.91 (1.12–3.24)	0.01
	Adult marriage ≥ 18	reference					
Fatty liver	**Child marriage < 18**	1.44 (1.22–1.70)	< 0.001	1.23 (1.01–1.49)	0.03	1.24 (1.02–1.51)	0.03
	Adult marriage ≥ 18	reference					
COPD	**Child marriage < 18**	1.57 (1.29–1.91)	< 0.001	1.22 (0.97–1.53)	0.08	1.19 (0.95–1.50)	0.12
	Adult marriage ≥ 18	reference					
Depression	**Child marriage < 18**	2.34 (2.13–2.58)	< 0.001	1.32 (1.19–1.47)	< 0.001	1.32 (1.19–1.48)	< 0.001
	Adult marriage ≥ 18	reference					
Thyroid disorder	**Child marriage < 18**	2.31 (2.04–2.62)	< 0.001	1.06 (0.93–1.21)	0.35	1.07 (0.93–1.22)	0.31
	Adult marriage ≥ 18	reference					
Cancer	**Child marriage < 18**	1.98 (1.23–3.19)	0.005	1.22 (0.70–2.14)	0.47	1.26 (0.72–2.22)	0.41
	Adult marriage ≥ 18	reference					
Obesity	**Child marriage < 18**	2.31 (2.14–2.50)	< 0.001	1.51 (1.38–1.65)	< 0.001	1.50 (1.37–1.65)	< 0.001
	Adult marriage ≥ 18	Reference					
Number of chronic Diseases							
≥ 2	**Child marriage < 18**	2.57 (2.37–2.79)	< 0.001	1.52 (1.37–1.67)	< 0.001	1.52 (1.37–1.67)	< 0.001
	Adult marriage ≥ 18	Reference					
Gender							
Male							
Common chronic diseases	***First marriage age years***						
Diabetes	**Child marriage < 18**	1.44 (0.98–2.11)	0.06	1.27 (0.86–1.9)	0.22	1.30 (0.87–1.94)	0.19
	Adult marriage ≥ 18	reference					
Hypertension	**(Child marriage < 18**	1.46 (1.05–2.05)	0.02	1.22 (0.86–1.75)	0.25	1.23 (0.86–1.76)	0.25
	Adult marriage ≥ 18	reference					
CVD	**Child marriage < 18**	1.41 (0.86–2.31)	0.16	1.07 (0.64–1.79)	0.77	1.16 (0.69–1.95)	0.56
	Adult marriage ≥ 18	reference					
Stroke	**Child marriage < 18**	2.91 (1.14–7.40)	0.02	2.01 (0.78–5.19)	0.14	2.28 (0.87–5.97)	0.09
	Adult marriage ≥ 18	reference					
Fatty liver	**Child marriage < 18**	0.97 (0.49–1.92)	0.94	1.05 (0.53–2.09)	0.87	1.24 (0.62–2.47)	0.53
	Adult marriage ≥ 18	reference					
COPD	**Child marriage < 18**	0.95 (0.41–2.17)	0.91	0.95 (0.41–2.21)	0.92	0.83 (0.36–1.91)	0.66
	Adult marriage ≥ 18						
Depression	**Child marriage < 18**	0.94 (0.57–1.56)	0.82	0.86 (0.51–1.42)	0.56	0.89 (0.53–1.48)	0.66
	Adult marriage ≥ 18	reference					
Thyroid disorder	**Child marriage < 18**	0.63 (0.20–2.01)	0.44	0.59 (0.18–1.899)	0.38	0.67 (0.21–2.14)	0.50
	Adult marriage ≥ 18	reference					
Cancer	**Child marriage < 18**	4.21 (1.23–14.35)	0.02	3.08 (0.89–10.67)	0.07	2.99 (0.85–10.54)	0.08
	Adult marriage ≥ 18	reference					
Obesity	**Child marriage < 18**	1.41 (1.07–1.88)	0.01	1.39 (1.04–1.84)	0.02	1.43 (1.07–1.90)	0.01
	Adult marriage ≥ 18	reference					
Number of chronic Diseases							
≥ 2	**Child marriage < 18**	1.55 (1.14–2.11)	0.005	1.31 (0.95–1.81)	0.09	1.41 (1.02–1.95)	0.03
	Adult marriage ≥ 18	reference					
Gender							
Female							

Table 3 (continued)

	Model 1			Model 2		Model 3	
		OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Common chronic diseases	**First marriage age (years)**						
Common chronic diseases	First marriage age (years)						
Diabetes	**Child marriage < 18**	1.58 (1.37–1.83)	< 0.001	1.26 (1.09–1.47)	0.002	1.25 (1.08–1.46)	0.003
	Adult marriage ≥ 18	reference					
Hypertension	**Child marriage < 18**	1.82 (1.63–2.04)	< 0.001	1.37 (1.21–1.55)	< 0.001	1.37 (1.21–1.55)	< 0.001
	Adult marriage ≥ 18	reference					
CVD	**Child marriage < 18**	2.31 (1.78–3.01)	< 0.001	1.69 (1.29–2.22)	< 0.001	1.67 (1.27–2.20)	< 0.001
	Adult marriage ≥ 18	reference					
Stroke	**Child marriage < 18**	2.52 (1.39–4.56)	0.002	1.84 (1.0–3.37.0.37)	0.04	1.84 (1.00–3.37.00.37)	0.04
	Adult marriage ≥ 18	reference					
Fatty liver	**Child marriage < 18**	1.30 (1.06–1.60)	0.01	1.18 (0.96–1.46)	0.10	1.19 (0.96–1.47)	0.09
	(Adult marriage ≥ 18)	reference					
COPD	**Child marriage < 18**	1.39 (1.10–1.77)	0.005	1.28 (1.0–1.63.0.63)	0.04	1.27 (1.00–1.62.00.62)	0.04
	Adult marriage ≥ 18	reference					
Depression	**Child marriage < 18**	1.38 (1.24–1.54)	< 0.001	1.36 (1.21–1.52)	< 0.001	1.35 (1.20–1.51)	< 0.001
	Adult marriage ≥ 18	reference					
Thyroid disorder	**Child marriage < 18**	1.09 (0.95–1.24)	0.20	1.08 (0.94–1.24)	0.24	1.09 (0.95–1.25)	0.21
	Adult marriage ≥ 18	reference					
Cancer	**Child marriage < 18**	1.35 (0.76–2.39)	0.29	1.06 (0.59–1.90)	0.82	1.10(0.61–1.98)	0.73
	Adult marriage ≥ 18						
Obesity	**Child marriage < 18**	1.56 (1.42–1.71)	< 0.001	1.50 (1.37–1.66)	< 0.001	1.50 (1.36–1.65)	< 0.001
	Adult marriage ≥ 18	reference					
Number of chronic Diseases							
≥ 2	**Child marriage < 18**	1.84 (1.66–2.03)	< 0.001	1.54 (1.39–1.71)	< 0.001	1.53 (1.38–1.70)	< 0.001
	Adult marriage ≥ 18	reference					

CVD:Cardiovascular diseases; COPD: Chronic obstructive lung diseases

Model 1: Crude OR; Model 2: Adjusted for age, gender (if applicable), residence region, smoking status; Model3: adjusted for age, gender (if applicable), residence region, physical activity (MET), Wealth score index

from several factors. A significant factor is child marriage, which often marks a difficult transition into adulthood and imposes adult responsibilities on young girls and boys [50]. Furthermore, child marriage can introduce additional stressors that extend beyond reproductive challenges. Adverse childhood experiences can also disrupt the hypothalamic-pituitary-adrenal (HPA) axis under stress. Such responses relate to changes in metabolism and eating patterns, which may increase the likelihood of obesity in both children and adults [50]. Childhood obesity, as well as obesity in later life, is a significant risk factor for hypertension, diabetes, and other metabolic disorders [51, 52]. Childhood obesity, as well as obesity in later life, is a significant risk factor for hypertension, diabetes, and other metabolic disorders.

This analysis, like other cross-sectional studies, has limitations. The cross-sectional design prevents identification of causal pathways; longitudinal data could address this in future research. Self-reported measures, including age at marriage and NCDs, may be subject to recall bias; future studies should incorporate objective health data and clinical or laboratory confirmation. Despite these limitations, we demonstrate a significant association between age at marriage and NCDs, which deserves the attention of public health practitioners and policymakers. Different combinations of NCDs used to define MM may affect the observed associations; future analyses should consider the Charlson Comorbidity Index. Residual confounding and limited generalizability beyond northwest Iran are additional constraints. Finally, some associations became non-significant in men after adjustment, which may reflect the relatively small number of male participants.

The large sample size is a major strength of this research. In addition, the study examines early marriage in both genders and assesses the health consequences of child marriage for both. Previous work has mostly focused on women or framed health outcomes in terms of quality of life and reproductive health. Few studies have evaluated the association between child marriage and NCDs. This study helps address that gap.

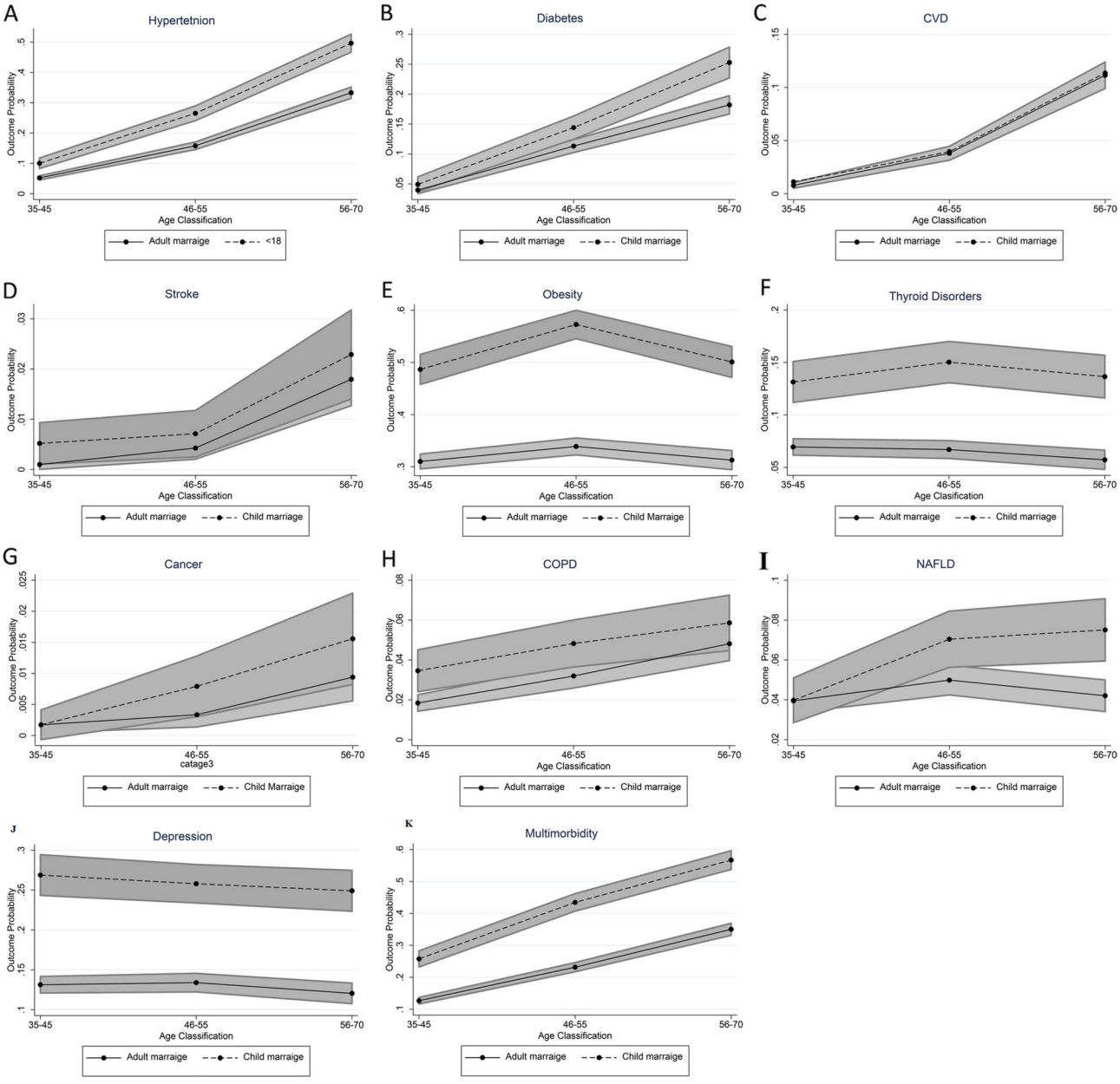

Fig. 2 Predicted probabilities of non-communicable diseases among Azar cohort population by age at first marriage, (A)Hypertension, (B) Diabetes, (C) Cardiovascular diseases, (D) Stroke, (E) Obesity, (F) Thyroiddisorders, (G) Cancer, (H) Chronic obstructive lung diseases, (I) Non-alcoholic fatty liver disease, (J) Depression, (K) Multimorbidity

Conclusion

Our findings show that child marriage is more prevalent among women than among men. We also found a significant association between child marriage and NCDs, especially in women. This result carries important implications. Despite global and national declines in child marriage, concern about this issue persists. Research and interventions have primarily focused on the reproductive and sexual health (RSH) of women married as children. However, given the evidence linking child marriage to NCDs in this group, especially women, our study demonstrates the need for health systems to adapt to emerging NCD-related needs. Such adaptation is crucial for addressing the complex health needs of this vulnerable group across the life course. In addition, screening programs for early NCD detection in child-married women, gender-sensitive health education, and community-based interventions to prevent early marriage are needed.

Supplementary Information

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Supplementary Material 1

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Authors' contributions
- Substantial contribution to conception and design, acquisition of data, or analysis and interpretation of data; SH, MHS, EF, RM, NG- Drafting the article or revising it critically for important intellectual content; EF, RM, NG- Final approval of the version to be published; SH, MHS, NG, RM, AR, EF, MJ- Agreement to be accountable for all aspects of the work thereby ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; SH, MHS, NG, RM, AR, EF, MJ.

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Data availability
The data that support the findings of this study are available from [Vice Chancellor for Research] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [Vice Chancellor for Research].

Declarations

Ethics approval and consent to participate
This study has been performed in accordance with the Declaration of Helsinki and has been approved by the Ethics Committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1403.416). We confirm that all methods were performed in accordance with the relevant guidelines and regulations. At the time of enrollment, written informed consent to participate in the study was obtained from participants (or their legal guardian in the case of illiterate participants). The aim and steps of the study were completely explained to the participants, then anyone who filled the informed consent was included. They were free to leave the study any time, and for any reason.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. Lancet. 2014;384(9937):45–52.
2. Anderson E, Durstine JL. Physical activity, exercise, and chronic diseases: a brief review. Sports Med Health Sci. 2019;1(1):3–10.
3. Beaglehole R, Bonita R, Horton R, Adams C, Alleyne G, Asaria P, et al. Priority actions for the non-communicable disease crisis. Lancet. 2011;377(9775):1438–47.
4. Organization WH. Noncommunicable diseases country profiles 2018. 2018.2020 Sep.
5. Yach D, Leeder SR, Bell J, Kistnasamy B, American Association for the Advancement of Science. Global chronic diseases. Science. 2005;307:317–317.
6. World Health Organization, Public Health Agency of Canada. Preventing chronic diseases: a vital investment. World Health Organization; 2005 Sep 28.
7. Sangal R, Patil M. Factors associated with the practice of child marriage among rural women. Int J Home Sci. 2018;4(1):28–32.
8. Wodon Q, Petroni S. The rippling economic impacts of child marriage. World Bank Blogs https://www.blogsworldbankorg/education/rippling-economic-impacts-child-marriage2017.
9. Fund UNCs. Is an end to child marriage within reach? Latest trends and future Prospects–2023 update. In.: UNICEF New York; 2023.
10. Barr H. Marry before your house is swept away: child marriage in Bangladesh. Human Rights Watch; 2015.
11. Stevanovic-Fenn N, Edmeades J, Lantos H, Onovo O. Child marriage, adolescent pregnancy and family formation in West and Central Africa: Patterns, trends, and drivers of change. Dakar, Senegal: UNICEF West and Central Africa Regional Office 2015.
12. Lowe M, Joof M, Rojas BM. Social and cultural factors perpetuating early marriage in rural Gambia: an exploratory mixed methods study. F1000Res. 2019. https://doi.org/10.12688/f1000research.21076.3.
13. Rumble L, Peterman A, Irdiana N, Triyana M, Minnick E. An empirical exploration of female child marriage determinants in Indonesia. BMC Public Health. 2018;18:1–13.
14. Saleheen AAS, Afrin S, Kabir S, Habib MJ, Zinnia MA, Hossain MI, et al. Sociodemographic factors and early marriage among women in Bangladesh, Ghana and Iraq: an illustration from multiple indicator cluster survey. Heliyon. 2021. https://doi.org/10.1016/j.heliyon.2021.e07111.
15. Datta BK, Haider MR. The double burden of overweight or obesity and anemia among women married as children in India: a case of the simpson's paradox. Obes Res Clin Pract. 2022;16(5):364–72.
16. Datta B, Tiwari A, Attari S. Child marriage and later-life risk of obesity in women: a cohort analysis using nationally representative repeated cross-sectional data from Tajikistan. Women. 2023;3(1):53–70.
17. Datta BK, Haider MR, Tiwari A, Jahan M. The risk of hypertension among child brides and adolescent mothers at age 20 s, 30 s, and 40 s: evidence from India. J Hum Hypertens. 2023;37(7):568–75.
18. Datta B, Tiwari A. Adding to her woes: child bride's higher risk of hypertension at young adulthood. J Public Health. 2023;45(2):e309-18.
19. Datta B, Tiwari A. Early marriage in adolescence and risk of high blood pressure and high blood glucose in adulthood: evidence from India. Women. 2022;2(3):189–203.
20. Datta B, Tiwari A, Glenn L. Stolen childhood taking a toll at young adulthood: the higher risk of high blood pressure and high blood glucose comorbidity among child brides. PLoS Glob Public Health. 2022;2(6):e0000638.
21. Adedokun O, Adeyemi O, Dauda C. Child marriage and maternal health risks among young mothers in Gombi, Adamawa State, nigeria: implications for mortality, entitlements and freedoms. Afr Health Sci. 2016;16(4):986–99.
22. Vikram K, Visaria A, Ganguly D. Child marriage as a risk factor for non-communicable diseases among women in India. Int J Epidemiol. 2023;52(5):1303–15.
23. Liu H, Zhang Z, Choi S-w. Risk of cardiovascular diseases and cancer in later life: the role of age at first marriage. Geriatrics. 2018;3(2):27.
24. Dupre ME, Beck AN, Meadows SO. Marital trajectories and mortality among US adults. Am J Epidemiol. 2009;170(5):546–55.
25. Poustchi H, Eghtesad S, Kamangar F, Etemadi A, Keshtkar A-A, Hekmatdoost A, et al. Prospective epidemiological research studies in Iran (the PERSIAN cohort study): rationale, objectives, and design. Am J Epidemiol. 2018;187(4):647–55.
26. Eghtesad S, Mohammadi Z, Shayanrad A, Faramarzi E, Joukar F, Hamzeh B, Farjam M, Sakhvidi MJZ, Miri-Monjar M, Moosazadeh M. The PERSIAN cohort: providing the evidence needed for healthcare reform. Arch Iran Med. 2017;20(11):691–5.
27. Farhang S, Faramarzi E, Amini Sani N, Poustchi H, Ostadrahimi A, Alizadeh BZ, Somi MH. Cohort profile: the AZAR cohort, a health-oriented research model in areas of major environmental change in central Asia. Int J Epidemiol. 2019;48(2):382–h382.

28. Skou ST, Mair FS, Fortin M, Guthrie B, Nunes BP, Miranda JJ, et al. Multimorbidity. Nat Rev Dis Primers. 2022;8(1):48.
29. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc. 2000;32(9):S498-504.
30. Aadahl M, Jørgensen T. Validation of a new self-report instrument for measuring physical activity. Med Sci Sports Exerc. 2003;35(7):1196–202.
31. Adult BM. Categories. BMI. Available online: https://www. cdc. gov/bmi/adult-calculator/bmi-categories. html (accessed on 19 March 2024). 2024.
32. Fang X, Fry D, Ren J, Jin W, Zhu Y, Sesay I, et al. The economic burden of child marriage in Nigeria. Child Abuse Negl. 2024;158:107135.
33. Nour NM. Child marriage: a silent health and human rights issue. Reviews Obstet Gynecol. 2009;2(1):51.
34. Efevbera Y, Bhabha J, Farmer P, Fink G. Girl child marriage, socioeconomic status, and undernutrition: evidence from 35 countries in sub-Saharan Africa. BMC Med. 2019;17(1):55.
35. Gastón CM, Misunas C, Cappa C. Child marriage among boys: a global overview of available data. Vulnerable Child Youth Stud. 2019;14(3):219–28.
36. Tiwari A, Datta BK, Haider MR, Jahan M. The role of child marriage and marital disruptions on hypertension in women-a nationally representative study from India. SSM-Population Health. 2023;22:101409.
37. Mim SA, Al Mamun ASM, Sayem MA, Wadood MA, Hossain MG. Association of child marriage and nutritional status of mothers and their under-five children in Bangladesh: a cross-sectional study with a nationally representative sample. BMC Nutr. 2024;10(1):67.
38. United Nations Children's Fund,Towards Ending Child Marriage: Global trends and profilesof progress, UNICEF, New York, 2021.
39. Azimi K. The trend of girl child marriage in Iran based on National census data. Sex Reprod Health Matters. 2020;28(1):1820655.
40. Datta BK, Haider MR. Child marriage and health disparities in adulthood: the differential risk of untreated hypertension among young adult women in India. Clin Hypertens. 2022;28(1):30.
41. John NA, Edmeades J, Murithi L. Child marriage and psychological well-being in Niger and Ethiopia. BMC Public Health. 2019;19:1–12.
42. Roth GA, Nguyen G, Forouzanfar MH, Mokdad AH, Naghavi M, Murray CJ. Estimates of global and regional premature cardiovascular mortality in 2025. Circulation. 2015;132(13):1270–82.
43. Martinez R, Lloyd-Sherlock P, Soliz P, Ebrahim S, Vega E, Ordunez P, et al. Trends in premature avertable mortality from non-communicable diseases for 195 countries and territories, 1990–2017: a population-based study. Lancet Glob Health. 2020;8(4):e511-23.
44. Varmaghani M, Pourtaheri A, Ahangari H, Tehrani H. The prevalence of adolescent pregnancy and its associated consequences in the Eastern mediterranean region: a systematic review and meta-analysis. Reprod Health. 2024;21(1):113.
45. Wells JC, Marphatia AA, Manandhar DS, Cortina-Borja M, Reid AM, Saville NS. Associations of age at marriage and first pregnancy with maternal nutritional status in Nepal. Evol Med Public Health. 2022;10(1):325–38.
46. Prakash R, Singh A, Pathak PK, Parasuraman S. Early marriage, poor reproductive health status of mother and child well-being in India. J Fam Plann Reprod Health Care. 2011;37(3):136–45.
47. Zeng YW, Chiu S-H, Yeh C-B. Childhood maltreatment associated with anxiety and depression and complex PTSD symptoms. Psychiatry Clin Psychopharmacol. 2024;34(3):201.
48. Fall CH, Sachdev HS, Osmond C, Restrepo-Mendez MC, Victora C, Martorell R, Stein AD, Sinha S, Tandon N, Adair L. Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low-income and middle-income countries (COHORTS collaboration). Lancet Global Health. 2015;3(7):e366–77.
49. Sezgin AU, Punamäki R-L. Impacts of early marriage and adolescent pregnancy on mental and somatic health: the role of partner violence. Arch Womens Ment Health. 2020;23(2):155–66.
50. Pearlin LI, Schieman S, Fazio EM, Meersman SC. Stress, health, and the life course: some conceptual perspectives. J Health Soc Behav. 2005;46(2):205–19.
51. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW, et al. Obesity and the metabolic syndrome in children and adolescents. N Engl J Med. 2004;350(23):2362–74.
52. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: definitions and controversies. BMC Med. 2011;9:1–13.

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