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RESEARCH ARTICLE

Socioeconomic inequality in cardio-metabolic risk factors in a nationally representative sample of Iranian adolescents using an Oaxaca-Blinder decomposition method: the CASPIAN-III study

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Abstract

Objectives The present research was conducted aiming at assessing the association of socioeconomic inequality in the prevalence of risk factors associated with cardio-metabolic disorders in a sample population of nationally representative Iranian adolescents and to identify its influencing factors.

Methods This study was conducted as part of a national-based surveillance program performed on 5625 individuals aged 10–18 years in 27 provinces in Iran. To determine the socioeconomic status (SES) of participants, we defined a new variable by applying the principal component analysis. Doing so, the socioeconomic inequality in cardio-metabolic risk factors was examined over the tertiles of SES using concentration index (C). Then, Oaxaca-Blinder decomposition analysis was carried out in order to decide upon the roots of inequality in the health system.

Results The mean (standard deviation) age of participants was 14.73 (2.41) years. The prevalence of cardio-metabolic parameters had considerable difference across SES tertiles. Elevated fasting blood glucose (FBG), elevated triglycerides (TG), abdominal obesity, elevated total cholesterol (TC), and metabolic syndrome (MetS) increased linearly by increasing SES tertiles. C index for depressed high density lipoprotein- cholesterol (HDL-C) was negative, which was suggestive of inequality in favor of high SES groups and for other cardio-metabolic parameters, it was positive, which indicate inequality was in favor of the lowest SES groups. The highest gap between the first and third tertiles of socioeconomic was for frequency of abdominal obesity; 13.18% of

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the lowest SES groups and 20.11% of the highest SES groups had abdominal obesity which accounts 6.93% gap in favor of the highest SES groups. The living area could be named as the main variables standing for the inequality of elevated FBS, elevated LDL-c, low HDL-c and abdominal obesity frequency between the first and the last SES group. In addition, BMI could stand as the main independent variable explaining the gap in elevated TG, elevated TC, elevated BP and MetS prevalence across the lowest and the highest SES group.

Conclusions The study revealed the considerable inequality in the prevalence of cardio-metabolic risk factors between the highest and the lowest SES groups of Iranian adolescents. Living area and BMI are the two main factors which explained inequality in prevalence of cardio metabolic risk factors between SES groups. These estimations could provide health policy markers with practical information for future complementary analyses.

Keywords Cardio-metabolic risk factors · Concentration · Inequality · Iran

Introduction

There is an alarming increase in the rate of chronic diseases in developing countries [1]. There exists an ever increasing interest to childhood precursor of chronic diseases, in particular cardiovascular disease (CVD) leading factors of some disorders, including metabolic syndrome (MetS) last long from infancy to adulthood [2, 3]. Mets is a global epidemic in all over the world, characterizes by the clustering of conditions, including obesity, dyslipidemia, impaired glucose metabolism and high blood pressure (BP) that increase CVD and type 2 diabetes [4].

Also, there remain a number of cardio-metabolic risk factors, including physical inactivity, hypercholesterolemia and smoking which contributing roles in multiple health conditions and diseases [5, 6].

Population studies have shown the association between socioeconomic inequality and the incidence of chronic diseases [7]. Also, epidemiological studies have revealed that children from families of low socioeconomic characteristics and education are more prone to the risk of developing cardio-metabolic parameters in comparison to children from families with higher purchasing power. Therefore, the association between socioeconomic status (SES) and health is not limited to adulthood [7, 8]. Several researches have shown that low SES could result in the increase of CVD through a mechanism of affecting behavioral risk factors and unhealthy dietary habits [9, 10]. However, other studies have shown that people were more susceptible to intake foods high in fat, which can result in higher cardio-metabolic risk factors such as TG [11, 12]. The reason such a difference could be explained by the fact that the epidemiological transition occurred beside the rapid changes in living style may have made individuals more prone to higher risk of cardio-metabolic risk factors which, finally, ends up in a higher rate of chronic diseases [12].

Therefore, controversy remains regarding the impact of SES factors on the Mets and other cardio-metabolic risk factors. The importance of SES inequality and their associations with health disorders has been documented among adults; however, results are limited and conflicting in the pediatric age groups [13]. Therefore, this study aimed at investigating the association between SES inequality and cardio-metabolic risk factors among Iranian adolescents using a novel and robust methodological approach for inequality assessment (Oaxaca-Blinder Decomposition method) and also determine which factors can explain this inequality.

Methods

This study was developed in consistence with the third school-based surveillance system entitled "**C**hildhood and **A**dolescence **S**urveillance and **P**revent**I**on of Adult **N**on-communicable **D**isease" (CASPIAN III) study (2009–2010). The study details and methodological protocols elaborate in details previously [14], and only the fundamental parts have described herein in brief.

Individuals were 5625 students, aged 10–18 years, and the sample selection was conducted based on multistage random cluster sampling method. The participants were selected from individuals living in rural and urban areas of 27 provinces in Iran. As per study protocol, the information bank of the Ministry of Health and Medical Education was used to stratify the eligible schools. Then, sample selection was carried out in each eligible school randomly. In a later step, in each of the selected schools, the sampling of students was random. A trained team of expert health care providers participated in data collection phase and engaged in the examination process using calibrated instruments. The standard protocols were used to design and complete checklists for all participants.

Clinical and laboratory measurements

Clinical and laboratory experiments were conducted through measuring height (Ht) and weight (Wt), according to standardized protocols, without shoes and lightly dressed condition. Body mass index (BMI) was calculated as weight (kg) /height (m^2). Waist circumference (WC) was measured by a no elastic tape at the midway between the lower border of the rib margin and the iliac crest at the end of normal expiration.

The measurement of BP was done using a standardized mercury sphygmomanometer, on the right arm after a 5 min rest in a sitting position. The first and fifth Korotkoff sounds were recorded as systolic and diastolic blood pressure, respectively.

After 12 h overnight fasting, a blood sample was drawn and delivered to the lab for each person. Fasting blood glucose (FBG), total cholesterol (TC), triglycerides (TG), high density lipoprotein-cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were measured enzymatically using auto-analyzers. HDL-C was characterized after dextran sulfate-magnesium chloride precipitation of non-HDL-C [15].

Due to the fact that we needed highly qualified data for the purpose of our multi-center data gathering, the different levels of quality assurance and control were taken into account by a Data and Safety Monitoring Board (DSMB) who were collaborating in the study.

Study terms

- **Cardiometabolic risk factors:** The participants were assumed as having metabolic syndrom if they had at least three of the following criteria according to Adult Treatment Panel III (ATP III) criteria modified for children and adolescents, were considered as having metabolic syndrome (MetS) [16]**.** The modified criteria for children and adolescents are defined as below: Abdominal obesity was defined as waist to height ratio (WHtR) more than 0.5 [17]; Elevated BP: either systolic or diastolic BP ≥90th percentile for age, sex and height; Low HDL-C: HDL-C ≤ 40 mg/dl (except in boys 15–19 years old that the cut off was <45 mg/dl); High TG: TG ≥ 100 mg/dl) was taken as the 90th percentile value for age; High FBG: FBG levels of ≥100 mg/dl [18].

  TC, LDL-C, and general obesity were considered in the present study as risk factors associated with cardio-metabolic disorders. High TC and LDL-C were defined according to the recent recommendation by the American Heart Association (TC ≥ 200 mg/dl, LDL-C > 110 mg/dl) [19]. General obesity definition was considered as BMI >95th percentile [17].
- **Socioeconomic status (SES):** In order to construct socio-economic status, we incorporated the previously approved approach of Progress in the International Reading Literacy Study (PIRLS) specifically designed for Iranian context [20]. Parents' education, parents' job, possessing private car, school type (public/private), type of home (private/rented) and having a personal computer at home were summarized in one main component SES using principle component analysis (PCA) [21].
- **Screen Time (ST):** The ST behavior of the children was investigated through the questionnaire which contained questions asking for the average number of hours/day they spent watching TV/VCDs, personal computer (PC), or electronic games (EG). For the analysis of correlates of ST, according to the international ST recommendations, ST was categorized into two groups: less than 2 h per day (Low) and 2 h per day or more (High) [22].
- **Physical Activity (PA):** For PA, the data regarding the PA during the past week was collected. Participants reported the weekly frequency of their leisure time PA outside the school. The duration of at least 30 min per day that caused heavy sweating or large increases in breathing or heart rate was considered as the main component of leisure time PA definition. Doing this way, we assumed PA less than two times per week as mild, two to four times a week as moderate and more than 4 h a week as vigorous [23].

Ethical concerns

The present research was in line with the declaration of Helsinki (Seoul, 2008). Ethical approval was given by the ethics committees of Isfahan and Tehran University of Medical Sciences.

Followed by providing each participant with a full explanation of the objectives and protocols, they were assured about the confidentiality of their statements.

Participation in the study was voluntary, and all of the potential participants were informed about their right to withdraw from the study at any time. The participants and their parents were also given informed consent and oral assent, respectively indicating their willingness to participate in the present research.

Statistical analyses

Statistical analysis was performed using survey data analysis methods in the Stata version 11.1 (Stata Corporation, College Station, TX, USA).

Socioeconomic inequality was estimated by calculating the prevalence of cardio-metabolic risk factors in tertiles of SES, the concentration index (C). To assess the association of cardio-metabolic risk factorsacross socioeconomic tertile, we used C which was interpreted according to the target variable versus SES distribution [24, 25]. The C was estimated using the following formula:

$$C = \frac{2}{n\mu}\sum_{i=1}^{n} h_i r_i - 1 - \frac{1}{n}$$

In this formula h_i is the amount of each cardiometabolic risk factors for the $i-th$ individual, r_i is the relative rank of the $i-th$ individual in the distribution of the SES variable and μ is the mean value of the cardio-metabolic risk factors. The negative and positive values of C show that inequality was in favor of high and low SES groups of the society respectively [26–28].

Decomposition of the gap in cardio-metabolic risk factors between the first and third tertile of SES was investigated using the counterfactual decomposition technique, widely used to study mean outcome differences between groups [27–29]. This method divides the gap between the means of an interested outcome variable into two components. The 'explained' (endowment) component arises because of differences in groups' characteristics such as differences in age, sex or other characteristics of two groups, and an 'unexplained' (coefficient) component is extracted from the differential effects of these characteristics [20].

Pearson Chi square test was used to calculate p for trend (p-trend) of each cardio-metabolic risk factor across tertile of SES. Association of independent variables with cardio-metabolic risk factors was assessed using multivariate logistic regression analysis. Results of multivariate logistic regression analysis are presented as OR (95% confidence interval (CI).Missing values in present study were imputed using Amelia package version 1.7.3 in R statistical package [30].

Results

Overall, 5223 students out of 5625 invited students completed (Participation rate: 92.8%) this survey. The mean (standard deviation) age of participants was 14.73 (2.41) years. Considering the gender, 49.9% and regarding the residential area, 67.4% of participants were females and urban area residents, respectively.

Table 1 shows the prevalence of cardio-metabolic parameters, across the tertiles of SES. Considering the socioeconomic tertiles, the prevalence of cardio-metabolic parameters had considerable difference across SES tertiles. The highest differences respectively belonged to low HDL-C (35.26%), abdominal obesity (15.87%), and elevated FBG (15.27%). Elevated FBG, elevated TG, abdominal obesity, elevated TC, and MetS increased linearly by increasing SES tertiles. The estimated values of C in the last column of Table 1 indicate the SES inequality in different tertiles. C index for depressed HDL-C was negative, which suggests inequality was in favor of high SES groups and for other cardio-metabolic parameters, it was positive, which indicate inequality was in favor of low SES groups.

In multivariate analysis, individuals in the highest SES groups (last tertile) had significantly higher odds of elevated TC (OR: 1.56, 95%CI: 1.14–2.14), and abdominal obesity (OR: 1.42, 95%CI: 1.19–1.70), compared with those counterparts in the lowest SES groups (first tertile). In addition, the odds of elevated FBG (OR: 1.62; 95%CI: 1.37–1.91), low HDL-C (OR: 1.24; 95%CI: 1.08–1.42), elevated BP (OR: 1.83; 95%CI: 1.43–2.34), abdominal obesity (OR: 1.19; 95%CI: 1.03–1.38) and MetS (OR: 2.26; 95%CI: 1.53–3.31) were significantly increased in girls than boys. Vigorous and moderate physical activity compared to mild PA had a protective association with low HDL-C, elevated LDL-C, and MetS. BMI is another factor that significantly increases the odds of elevated TG (OR: 1.18; 95%CI: 1.15–1.20), low HDL-C (OR: 1.05; 95%CI: 1.03–1.06), elevated BP (OR: 1.14; 95%CI: 1.11–1.17), elevated TC (OR: 1.07; 95%CI: 1.04–1.1) and MetS (OR: 1.31; 95%CI: 1.26–1.36). Also living in rural area decreased the odds of elevated TG and abdominal obesity and increased the odds of elevated FBS, low HDL. Family history of chronic diseases, and age were other associated factors for cardio-metabolic parameters ($p < 0.05$).

Tables 2 and 3 shows the decomposition of the gap in cardio-metabolic risk factors prevalence between the first and the last tertile of SES. The highest gap between the first and the last tertile of SES was in abdominal obesity prevalence; 13.18% of the lowest SES groups and 20.11% of the highest SES groups had abdominal obesity which accounts 6.93% gap in favor of the highest SES groups. Of 6.93% gap, 2.54% was attributed to the different effects of the

Table 1 Socioeconomic inequality in cardio-metabolic disorders prevalence in children and adolescents

Outcome	T1%(95% CI)	T2%(95% CI)	T3%(95% CI)	Total %(95% CI)	P-trend	C (SD)
Elevated FBG	13.5(11.96,15.2)	15.2(13.41,17.18)	17.4(15.42,19.01)	15.27(14.33,16.26)	0.008	0.05(0.02)
Elevated TG	7.18(6.03,8.53)	7.78(6.48,9.31)	9.03(7.73,10.53)	8.00(7.26,8.81)	0.06	0.05(0.03)
Low HDL-C	36.53(34.08,39.04)	36.69(34.05,39.42)	32.87(30.54,35.29)	35.26(33.89,36.66)	0.04	−0.02(0.01)
Elevated LDL-C	5.53(4.35,7.00)	5.22(4.00,6.77)	6.52(5.24,8.10)	5.78(5.04,6.61)	0.22	0.04(0.04)
Elevated BP	5.9(4.92,7.05)	6.64(5.50,7.98)	6.09(5.05,7.33)	6.18(5.56,6.88)	0.83	0.01(0.03)
Abdominal obesity	13.18(11.8,14.70)	14.16(12.59,15.89)	20.12(18.37,21.99)	15.87(14.86,16.73)	<0.001	0.1(0.02)
Elevated TC	4.18(3.33,5.24)	5.51(4.44,6.82)	7.49(6.34,8.84)	5.72(5.12,6.39)	<0.001	0.13(0.03)
MetS (n)	3.18(39)	3.8(39)	5.16(64)	4.07(142)	0.003	0.11(0.04)

FBG, Fasting Blood Glucose; *TG*, triglycerides; *HDL-C*, High-Density Lipoprotein-Cholesterol; *LDL-C*, Low-Density Lipoprotein Cholesterol; *BP*, Blood Pressure; *TC*, Total Cholesterol; *MetS*, Metabolic Syndrome; *CI*, Confidence Interval; *T*, Tertile; *C*, Concentration index; *SD*, Standard Deviation

Table 2 Association of independent variables with cardio-metabolic disorders in multivariate logistic regression

Variables	Elevated FBG OR(95% CI)	Elevated TG OR(95% CI)	Low HDL-C OR(95% CI)	Elevated LDL-C OR(95% CI)	Elevated BP OR(95% CI)	Elevated TC OR(95% CI)	Abdominal obesity OR(95% CI)	MetS OR(95% CI)
SES (T1)								
T2	1.09 (0.89,1.35)	1.03 (0.78,1.37)	1.03 (0.87,1.21)	0.93 (0.63,1.35)	1.05 (0.79,1.39)	1.28 (0.92,1.79)	1.03 (0.85,1.24)	1.01 (0.62,1.64)
T3	1.14 (0.93,1.40)	1.10 (0.83,1.44)	0.90 (0.77,1.06)	1.05 (0.74,1.51)	0.88 (0.66,1.19)	1.56 (1.14,2.14)*	1.42 (1.19,1.70)*	0.99 (0.62,1.56)
Physical activity (Mild)								
Moderate	1.05 (0.87,1.28)	0.86 (0.66,1.12)	0.74 (0.63,0.87)*	0.58 (0.4,0.85)*	1.20 (0.2,1.56)	1.05 (0.78,1.42)	1.06 (0.9,1.26)	0.59 (0.38,0.91)*
Vigorous	1.26 (1.00,1.58)*	0.99 (0.71,1.37)	0.60 (0.49,0.74)*	0.54 (0.33,0.87)*	0.90 (0.62,1.31)	1.47 (1.05,2.05)*	0.85 (0.68,1.06)	0.39 (0.20,0.77)*
Sex(Boy)								
Girl	1.62 (1.37,1.91)*	1.06 (0.85,1.33)	1.24 (1.08,1.42)*	0.96 (0.71,1.29)	1.83 (1.43,2.34)*	0.77 (0.60,1.00)*	1.19 (1.03,1.38)*	2.26 (1.53,3.31)*
Age								
	0.99 (0.96,1.03)	0.94 (0.9,0.99)*	1.03 (0.10,1.06)	0.90 (0.84,0.96)*	1.15 (1.09,1.22)*	0.91 (0.86,0.97)*	1.01 (0.98,1.04)	0.96 (0.88,1.04)
Area (Urban)								
Rural	0.68 (0.56,0.83)*	1.33 (1.04,1.70)*	1.43 (1.23,1.65)*	0.73 (0.52,1.05)	0.84 (0.64,1.10)	0.81 (0.60,1.08)	0.60 (0.50,0.72)*	0.64 (0.40,1.04)
Family history chronic disease (No)								
Yes	1.12(0.92,1.38)	1.47(1.08,1.99)*	0.91(0.78,1.07)	1.41(0.94,2.13)	0.79(0.60,1.04)	1.08(0.79,1.48)	1.41(1.17,1.70)*	0.84(0.53,1.33)
Smoking								
	0.86 (0.69,1.07)	0.82 (0.61,1.10)	1.04 (0.86,1.26)	0.83 (0.55,1.24)	1.40 (0.99,1.99)	0.77 (0.56,1.07)	0.92 (0.76,1.12)	0.78 (0.49,1.25)
Screen time(<=2 h)								
>2 h	1.1 (0.89,1.36	1.12 (0.84,1.50)	0.95 (0.81,1.12)	1.21 (0.82,1.78)	0.96 (0.71,1.30)	1.30 (0.93,1.84)	1.05 (0.87,1.27)	1.00 (0.60,1.66)
BMI								
	1.01 (0.99,1.03)	1.18 (1.15,1.20)*	1.05 (1.03,1.06)*	1.03 (1.00,1.07)	1.14 (1.11,1.17)*	1.07 (1.04,1.1)*	–	1.31 (1.26,1.36)*

FBG, Fasting Blood Glucose; *TG*, triglycerides; *HDL-C*, High-Density Lipoprotein-Cholesterol; *LDL-C*, Low-Density Lipoprotein Cholesterol; *BP*, Blood Pressure; *TC*, Total Cholesterol; *MetS*, Metabolic Syndrome.; *BMI*, Body Mass Index; Adjusted OR, Odds Ratio; *CI*, Confidence Interval; *T*, Tertile

*Statistically significant

Table 3 Decomposition of the gap in cardio-metabolic disorders prevalence between the first and third tertiles of socioeconomic status

	Elevated FBG	Elevated TG	Low HDL-C	Elevated LDL-C	Elevated BP	Elevated TC	Abdominal obesity	MetS
Prevalence in first tertile	13.50(11.83,15.17)*	7.18(5.93,8.43)*	36.53(33.99,39.06)*	5.53(4.21,6.84)*	5.90(4.83,6.96)*	4.18(3.23,5.13)*	13.18(11.72,14.64)*	3.18(2.20,4.17)*
Prevalence in third tertile	17.13(15.27,18.99)*	9.03(7.63,10.43)*	32.85(30.42,35.27)*	6.52(5.09,7.94)*	6.09(4.95,7.23)*	7.49(6.22,8.76)*	20.11(18.29,21.93)*	5.16(3.93,6.39)*
Differences (Total gap)	−3.63(−6.13,-1.13)*	−1.85(−3.72,0.03)	3.68(0.17,7.19)*	−0.99(−2.93,0.95)	−0.19(−1.75,1.37)	−3.31(−4.90,-1.72)*	−6.93(−9.26,-4.59)*	−1.98(−3.55,-0.40)*
Due to endowments (explained)								
Age	0.0003(−0.05,0.05)	0.06(−0.08,0.19)	−0.03(−0.14,0.08)	0.07(−0.07,0.20)	−0.01(−0.11,0.08)	0.04(−0.06,0.13)	−0.0004(−0.02,0.02)	0.06(−0.05,0.17)
Sex	−0.06(−0.29,0.16)	−0.01(−0.06,0.03)	−0.08(−0.27,0.11)	0.02(−0.04,0.07)	−0.00(−0.09,0.09)	0.03(−0.05,0.10)	−0.02(−0.09,0.05)	−0.00(−0.12,0.11)
Living area	−1.46(−2.27,-0.65)*	0.57(−0.03,1.18)	2.25(1.11,3.39)*	−0.72(1.28,-0.16)*	−0.00(−0.46,0.45)	−0.44(−0.90,0.02)	−1.93(−2.57,-1.29)*	−0.20(−0.61,0.21)
FH of chronic diseases	−0.10(−0.26,0.06)	−0.12(−0.24,-0.0006)*	0.07(−0.17,0.30)	−0.06(−0.17,0.05)	0.05(−0.07,0.16)	−0.07(−0.17,0.01)	−0.28(−0.49,-0.09)*	−0.03(−0.13,0.07)
Smoking	−0.1(−0.32,0.12)	−0.06(−0.21,0.1)	0.04(−0.26,0.35)	0.03(−0.13,0.18)	0.13(−0.00,0.27)	−0.06(−0.20,0.08)	−0.12(−0.32,0.08)	−0.07(−0.23,0.08)
Screen time	−0.06(−0.43,0.32)	−0.03(−0.29,0.24)	0.29(−0.25,0.83)	−0.05(−0.33,0.23)	0.09(−0.14,0.31)	−0.15(−0.36,0.07)	−0.13(−0.48,0.22)	0.09(−0.11,0.29)
Physical activity	−0.00(−0.13,0.12)	0.03(−0.05,0.12)	0.22(−0.11,0.55)	0.06(−0.08,0.19)	−0.02(−0.08,0.04)	−0.01(−0.09,0.06)	−0.06(−0.17,0.06)	0.07(−0.03,0.16)
BMI	−0.12(−0.49,0.26)	−1.68(−2.24,-1.11)*	−1.21(−1.82,-0.59)*	−0.29(−0.64,0.06)	−1.00(−1.38,-0.62)*	−0.46(−0.77,-0.15)*	–	−1.73(−2.36,-1.10)*
Subtotal gap	−1.91(−2.86,-0.96)*	−1.23(−2.05,-0.42)*	1.56(0.13,2.98)*	−0.95(−1.65,-0.24)*	−0.77(−1.42,-0.13)*	−1.13(−1.73,-0.53)*	−2.54(−3.33,-1.75)*	−1.82(−2.56,-1.08)*
Due to coefficients (unexplained)								
Age	17.87(1.48,34.26)*	4.73(−7.86,17.32)	18.51(−5.34,42.37)	−4.00(−17.90,9.90)	−1.35(−11.33,8.63)	−1.43(−13.22,10.36)	9.38(−4.96,23.73)	−2.75(−13.29,7.79)
Sex	0.94(−6.65,8.53)	−3.66(−9.30,1.98)	−2.72(−13.29,7.84)	3.24(−2.72,9.21)	−2.50(−7.17,2.17)	4.01(−0.88,8.90)	−13.15(−20.18,-6.13)*	−2.86(−7.66,1.93)
Living area	−0.41(−7.61,6.78)	4.56(−0.82,9.95)	3.09(−7.62,13.79)	−3.04(−8.65,2.56)	1.42(−2.98,5.83)	4.12(−0.07,8.30)	11.19(5.19,17.19)*	−0.41(−4.50,3.69)
FH of chronic diseases	6.82(2.03,11.61)*	0.35(−2.79,3.49)	−4.82(−11.43,1.79)	−0.77(−4.23,2.68)	−0.28(−3.25,2.69)	−0.51(−3.32,2.29)	−2.75(−5.86,1.35)	−0.11([−2.85,2.62)
Smoking	−17.05(−31.66,-2.45)*	−3.84(−14.30,6.62)	−21.86(−41.01,-2.71)*	−3.38(−13.85,7.10)	−3.30(−10.95,4.35)	1.88(−6.95,10.72)	5.30(−7.25,17.86)	−7.02(−16.75,2.72)
Screen time	−2.59(−7.82,2.63)	1.57(−2.33,5.47)	0.65(−6.83,8.14)	−1.24(−5.33,2.86)	−1.91(−4.93,1.11)	−2.51(−5.66,0.64)	−0.29(−5.24,4.65)	−0.21(−3.25,2.82)
Physical activity	0.10(−2.08,2.28)	0.16(−1.37,1.69)	0.73(−2.17,3.63)	−0.17(−1.82,1.48)	−0.74(−2.04,0.56)	0.10(−1.23,1.44)	−0.22(−2.18,1.74)	−0.74(−1.99,0.51)
BMI	−1.01(−13.91,11.89)	−3.55(−16.61,9.50)	−13.66(−32.03,4.71)	4.87(−6.14,15.89)	−3.98(−14.33,6.35)	0.21(−9.87,10.30)	–	−7.72(−20.94,5.51)
Constant	−6.39(−32.61,19.84)	−0.94(−20.28,18.39)	22.20(−13.56,57.96)	4.44(−15.37,24.25)	13.22(−2.49,28.94)	−8.05(−24.89,8.79)	−13.84(−36.04,8,36)	21.67(4.02,39.31)*
Subtotal gap	−1.72(−4.40,0.95)	−0.62(−2.49,1.26)	2.12(−1.57,5.82)	−0.04(−2.17,2.09)	0.58(−0.98,2.15)	−2.18(−3.79,-0.56)*	−4.39(−6.79,-1.99)*	−0.16(−1.71,1.39)

Glucose; *TG*, triglycerides; *HDL-C*, High-Density Lipoprotein-Cholesterol; *LDL-C*, Low-Density Lipoprotein Cholesterol; *BP*, Blood Pressure; *TC*, Total Cholesterol; *MetS*, Metabolic Syndrome.; *FH*, family history; *BMI*, Body Mass Index independent variables studied (explained component) and 4.39% was attributed to the differences of coefficients of regression models (unexplained component) in the two groups. It means that the difference of abdominal obesity frequency between the lowest and the highest SES would decrease from 6.93% to 4.39% if the lowest SES group was similar to the highest SES groups in term of all studied independent variables.

Living area is the main independent variable which explained the inequality in elevated FBS, elevated LDL-C, low HDL-C and abdominal obesity frequency between the first and the last tertile of SES. Moreover, BMI is the main independent variable which explained the gap in elevated TG, elevated TC, elevated BP and MetS prevalence between the lowest and the highest SES group.

Discussion

To the best of our knowledge, the present study is the first study in Iran, even in the Middle East and North Africa (MENA) region, which assessed socio-economic inequality in the cardio-metabolic risk factors and its determinants in adolescents using the Blinder-Oaxaca decomposition method. The present study shows that the most of cardio-metabolic risk factors such as elevated FBG, TG, TC, abdominal obesity, and MetS increased linearly by increasing SES tertiles. ST, living area, family history of chronic diseases and PA were seen to make a significant contribution to the gap of cardio-metabolic risk factors prevalence between the two socioeconomic groups.

In the present study the association of socioeconomic status with elevated BP was not statistically significant. This result was in contrary to previous studies [31, 32]. Results of Berg et al.'s cohort study showed that children with middle or low educated mothers were more likely to have pre-hypertension compared with children with high-educated mothers. They also found that children from lower SES families have a higher risk of HTN [31]. With Fateh nationwide study, SES was linearly associated with HTN in Iranian adults [32]. However, in our study, lowest change (6.18%) in elevated BP of adolescents caused by SES and only BMI had significant contribution to this gap. Childhood BMI was shown previously to be strongly related to SES [33–36], and our results showed that socioeconomic differences in blood pressure and pre-hypertension can be explained by an increasing BMI.

A systematic review of social health inequalities in Swedish children and adolescents found a higher social risk for overweight (RR: 1.8, 95%CI: 1.3–3.7), obesity (RR: 1.8, 95%CI: 1.3–2.0), diet (RR: 1.6, 95%CI: 1.1–1.8) and low physical activity (RR: 1.6, 95%CI: 1.2–2.1) [37]. Another study in Serbia showed that richer-class households had significantly higher risky behaviors than poorest households [38].

In previous decades, obesity was more common in high SES groups. Today, children and adolescents from lower SES tend to be more obese and overweight in high-income countries [39]. The Health Behavior in School-aged Children (HBSC) study has found that family SES is one the most important predictor of adolescents' health. In another word, SES may prone families' to adopt healthy behaviors such as eating fruit and vegetables [40–42] and participating in leisure time PA [43, 44]. Living in low SES family may restrict family to have adequate access to health resources [45] and exposed them to psychosocial distress, which support health inequalities in general health and well-being [46].

A systematic review on socioeconomic inequality in obesity in Iran showed that socio-demographic factors were clearly associated with obesity [47].In a cross national study [48], wealth and education inequalities were more highlighted in the low-income country group than the middle-income country group and income and education were associated with prevalence of some non-communicable diseases and risk factors.

A previous study in West of Iran revealed that hypertension, insufficient consumption of fruits and vegetables, consumption unhealthy diet and insufficient consumption of sea foods are more prevalent among lower socioeconomic groups and there was no significant association between SES with excess weight and hypercholesterolemia [49].

In present study abdominal obesity was prevalent in the high SES group which was in line with previous studies in Iran [50, 51]. It seems that the association of weight disorders and SES varied across countries according to their SES and development. A Cross-national study found that obesity in China and Russia were more prevalent in the high SES subject and in the US, low SES groups were at a higher risk of obesity [51].

A better understanding of association of cardio-metabolic risk factors and SES underscore the necessity of implementing evidence-based health promotion programs and preventive strategies according to SES.

The current study was conducted in a large cross sectional study. This analysis has several limitations. First, the cross sectional design makes it difficult to determine the direction of causality. This limitation can be overcome with the use of cohort studies. A second methodological issue is with regard to the accuracy of the data collected through self-administered questionnaire. The study used self-reported data for estimating of parental occupation and education, PA, ST and smoking. However, we think it is unlikely that this bias should affect the children's report.

Conclusion

The study revealed the considerable inequality in the prevalence of cardio-metabolic risk factors between the highest and the lowest SES groups of Iranian adolescents. Living area and BMI are the two main factors which explained inequality in the prevalence of cardio-metabolic risk factors between SES groups. These estimations provide practical information for health policies and programs and future complementary analyses.

Authors' contributions RK, MEM, RH, GA and MQ: designing the study, GS, FM and MQ Drafting of the manuscript, MQ, AS and RH: Analysis and interpretation of data AMG and ZA: Acquisition of data and RK and MQ: Critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

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Data availability Please contact author for data requests.

Compliance with ethical standards

Conflict of interest The authors also have no conflicts of interest and have no involvement that might raise the question of bias in the results reported here.

Ethical approval The present study was approved by ethical committee of Tehran University of Medical Sciences and Isfahan University of Medical Sciences.

Competing interests The authors declare that they have no competing interests.

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