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Demographic and Socioeconomic Influences on Male Anthropometric Status: A Public Health Perspective from Vietnam

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Abstract: Background/Objectives: Males exhibit higher health-related risk behaviours compared to females. This study aimed to determine the anthropometric status of adult males and associations of the anthropometric indicators with demographic and socioeconomic factors, with the goal of guiding healthy anthropometric status and nutrition interventions. **Methods**: A cross-sectional study was conducted on 453 Vietnamese males aged ≥18 years. Weight, height and waist circumference measurements were collected and BMI, A Body Shape Index (ABSI), Body Roundness Index (BRI) and Waist to Height Ratio (WtHR) were calculated. Demographic and socioeconomic data included age, ethnicity, marital status, education level, employment status, monthly household income, monthly personal income, monthly household food expenditure, and the total number of household possessions. **Results**: Education level showed a significant association with BMI (negative association), while age (positive association) and monthly household income (negative association) were significantly associated with WtHR. Employment was significantly associated with ABSI. Education level was significantly associated with BRI. **Conclusions**: The findings highlight the complex relationship between anthropometric measurements reflecting nutritional status and demographic and socioeconomic factors, underscoring the importance of considering these variables in public health strategies aimed at reducing poor health and improving nutritional status in males in Vietnam.

Keywords: anthropometry; BMI; WtHR; ABSI; BRI

1. Introduction

Vietnam is undergoing a nutrition transition, characterised by a rising incidence of non-communicable diseases across all regions and population groups. Males exhibit higher-risk behaviours compared to females, such as smoking tobacco (45.3% of males) and consuming alcohol (44.2%), while these figures are around 1% for females [1]. The same pattern is observed for behaviours such as skipping meals, impulsive eating, and taste preferences for salty or sweet foods [2]. Males also have a higher prevalence of chronic diseases compared to females, such as hypertension (36.8% vs. 20.1%, respectively) [3]. The risk of premature death from non-communicable diseases is also higher in males than in females [4]. This disparity underscores the

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need for further investigations to propose effective solutions for controlling risk behaviours and improving the health status of Vietnamese males.

Currently, BMI is the most common anthropometric indicator used to assess the nutritional status of adults [5]. However, there is controversy about whether BMI can distinguish adiposity in body segments such as the abdomen, thighs, hips, or limbs. Waist-to-height ratio (WtHR) was subsequently proposed as an indicator of abdominal obesity [6]. This has been identified as a predictor of metabolic-dysfunction-associated fatty liver disease [7], diabetes, hypertension, and dyslipidemia [8–10]. Additionally, A Body Shape Index (ABSI), based on waist circumference adjusted for weight and height [11], and Body Roundness Index (BRI), which assesses visceral adipose tissue and body fat percentage [12], were developed to estimate body composition and the risks of chronic diseases. ABSI has been shown to be positively associated with cardiovascular diseases and mortality [11,13]. Similarly, BRI has also been identified as an effective screening tool in clinical settings for cardiovascular and metabolic syndrome risks in the Chinese adult population, American men, and young patients [12,14–16].

Public health nutrition policies in Vietnam have focused on maternal health and children, as they are more vulnerable to malnutrition and micronutrient deficiencies than males [17]. Research typically has not differentiated data on males' nutrition status, even in the general national nutrition survey [18]. Therefore, there are limited data on the nutritional status of males in Vietnam, which may pose challenges for policymakers when targeting this sub-group in future nutrition policies.

Anthropometric measures such as BMI, WtHR, ABSI, and BRI are proxies of nutritional status. BMI and WtHR are correlated with socioeconomic status, education levels, age, and sex [19,20]. However, information on the correlation between ABSI, BRI, and demographic factors remains limited in Vietnam. This study aimed to determine the anthropometric status of adult males and explore the associations between anthropometric indicators and demographic and socioeconomic factors.

2. Materials and Methods

2.1. Study Design

A cross-sectional study was conducted from 2020 to 2021 on 453 adult males across three provinces in Vietnam.

2.2. Sample Size

The sample size was calculated for a proportion study, based on a 14.9% prevalence of overweight and obesity among males [21], with a 95% confidence interval, a 5% error margin, and a design effect of 2. Accounting for a 15% refusal rate, the desired sample size was 449 males. Ultimately, 453 males participated in the study.

2.3. Location Selection and Recruitment

A multistage random sampling strategy was employed. One province from each of Vietnam's three main regions (Northern, Central, and Southern) was randomly selected, followed by the random selection of three districts per province. District Health Centres were invited to participate through written invitations, phone calls, and emails. Communes were selected until the sample size was met, resulting in 18 participating communes.

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2.4. Participant Recruitment

Village health workers distributed study information flyers to all households in the participating communes. Males aged ≥18 years were invited. Exclusions included individuals under 18 years, and those with anthropometric abnormalities, intellectual impairments, or chronic diseases affecting participation.

2.5. Anthropometric Measures

Participants were weighed in light clothing without shoes with calibrated electronic body scales (SECA Robusta 813, SECA GmbH & Co. KG, Hamburg, Germany). Each participant was weighed twice to the nearest 0.1 kg; if the two measurements differed by more than 0.1 kg, a third measurement was taken. Height was measured twice to the nearest 0.1 cm with a SECA stadiometer (SECA 222, SECA GmbH & Co. KG, Hamburg, Germany). Participants were measured without a hat, shoes or socks. If the duplicate measurements differed by more than 0.1 cm, a third measurement was taken. Waist circumference (WC) was measured twice horizontally to the nearest 0.1 cm with a non-stretchable tape (Lufkin W606PM, Apex Tool Group, MD, USA) at a point halfway between the lowest rib and the top of a participant's hipbone [22]. Measurements were taken twice, with a third measurement taken if discrepancies exceeded 0.1 cm. Final values were the mean of the two or three measurements, as appropriate. All anthropometric measurements were conducted by trained staff from the National Institute of Nutrition in Vietnam following standardised procedures [22].

The following indices were calculated:

- BMI was calculated by dividing weight in kg by the square of height in meters [5]
- ABSI was calculated as follows: WC/(Weight–2/3 * Height ½) [11]
- BRI was calculated as follows: 364.2–365.5*(1− (WC/2π2) / (0.5*Height2))1/2 [12]
- WtHR was calculated by dividing waist in cm by height in cm.

2.6. Demographic and Socioeconomic Data

Data were collected using a pretested, researcher-administered questionnaire. The following data were collected: age, ethnicity, marital status, education level, employment status, monthly household income, monthly personal income, monthly household food expenditure, and the total number of household possessions from a standardised list including: computer, video compact disc player, digital video disc player, fridge, washing machine, air conditioner, motorbike, car, bicycle, and telephone.

2.7. Data Analysis

Participants' ethnicity was categorised as Kinh or other groups. Marital status was classified as married or not married. Education level was dived into four categories: primary school (grades 1-5), secondary school (grades 6-9), high school (grades 10-12), or university degree and above [23].

Linear mixed models, with commune as a random effect, were used to estimate the association between continuous outcomes (BMI, WtHR, ABSI, and BRI) and demographic and socioeconomic variables. Both univariate associations (considering only one demographic or socioeconomic factor at a time), and adjusted associations (including all demographic and socioeconomic factors (i.e., age, ethnicity, marital status, education level, employment status, and income related variables) were reported. Coefficient values for the associations between ABSI and BRI and the defined factors were too small (<0.00001) for all sub-groups of all covariates, therefore we did not present the data in Tables.

All estimates are reported with 95% confidence intervals (CI). Analyses were performed with Stata (version 14.0; Stata Corp LP, TX, USA).

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3. Results

3.1. Characteristics of Adult Males Who Took Part in the Research

Out of 650 men approached for participation, 453 agreed to participate and were included in the analysis. The participants had an average age of 37.8 years (SD 11.2). Among them, 80.4% were Kinh, 51.4% held a university degree, 70.0% were employed, and 73.5% were married.

Table 1. Characteristics of the participants.

		N	%	mean	sd
Age (years)		453		37.8	11.2
Height (cm)		453		164.1	5.5
Weight (kg)		453		65.7	9.0
Waist circumference (cm)		449		81.7	9.2
BMI*		453		24.3	3.1
Body Roundness Index**		453		3.35	1.14
A Body Shape Index***		453		0.076	0.007
Weight to Height Ratio ****		449		0.50	0.08
Ethnicity	Kinh	364	80.4		
	Other	89	19.6		
Education	Primary school (grades 1-5)	61	14.3		
	Secondary school (grades 6-9)	84	19.7		
	High school (grades 10-12)	62	14.6		
	University and above	219	51.4		
Employment	Unemployed	117	30.0		
	Employed	273	70.0		
Marital status	Married	322	73.5		
	Not married	116	26.5		
Number of household possession		438		6.5	2.1
Monthly personal income (million VND)		401		5.9	3.2
Monthly household income (million VND)		377		11.9	5.9
Monthly household food expenditure (million VND)		366		5.1	3.2

* BMI was calculated by dividing weight in kg by the square of height in meters. ** Body Roundness Index was calculated as follows: $364.2–365.5*(1– (WC/2\pi^{2)} / (0.5*Height^{2}))^{1/2}$ [12]. ***A Body Shape Index was calculated as follows: $WC/(Weight^{-2/3} * Height^{½})$ [11]. **** Waist to Height Ratio was calculated by dividing waist in cm by height in cm.

3.1. Associations Between Anthropometric Indicators and Demographic and Socioeconomic Factors Among Males

Body Mass Index

BMI showed a significant association with education level in both univariate and multivariate analyses (Table 2). The overall coefficient for the association between education and BMI was -0.41 (95% CI: -0.78, -0.03) (results not shown in Table 2). Subgroup analysis showed that males who completed high school tended to have a higher BMI compared to those who completed primary school.

Waist-to-Height Ratio

In the univariate analyses, WtHR was significantly associated with age, marital status, and monthly household income. However, in the multivariate analysis, only age and monthly household income remained statistically significant (Table 3). Higher age was associated with higher WtHR, while higher household income was associated with a lower WtHR.

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A Body Shape Index

Age and employment were significantly associated with ABSI in the univariate analyses. In the multivariate analysis, only employment remained statistically significantly associated (p=0.017) (data not presented in a Table). Being employed was associated with a more favourable ABSI.

Body Roundness Index

BRI was negatively associated with education in both univariate and multivariate analyses (p=0.018) (data not presented in a Table). Higher education levels were associated with lower BRI values.

Table 2. Associations between BMI and demographic and socioeconomic factors.

		Raw estimates		Univariate analysis*			Multivariate analysis**		
		Total	**BMI** mean (SE)	**Coef (95% CI)**	**p-value**	**overall p-value**[***]	**Coef (95% CI)**	**p-value**	**overall p-value**[***]
Age (years)		453	25.2 (0.59)	-0.04 (-0.15, 0.06)	0.415		-0.11 (-0.32, 0.10)	0.305	
Ethnicity	Kinh (reference)	364	24.4 (0.16)	0			0		
	Other	89	24.4 (0.32)	-0.22 (-3.20, 2.77)	0.888		-0.47 (-5.40, 4.45)	0.850	
Education level	Primary school (grades 1-5) (reference)	61	23.3 (0.41)	0		0.007	0		0.014
	Secondary school (grades 6-9)	84	24.7 (0.38)	0.83 (-3.26, 4.92)	0.691		-0.27 (-6.87, 6.33)	0.936	
	High school (grades 10-12)	62	30.4 (4.01)	6.58 (2.17, 10.99)	0.003		6.84 (-0.63, 14.3)	0.073	
	University and above	219	24.5 (0.19)	0.87 (-2.70, 4.43)	0.633		-1.42 (-8.54, 5.70)	0.696	
Employment	Unemployed (reference)	117	26.2 (0.93)	0			0		
	Employed	273	23.6 (0.29)	2.25 (-0.60, 5.11)	0.122		4.29 (-0.64, 9.21)	0.088	
Marital status	Married (reference)	321	24.4 (0.17)	0			0		
	Not married	107	24.4 (0.30)	1.58 (-1.16, 4.32)	0.258		1.54 (-3.96, 7.04)	0.583	
Number of household possessions		438		0.39 (-0.19, 0.96)	0.187		0.51 (-0.48, 1.50)	0.316	
Monthly personal income (million VND)		400		-0.13 (-0.53, 0.28)	0.535		0.03 (-0.75, 0.81)	0.936	
Monthly household income (million VND)		376		-0.09 (0.33, 0.15)	0.472		-0.24 (-0.64, 0.17)	0.254	
Monthly household food expenditure (million VND)		365		-0.20 (-0.64, 0.24)	0.382		-0.23 (-0.87, 0.41)	0.488	

*Linear mixed model including the covariate as a fixed effect and commune as a random effect. ** Linear mixed model including all nine demographic and socioeconomic factors as fixed effects and commune as a random effect. *** Overall *p*-value for the association between the outcome and the demographic or socioeconomic factor.

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Table 3. Associations between WtHR and demographic and socioeconomic factors.

		Raw estimates		Univariate analysis*			Multivariate analysis**		
		Total	**WtHR** Mean (SE)	**Coef (95%CI)**	**p-value**	**overall p-value*****	**Coef (95%CI)**	**p-value**	**overall p-value*****
Age (years)		449	0.50 (0.003)	0.001 (0.000, 0.001)	0.002		0.001 (0.000, 0.002)	0.007	
Ethnicity	Kinh (reference)	362	0.50 (0.004)	0			0		
	Other	87	0.51 (0.006)	0.005 (-0.015, 0.024)	0.636		-0.002 (-0.032, 0.027)	0.891	
Education level	Primary school (grades 1-5) (reference)	61	0.50 (0.007)	0			0		
	Secondary school (grades 6-9)	83	0.50 (0.006)	0.006 (-0.021, 0.032)	0.683	0.188	0.018 (-0.021, 0.579)	0.363	0.115
	High school (grades 10-12)	62	0.52 (0.020)	0.026 (-0.003, 0.054)	0.078		0.049 (0.005, 0.093)	0.030	
	University and above	216	0.50 (0.004)	0.002 (-0.022, 0.254)	0.879		0.020 (-0.022, 0.062)	0.348	
Employment	Unemployed (reference)	117	0.49 (0.006)	0			0		
	Employed	269	0.50 (0.005)	0.016 (-0.001, 0.034)	0.080		0.009 (-0.020, 0.039)	0.528	
Marital status	Married (reference)	318	0.51 (0.005)	0			0		
	Not married	107	0.48 (0.005)	0.024 (0.007, 0.042)	0.007		-0.000 (-0.033, 0.033)	0.995	
Number of household possessions				0.001 (-0.003, 0.005)	0.734		0.004 (-0.001, 0.010)	0.156	
Monthly personal income (million VND)				-0.001 (-0.003, 0.001)	0.575		0.002 (-0.003, 0.007)	0.412	
Monthly household income (million VND)				-0.002 (-0.003, -0.000)	0.028		-0.003 (-0.005, -0.001)	0.018	
Monthly household food expenditure (million VND)				0.000 (-0.002, 0.003)	0.790		0.001 (-0.002, 0.005)	0.498	

* Linear mixed model including the covariate as a fixed effect and commune as a random effect. ** Linear mixed model including all five demographic and socioeconomic factors as fixed effects and commune as a random effect. *** Overall *p*-value for the association between the outcome and the demographic or socioeconomic factor.4. Discussion.

The results of this study showed that, among adult Vietnamese men, BMI and BRI were significantly negatively associated with education, WtHR was positively correlated with age and negatively correlated with monthly household income, and being employed was associated with a more favourable ABSI.

The findings also indicated significant variations in anthropometric indices reflecting the nutrition status among Vietnamese males, influenced by various demographic and socioeconomic factors. Further research is needed to explore the underlying mechanisms driving these associations and to evaluate the effectiveness of interventions targeting healthy anthropometric outcomes or nutritional status. Longitudinal studies could provide deeper insights into how sociodemographic factors influence changes in anthropometric indices over time, which may help Vietnam make significant strides in improving the health and well-being of its male population.

Findings from the current research revealed that higher education levels were linked to lower BMI and BRI, indicating that educational attainment may influence body weight and shape. This contrasts with other research in Vietnam and other low- and middle-income countries. Studies in Thailand, Malaysia, and Indonesia have shown that higher education correlates with increased BMI and central obesity [25–27]. These populations are undergoing a nutrition transition and experiencing

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rapid economic growth and urbanization, leading to lifestyle changes such as higher consumption of processed foods and reduced physical activity among the educated. In contrast, in high-income countries such as the US and EU nations, a **negative** association is commonly found between education levels and obesity [28,29]. Higher education is typically linked to **lower** BMI and BRI, particularly among women. This trend is thought to be related to greater health awareness, better access to healthier food options, and more opportunities for physical activity in higher socioeconomic groups. These associations could be attributed to lifestyle and dietary habits that vary with education. It is challenging to explain why the findings from our study are inconsistent with other studies in low- and middle- income countries; it is possible that it may be due to the differences in sample size, sampling, characteristics of the participants and behaviours specific to Vietnam. One possibility is that more than 50% of the participants in this research had a university degree or higher, which may contribute to higher health literacy and better management of body weight and shape. The limitations of a cross-sectional study challenge us to further explore the association, and further research is recommended.

Age and abdominal obesity were found to be positively associated, particularly among males in Asian communities. South Asian men are more likely to develop abdominal obesity at younger ages [30], while East Asian men tend to accumulate abdominal fat more noticeably in older ages [31]. Researchers have concluded that, as males age, reduced testosterone concentrations increase the risk of obesity [32,33]. A lower metabolic rate [34] may also contribute to increased adiposity in aging individuals. Moreover, the longer people live, the more obesity risks they accumulate, such as physical inactivity and unhealthy eating behaviours. Therefore, the positive relationship between age and abdominal obesity observed in our research is consistent with the literature. Given the diversity of genetic factors, culture, and diet, targeted interventions for preventing and managing abdominal obesity should be tailored to the specific needs and characteristics of each population.

In addition, WtHR and ABSI were significantly associated with income and employment status, two indicators of wealth. Higher-income and employment were linked to lower WtHR and ABSI, suggesting that socioeconomic status plays a crucial role in determining body composition or shape. This finding also emphasizes the importance of addressing socioeconomic disparities in health and nutrition interventions. In the US, higher-income individuals are generally more likely to have a lower WtHR, reflecting better abdominal fat distribution and overall health [35]. Access to health education, healthier food options, and gym facilities is more common among wealthier populations, resulting in lower levels of central obesity. Similar patterns are observed across developing countries, where higher-income individuals tend to have lower WtHR and ABSI [36–38]. In many low- and middle-income Asian countries, higher income is also associated with **lower WtHR and ABSI**, particularly in urban areas, where wealthier individuals have better access to healthcare, healthier food, and more opportunities for physical activity [39,40]. However, it should be noted that wealth is not the sole determinant of central obesity, and its influence on abdominal adiposity can vary. A study of the US National Health and Nutrition Examination Survey from 1988 to 2015 found that educated adults had a higher prevalence of obesity-associated mortality risk and excess deaths compared to those with lower education levels [41]. In another study, educational level was found to be non-linearly associated with adiposity and modified by race [42]. These observations suggest the need for further research to better control for confounders related to socioeconomic determinants of obesity and to provide a more nuanced understanding of how these factors interact.

The findings of this study have several important implications for public health policy in Vietnam. Firstly, the positive association between age and abdominal obesity suggests the need for public health initiatives targeting older males. In Vietnam, nutritional interventions have traditionally focused on children and maternal health with less investment in the older population. Programs promoting physical activity and healthy eating are commonly used to manage and prevent abdominal obesity. Countries such as Japan (**Metabo Law)**, Australia (**Move It AUS campaign), and** Thailand have adopted similar approaches, achieving improved public health outcomes related to obesity [43,44]. Therefore, these strategies should be reviewed and adapted for implementation in the

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middle-aged and older groups, taking into account the local context in Vietnam. Secondly, the association between higher education levels and lower BMI and BRI suggests that education influences body weight and shape. Public health policies could include educational campaigns that promote healthy lifestyle choices and dietary habits, particularly targeting individuals with higher education levels. Additionally, the significant associations between WtHR, ABSI, and socioeconomic factors such as income and employment status highlight the need to address socioeconomic disparities. Policies aimed at improving access to healthy foods and opportunities for physical activity in lower-income and unemployed populations could help reduce these disparities.

Strengths and limitations

To the authors' knowledge, this study is unique in focusing on anthropometric measures among adult males in Vietnam. Although, the sample size was not large, participants were randomly selected and representative of other males in the three geographic regions in Vietnam with no refusal cases. The majority of participants had a higher educational attainment, allowing them to provide accurate recall information.

One limitation of this study is its cross-sectional design, which prevents the establishment of causality. Future studies should consider using longitudinal designs to better understand causal relationships and changes over time.

In the context of Vietnam, conducting community-based surveys presents unique challenges. The diverse geographical and cultural aspects of Vietnam mean that data collection methods must be carefully tailored to ensure representativeness and accuracy. For instance, rural and remote areas may have limited access to communication infrastructure, making it difficult to reach all potential participants. Moreover, varying levels of literacy and understanding of health-related concepts can affect the quality of self-reported data. Developing educational materials for these areas is further complicated by the diversity of ethnic groups and traditional behaviors.

Community-based surveys often rely on local health workers and volunteers for data collection, which can introduce variability in how data are collected and recorded. Training and standardization of procedures are crucial to minimize these inconsistencies. Despite these efforts, some degree of variability is inevitable, which can affect the reliability of the findings.

4. Conclusions

This study highlights the significant associations between anthropometric indices reflecting nutritional status and demographic and socioeconomic factors among Vietnamese males. Addressing these factors through targeted public health interventions could help mitigate the high prevalence of overweight and obesity, ultimately improving health outcomes for this population.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Abbreviations

The following abbreviations are used in this manuscript:

BMI	Body Mass Index
WtHR	Waist-to-height ratio
ABSI	A Body Shape Index
BRI	Body Roundness Index

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