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Socioeconomic Status and Metabolic Syndrome in Southwest Iran: Results from Hoveyzeh Cohort Study(HCS)

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Abstract

Background

Socioeconomic status (*SES*) is a strong predictor of morbidity and premature mortality, especially non-communicable diseases (*NCDs*). However, the effect of these factors on Metabolic Syndrome (*MetS*) is not yet clear. This study is to assess the relationship between socioeconomic indicators and MetS.

Methods

In this prospective cohort study, 10009 people aged 35-70 years enrolled from May 2016 to August 2018. MetS was determined based on the standard national cholesterol education program (*NCEP*) - adult treatment panel III (*ATP III*) or *NCEP-ATP III* criteria. Demographics and socioeconomic data were gathered face to face by trained interviews. Also, lab, anthropometrics, and blood pressure measurements were assayed for participants. Logistic regression was used to estimate the association between SES and *MetS*, with adjustment of potential confounding variables.

Results

The overall prevalence of *MetS* in participants was 39.1%. The crude odds ratios for all the assessed variables were statistically significant (p<0.05). After adjustment for age, sex, physical activity, smoking, and alcohol use as potential confounders, the results indicated significant direct independent associations between skill level (p=0.006) and Townsend index (p=0.002) with *MetS*, while no significant associations were seen between educational level and wealth status with *MetS*.

Conclusion

The results of our study showed that SES is related to *MetS*. Among four assessed SES indicators, skilled levels and Townsend score had a stronger association with *MetS*. We recommend considering people’s SES when interventional programs are planning and conducting on *MetS* in each community.

Background

Non-communicable diseases are the leading global reason for death and excessively afflict those living in low-income and lower-middle-income countries (*LLMICs*) (1). Almost three-quarters of all deaths and 82% of premature deaths occurring within *LLMICs* due to non-communicable diseases (*NCD*s) (2). Generally, morbidity and mortality rates of diseases are higher among people with lower socioeconomic status (*SES*) (3). The major aim of social epidemiology is the study of the relationship between SES and health outcomes in populations. Today, it is well known that in almost all countries, more people of lower *SES* have experienced poorer health than those of higher *SES* (4).

Metabolic syndrome (*MetS*) is a combination of abdominal obesity, glucose intolerance, dyslipidemia, and hypertension. Each of these disorders is a well-known risk factor for cardiovascular disease and type

2 diabetes (5). The prevalence of MetS has been estimated at around 20–25% of the world's adult population (6). It has increased rapidly in both developed and developing countries during recent years (7–9). The socioeconomic factors are actively involved in the development of MetS. Some studies conducted in the United States (10), Netherlands, Poland (11), Tunis (12), Suriname (13), Iran (14, 15), Brazil (16–18), and Mesoamerican countries (19) showed that MetS prevalence decreases with better education (20–22), occupational class (23), income (24, 25), and wealth status (26). On the other hand, reverse patterns were observed in Nigeria, Saudi Arabia, and India, i.e., there was more likelihood for individuals with high socioeconomic status for having *MetS* (27–29).

Due to the higher prevalence rate of *MetS* in Hoveyzeh (30), compared to the rates of other regions of Khuzestan province rates (32) and Iran (31), and also, the important role of *SES* in *NCDs*, we designed a study to investigate the relationship between metabolic syndrome and socioeconomic factors, including education, wealth index, skill level, and Townsend deprivation index in the context of a well-designed population-based cohort study.

Methods

Study Design and Sampling Method

The participants of this study were given from the Hoveyzeh Cohort Study (HCS). The *HCS* is a prospective population-based cohort study of 10009 adults (age 35-70 years) recruited from May 2016 to August 2018 to assess NCDs in the southwest of Iran (33). The HCS is one of the centers of the Prospective Epidemiological Research Studies in IrAN (PERSIAN Cohort), with 180, 000 Iranian adults (34).

Definition of the Metabolic Syndrome

The MetS criteria are including abdominal obesity (waist circumstance ≥ 102 in men and ≥88 in women), serum triglycerides (≥150 mg/dL), or take hypertriglyceridemia medications, serum high density lipoprotein (HDL) cholesterol (≥40 mg/dL in men and NCDs 50 in women), or take drug treatment for low HDL cholesterol, blood pressure ≥130/85 mmHg, or take hypertension drugs, fasting plasma glucose (FPG) ≥100 mg/dL, or take hyperglycemia drugs. The presence of at least 3 out of the 5 criteria constitutes a diagnosis of MetS(11) (33).

Measurements for assessment of SES

We used four indicators to assess SES in this analysis: The Townsend deprivation index, as an area-level indicator of *SES*, the wealth index, as a household level indicator of *SES*, and educational level and skill level, as individual-level socio-economic indicators.

The wealth index was calculated according to the information on households' assets, including freezer, TV, motorbike, cell phone, car, vacuum cleaner, internet access, washing machine, computer, and household utilities consist of house ownership, number of rooms per capita. A principal component analysis (*PCA*) was conducted to assign a coefficient to each asset. The sum of the first component scores constructed the wealth scores. Finally, the score of wealth index was converted to 5-ordered categories from poorest to richest (35).

Townsend deprivation index was calculated in four steps: 1) To calculate the percentage of households of non-car ownership, non-house ownership, having unemployed adults and overcrowding; 2) To calculate logged unemployed and logged overcrowds; 3) To calculate Z score of no car, non-homeowners, unemployed, and overcrowd; 4) To calculate Z score of no car + Z score of the non-homeowner + Z score of unemployed + Z score of overcrowding = *TDS* (36).

In our study, occupational classification was done according to the International Standard Classification of Occupations (*ISCO-8*). Skill level is considered a function of the complexity and range of performing tasks and duties related to an occupation. Four broad and ordered skill levels are used in *ISCO-08*. Skill Level 1 typically involves the performance of simple and routine physical or manual tasks. Many occupations at Skill Level 1 may require physical strength and/or endurance. In skill level 2, the ability to read information and perform simple arithmetical calculations is usually essential. Skill level 3 generally requires a high level of literacy, numeracy, and well-developed interpersonal communication skills. Finally, Skill level 4 requires extended levels of literacy and numeracy, sometimes at a very high level, and excellent interpersonal communication skills (Geneva: ILO, 2012).

Lifestyle measurements

The metabolic equivalent of the task (*MET* Index) is the ratio of a person's working metabolic rate relative to his/her resting metabolic rate. One *MET* is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of one kcal/kg/hour. A person who has smoked no less than 100 cigarettes during his or her lifetime is defined as a smoker. To determine alcohol abuse among participants, we asked whether they have continually used them in their lifetime. The amount of consumption and its type has also been asked (1).

Statistical analysis

Descriptive statistics measures were performed using mean and standard deviation for quantitative variables, while frequency and percentage were used for categorical variables. Chi-square test, chi-square test for trend, and crude odds ratio was used to assess associations in univariate analysis. In multivariable analysis, adjusted odds ratios from the unconditional logistic regression model were used as the measures of association between the study variables. All reported p-values were based on two-tailed tests and compared to a significance level of 0.05. IBM® SPSS® Statistics 26.0 version 26 was used for the statistical analysis.

Results

Table 1 shows the characteristics of study participants; among 10009 participants, 59.8% (n = 5983) were female. The mean ± SD of the participants' age was 48.8 ± 9.2 years. The overall prevalence of MetS in participants was 39.1% (95% CI 38.1–40.1). In general, the prevalence of MetS was higher in women (45.7%) compared to men (29.3%) ($p < 0.001$). The prevalence rates, in total, were raised by increasing the age of the participants, although, in males, the rates slightly decreased over the age of 60 years (Table 1).

Table 1
Prevalence rates of MetS by sex and age groups

Age group	Male			Female			P-value
	n	case	Prevalence (%) (95% CI)	n	case	Prevalence (%) (95% CI)	
35–39	732	160	21.9 (18.9–25.0)	1180	315	26.7 (24.2–29.3)	0.017
40–44	794	202	25.4 (22.4–28.6)	1231	444	36.1 (33.4–38.8)	< 0.001
45–49	704	216	30.7 (27.3–34.2)	1093	500	45.7 (42.8–48.8)	< 0.001
50–54	608	205	33.7 (30.0-37.6)	874	467	53.4 (50.1–56.8)	< 0.001
55–59	541	186	34.4 (30.4–38.6)	740	455	61.5 (57.9–65.0)	< 0.001
60–64	361	121	33.5 (28.7–38.6)	437	270	61.8 (57.0–66.4)	< 0.001
≥ 65	286	90	31.5 (26.1–37.2)	428	282	65.9 (61.2–70.4)	< 0.001
Total	4026	1180	29.3 (27.9–30.7)	5983	2733	45.7 (44.4–47.0)	< 0.001

Bivariate analysis in Table 2 showed that the prevalence of *MetS* was associated with age, sex, educational level, *MET*, wealth status, job, Townsend index, smoking, and alcohol use ($P < 0.05$). The prevalence of *MetS* was higher among females, smokers, and non-alcoholic people than the others ($P < 0.05$). Also, the prevalence of *MetS* was significantly higher among older than younger people. The result of trend analyses clearly indicates significantly an upward pattern for age group ($P < 0.001$) and wealth status ($P = 0.041$), while this pattern was downward for educational level, area deprivation status (Townsend Index), and physical activity ($P < 0.001$). Besides, the lowest prevalence of *MetS* was seen among participants in Skill Level IV (mainly manual workers), although the trend was not significant (p for trend = 0.48)

Table 2
Prevalence of MetS by demographic, socio-economic, and lifestyle characteristics of study participants

Variable		Total	Cases	Prevalence % (CI 95%)	P-value *	P-value for trend **
Overall prevalence		10009	3913	39.1 (38.1–40.1)		
Age Group	35–39	1912	475	24.8 (22.9–26.8)	< 0.001	< 0.001
	40–44	2025	646	31.9 (29.9–34.0)		
	45–49	1797	716	39.8 (37.6–42.2)		
	50–54	1482	672	45.3 (42.8–47.9)		
	55–59	1281	641	50.0 (47.3–52.8)		
	60–64	798	391	49.0 (45.5–52.5)		
	≥ 65	714	372	52.1 (48.4–55.8)		
Sex	Male	4026	1180	29.3 (27.9–30.7)	< 0.001	
	Female	5983	2733	45.7 (44.4–47.0)		
Educational level	Illiterate	6209	2654	42.7 (41.5–44.0)	< 0.001	< 0.001
	Primary school	1665	599	36.0 (33.7–38.3)		

*Chi-square test; **Chi-square for trend test

Variable		Total	Cases	Prevalence % (CI 95%)	P-value *	P-value for trend **
	Secondary school	673	225	33.4 (29.9–37.1)		
	High school	741	232	31.3 (28.0–34.8)		
	University	721	203	28.2 (24.9–31.6)		
Physical activity (*MET* Score)	Q1	2503	1201	48.0 (46.0–50.0)	< 0.001	< 0.001
	Q2	2505	1053	42.0 (40.1–44.0)		
	Q3	2508	913	36.4(34.5–38.3)		
	Q4	2493	746	29.9(28.1–31.8)		
Wealth Status	Poorest	2012	748	37.2 (35.1–39.3)	0.003	0.041
	Poor	2057	750	36.5 (34.4–38.6)		
	Moderate	2087	846	40.5 (39.7–44.0)		
	Rich	2023	838	41.4 (39.3–43.6)		
	Richest	1830	731	39.9 (37.7–42.2)		
Job	Skill Level I	290	50	17.2 (13.1–22.1)	< 0.001	0.48

*Chi-square test; **Chi-square for trend test

Variable		Total	Cases	Prevalence % (CI 95%)	P-value *	P-value for trend **
	Skill Level II	2561	761	29.7 (27.9–31.5)		
	Skill Level III	84	28	33.3 (23.4–44.5)		
	Skill Level IV	345	88	25.5 (21.0–30.5)		
Area deprivation status (Townsend Index)	Most Affluent	2390	1190	49.8 (47.8–51.8)	< 0.001	< 0.001
	Affluent	1856	728	39.2 (37.0–41.5)		
	moderate	1890	781	41.3 (39.1–41.6)		
	Deprived	1293	425	32.9 (30.3–35.5)		
	Most Deprived	2580	789	30.6 (28.8–32.4)		
Smoking	Yes	7920	3191	40.3(39.2–41.4)	< 0.001	
	No	2089	722	34.7(32.5–36.6)		
Use Alcohol	Yes	197	61	31.0(24.6–37.9)	0.019	
	No	9812	3852	39.3 (38.3–40.2)		
*Chi-square test; **Chi-square for trend test						

Multivariable Analysis

The crude and adjusted odds ratios using the logistic regression model are presented in Table 3. For all the assessed variables, the crude odds ratios were statistically significant ($p < 0.05$); therefore, we included all of them into the multiple logistic regression model. According to the results of the Hosmer-Lemeshow test, the goodness of fit of the model was good (Chi-square = 9.67, df = 8, P = 0.29). After adjustment for age, sex, physical activity, smoking, and alcohol use as potential confounders, the results indicated independent direct significant associations between skill level and Townsend index with MetS, while no significant associations were seen between educational level and wealth status with the condition.

Table 3
Crude and adjusted odds ratios using the logistic regression model

Variable		Crude Odds Ratio (95% CI)	*Adjusted Odds Ratio (95% CI)	P-value
Age Group	35–39	1	1	< 0.001
	40–44	1.42 (1.23–1.63)	1.33 (1.04. – 1.68)	
	45–49	2.00 (1.74–2.31)	1.79 (1.40–2.30)	
	50–54	2.51 (2.17–2.90)	1.99 (1.51–2.61)	
	55–59	3.03 (2.61–3.52)	1.78 (1.31–2.43)	
	60–64	2.91 (2.44–3.46)	1.74 (1.16–2.60)	
	≥ 65	3.29 (2.75–3.94)	2.02 (1.24–3.27)	
Sex	Male	1	1	< 0.001
	Female	2.028 (1.86–2.21)	1.87 (1.43–2.44)	
Educational level	Illiterate	1	1	0.065
	Primary school	0.75 (0.67–0.84)	1.24 (0.99–1.54)	
	Middle school	0.67 (0.57–0.80)	1.36 (1.04–1.78)	
	High school	0.61 (0.52–0.72)	0.96 (0.73–1.27)	
	University	0.53 (0.44–0.62)	1.04 (0.75–1.44)	
Current Smoking	No Smoker	1	1	0.81
	Smoker	1.28 (1.15–1.41)	0.98 (0.82–1.017)	
Alcohol use	No	1		0.42

*The adjusted odds ratios are controlled for age, sex, physical activity, smoking, and alcohol use.

Legend of tables:

Variable		Crude Odds Ratio (95% CI)	*Adjusted Odds Ratio (95% CI)	P-value
	Yes	.69 (.51-.94)	1.17 (0.81–1.69)	
MET	Q1	2.16 (1.92–2.43)	1.57 (1.26–1.96)	< 0.001
	Q2	1.70 (1.51–1.91)	1.31 (1.05–1.64)	
	Q3	1.34 (1.19–1.51)	1.08 (0.87–1.35)	
	Q4	1	1	
Wealth Status	Poorest	1	1	0.30
	Poor	0.97 (0.85–1.10)	1.13 (0.83–1.54)	
	Moderate	1.15 (1.02–1.31)	1.25 (0.92–1.69)	
	Rich	1.19 (1.05–1.36)	1.21 (0.89–1.65)	
	Richest	1.12 (0.99–1.28)	1.40 (1.01–1.93)	
Job	Skill Level I	1	1	0.006
	Skill Level II	2.03 (1.48–2.78)	1.57 (1.13–2.18)	
	Skill Level III	2.40 (1.39–4.14)	1.89 (1.07–3.35)	
	Skill Level IV	1.64 (1.11–2.43)	1.09 (0.70–1.76)	
Townsend Index	Most Affluent	2.25 (2.01–2.53)	1.71 (1.26–2.31)	0.002
	Affluent	1.46 (1.29–1.66)	1.23 (1.01–1.51)	
	Moderate	1.60 (1.41–1.81)	1.49 (0.72–2.47)	
	Deprived	1.11 (0.96–1.28)	1.29 (1.02–1.63)	

*The adjusted odds ratios are controlled for age, sex, physical activity, smoking, and alcohol use.

Legend of tables:

Variable		Crude Odds Ratio (95% CI)	*Adjusted Odds Ratio (95% CI)	P-value
	Most Deprived	1		
*The adjusted odds ratios are controlled for age, sex, physical activity, smoking, and alcohol use.				
Legend of tables:				

The adjusted odds ratios for *SES* indicators are shown in Figs. 1 to 4. People with skill level 3 had significantly higher odds compared to the participant with skill level 1 [*OR* = 1.89 (95% *CI*; 1.07 to 3.35)]. Participants living in the most affluent areas had 71% more odds of MetS compared to those living in the most deprived areas [*OR* = 1.71 (95% *CI*; 1.26 to 2.31)]. Besides, age, sex, and physical activity were independently associated with the condition, while no association was seen between cigarette and alcohol use with the disease. The odds ratio of MetS for the age group of ≥ 65 was two times higher than the age group of 35–39 as the reference group [*OR* = 2.02 (95% *CI*; 1.24 to 3.27)]. The odds ratio of having *MetS* in females was 87% higher than males [*OR* = 1.87 (95% *CI*; 1.43 to 2.44)]. Also, the odds ratio of *MetS* was 57% higher among participants with low physical activity in comparison to participants with high physical activity [*OR* = 1.57 (95% *CI*; 1.26 to 1.96)].

Discussion

Our findings showed a considerably high prevalence of MetS in the studied population (39.1%). It was higher than the average rates for countries in the Middle East (25%) (37). The prevalence of MetS was obviously higher in women than in men, so that the odds ratio of MetS was 87% more for women. This was concordant with the results of most studies (14, 38). The observed difference can mainly be due to the higher prevalence of important disorders like obesity and diabetes in women compared to men. According to the results, the prevalence of MetS raised with increasing the age of the participants. This finding was consistent with the results of most studies conducted in Iran and other countries (14, 18, 39–44).

The prevalence of MetS was significantly higher in smokers compared to non-smokers. In some conducted studies, this association was observed (45), while in some other studies, it was not (38, 46). Also, the prevalence of MetS in alcohol consumers was lower than in non-alcohol consumers (31% vs. 39.3%), but these associations were not significant after controlling for the confounder factors. The effect of alcohol consumption on MetS is inconsistent in the results of various studies. Some studies similar to our results found no relationship between alcohol use and MetS (44, 47). On the other hand, some studies have shown a positive association between MetS and alcohol consumption (48) and some others demonstrated a negative association (49).

According to our results, a significant inverse association was seen between physical activity and MetS. This finding is in accordance with other studies (7, 50, 51). Several explanations are regarding the beneficial effects of physical activity and *Mets*, including increased insulin sensitivity (52), better glycemic control via pancreatic *β-cell* insulin secretory compensation (53), improved lipoprotein lipids, such as decreased *TG* and increased high-density lipoprotein cholesterol (*HDLC*) (54).

Studies on the association between socioeconomic status and diseases are very common. In this study, we examined four important indicators that determine economic status. Education is a good indicator of social position in epidemiological studies and is often seen as the easier way of measuring present socioeconomic status because it precedes other indicators, such as income or occupational-based social position. The univariate results showed that there was a significant inverse relationship between education level and *MetS*. The highest prevalence was observed in the illiterate group, but after controlling the confounders in multivariable regression analysis, this relationship was not significant. This finding is consistent with some results from the other studies (45, 55).

Household wealth includes income, savings, and all marketable assets because it captures the accumulation of personal and intergenerational capital and assets from all household members over time. Continuing material security associated with wealth can benefit health by a sense of protection, autonomy, and prestige (56). In our study, participants in higher wealth quintiles had more MetS compared to the poorest groups. However, the relationship between the wealth index and MetS was not statistically significant. In a similar study, conversely, the relationship between the wealth index and MetS was statistically significant. They reported that the prevalence of MetS in the poorest group was higher than in the other groups (57).

Our study results showed a statistically significant relationship between skill level and *MetS* after adjusting for confounder factors. The results indicated that the odds ratios of having MetS were lower in skill levels one and four. These can be due to higher physical activity and less obesity in participants with skill level one, namely manual workers, and also, greater awareness about risk factors and more proper lifestyle in managers belonging to skill level four. In a similar study, in the occupational subgroups, equipment, machine operation, and assembling workers group showed the highest prevalence of the *MetS*, same our finding but unlike our results, “managers” had a high rate of *MetS*. Also, similar to our study, they demonstrated manual workers were significantly less likely to have the MetS relative to non-manual workers (58).

In this study, in multiple logistic regression analysis, the inverse relationship between the Townsend deprivation index and MetS was statistically significant. In contrast to our findings, Yanan Qiao (59) showed that the Townsend deprivation index was strongly associated with a *MetS* so that in the residences of the most deprived area, the prevalence of MetS was higher in relation to the most affluent area.

The large sample size in the context of a population-based cohort study was one of the strengths of our study. This leads to providing more precise estimates by reducing the probability of random error. Second, the use of the well-trained questioners and the presence of several levels of supervisors in this study can be from its strengths. Third, we included several indicators of SES in the individual, household, and area levels in this analysis that can able us to assess different aspects of this complex issue. Fourth, we used valid measures to diagnose *MetS*. This can reduce the probability of the outcome misclassification. Fifth, our study was conducted on the Arab population, ethnicity, and lifestyle of Iranian Arabs is almost the same as people of neighboring countries, especially south of Iraq and Kuwait. So, the findings from the HCS can be generalized to a wide geographical area covering millions of people. On the other hand, there were some limitations in our study. First, the observed associations are not proving causality because the study design was a cross-sectional survey, and reverse causality bias could occur. Another limitation was recruiting prevalent cases instead of incident cases in our study. It can induce selection bias because the assessed patients were only the cases who survived did not include all the patients. Therefore, the findings of this study may be only generalized to this group of patients and not to fatal cases of the disease.

Conclusion

In summary, this study showed that SES is related to *MetS*. Among the four assessed SES indicators, skilled levels and Townsend score had a stronger association with *MetS*. Also, older age group and female gender, and low physical activity were considered as other risk factors for *MetS*. We recommend considering people's SES when interventional programs are planning and conducting on *MetS* in each community.

Abbreviations

MetS: Metabolic syndrome, SES: Socioeconomic status, HICs-high income countries, LMICs: low-and middle-income countries, ORs: Odds ratios, 95%CI: 95% confidence interval.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences (*IR.AJUMS.REC.1398.276*). On the day of registration, informed written consent was received from the study participants.

Ethical Statement

The study protocol was approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences (*IR.AJUMS.REC.1398.276*)

Consent for publication

Not applicable.

Availability of data and materials

Upon request, the data analyzed at Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, will be made access onsite to external researchers; for this reason, Dr. Cheraghian should be contacted.

Competing interests

The authors declare that they have no conflict of interest.

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Authors' contributions

BCh and *NS* contributed to the conception and design, data interpretation, and writing of the manuscript. *BCh* contributed to the statistical analyses of this investigation. *ZR* contributed to the data collection and preformation of this investigation. *SAH*, *FR*, *SJH*, and *ZR* contributed to the data interpretation, preparation of the manuscript, and data collection. All authors have read and agreed to the published version of the manuscript.

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Figures

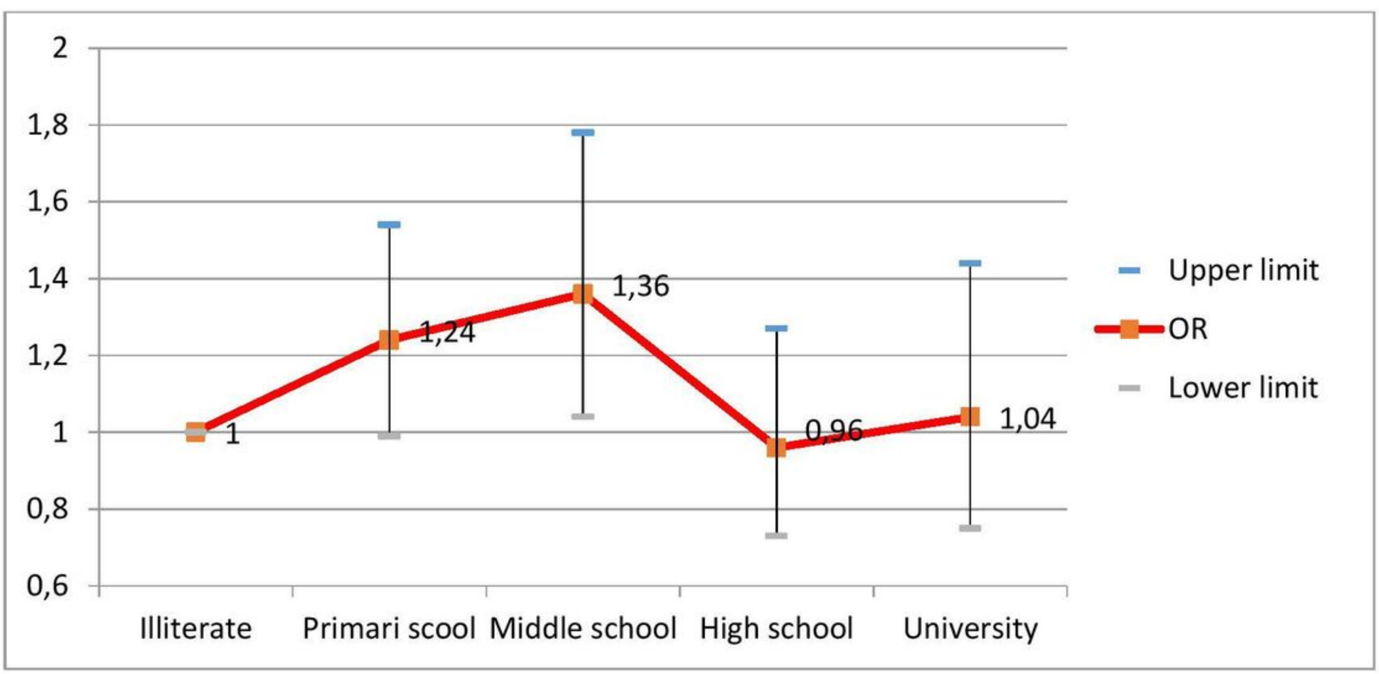

Figure 1

Adjusted odds ratios (95% CI) of MetS according to levels of education

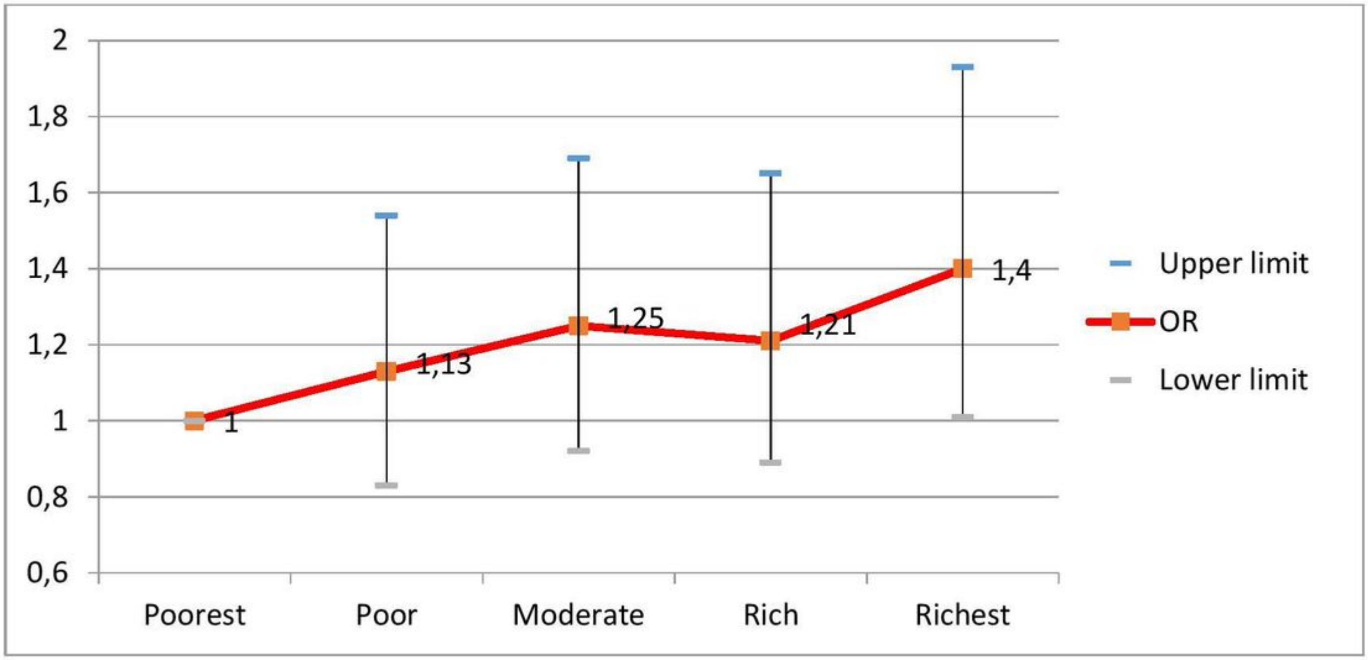

Figure 2

Adjusted odds ratios (95% CI) of MetS according to wealth status

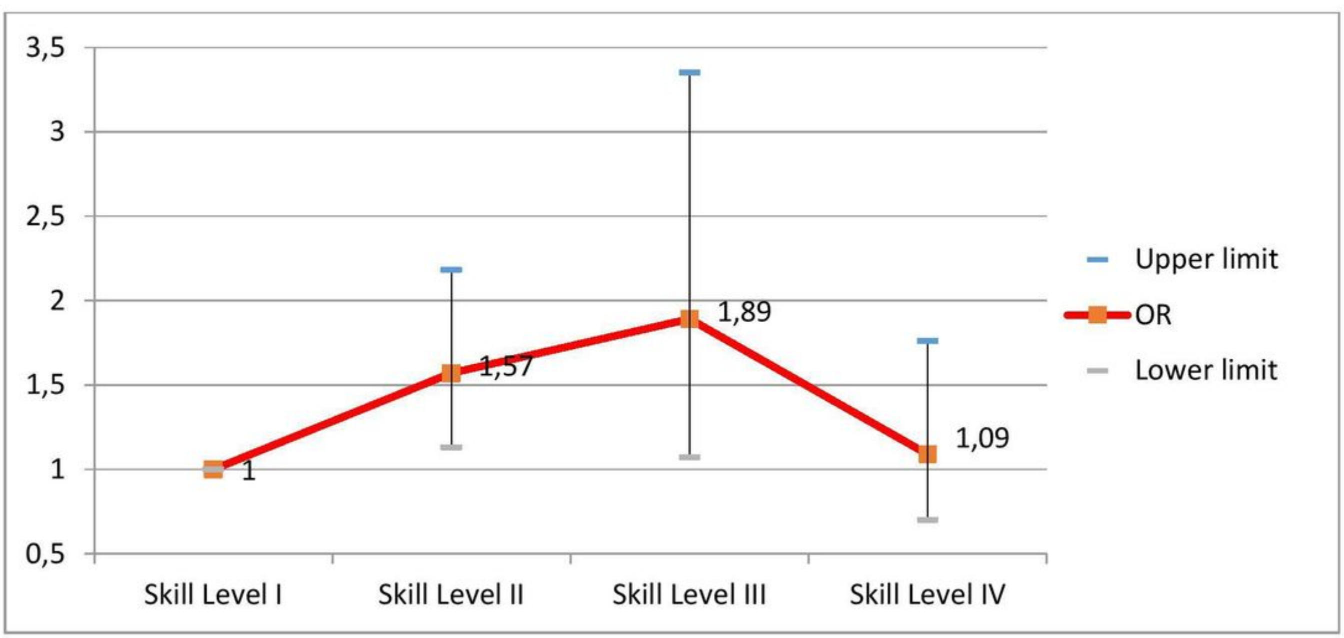

Figure 3

Adjusted odds ratios (95% CI) of MetS according to skill levels

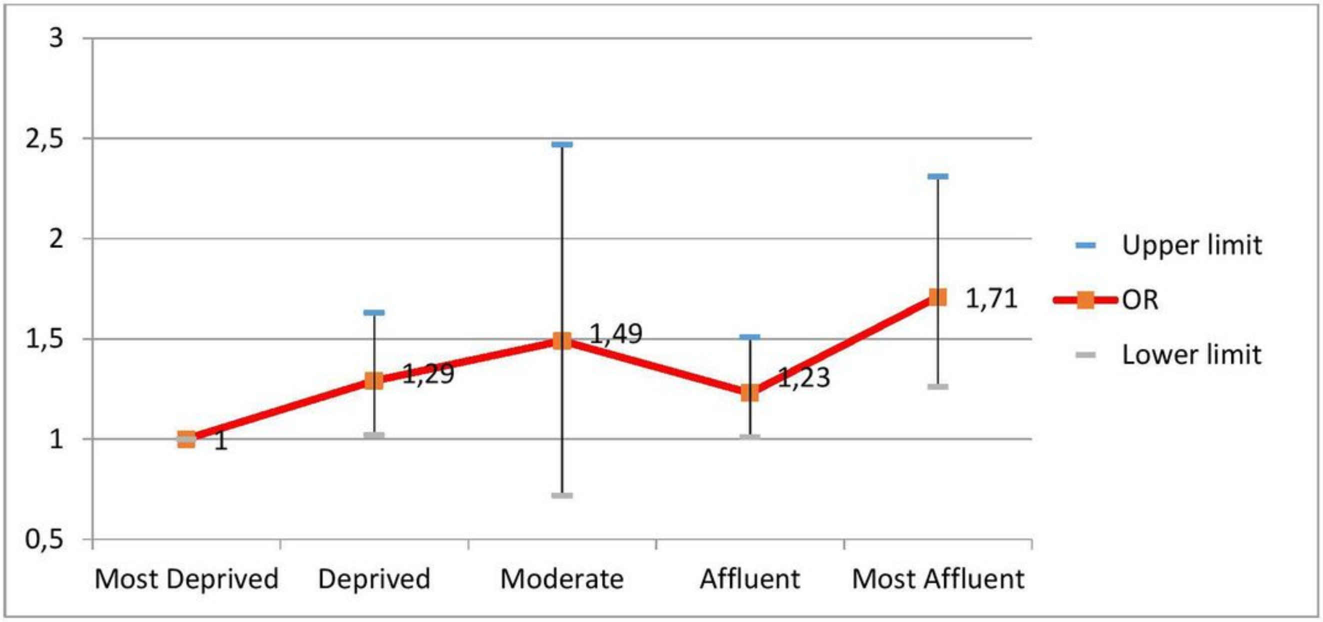

Figure 4

Adjusted odds ratios (95% CI) of MetS according to Townsend index