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Association between individual, household, and area-level socioeconomic status indicators with anthropometric indexes

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ABSTRACT

Objectives: Overweight and obesity are major determinants that contribute to the occurrence of non-communicable diseases. We aim to examine the association between anthropometric indexes and socioeconomic status.

Study design: This study was a population-based cross-sectional study conducted on 9846 adults aged 35 to 70 years who participated in the Hoveyzeh Cohort Study from May 2016 to August 2018 in southwestern Iran.

Methods: We assessed the relationship between three levels of socioeconomic indicators with eight anthropometric indexes. Multiple logistic regression was used to adjust the potential confounders.

Results: The mean ± sd age of 9846 participants was 48.80 ± 9.20, and 5820 (59.1 %) were female Among the socioeconomic indicators, after control for potential confounders, the wealth index and, in the second place, the townsend deprivation index had the strongest relationships with anthropometric indexes. In contrast, the relationships between education and anthropometric indexes were mostly weak and without certain trends. Among the anthropometric indexes, waist circumference, abdominal volume index, and waist to height ratio had a statistically significant association with socioeconomic indicators. The weakest associations were found for the waist to hip ratio index.

Conclusion: This study showed significant associations between socioeconomic and anthropometric indicators. The role of economic factors is more decisive than social factors.

1. Introduction

Overweight and obesity are prominent determinants that contribute to the occurrence of non-communicable diseases (NCDs), encompassing diabetes mellitus type 2, elevated blood pressure, cardiovascular ailments, specific forms of malignancies, as well as musculoskeletal disorders (Biswas et al., 2017). Anthropometric indexes are measurements used to assess various aspects of the human body, such as size, shape, and composition (Lara and Graup, 2017). Body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) are among the most widely used anthropometric indices. These indexes are associated with various health conditions, including diabetes and cardiovascular risk (Shakeri et al., 2015). Overall, anthropometric indexes provide valuable insights into the relationship between body characteristics and health outcomes.

Socioeconomic status (SES) is a multidimensional construct encompassing objective characteristics, such as income, education, and occupation, and subjective ratings of one's placement in the socioeconomic spectrum (Navarro-Carrillo et al., 2020). It is positively associated with better health and influences health through various avenues, including the ability to purchase health-promoting resources, socialization of health habits, and the bidirectional relationship between health and SES (Barwise et al., 2019). SES is utilized in sociological research to understand variations in health status among social groups and is measured using variables such as occupational prestige, educational attainment, income, and neighborhood SES (Baker, 2014).

Anthropometric indexes, such as BMI and WC, have been linked to SES in several studies. Lower SES, as measured by factors such as

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household income and education, has been associated with higher annual increases in weight and WC (Chiappori et al., 2012). In one study, it was found that individuals with lower education levels had a greater annual increase in weight and WC compared to those with higher education levels (Ajami et al., 2018). Similarly, women with lower incomes had a higher annual increase in weight and WC compared to women with higher incomes (Freitas, 2016). These findings suggest that individuals with lower SES are at a higher risk of weight gain and central obesity, highlighting the importance of considering socioeconomic factors in the development of preventive measures (Chiappori et al., 2012).

The aim of this study was to examine the association between eight anthropometric indices with education level, wealth index and townsend deprivation index in the Hoveyzeh Cohort Study population. By understanding the association between anthropometric indexes and SES, we hope to contribute to the growing body of knowledge on this topic and provide insights for future research and policy development.

2. Methods

2.1. Study design and participants

This study was a population-based cross-sectional study. It utilized the data from the enrollment phase of the Hoveyzeh Cohort Study (HCS) (Cheraghian et al., 2020). The Hoveyzeh Cohort Study enrolled 10,009 adults aged 35 to 70 years from May 2016 to August 2018 in southwestern Iran. Inclusion criteria consisted of the age of 35–70 years old, resident of Hoveyzeh, without severe mental disorders, ability to answer the questionnaires without help, and not being deaf or hard of hearing. We excluded 163 pregnant women and finally, 9846 people were assessed in the analysis.

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1400.623).

2.2. Socioeconomic indicator

We assessed socioeconomic status at three levels. Education level considered as an individual-level indicator, the wealth index as an indicator of SES at the household level, and the townsend deprivation index (TDI) as an area-level SES indicator. The data about education level were gathered based on self-reporting method and were categorized into five ordinal categories as illiterate, primary school, secondary school, high school or diploma, and university. The wealth index is a socioeconomic composite indicator that is calculated based on the ownership of household assets. The wealth index was constructed using principal component analysis (PCA) (Smits and Steendijk, 2015). Finally, the wealth scores were converted into five categories from the poorest to the richest, based on the quintiles. Furthermore, TDI is a measure of area deprivation that assesses socioeconomic factors (Lincaru and Atanasiu, 2015). The four variables used to calculate the TDI were unemployment, car ownership, overcrowding, and home ownership. To calculation the scores, first, the proportion of each factor was derived for each area. Then all four variables were standardized using a z-score. These four standardized scores were then summed to obtain the townsend deprivation index. Positive values of the index indicate areas with high deprivation, while, the negative values indicate affluence area. Finally, the TDI scores were categorized into five ordinal categories based on the quintiles including most affluent, affluent, moderate, deprived, and most deprived (Lincaru and Atanasiu, 2015). To assess the validity of TDI for applying in the Hoveyzeh region, the mean of townsend scores was compared between the urban area (-0.35 ± 1.36) and the rural area (1.75 ± 1.98), that a statistically significant deference was found between means scores of the two area ($P < 0.001$). Because it has already been established that the rural areas of Hoveyzeh are generally more deprived than its urban areas, therefore, the higher score of this index in the rural areas can indicate a proper structural validity of this index for the studied area.

2.3. Anthropometric indexes measurement

The anthropometric measurements were performed by trained personnel. Height (cm) was measured using a ruler (Seca 206 precision of 0.1 cm) in a standing position without shoes, shoulders relaxed, facing forward with the head facing the wall. Weigh (kg) was measured with minimal clothing on a standing scale (Seca 755 precision 0.05 kg). Additionally, a locking tape measure (Seca) was used to measure waist, wrist, and hip circumference (cm). Eight anthropometric indexes were used in this analysis, including body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), waist to height ratio (WHtR), abdominal volume index (AVI), body adiposity index (BAI), body roundness index (BRI) and visceral adiposity index (VAI). These anthropometric indexes were calculated using the following equations (Eqs. 1–5)

$$1\Big)\ \mathrm{BMI} = \frac{weight(kg)}{height^2(m)}$$

$$2\Big)\ \mathrm{WHR} = \frac{WC(cm)}{HC(cm)}$$

$$3\Big)\ \mathrm{WHtR} = \frac{WC(cm)}{height(\mathrm{cm})}$$

$$4)\ \mathrm{AVI} = \left[2\left(WC^2\right) + 0.7(waist/hip)^2\right]\Big/1000$$

$$5\Big)\ \mathrm{BAI} = \frac{hip}{height^{1.5}}$$

6) BRI = $364.2–365.5 \times \sqrt{1}–\ (\mathrm{WC}/2\pi)\ ^2/\ (0.5 \times \mathrm{Height})\ ^2$
7) VAI = $(0.81 \times \mathrm{HDL})\ 2\mathrm{WC} \times \mathrm{TG}$.

2.4. Covariates

The other variables used in this analysis were age groups (35–44, 45–54,55–64, and ≥ 65 years), sex (male, female), and area of residence (urban and rural). To evaluate the physical activity of the participants, the international physical activity questionnaire (IPAQ) was utilized. Its validity and reliability had been previously assessed in a study conducted by Moghadam et al. (Moghaddam et al., 2012).The physical activity and metabolic equivalent (MET) scores were reported for a 24-h task (Ainsworth et al., 2000). The physical activity score was categorized into quartiles in our analysis. The diet intake was evaluated by a quantitative 130-item food frequency questionnaire (FFQ) and for analyzing dietary intake data such as energy, N4 software for nutrition was used. The validity and reliability of the FFQ have already been stablished for Iranian population (Eghtesad et al., 2023). The trained interviewers asked participants to report how often, on average, they have consumed each food item daily, weekly, monthly, or yearly scale over the last year. In this study, some potential sources of bias, including social acceptability bias, incorrect response bias, and recall biases can affect the results especially in assessing the FFQ and socioeconomic indexes. To minimize recall bias, the participants were asked the participants about food consumption for relatively short time durations and current status of the socioeconomic position. To reduce the probability of social acceptability bias, interviewers from other neighborhoods were assigned for each participant. To control incorrect responses bias, food photo albums and various depicting food sizes, such as spoons, plates, boxes, matchboxes, and glasses were utilized.

2.5. Statistical analysis

Descriptive statistical measurements were performed using mean and standard deviation for the quantitative variables, while frequencies and percentages were used for categorical variables. The chi-square test was utilized to analyze the differences in demographic and socioeconomic variables between men and women, while the independent *t*-test was employed to assess the differences in mean physical activity scores and calorie consumption between the two gender groups. To examine the association of independent variables of socioeconomic status at the individual, household, and regional levels on anthropometric indices, crude odds ratios were calculated using univariate logistic regression. The initial criterion for variables to be included in multiple regression models was a significance level of $P < 0.25$ in univariate logistic regression analysis. A multilevel logistic regression test was used to examine the strength of the association between independent variables and the outcome variable while controlling for confounding factors. All the reported *p*-values were based on two-tailed tests and compared at the 0.05 significance level. IBM® SPSS® Stats 26.0 was used for statistical analysis.

3. Results

A total number of 9846 individuals were assessed in this analysis. The mean ± SD age of the participants was 48.80 ± 9.20 and 5820 (59.1 %) of them were female. Our results showed a significant difference in age distribution between males and females ($p = 0.027$). A higher percentage of males residing in urban areas compared to females, this difference was not statistically significant ($p = 0.052$). The mean scores of physical activity level and calorie intake were significantly higher among males compared to females (both $p < 0.001$). Males tended to be more educated and to have better wealth status than females (p < 0.001). On the other hand, females are more likely to live in affluent areas compared to males (p < 0.001) (Table 1).

Table 2. demonstrates the crude odds ratios and corresponding *p*-values for demographic and socioeconomic factors associated with anthropometric indexes. There were direct associations between age with WC, WHR, WHtR, AVI, VAI, and BRI. On the other hand, there were significant inverse associations between age with BMI and BAI. The odds of having an abnormal anthropometric status for all assessed indexes, including WC, WHtR, WHR, BAI, AVI, BMI, VAI, and BRI in women were significantly higher than in men.

Compared to the residents of rural areas, the odds of having abnormal BMI, AVI, BAI, WC, WHtR, VAI, and BRI were significantly higher in the participants who lived in urban areas. Nevertheless, no association was found between the area of residence and WHR. With increasing physical activity, the odds of abnormal anthropometric status for all the assessed indexes decreased.

The odds of abnormal BMI increased with increasing energy consumption. On the other hand, increasing energy consumption was associated with decreased odds of abnormal WC, WHR, WHtR, BAI, VAI, and BRI. Despite this, no association was found between energy consumption and AVI.

Education level, as an individual level of socioeconomic status were inversely associated with, WC, WHR, WHtR. On the other hand, this association was direct and significant for BMI, OR = 1.24 (1.02–1.49), although, no association were seen for AVI, VAI, and BAI.

At the household socioeconomic level, there were significant and direct associations between wealth index and some of the anthropometric indexes, including AVI, BMI, WHtR, BAI, VAI, and BRI. On the other hand, WC, and, WHR, did not show any significant association with wealth index.

In the area level socioeconomic, there were significant and inverse associations between TDI and all the assessed anthropometric indexes so that in comparison to the reference group (most deprived), higher odds of having abnormal anthropometric status were seen in the most affluent group.

The adjusted odds ratios and corresponding confidence intervals and *p*-values for evaluating the association between socioeconomic indicators and anthropometric indexes, controlled for potential confounders, are presented in Table 3. At the individual level of socioeconomic, odds of having abnormal WHR were seen significantly lower in the people who graduated from university in comparison to the reference group (illiterate), OR = 0.76 (0.59–0.98). On the other hand, direct and significant associations were seen for BMI, OR = 1.24 (1.01–1.54), WHtR, OR = 1.36(1.03–1.80), and BAI, OR = 1.26

Table 1
Demographic and socioeconomic characteristics of the study participants by gender in Southwest Iran, 2016–2018 (*n* = 9846).

Variable		Male (*n* = 4026)		Female (*n* = 5820)		Total (n = 9846)		p-value
		N (mean)	% (SD)	N (mean)	% (SD)	N(mean)	% (SD)	
Age (year)	**35–44**	1526	37.9	2325	39.9	3851	39.1	**0.027**
	45–54	1312	32.6	1924	33.1	3236	32.9	
	55–64	902	22.4	1151	19.8	2053	20.9	
	≥ 65	286	7.1	420	7.2	706	7.2	
Area of residence	**Urban**	2531	62.9	3546	60.9	6077	61.7	0.052
	Rural	1495	37.1	2274	39.1	3769	38.3	
Physical Activity		(38.05)	(7.47)	(36.45)	(4.13)	(37.11)	(5.79)	**<0.001**
Calorie Consumption		(3397.53)	(1027.79)	(2699.15)	(821.98)	(2984.72)	(947.23)	**<0.001**
Educational Level	**Illiterate**	1625	40.4	4468	76.8	6093	61.9	**<0.001**
	Primary school	841	20.9	796	13.7	1637	16.6	
	Middle school	466	11.6	200	3.4	666	6.8	
	High school	542	13.5	191	3.3	733	7.4	
	University	552	13.7	165	2.8	717	7.3	
Wealth index	**Poorest**	647	16.1	1315	22.6	1962	19.6	**<0.001**
	Poor	729	18.1	1271	21.8	2000	20.3	
	Moderate	821	20.4	1136	19.5	1957	19.9	
	Rich	880	21.9	1102	18.9	1982	20.8	
	Richest	949	23.6	996	17.1	1945	19.8	
Townsend deprivation Index	**Most Affluent**	486	12.1	1848	31.8	2334	23.7	**<0.001**
	Affluent	942	23.4	889	15.3	1831	18.6	
	moderate	438	10.9	1419	24.4	1857	18.9	
	Deprived	534	13.3	738	12.7	1272	12.9	
	Most Deprived	1626	40.4	926	15.9	2552	25.9	

Notes: $P < 0.05$: a statistically significant level in the chi-square test; P < 0.05: a statistically significant level in the independent test for quantitative variables (parametric variables).

Table 2
Crude odds ratios and their 95 % confidence intervals of demographic and socioeconomic characteristics for anthropometric measurements in study participants using the univariable logistic regression model in Southwest Iran, 2016–2018 (n = 9846).

Variable		BMI	WC	WHR	WHtR	AVI	BAI	VAI	BRI
		Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)	Crude Odds Ratio (95 % CI)
Age (year)	35–44	1	1	1	1	1	1	1	1
	45–54	1.00 (0.89–1.12)	1.22 (1.11–1.35)	2.15 (1.84–2.50)	1.35 (1.15–1.58)	1.23 (1.06–1.42)	0.95 (0.86–1.05)	1.21 (1.10–1.33)	1.49 (1.35–1.66)
	55–64	0.72 (0.63–0.81)	1.28 (1.14–1.43)	3.66 (2.94–4.57)	1.51 (1.24–1.83)	1.44 (1.21–1.71)	0.76 (0.68–0.86)	1.20 (1.08–1.34)	1.77 (1.56–2.01)
	≥ 65	0.47 (0.39–0.56)	1.07 (0.91–1.26)	4.99 (3.32–7.52)	1.20 (0.92–1.58)	1.05 (0.83–1.35)	0.65 (0.55–0.77)	1.08 (0.92–1.27)	1.54 (1.27–1.85)
Sex	Male	1	1	1	1	1	1	1	1
	Female	1.76 (1.61–1.94)	13.09 (11.86–14.45)	2.39 (2.09–2.74)	5.52 (4.71–6.47)	1.92 (1.70–2.19)	2.08 (1.91–2.26)	1.35 (1.24–1.47)	1.68 (1.53–1.84)
Area of residence	Urban	1.68 (1.53–1.85)	1.29 (1.18–1.40)	1.03 (0.89–1.18)	1.38 (1.21–1.59)	1.61 (1.42–1.83)	1.52 (1.39–1.66)	1.20 (1.11–1.31)	1.56 (1.43–1.70)
	Rural	1	1	1	1	1	1	1	1
Physical Activity		0.98 (0.97–0.99)	0.95 (0.94–0.96)	0.96 (0.95–0.97)	0.95 (0.94–0.96)	0.96 (0.95–0.97)	0.98 (0.97–0.99)	0.97 (0.96–0.97)	0.96 (0.95–0.97)
Calories		1.04 (1.02–1.07)	0.84 (0.83–0.86)	0.97 (0.94–0.99)	0.94 (0.91–0.97)	1.01 (0.98–1.04)	0.98 (0.95–0.99)	0.97 (0.95–0.98)	0.97 (0.95–0.99)
Educational level	Illiterate	1	1	1	1	1	1	1	1
	Primary school	1.21 (1.06–1.38)	0.62 (0.56–0.69)	0.55 (0.46–0.65)	0.79 (0.66–0.96)	1.13 (0.97–1.35)	1.09 (0.97–1.23)	0.94 (0.84–1.05)	0.93 (0.82–1.06)
	Middle school	1.32 (1.08–1.60)	0.44 (0.37–0.51)	0.50 (0.39–0.64)	0.66 (0.51–0.85)	1.18 (0.91–1.54)	1.09 (0.92–1.30)	0.91 (0.77–1.07)	1.01 (0.84–1.20)
	High school	1.07 (0.89–1.28)	0.34 (0.29–0.39)	0.34 (0.28–0.42)	0.49 (0.39–0.62)	0.84 (0.67–1.06)	1.02 (0.87–1.20)	0.93 (0.79–1.08)	0.71 (0.60–0.84)
	University	1.24 (1.02–1.49)	0.30 (0.26–0.36)	0.38 (0.31–0.47)	0.62 (0.48–0.79)	0.91 (0.72–1.15)	1.03 (0.87–1.21)	0.82 (0.70–0.96)	0.71 (0.59–0.83)
Wealth index	Poorest	1	1	1	1	1	1	1	1
	Poor	1.16 (1.01–1.33)	1.06 (0.93–1.20)	1.19 (0.97–1.47)	1.26 (1.03–1.54)	1.27 (1.07–1.52)	1.19 (1.05–1.36)	0.98 (0.87–1.11)	1.11 (0.96–1.27)
	Moderate	1.51 (1.31–1.74)	1.07 (0.94–1.22)	0.95 (0.78–1.16)	1.34 (1.09–1.64)	1.53 (1.28–1.84)	1.38 (1.21–1.57)	1.10 (0.97–1.25)	1.31 (1.14–1.50)
	Rich	1.82 (1.57–2.10)	1.21 (1.06–1.38)	1.25 (1.01–1.55)	1.78 (1.43–2.21)	2.11 (1.74–2.58)	1.66 (1.45–1.89)	1.17 (1.03–1.33)	1.61 (1.40–1.86)
	Richest	2.36 (2.02–2.75)	1.1 1 (0.98–1.27)	1.11 (0.90–1.36)	1.81 (1.46–2.25)	2.52 (2.05–3.11)	1.77 (1.55–2.03)	1.11 (0.98–1.26)	1.76 (1.52–2.03)
Townsend deprivation Index	Most Affluent	2.60 (2.26–2.99)	4.44 (3.91–5.05)	1.85 (1.53–2.24)	4.62 (3.46–5.85)	3.42 (2.79–4.19)	2.63 (2.3–2.96)	1.47 (1.32–1.65)	2.48 (2.17–2.84)
	Affluent	1.82 (1.58–2.09)	1.68 (1.49–1.90)	1.27 (1.05–1.53)	1.92 (1.58–2.33)	1.83 (1.53–2.21)	1.63 (1.43–1.85)	1.18 (1.04–1.33)	1.47 (1.29–1.68)
	moderate	1.45 (1.27–1.66)	3.09 (2.72–3.51)	2.19 (1.76–2.72)	2.83 (2.28–3.52)	1.90 (1.58–2.29)	1.54 (1.35–1.74)	1.27 (1.13–1.44)	1.49 (1.31–1.71)
	Deprived	1.11 (0.96–1.28)	1.51 (1.32–1.73)	1.23 (0.99–1.51)	1.46 (1.19–1.79)	1.19 (0.99–1.44)	1.14 (0.99–1.31)	1.09 (0.95–1.24)	0.93 (0.81–1.07)
	Most Deprived	1	1	1	1	1	1	1	1

Notes: $P < 0.05$ was considered a statistically significant level in the logistic regression model; *BMI* Body Mass Index, *WC* Waist Circumference, *WHR* Waist to Hip Ratio, *WHtR* Waist to Height Ratio, *AVI* Abdominal Volume Index, *BAI* Body Adiposity Index, *BRI* Body Roundness Index and *VAI* Visceral Adiposity Index.

(1.04–1.52). However, no significant relationships were seen for WC, OR = 0.89 (0.73–1.09) and AVI, OR = 1.19 (0.92–1.56).

At the household socioeconomic level, there are significant and direct associations between wealth index and all of the anthropometric indexes, so in comparison to the reference group (poorest), higher odds of having abnormal anthropometric status were seen in the richest participants for all of the assessed anthropometric indexes including AVI, OR = 2.54 (2.03–3.17), BMI, OR = 2.15 (1.82–2.53), WC, OR = 1.77 (1.49–2.09), WHtR, OR = 2.34 (1.83–2.96), and BAI, OR = 1.74 (1.50–2.01), and WHR, OR = 1.37 (1.09–1.72).

In the area level socioeconomic, there were significant and inverse associations between the TDI and most of the anthropometric indexes so that in comparison to the reference group (most deprived), odds of having abnormal anthropometric status were seen significantly higher in the most affluent group for WC, OR = 1.55 (1.32–1.83), WHtR, OR = 2.12 (1.63–2.76), AVI, OR = 2.32 (1.84–2.92), BAI, OR = 1.75 (1.51–2.03), BMI, OR = 1.79 (1.53–2.11), although, it was not significant for WHR, OR = 1.16 (0.92–1.46).

4. Discussion

This study examined the association between anthropometric indexes and socioeconomic status in individual aged 35–70 in southwest Iran. Our finding showed education and wealth index were linked to various anthropometric measurements. The wealth index had a statistically significant association with anthropometric indicators, while education showed weaker relationships.

Numerous studies indicate that lower SES is associated with higher rates of obesity. This trend is particularly evident in high-income countries (Kim and von dem Knesebeck, 2018; Li et al., 2023), where individuals with lower income levels tend to have poorer dietary habits and limited access to healthy food options. Previous studies suggest that psychological distress and emotional eating mediate the relationship between lower SES and obesity. Individuals from lower SES backgrounds may experience higher levels of stress, which can lead to emotional eating and subsequently higher BMI (Spinosa et al., 2019). In some low-income countries, the relationship between SES and obesity is

Table 3
Adjusted odds ratios and their 95 % confidence intervals of demographic and socioeconomic characteristics for anthropometric measurements in study participants using the univariable logistic regression model in Southwest Iran, 2016–2018 ($n = 9846$).

Variable		BMI	WC	WHR	WHtR	AVI	BAI	VAI	BRI
		Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)	Adjusted Odds Ratio (95 % CI)
Educational level	Illiterate	1	1	1	1	1	1	1	1
	Primary school	1.19 (1.03–1.37)	1.20 (1.04–1.39)	0.87 (0.72–1.06)	1.32 (1.07–1.62)	1.39 (1.15–1.68)	1.21 (1.07–1.38)	1.02 (0.91–1.14)	1.13 (0.99–1.29)
	Middle school	1.39 (1.13–1.72)	1.29 (1.05–1.58)	0.99 (0.76–1.30)	1.44 (1.09–1.91)	1.66 (1.25–2.21)	1.37 (1.14–1.66)	1.02 (0.86–1.21)	1.35 (1.11–1.65)
	High school	1.14 (0.93–1.39)	0.98 (0.81–1.19)	0.67 (0.52–0.85)	1.08 (0.84–1.39)	1.17 (0.91–1.49)	1.29 (1.08–1.55)	1.03 (0.88–1.22)	0.92 (0.77–1.11)
	University	1.24 (1.01–1.54)	0.89 (0.73–1.09)	0.76 (0.59–0.98)	1.36 (1.03–1.80)	1.19 (0.92–1.56)	1.26 (1.04–1.52)	0.87 (0.73–1.03)	0.87 (0.72–1.05)
Wealth index	Poorest	1	1	1	1	1	1	1	1
	Poor	1.11 (0.96–1.23)	1.20 (1.02–1.40)	1.31 (1.06–1.63)	1.38 (1.11–1.69)	1.28 (1.07–1.54)	1.18 (1.03–1.35)	0.98 (0.87–1.11)	1.12 (0.97–1.28)
	Moderate	1.34 (1.15–1.56)	1.42 (1.21–1.68)	1.21 (0.97–1.50)	1.59 (1.28–1.99)	1.54 (1.27–1.87)	1.29 (1.03–1.35)	1.10 (0.97–1.25)	1.32 (1.14–1.53)
	Rich	1.69 (1.45–1.97)	1.85 (1.57–2.18)	1.57 (1.25–1.96)	2.22 (1.76–2.79)	2.17 (1.77–2.66)	1.65 (1.43–1.89)	1.16 (1.02–1.32)	1.66 (1.43–1.92)
	Richest	2.15 (1.82–2.53)	1.77 (1.49–2.09)	1.37 (1.09–1.72)	2.34 (1.83–2.96)	2.54 (2.03–3.17)	1.74 (1.50–2.01)	1.09 (0.95–1.25)	1.74 (1.49–2.03)
Townsend deprivation Index	Most Affluent	1.79 (1.53–2.11)	1.55 (1.32–1.83)	1.16 (0.92–1.46)	2.12 (1.63–2.76)	2.32 (1.84–2.92)	1.75 (1.51–2.03)	1.17 (1.03–1.34)	1.65 (1.14–1.93)
	Affluent	1.59 (1.37–1.85)	1.34 (1.15–1.55)	1.19 (0.97–1.46)	1.65 (1.35–2.02)	1.64 (1.35–1.98)	1.41 (1.23–1.61)	1.06 (0.94–1.20)	1.27 (1.10–1.46)
	moderate	1.07 (0.92–1.24)	1.19 (1.02–1.39)	1.57 (1.24–1.99)	1.50 (1.18–1.89)	1.43 (1.17–1.74)	1.09 (0.95–1.25)	1.07 (0.94–1.22)	1.13 (0.98–1.30)
	Deprived	0.94 (0.80–1.09)	0.87 (0.73–1.02)	1.09 (0.88–1.37)	1.08 (0.87–1.34)	1.04 (0.86–1.27)	0.93 (0.80–1.07)	0.98 (0.85–1.13)	0.79 (0.68–0.91)
	Most Deprived	1	1	1	1	1	1	1	1

Notes: $P < 0.05$ was considered a statistically significant level in the logistic regression model; The adjusted odds ratios are controlled for age, sex, area of residence, physical activity, and energy consumption; *BMI* Body Mass Index, *WC* Waist Circumference, *WHR* Waist to Hip Ratio, *WHtR* Waist to Height Ratio, *AVI* Abdominal Volume Index, *BAI* Body Adiposity Index, *BRI* Body Roundness Index and *VAI* Visceral Adiposity Index.

reversed; those with higher SES are more likely to be obese (Kim and von dem Knesebeck, 2018). This phenomenon is attributed to increased access to high-calorie foods and a shift away from physically demanding jobs as economies develop (Daran et al., 2023). The pattern of obesity in Iran is similar to that of developing countries, with obesity increasing with improving socioeconomic status.

The relationship between education and anthropometric indices can vary depending on the study population and context being studied (Maheri et al., 2022). Education can influence nutritional status in several ways. Individuals with higher education may have better knowledge about healthy eating habits, which can lead to better food choices and improved nutritional status. Additionally, higher education can lead to better employment opportunities and higher income, improving access to nutritious food and healthcare (Derakhshandeh-Rishehri et al., 2022). Education can influence health behaviors, such as physical activity and smoking, impacting anthropometric measurements (Raghupathi and Raghupathi, 2020). However, higher education can also be associated with sedentary lifestyles due to desk-based jobs and long hours of study (Romero-Blanco et al., 2020). This can contribute to higher rates of obesity and related anthropometric measurements such as WC and BMI.

Our results showed that a higher wealth index was directly associated with abnormal anthropometric indexes. In comparison to individuals from the poorest households, those from the richest households had higher odds of having abnormal anthropometric indexes. A higher wealth index is often associated with better access to food and a more diverse diet, which can lead to improved nutritional status (Tesfaw and Muluneh, 2021). This can be reflected in anthropometric measurements such as height, weight, and BMI. Individuals from higher-wealth households may have better overall growth and development, resulting in taller stature and higher BMI values compared to individuals from lower-wealth households (Tesfaw and Muluneh, 2021). On the other hand, a higher wealth index can also be associated with a sedentary lifestyle and access to processed, energy-dense foods, which can contribute to an increased risk of obesity (Templin, 2019). A study conducted in Nairobi slums found that the prevalence of obesity increased from 10 % in the first wealth quintile to 26.2 % in the fifth wealth quintile (Haregu et al., 2018).

In this study, a higher level of area deprivation was inversely associated with abnormal anthropometric status, so in comparison to individuals who lived in the most deprived area, the people who lived in the most affluent area had higher odds of having abnormal anthropometric indexes. Higher levels of deprivation, as measured by the TDI, are often associated with poorer access to resources such as nutritious food, healthcare, and education (Ye et al., 2023). This can result in higher rates of malnutrition and poorer anthropometric outcomes. Individuals living in more deprived areas may have a higher prevalence of undernutrition. Paradoxically, higher levels of deprivation can also be associated with higher rates of obesity in some populations (Levine, 2011). This phenomenon, known as the "deprivation-obesity paradox," suggests that individuals in more deprived areas may have limited access to healthy, affordable food options and recreational facilities, leading to higher consumption of energy-dense, processed foods, and sedentary lifestyles (Żukiewicz-Sobczak et al., 2014). Also, the TDI is often used to assess health inequalities between different socioeconomic groups. Anthropometric measurements can be used as indicators of overall health and well-being. Higher levels of deprivation, as measured by the TDI, are often associated with poorer health outcomes, including higher rates of chronic diseases such as diabetes and cardiovascular diseases, which can be reflected in anthropometric measurements (Park, 2021).

An attractive note in our findings was that the results of the multiple logistic regression were different from the crude odds ratios in the univariate logistic regression related to WHR, WHtR, AVI, and WC, especially for education. The reason could be that abnormal WC is much frequent in women than men and WC was used in all of these indicators. Therefore, the relationship between these anthropometric indicators and socioeconomic indicators was changed after adjusting for gender.

The results of the present study showed that the economic dimension is more important than the social dimension in anthropometric measurements. Economic factors often provide the necessary resources for better nutrition and health, while social factors like education influence behaviors that can enhance or mitigate these effects. Therefore, both dimensions are critical, and their relative importance may vary depending on specific contexts or populations studied. Economic factors are particularly influential in determining access to resources such as food quality and healthcare, which directly influence anthropometric measures such as BMI, weight, and waist circumference. In line with these results, Utkualp et al. showed that economic factors are particularly influential in determining access to resources like food quality and healthcare, which directly affect anthropometric measures such as BMI, weight, and waist circumference (Utkualp and Ercan, 2015). However, some studies suggest that economic factors may overshadow the influence of education in low-income populations where access to basic resources is limited. While education is vital for health literacy, its impact is diminished in the absence of economic resources. For instance, educated individuals may still struggle to afford nutritious food or healthcare (Christabel et al., 2024). The lack of financial means can lead to poor health outcomes, regardless of educational background, highlighting the need for integrated policy approaches that address both education and economic barriers (Raghav and Sm, 2024).

Our study had several strengths; first, the large studied sample size guarantees sufficient statistical power and gives precise estimations for the rates, as can be found in the narrow confidence intervals. Second, to use of several SES indicators and anthropometric indexes were gathered by standard instruments and by trained personnel according to a well-designed study protocol. Third, our study was conducted on an Arab population. Regarding to similarity of culture, lifestyles, and diet, the findings can be generalized to a large population of southwest Iran, south of Iraq, and some countries that border the Persian Gulf. On the other hand, had some limitations. First, data on socioeconomic and nutrition variables were collected using a self-reported method. Since some participants may not have provided accurate answers to the questions, the findings could be affected by information bias such as recall and exposure misclassification. Second, the design of this study was cross-sectional, so the findings about associations between socioeconomic indicators and anthropometric indexes could be subject to temporal bias. Third, failure to collect certain confounding variables, such as cultural dietary habits beyond total calorie intake, and family health history, may induced residual confounding.

5. Conclusion

Our study showed significant associations between socioeconomic and anthropometric indicators. It seems that among the assessed population, the role of economic factors is more decisive than social factors for this relationship. The findings of this study help health system managers and officers to focus on prevention interventions and screening programs in high-risk groups regarding the limited financial and human resources.

Statements of ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1400.623).

CRediT authorship contribution statement

Zahra Rahimi: Writing – review & editing, Project administration, Methodology, Formal analysis, Conceptualization. **Maedeh Raeisi zadeh:** Writing – review & editing, Supervision. **Seyed Ahmad Hosseini:** Writing – review & editing, Supervision. **Seyedeh Yasaman Alemohammad:** Writing – original draft, Data curation. **Sara Sarvandian:** Writing – review & editing, Writing – original draft, Project administration. **Bahman Cheraghian:** Writing – review & editing, Project administration, Methodology, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2025.103036.

Data availability

No data was used for the research described in the article.

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