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Contribution of Health Literacy and Sociodemographic Factors to Body Mass Index among Croatian Adults

Health Literacy, Sociodemographics, and BMI

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ABSTRACT

Introduction: Obesity is a chronic disease with serious health consequences, including cardiovascular diseases, diabetes, and certain cancers. Identifying factors associated with BMI is essential for prevention and public health planning. This study aimed to examine the contribution of health literacy and sociodemographic factors to BMI among adults in Croatia.

Methods: A cross-sectional study was conducted among 195 adults residing in Croatia. Data were collected in person using paper-based instruments. Participants independently completed the sociodemographic and lifestyle section, whereas the SAHLCA-50 was administered face-to-face by a member of the research team. Spearman's rank correlation and multiple linear regression analyses were used to examine associations with BMI and identify its independent predictors.

Results: The median BMI was 25.1 (IQR 22.4–28.6), with 34.9% of participants overweight and 17.4% obese. Significant correlations were observed between BMI and age ($\rho = 0.372$, $P < 0.001$), sex ($\rho = -0.176$, $P = 0.014$), education ($\rho = -0.193$, $P = 0.007$), and health literacy ($\rho = -0.172$, $P = 0.016$). Regression analysis showed that only age and sex were significant predictors of BMI, explaining 13.1% of the variance (adjusted $R^2 = 0.131$). Health literacy and the remaining sociodemographic variables were not significant predictors of BMI in the multivariable model.

Conclusions: Age and sex were independently associated with BMI, whereas health literacy was not a significant predictor after adjustment for sociodemographic characteristics. Further studies incorporating detailed behavioral, lifestyle, and socioeconomic variables are needed to clarify the relationship between health literacy and BMI.

INTRODUCTION

Obesity is defined as excessive accumulation of adipose tissue and is recognized as a chronic and complex disease that can negatively affect health. It increases the risk of developing type 2 diabetes, cardiovascular diseases, bone and reproductive health problems, as well as certain types of cancer. In addition to its health consequences, obesity can significantly affect quality of life, including difficulties with sleep and mobility [1, 2].

Today, obesity is a global health problem that has been steadily increasing over recent decades. According to data from 2022, one in eight people worldwide lives with obesity, while 43% of adults aged over 18 are overweight, and 16% of them live with obesity. Since 1990, the prevalence of obesity among adults has more than doubled, while in adolescents it has quadrupled [1]. In 2024, an estimated 35 million children under five years of age were overweight. In 2022, more than 390 million children and adolescents aged 5–19 years were overweight, including over 160 million living with obesity [1].

Between 1990 and 2022, the global prevalence of obesity increased substantially, and more than one billion people worldwide were living with obesity by 2022 [2, 3]. The scale and geographic reach of this increase make obesity a global public health challenge. In addition to its clinical burden, obesity is associated with stigma and substantial psychological and social consequences [4]. For this reason, it is important to identify the factors associated with obesity in order to support timely prevention and intervention.

Population-based studies have shown that health literacy is associated with socioeconomic position, health-risk behaviors, and health status [5–7]. Health literacy is a multidimensional construct that encompasses the knowledge, motivation, and competencies required to access, understand, evaluate, and use health information [8]. Studies have reported associations between health literacy and nutrition–exercise behaviors, motivational readiness for physical activity, healthy eating habits, and fast-food consumption [9–12]. These findings suggest that health literacy may be relevant to weight-related behaviors, although they do not establish a mediating or causal effect on BMI.

Body image, eating attitudes, physical activity, and socioeconomic circumstances across the life course are related to weight-related outcomes and health behaviors [13, 14]. Studies in adult populations have also identified sociodemographic and behavioral factors, including age, marital status, education, and dietary intake, as correlates of overweight and obesity [15, 16]. Ethnicity and place-related social context are associated with disparities in obesity [17, 18], while weight-related stigma may differ according to age, sex, and ethnicity [19]. Behavioral and psychological factors, including eating-related behaviors and habitual responding, may also be associated with higher BMI [20, 21]. These findings highlight the complex interplay of biological, behavioral, psychological, and sociodemographic factors associated with BMI. A multidisciplinary approach involving various healthcare professionals is essential for effective obesity prevention and management. According to clinical guidelines, obesity should be managed as a chronic disease through comprehensive, patient-centred care [22]. Nurses can contribute through patient assessment, education, lifestyle counselling, care coordination, and long-term follow-up [23–25]. As nurses and midwives together account for nearly half of the global health workforce, their contribution to obesity prevention and management is of particular importance [26].

This study contributes to the existing literature by providing data on the association of body mass index (BMI) with health literacy, as well as key sociodemographic and behavioral variables among adults in Croatia. The obtained results contribute to a better understanding of the factors associated with obesity in the local context and may serve as a basis for the development of targeted public health interventions and recommendations.

This study aimed to examine the contribution of health literacy and sociodemographic factors to body mass index (BMI). Specifically, it aimed to: a) analyze BMI according to standard classifications; b) investigate differences in BMI according to employment and marital status; and c) examine associations between BMI and sex, age, educational level, self-rated health, meal frequency, place of residence, physical activity, and health literacy.

METHODS

Study design

A cross-sectional study was conducted between March and April 2023 among adults residing in Croatia.

Participants

The study included 195 adults residing in Croatia. The inclusion criteria were age 18 years or older, current residence in Croatia, ability to read and understand the Croatian language, and provision of informed consent to participate in the study. The exclusion criteria were age younger than 18 years, residence outside Croatia, inability to read or independently complete the questionnaire, refusal or withdrawal of informed consent, and questionnaires with missing data that prevented the calculation of BMI or the SAHLCA-50 total score.

An a priori power analysis was performed using G*Power [27] to estimate the required sample size for multiple linear regression (fixed model, R^2 deviation from zero). Assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, statistical power $(1 - \beta) = 0.95$, and nine predictors, the required sample size was 166 participants. The final sample comprised 195 participants, exceeding the estimated minimum sample size.

Data collection procedure

Data were collected in person between March and April 2023 using paper-based instruments. Participants independently completed the sociodemographic and lifestyle section of the questionnaire. The SAHLCA-50 was administered individually, face-to-face, by a member of the research team, who recorded the participants' pronunciation and word-association responses. The average time required to complete the entire data collection procedure was approximately 10–13 minutes.

Instruments

The questionnaire consisted of two sections. The first section collected sociodemographic data, including sex, age, place of residence, educational level, employment status, and marital status, as well as information on physical activity and the number of meals consumed per day. Body weight and height were self-reported. BMI was calculated as body weight in kilograms divided by height in meters squared (kg/m²). According to World Health Organization criteria, participants were classified as underweight (BMI < 18.5 kg/m²), normal weight (BMI 18.5–24.9 kg/m²), overweight (BMI 25.0–29.9 kg/m²), or obese (BMI ≥ 30.0 kg/m²) [1]. The second section assessed functional health literacy using the Short Assessment of Health Literacy for Croatian Adults (SAHLCA-50). The instrument consists of 50 medical terms. For each item, participants were asked to read the medical term aloud and select the semantically related word from two alternatives; the response option “I do not know” was also available. One point was awarded when both the pronunciation and word association were correct, whereas an incorrect response or the response “I do not know” was scored as 0. The total score ranged from 0 to 50, with higher scores indicating higher functional health literacy. The Croatian validation study demonstrated high internal consistency (Cronbach's $\alpha = 0.91$) [28].

Statistical data analysis

Descriptive statistics were used to summarize the study variables. Continuous variables are presented as medians and interquartile ranges (IQRs). The normality of data distribution was assessed using the Shapiro–Wilk test. Since the data were not normally distributed ($P < 0.05$), non-parametric tests were applied. The Mann–Whitney U test was used to compare two independent groups, and the Kruskal–Wallis test was used to compare multiple independent groups. When the Kruskal–Wallis test indicated a significant difference, pairwise comparisons were performed using Dunn's post hoc test. Associations between variables were assessed using Spearman's rank correlation coefficient. Multiple linear regression analysis was performed to identify predictors of body mass index (BMI). All assumptions for regression analysis, including linearity, normality of re-

siduals, homoscedasticity, and absence of multicollinearity, were verified before analysis. A two-sided P value < 0.05 was considered statistically significant. Statistical analyses were performed using JASP version 0.17.2.1 (Department of Psychological Methods, University of Amsterdam, Amsterdam, The Netherlands) [29].

Ethical considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The study involved an anonymous, non-interventional survey of adults from the general population and did not include the collection of directly identifiable personal data. Participation was voluntary. Before completing the questionnaire, all participants received written and verbal information about the purpose and procedures of the study and provided written informed consent. Participants were informed that they could withdraw from the study at any time without consequences. Signed informed consent forms were stored separately from the completed questionnaires in sealed envelopes to prevent any link between participants and their responses.

RESULTS

A total of 195 participants were included in the study, of whom 165 (84.6%) were female and 30 (15.4%) were male. The median age was 35 years (IQR, 26–47 years) (Table 1).

Table 1. Distribution of participants' demographic characteristics (N = 195)

Characteristics		n (%)
Sex	Male	30 (15.4)
	Female	165 (84.6)
Marital status	Married	122 (62.6)
	Divorced	9 (4.6)
	Single	57 (29.2)
	Widowed	7 (3.6)
Education level	Elementary school	7 (3.6)
	Secondary education	130 (66.7)
	Higher education	37 (19.0)
	University degree and above	21 (10.8)
Employment	Employed	156 (80.0)
	Unemployed	33 (16.9)
	Retired	6 (3.1)
Place of residence	City	98 (50.3)
	Village	97 (49.7)
Physical activity	No	61 (31.3)
	Several times a year	27 (13.8)
	Several times a week	48 (24.6)
	Several times a month	38 (19.5)
	Daily	21 (10.8)
Number of meals per day	One meal	5 (2.6)
	Two meals	65 (33.3)
	Three meals	95 (48.7)
	Four meals	30 (15.4)
Self-rated health	Very poor	0 (0.0)
	Poor	7 (3.6)
	Moderate	40 (20.5)
	Good	113 (57.9)
	Very good	35 (17.9)
Presence of chronic disease	Yes	42 (21.5)
	No	153 (78.5)

Most participants had normal body weight (88, 45.1%). The median BMI was 25.1 (IQR, 22.4–28.6), and the median health literacy score was 47 (IQR, 44–48) (Table 2).

Table 2. Distribution of BMI categories and descriptive statistics for body mass index and health literacy (N = 195)

Variable		n (%)
BMI category	Underweight	5 (2.6)
	Normal weight	88 (45.1)
	Overweight	68 (34.9)
	Obesity	34 (17.4)
		Median (IQR)
BMI		25.1 (22.4 – 28.6)
Health literacy score		47 (44 – 48)

Note: BMI – body mass index

BMI differed significantly according to marital status (P = 0.015). Post hoc Dunn's test indicated that single participants had significantly lower BMI than married and widowed participants (P < 0.05). BMI also differed significantly according to employment status (P = 0.018). Retired participants had significantly higher BMI than employed and unemployed participants (P < 0.05) (Table 3).

Table 3. BMI by marital and employment status (N = 195)

Variable		BMI	*P-value**
		Median (IQR)	
Marital status	Married	25.76 (23.17– 28.73)	0.015
	Divorced	23.37 (22.13 – 26.53)	
	Single	24.11 (20.55 – 26.71)	
	Widowed	28.68 (23.35 – 35.43)	
Employment	Employed	25.04 (22.65 – 28.53)	0.018
	Unemployed	24.16 (21.65 – 29.24)	
	Retired	30.44 (27.63 – 35.25)	

Note: BMI – body mass index; *Kruskal–Wallis test.

Spearman correlation analysis showed that BMI was significantly negatively correlated with health literacy (ρ = −0.172, P = 0.016), sex (ρ = −0.176, P = 0.014), and educational level (ρ = −0.193, P = 0.007). BMI was also moderately positively correlated with age (ρ = 0.372, P < 0.001), indicating that BMI tended to increase with increasing age (Table 4).

Table 4. Spearman correlations between BMI and selected sociodemographic and health-related variables

Variables		BMI
Age	ρ	0.372
	P-value	<0.001
Sex	ρ	-0.176
	P-value	0.014
Education	ρ	-0.193
	P-value	0.007
Presence of chronic disease	ρ	-0.132
	P-value	0.065
Self-rated health	ρ	0.063
	P-value	0.384
Physical activity	ρ	-0.129
	P-value	0.073
Place of residence	ρ	0.067
	P-value	0.352
Number of meals per day	ρ	0.033
	P-value	0.649
Health literacy score	ρ	-0.172
	P-value	0.016

Note: ρ = Spearman correlation coefficient; *P values* for Spearman correlation analysis

A multiple linear regression analysis was performed to identify predictors of BMI. Variables that were significantly associated with BMI in the bivariate analyses (educational level, age, sex, employment status, marital status, and health literacy) were included in the regression model. The overall model was statistically significant ($F(9, 185) = 4.26$, $P < 0.001$) and explained 13.1% of the variance in BMI (adjusted $R^2 = 0.131$). Age (B = 0.120, β = 0.321, 95% CI for B 0.054–0.185, $P < 0.001$) and sex (B = −2.708, β = −0.201, 95% CI for B −4.608 to −0.807, $P = 0.005$) were significant independent predictors of BMI (Table 5).

Table 5. Multiple linear regression analysis of predictors of body mass index (BMI)

	B	β	t	*P*	95% CI for B		Adjusted R2
					Lower Bound	Upper Bound	
(Constant)	29.546		6.239	<0.001	20.203	38.889	0.131
Education	-0.470	-0.070	-0.951	0.343	-1.443	0.504	
Age	0.120	0.321	3.588	<0.001	0.054	0.185	
Literacy	-0.028	-0.023	-0.287	0.774	-0.215	0.160	
Sex	-2.708	-0.201	-2.810	0.005	-4.608	-0.807	
Employment - retired	-1.363	-0.048	-0.525	0.600	-6.481	3.755	
Employment - employed	-0.682	-0.056	-0.735	0.463	-2.510	1.147	
Marital - single	-0.446	-0.042	-0.525	0.600	-2.123	1.231	
Marital - divorced	-2.379	-0.103	-1.439	0.152	-5.639	0.882	
Marital - widowed	2.004	0.077	1.076	0.283	-1.671	5.678	

Note: B – unstandardized regression coefficient; β – standardized regression coefficient; CI – confidence interval; adjusted R^2 – adjusted coefficient of determination.

DISCUSSION

This study examined the contribution of health literacy and sociodemographic factors to BMI. Although several variables were significantly associated with BMI in the bivariate analyses, only age and sex remained significant independent predictors in the multivariable regression model.

In the present sample, male sex was independently associated with higher BMI. Sex differences in BMI may reflect biological differences in body composition and fat distribution, as well as sociocultural and behavioral factors [30]. Studies among adolescents and university students have also reported sex differences in body-image dissatisfaction, appearance comparisons, and body self-perception [31–35]. However, because these studies predominantly involved younger populations and focused on body image rather than predictors of BMI, they should be interpreted as contextual evidence rather than direct explanations of the association observed in the present study.

Age was positively associated with BMI and remained an independent predictor in the multivariable model. Age-related changes in height, errors in self-reported weight and height, and differences in body composition can affect BMI estimates and their interpretation [36–40]. Studies in older adults have also shown that the use of alternative height measures may materially alter BMI values and nutritional classification [41, 42]. Therefore, the association observed in the present study should be interpreted as a relationship between chronological age and BMI rather than as evidence of a specific metabolic or hormonal mechanism.

Health literacy was negatively correlated with BMI in the bivariate analysis but was not an independent predictor after adjustment for sociodemographic characteristics. The relatively narrow distribution of SAHLCA-50 scores in the present sample, with a median of 47 and an interquartile range of 44–48, may have reduced the ability to identify an independent association.

Evidence regarding the relationship between health literacy and BMI is inconsistent. A Croatian study using the SAHLCA-50 found no statistically significant differences in health literacy according to BMI categories [43]. In contrast, a population-based study among Albanian adults found that inadequate health literacy was independently associated with higher odds of overweight and obesity [44]. Studies among Taiwanese schoolchildren and Portuguese adults also reported associations between health literacy and weight-related outcomes [45, 46], whereas a study among Iranian high school students found no statistically significant correlation between health literacy and BMI [47].

Taken together, these findings suggest that the relationship between health literacy and BMI may vary according to age, population characteristics, the instrument used to assess health literacy, and the behavioral and socioeconomic variables included in the analysis. Health literacy may support healthier decision-making, but it should not be interpreted as a sufficient or direct determinant of body weight.

Overall, the variables included in the regression model explained a relatively small proportion of BMI variance (adjusted R^2 = 0.131). This result indicates that a substantial proportion of BMI variance remains unexplained and may be attributable to biological, psychological, behavioral, social, and environmental factors that were not included in the model. Therefore, these findings emphasize the need for future research that would encompass a wider spectrum of variables and consider possible interactions between individual characteristics, lifestyle, and socioeconomic circumstances.

In this sample, 68 participants (34.9%) were overweight and 34 participants (17.4%) were obese, indicating that excess body weight was common among the participants. These findings are consistent with current global estimates reported by the World Health Organization, indicating that overweight and obesity remain major public health challenges worldwide [1]. Such data confirm that obesity remains a serious public health problem and emphasize the need for preventive and intervention measures in different age groups.

The results indicate the need for a personalized and age-sensitive approach to the prevention and treatment of obesity. Older adults should be included in programs that promote physical activity and support metabolic health, while the development of sex-specific educational strategies is also recommended, given the differences between men and women in body perception, motivation, and approaches to weight management. Nurses, as key members of multidisciplinary teams, play an important role in implementing such interventions by identifying at-risk groups, providing individualized counseling, and encouraging long-term behavioral change. The relatively high proportion of participants with overweight or obesity highlights the importance of early prevention, particularly among younger adults. Programs that promote healthy eating habits, regular physical activity, and reduced sedentary behavior should be an integral part of primary healthcare, educational curricula, and public health initiatives.

Future research should include participants across a broader age range to improve the generalizability of the findings. It is also recommended to include a larger sample and apply a longitudinal study design to better examine the causal relationship between health literacy and changes in nutritional status over time. Furthermore, incorporating objective measures of physical activity, dietary habits, and psychological factors may provide a more comprehensive understanding of their potential mediating or moderating role in the relationship between health literacy and BMI.

Study Limitations

Despite the contribution of this study, several limitations should be considered when interpreting the findings. The study relied on self-reported data, which may have resulted in inaccuracies in reporting body weight, height, and dietary habits. In addition, the sample was relatively small and not fully representative of the Croatian adult population, owing to the predominance of younger participants and women. Furthermore, the cross-sectional design precludes conclusions about causal relationships between health literacy and BMI. Finally, several potentially important variables, including detailed measures of physical activity, stress, socioeconomic status, and genetic predisposition, were not assessed and may have contributed to the unexplained variation in BMI.

CONCLUSION

The results of this study highlight the multifactorial nature of body mass index (BMI), with age and sex emerging as significant independent predictors, whereas health literacy was not a significant predictor in the multivariable model. Nevertheless, health literacy remains an important component of health promotion, as it may support healthier decisions and behaviors that influence nutritional status over time. These findings underscore the importance of adopting a comprehensive approach to obesity prevention and management that considers biological, psychological, and social determinants of body weight.

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Author Contributions

Conceptualization, M.M. and Š.M.; Methodology, I.M., Ž.D., R.L.; Software, M.M., M.V.; Formal Analysis, M.M., M.V., R.L.; Investigation, S.K., I.B.; Resources, S.K., I.B.; Writing – Original Draft Preparation, M.M., I.M., R.L.; Writing – Review & Editing, Š.M., Ž.D.; Visualization, S.K., I.B.; Supervision, M.M. and Š.M.

Declaration of Conflicting Interest

The authors declare no conflicts of interest.

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