Original scientific paper

Dual Burden of Malnutrition in Adult Women of Paschim Medinipur, India

S.M.M. Alam, D. Das and S. Roy

Human Biology Review, Volume 14 (1), pp. 37-49

Revised and accepted on January 15, 2025

Authors and affiliations

Sk. Md Murtaja Alam, Ph.D. Scholar, Department of Anthropology, Vidyasagar University.

Email: skmdmurtajaalam@gmail.com

Deepshikha Das, M.Sc., Department of Anthropology, Vidyasagar University.

Email: deepshikhadas0@gmail.com

Dr. Shimul Roy, Assistant Professor, Department of Anthropology, Vidyasagar University.

Email: shimulroy888@gmail.com

Corresponding Author: **Dr. Shimul Roy, Assistant Professor, Department of Anthropology, Vidyasagar University, Midnapore, West Bengal, India. Email ID: shimulroy888@gmail.com*

Dual Burden of Malnutrition in Adult Women of Paschim Medinipur, India

S.M.M. Alam, D. Das and S. Roy

ABSTRACT:

Undernutrition has always been a significant public health challenge in middle and lower-income countries. However, due to improved socio-economic conditions and lifestyle changes, undernutrition is decreasing while overnutrition is increasing rapidly. This has led to a dual burden of malnutrition, particularly among women. This cross-sectional study was conducted in two phases in 2019 and 2022, among adult women (18 to <60 years) in the Midnapore municipal area of Paschim Medinipur, West Bengal, India, with the aim of assessing the nutritional status of adult women in the area. The study also aimed to examine the socio-economic factors that influence the nutritional status of the study population. Primary data were collected using structured surveys and interviews, and anthropometric measurements were taken using standard procedures. Total 200 participants were included in the study using purposive sampling method. Statistical significance was considered at p-values ≤0.05. The study found that overnutrition is highly prevalent among the participants (45%), while undernutrition is also a concern, affecting a significant number of women (8%). Additionally, central obesity is high among the participants. Factors such as age, education, occupation, and physical activity were found to be statistically associated with the nutritional status of the participants. In India, the focus of academic and awareness programs has historically been on combating undernutrition. However, with the changing circumstances, there is a need to realign the focus and promote healthy eating and lifestyle habits.

Keywords: Nutritional status, Malnutrition, Women, Central Obesity, Undernutrition, Overnutrition

INTRODUCTION:

In low and middle-income countries, malnutrition is a critical health problem among women (Muller & Krawinkel, 2005; Acharya et al., 2017). There is a dual challenge of malnutrition, including undernutrition and overnutrition, with the increase of overnutrition and decrease of

undernutrition, a phenomenon known as the Nutrition Transition (Nayak & Sreegiri, 2016). This signifies that industrialized nations are predominantly dealing with issues like overweight and obesity, while significant segments of the global population, mainly rural and tribal communities, continue to suffer from undernutrition (Young, 2004; Nayak & Sreegiri 2016).

Women are particularly vulnerable to nutritional problems due to various factors, including their household standard of living, religion, reproductive biology, social status, education, eating habits, sedentary lifestyles, and many others (Bharali et al., 2017; Bharati et al. 2019). Socio-cultural traditions and disparities in household work patterns can further increase women's risk of malnutrition (Khadivzadeh, 2002; Mihretie, 2018).

Anthropometry is a crucial component in assessing nutritional status in adults. Anthropometric data provides insights into overall health and dietary status (Simko et al., 1995; Jimenez, 2013). Body Mass Index (BMI) is a well-established indicator of anthropometry for assessing nutritional status (WHO, 1995; Jeyakumar et al., 2013). In an adult population of developing countries, BMI is considered one of the best indicators (easy and efficient in time and resources), which not only assesses nutritional status but also indirectly evaluates the socio-economic condition of the population (Khongsdier, 2002; Adak et al., 2006; Banik, 2008).

Like many countries, in India, overweight and obesity are increasingly becoming major public health issues due to shifts in lifestyles, changes in food habits, mechanization of agriculture, high consumption of fat and energy-dense foods, and reduced physical activity. While overnutrition is rising, undernutrition remains one major health challenge (Kshatriya & Achary, 2016; Bharati et al., 2019), creating a dual burden of malnutrition.

Nutritional status is influenced by an individual's food consumption, lifestyle, and other factors (Shetty & James, 1994; WHO, 2006; Nithya & Bhavani, 2017). Poor hygienic practices can cause infectious diseases such as diarrhea, leading to malnutrition (Stevens et al., 2022; Victora et al., 2021). Considering the importance of nutritional status, many studies have been conducted to understand the nutritional status of adult women, emphasizing the importance of such research (Fajobi et al., 2023; Sheema et al., 2016; Bhandari et al., 2016; Issa et al., 2024).

Aims and objectives: This present study was conducted among the adult women of the Midnapore municipal area, Paschim Medinipur, West Bengal, India, to recognize the following objectives:

1. To assess the nutritional status of the study population.
2. To understand the factors influencing the nutritional status of the participants.

METHODOLOGY:

This cross-sectional, community-based study was conducted in the Midnapore Sadar block of Paschim Medinipur, West Bengal, India. It employed a descriptive and ex-post-facto research design, focusing on young and middle-aged women from the Midnapore municipality area. Participation was voluntary, and verbal consent was obtained from all participants. Inclusion criteria were the following: adult women between 18 and <60 years of age, presumably healthy, who gave consent to participate in this study. Pregnant women or women who had delivery within one year were excluded from this study. In this study, 200 adult women (18 to < 60 years) were chosen through purposive sampling. Data was collected in mainly two phases in 2019 and 2022. All participants were clearly informed of the purpose and procedures of the study. No invasive tests were performed, and confidentiality was maintained. Participation in this study was voluntary, and consent was taken from each participant before data collection. Socio-demographic and economic data were gathered from each participant using the structured schedule and interviews. All the anthropometric measurements were measured following the standard procedure outlined by Winer and Laurie (1969). The measurements included height, waist circumference (WC), hip Circumference (HC), and mid-upper arm circumference (MUAC), which was measured to the nearest of 0.1 cm. Body weight was measured to the nearest of 0.5 kg. The participants were classified into various nutritional status categories according to the BMI classifications of WHO (1995). Mid-upper arm Circumference was calculated according to FANTA recommendations (Tang et al., 2020), and waist-hip ratio (WHR) classifications (WHO, 1989) were also used to determine nutritional status and central obesity among the participants. Collected data were organized and analyzed using SPSS (Statistical Package for Social Sciences) version 25. Statistical methods were used to analyze the data, including percentages and Chi-square tests. A p-value of ≤0.05 was regarded as statistically significant.

RESULTS

The socio-demographic characteristics of the study participants are summarized in Table 1. Most women in the study fell within the 31-45 years age range. Most of the participants (88%) were married, while a smaller percentage were unmarried (5.5%) or widowed (6.5%). The data indicates that most participants had completed at least secondary education or higher. 20.5% had graduated or pursued higher education, 19% had completed higher secondary education, and many were preliterate (16%).

Table 1: Socio-demographic characteristics of the study population

Variables	Frequency (n=200)	Percentage (%)	Variables	Frequency (n=200)	Percentage (%)
Age group (Years)			Occupation		
18-30	49	24.5	Homemaker	107	53.3
31-45	103	51.5	Day Labour /Housemaid	24	12.0
46-60	48	24.0	Business	21	10.5
Educational status			Service	48	24.0
Pre-literate	33	16.5	Physical Activity		
Primary	16	8.0	Low	47	23.5
Secondary	72	36.0	Moderate	121	60.5
Higher Secondary	38	19.0	High	32	16.0
Graduate+	41	20.5	Communities		
Marital Status			General	150	75
Unmarried	11	5.5	ST	10	5
Married	176	88.0	SC	20	10
Widow	13	6.5	OBC	20	10

ST=Scheduled Tribes, SC= Scheduled Castes, OBC=Other Backward Communities

Additionally, over half of the participants identified themselves as homemakers (53.3%). Many did not have formal occupations, but a portion of them were engaged in business (10.5%), daily labour/housekeeping (12%), or service roles (24%). In terms of physical activity, the majority of participants engaged in moderate physical activity (60.5%), with a smaller percentage participating in high-intensity physical activities (16%). Table 2 shows the basic statistics (mean, SD, SE) of different anthropometric variables.

The study population's overall nutritional status is detailed in Table 3. The findings indicate that 53% of adult women are malnourished, with 45% being overweight or obese. Although underweight is less prevalent than overnutrition, 8% of the participants still suffer from undernutrition. The table also shows that 19% of the participants were undernourished according

to MUAC measurements. Additionally, 38.5% of adult women were identified as centrally obese based on their waist-to-hip ratio (WHR).

Table 2: Basic statistics of anthropometric variables

Anthropometric variables	Mean	Standard Deviation (SD)	Standard Error (SE)
Height	152.1881	5.28856	.37396
Weight	57.50	12.113	.857
BMI	24.7244	4.57816	.32372
MUAC	26.6460	3.77421	.26688
Waist Circumference	82.5050	12.53039	.88603
Hip Circumference	97.9005	13.46521	.95213

Table 3: Nutritional Status (different criteria) of adult women of Midnapore

Nutritional Status		Frequency (n)	Percentage (%)
According to BMI classifications	Underweight (<18.5)	16	8
	Normal (18.50-24.99)	94	47
	Overweight (≥ 25.00)	90	45
According to MUAC classifications	Undernutrition (<24.00)	38	19
	Normal (≥24.00)	162	81
Central Obesity according to WHR	Normal	123	61.5
	Central Obesity (≥.85)	77	38.5

Table 4 represents the association of socio-economic factors with the nutritional status of the participants. The age group of the study participants has a Statistically significant ($\chi2$= 11.648; $p \leq 0.05$) association with their nutritional status. According to the result, the community of the participants has no statistically significant influence on the nutritional status of the participants. The participants' educational status and occupational status have a statistically significant association with the nutritional status of the participants. At the same time, the participant's marital status and physical activity have no significant association with their nutritional status. Table 5 represents different socio-demographic factors in the central obesity of the participants. A large proportion of women is centrally obese (38.5%). Women from all age groups show a high percentage of central obesity, among which 31-45 years age group show the highest percentage of central obesity (44.7%). Here, we can observe that the central obesity of participants has a statistically significant ($\chi2$= 10.191; $p \leq 0.05$) association with educational status, where most upper-education group shows a higher percentage of central obesity. According to the occupational

category, homemakers and servicewomen are most vulnerable to central obesity. Central obesity has a significant relationship with physical activity. The result suggests that those with central obesity work to get healthy

Table -4: Socio-demographic character wise nutritional status of the participants

Associated factors		Nutritional status (BMI)			Fisher's Exact test
		Underweight n (%)	Normal n (%)	Overweight n (%)	
Age group	18-30	7 (14.3)	26 (53.1)	16 (32.7)	11.648*
	31-45	3 (2.9)	45 (43.7)	55 (53.4)	
	46-60	6 (12.5)	23 (47.9)	19 (39.6)	
Community	General	10 (6.7)	64 (42.7)	76 (50.7)	11.309
	S.T.	1 (10.0)	7 (70.0)	2 (20.0)	
	S.C.	4 (20.0)	10 (50.0)	6 (30.0)	
	OBC	1 (5.0)	13 (65.0)	6 (30.0)	
Educational Status	Illiterate	7 (21.2)	19 (57.6)	7 (21.2)	19.747*
	Primary	1 (6.3)	9 (56.3)	6 (37.5)	
	Secondary	5 (6.9)	35 (48.6)	32 (44.4)	
	H.S.	1 (2.6)	19 (50.0)	18 (47.4)	
	Graduate+	2 (4.9)	12 (29.3)	27 (65.9)	
Occupational Status	Homemaker	4 (3.7)	58 (54.2)	45 (42.1)	15.763*
	Maid/Labour	6 (25.0)	11 (45.8)	7 (29.2)	
	Business	1 (4.8)	9 (42.9)	11 (52.4)	
	Service	5 (10.4)	16 (33.3)	27 (56.3)	
Marital Status	Unmarried	2 (18.2)	3 (27.3)	6 (54.5)	6.504
	Married	12 (6.8)	83 (47.2)	81 (46.0)	
	Widow	2 (15.4)	8 (61.5)	3 (23.1)	
Physical Activity	No	1 (2.6)	25 (53.2)	21 (44.7)	3.337
	Low	12 (9.9)	55 (45.5)	54 (44.6)	
	High	3 (9.4)	14 (43.8)	15 (46.9)	

*p≤0.05

Table -5: Socio-demographic character-wise central obesity among the adult women

Variables		WHR category		Fisher's Exact test
		Normal n (%)	Central Obesity n (%)	
Age Group	18-30	34 (69.4)	15 (30.6)	3.480
	31-45	57 (55.3)	46 (44.7)	
	46-60	32 (66.7)	16 (33.3)	
Community	General	91 (60.7)	59 (39.3)	1.987
	S.T.	6 (60.0)	4 (40.0)	
	S.C.	15 (75.0)	5 (25.0)	
	O.B.C.	11 (55.0)	9 (45.0)	
Educational Status	Illiterate	22 (66.7)	11 (33.3)	10.191*
	Primary	13 (81.3)	3 (18.8)	
	Secondary	35 (48.6)	37 (51.4)	

	H.S.	28 (73.7)	10 (26.3)	
	Graduate	25 (61.0)	16 (39.0)	
Occupational Status	Homemaker	62 (57.9)	45 (42.1)	5.118
	Daily Labor	19 (79.2)	5 (20.8)	
	Business	15 (71.4)	6 (28.6)	
	Service	27 (56.3)	21 (43.8)	
Marital Status	Unmarried	9 (81.8)	2 (18.2)	1.931
	Married	106 (60.2)	70 (39.8)	
	Widow	8 (61.5)	5 (38.5)	
Physical Activity	Low	37(78.7)	10 (21.3)	8.108*
	Moderate	67 (55.4)	54 (44.6)	
	High	19 (59.4)	13 (40.6)	

*$p \leq 0.05$

DISCUSSION:

Better nutritional status indirectly refers to a healthy diet and overall well-being. Various socioeconomic, cultural, traditional, and demographic factors play a significant role in shaping individuals' dietary patterns and nutritional status (Sheema et al., 2016). Millions of women across the world are now suffering from undernutrition due to Protein, energy, vitamin, and mineral deficiency, as well as poor socioeconomic and health conditions (Kumar et al., 2019).

The present study reveals that 47 percent of participants had normal nutritional status (according to BMI), and others were malnourished. Though the rate of undernourishment (8%) is comparatively lower in the present study population, overweight is a significant concern among women. Similar to the study of Sinha and Kapoor (2010), the present study also found that women in the 31-40 age group have a higher prevalence of overweight. However, Mahfuza et al. (2016) reported that overweight was more common in the 23-28 age group, which indicates age variation in the prevalence of over nourishment. The percentage of underweight women was slightly higher among the age group 18-30 years. Malnutrition (undernutrition and overnutrition) was higher among women in the higher age group. A similar result was found in other studies by Allman-Farinelli et al. (2008), Reither et al. (2009), Rengma et al. (2015), Wilk et al. (2017), Chaurasiya et al. (2019), Waghmare et al. (2022), which may suggest a trend of increasing overnutrition among higher age groups. There is a significant relationship between education and nutritional status (Wang et al., 2022). Higher education often comes with better nutritional knowledge, but this does not always translate into healthier eating habits. Educated individuals might understand nutrition but face challenges applying this knowledge due to lifestyle constraints or preferences. The current study demonstrates a statistically significant relationship between educational status and the

nutritional status of participants. The present study is an exact example of a situation where higher education does not translate into better nutrition due to lifestyle constraints. With the increased level of education, the percentage of undernourished women decreases, but overnutrition increases to a very concerning level. Many other studies also suggested that more education increases the percentage of overweight among women (Luhar et al., 2018; Mehboob et al., 2016; Rai et al., 2018; Waghmare et al., 2022).

The relationship between occupation and health is complex. However, a stable and fulfilling occupation can provide financial security and improve access to healthcare, nutritious food, and other resources necessary for maintaining good health. Our study found a statistically significant association between occupation and nutritional status among participants. Those engaged in business, services, or homemakers exhibited a lower percentage of undernourishment but a higher frequency of overnutrition. In contrast, maids and laborers had a higher prevalence of undernutrition but a much lower percentage of overnutrition. Other research has also reported a significant association between nutritional status and participants' occupation (King et al., 2001; Monda et al., 2008). The overall nutritional status of the study population is concerning, with a very high prevalence of overnutrition. The positive aspect is that the participants are conscious about their health condition, as a higher percentage of overnourished women do physical exercise to control the situation.

Conclusion:

The present study suggested that many adult women in the Midnapore municipal area are experiencing high malnutrition rates. Though the percentage of undernourished women in the study area is comparatively lower among the participants compared to previous literature, overnutrition is already a grave concern among the study population. This indirectly indicates improper health and well-being, affecting physical, mental, and social well-being, as individuals may experience reduced productivity and poor quality of life. Based on the findings, our study also indicates that increasing age, education status, and occupational status of women play a significant role in the nutritional outcome of the participants. Further in-depth research should be conducted to explore these influential factors.

Recommendation:

Overnutrition has emerged as the main nutritional challenge in urban areas in recent times, as supported by the results of the present study. In India, academic and awareness programs have traditionally focused on addressing undernutrition. However, with changing circumstances, there is a need to shift the focus and promote healthy eating and lifestyle habits.

Conflict of Interest

The authors declare that no known competing financial interests can influence the present study.

REFERENCES:

Acharya SR, Bhatta J, Timilsina DP. 2017. Factors associated with nutritional status of women of reproductive age group in rural, Nepal. *Asian Pacific Journal of Health Sciences,* 4(4): 19-24.

Adak DK, Gautam RK, Bharati S, Gharami AK, Pal M, Bharati P. 2006. Body mass index and chronic energy deficiency of adult males of Central Indian populations. *Human biology,* 78(2):161-178.

Allman-Farinelli MA, Chey T, Bauman AE, Gill T, James WP. 2008. Age, period and birth cohort effects on prevalence of overweight and obesity in Australian adults from 1990 to 2000. *European journal of clinical nutrition,* 62(7): 898–907.

Banik SD. 2008. Nutritional status of adult men from the Oraon tribe in Ranchi District of Jharkhand, India. *Malaysian journal of nutrition,*14(1): 91-99.

Bhandari S, Sayami JT, Thapa P, Sayami M, Kandel BP, Banjara MR. 2016. Dietary intake patterns and nutritional status of women of reproductive age in Nepal: findings from a health survey. *Archives of public health,*74:1-11.

Bharali N, Mondal N, Singh KN. 2017. Prevalence of undernutrition, overweight and obesity among Nyishi tribal women of Arunachal Pradesh, Northeast India. *Human Biology Review,* 6(1): 63-78.

Bharati S, Pal M, Sen S, Bharati P. 2019. Malnutrition and anemia among adult women in India, *Journal of Biosocial Science*, 51(5): 658-668.

Chaurasiya D, Gupta A, Chauhan S, Patel R, Chaurasia V. 2019. Age, period and birth cohort effects on prevalence of obesity among reproductive-age women in India. *SSM - population health*, 9: 100507. https://doi.org/10.1016/j.ssmph.2019.100507.

Fajobi DT, Ajetomobi JO, Raufu MO, Fajobi MO, Paramasivam P. 2024. Effects of food price on nutrition outcomes among women in Nigeria. *Food Science & Nutrition,* 12(1): 94-104.

Issa MY, Diagana Y, Khalid EK, Coulibaly SM, Gueye A, Dehah RM, Vall OEKM. 2024. Dietary diversity and its determinants among women of reproductive age residing in the urban area of Nouakchott, Mauritania. *BMC Public Health*, 24(1): 916.

Jeyakumar A, Ghugre P, Gadhave S. 2013. Mid-upper-arm circumference (MUAC) as a simple measure to assess the nutritional status of adolescent girls as compared with BMI. *Infant, Child, & Adolescent Nutrition*, 5(1): 22-25.

Jimenez EG. 2013. Body composition: assessment and clinical value. *Endocrinología y Nutrición*, 60 (2): 71-77.

Khadivzadeh T. 2002. Mid-upper arm and calf circumference as indicators of nutritional status in women of reproductive age. *EMHJ-Eastern Mediterranean Health Journal*, 8 (4-5): 612-618.

Khongsdier R. 2002. Body mass index and morbidity in adult males of the War Khasi in Northeast India. *European Journal of Clinical Nutrition,* 56(6): 484-489.

King GA, Fitzhugh EC, Bassett DR-Jr, McLaughlin JE, Strath SJ, Swartz AM, Thompson DL. 2001. Relationship of leisure-time physical activity and occupational activity to the prevalence of obesity. *International journal of obesity,* 25(5): 606-612.

Kshatriya GA, Acharya SK. 2016. Gender disparities in the prevalence of undernutrition and the higher risk among the young women of Indian Tribes, *Plos One,* 11(7):1-22.

Kumar P, Sinha R, Patil N, Kumar V. 2019. Relationship between mid-upper arm circumference and BMI for identifying maternal wasting and severe wasting: a cross-sectional assessment. *Public Health Nutrition*, 22(14): 2548-2552.

Luhar S, Mallinson PAC, Clarke L, Kinra S. 2018. Trends in the socioeconomic patterning of overweight/obesity in India: a repeated cross-sectional study using nationally representative data. *BMJ open*, 8(10). DOI: 10.1136/bmjopen-2018-023935.

Mahfuza I, Arzina H, Kamruzzaman MM, Afifa K, Afzal HM, Rashed N, Roksana H. 2016. Microbial status of street vended fresh-cut fruits, salad vegetables and juices in Dhaka city of Bangladesh. *International Food Research Journal,* 23(5): 2258-2264.

Mehboob B, Safdar NF, Zaheer S. 2016. Socio-economic, environmental and demographic determinants of rise in obesity among Pakistani women: a systematic review. *J Pak Med Assoc*, 66(9): 1165-72.

Mihretie Y. 2018. Review on factors affecting the nutritional status of women in Ethiopia. *Interventions Obes Diabetes,* 2(1) : 1-3. DOI: 10.31031/IOD.2018.02.000526

Monda KL, Adair LS, Zhai F, Popkin BM. 2008. Longitudinal relationships between occupational and domestic physical activity patterns and body weight in China. *European journal of clinical nutrition*, 62(11): 1318-1325.

Müller O, Krawinkel M. 2005. Malnutrition and health in developing countries. *CMAJ*, 173(3): 279-286.

Nayak MSDP, Sreegiri S. 2016. A study on nutritional status of tribal women in Visakhapatnam district, Andhra Pradesh, India. *Int J Community Med Public Health*, 3(8): 2049-2053.

Nithya DJ, Bhavani RV. 2018. Dietary diversity and its relationship with nutritional status among adolescents and adults in rural India. *Journal of biosocial science*, 50(3): 397-413.

Rai RK, Jaacks LM, Bromage S, Barik A, Fawzi WW, Chowdhury A. 2018. Prospective cohort study of overweight and obesity among rural Indian adults: sociodemographic predictors of prevalence, incidence and remission. *BMJ open*, 8(8). DOI: 10.1136/bmjopen-2017-021363

Reither EN, Hauser RM, Yang Y. 2009. Do birth cohorts matter? Age-period-cohort analyses of the obesity epidemic in the United States. *Social science & medicine,* 69(10): 1439–1448.

Rengma MS, Sen J, Mondal N. 2015. Socio-economic, demographic and lifestyle determinants of overweight and obesity among adults of Northeast India. *Ethiopian journal of health sciences,* 25(3): 199-208.

Sheema MK, Rahman RM, Yasmin Z, Rahman MS, Choudhary MY, Ali MFR, Javed A. 2016. Food habit and nutritional status of rural women in Bangladesh. *American Journal of Rural Development* 4(5): 114-119.

Shetty PS, James WP. 1994. Body mass index. A measure of chronic energy deficiency in adults. *FAO Food and Nutrition paper*, 56:1–57.

Simko MD, Cowell C, Gilbride JA. 1995. *Nutrition assessment: A comprehensive guide for planning intervention*. Gaithersburg: Aspen Publishers.

Sinha R, Kapoor AK. 2010. Cultural practices and nutritional status among premenopausal women of urban setup in India. *The Open Anthropology Journal,* 3:168-171.

Stevens GA, Beal T, Mbuya MNN, Luo H, Neufeld LM. 2022. Micronutrient deficiencies among preschool-aged children and women of reproductive age worldwide: a pooled analysis of individual-level data from population-representative surveys. *Lancet Glob Health*, 10(11). DOI: 10.1016/S2214-109X(22)00367-9.

Tang AM, Chung M, Dong KR, Bahwere P, Bose K, Chakraborty R, Charlton K, Das P, Ghosh M, Hossain MI, Nguyen P, Patsche CB, Sultana T, Deitchler M, Maalouf-Manasseh Z. 2020. Determining a global mid-upper arm circumference cut-off to assess underweight in adults (men and non-pregnant women). *Public Health Nutrition*, 23(17): 3104-3113.

Victora CG, Christian P, Vidaletti LP, Gatica-Domínguez G, Menon P, Black RE. 2021. Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. *The Lancet,* 397(10282): 1388-1399.

Waghmare H, Chauhan S, Sharma SK. 2022. Prevalence and determinants of nutritional status among women and children in Pakistan. *BMC Public Health*, 22:766:1-13.

Wang K, Wu C, Yao Y, Zhang S, Xie Y, Shi K, Yuan Z. 2022. Association between socio-economic factors and the risk of overweight and obesity among Chinese adults: a retrospective cross-sectional study from the China Health and Nutrition Survey. *Global health research and policy* 7(1): 41:1-10.

Weiner JS, Lourie JA. 1969. *Human biology: a guide to field methods*. International Biological Programme Handbook No. 9. Oxford: Blackwell Scientific Publication.

WHO. (1989). *Measuring obesity: classification and description of anthropometric data: report on a WHO consultation on the epidemiology of obesity, Warsaw, 21-23 October 1987*. World Health Organization, Regional Office for Europe.

WHO. 1995. *Physical status: The use of and interpretation of anthropometry*. World Health Organization: Report of a WHO Expert Committee.

WHO. 2006. *Adolescent Nutrition: A Review of the Situation in Selected South-East Asian Countries*. SEA-NUT-163. New Delhi: Regional Office for South East Asia.

Wilk P, Maltby A, Cooke M. 2017. Changing BMI scores among Canadian Indigenous and non-Indigenous children, youth, and young adults: Untangling age, period, and cohort effects. *Canadian Studies in Population* 44(1-2): 28-41.

Young TK. 2004. *Population health: concepts and methods*. New York: Oxford University Press.