Association between hypertension and obesity: an empirical study of Lahaul valley, Himachal Pradesh, India

Mandeep Kaur* and Kuldip Kaur

Guru Nanak Dev University, Amritsar 143 005, India

Obesity and overweight have emerged as potential risk factors for hypertension, coronary heart diseases and diabetes. These non-communicable diseases are increasing due to the high consumption of processed food and the adoption of a sedentary lifestyle. The present study aims to explore the prevalence of overweight, obesity, hypertension and behavioural factors among women in Lahaul valley, Himachal Pradesh, India. A group of 230 women from five villages of Lahaul valley was surveyed through interview method. First, descriptive statistics on anthropometric variables was done, followed by a binary logistic regression technique in order to calculate the odds ratio. Out of 230 sample participants, 31.7% were in the category of overweight and obesity, 51.7% were under systolic hypertension and 46.5% suffered from diastolic hypertension. The binary logistic regression method provided significant odds ratio, which revealed an association among body mass index, intake of excessive salt, tobacco products, physical inactivity and hypertension. The study concludes that being overweight, intake of extra sodium and physical inactivity are major risk factors for hypertension among women in Lahaul valley.

Keywords: Body mass index, hypertension, non-communicable diseases, obesity, odds ratio.

Background

OWING to substantial changes in the lifestyle and choices of individuals, non-communicable diseases are becoming a threat nowadays. According to the World Health Organization (WHO), Geneva, Switzerland, 60% of the deaths in India are mainly due to lifestyle diseases such as obesity, hypertension, diabetes, cardiovascular diseases and stroke[1]. It has been empirically established that obesity has a close linkage with hypertension. At present, hypertension is a major non-communicable disease in India and is particularly found among women. According to the fact sheet of WHO on hypertension, an estimated 1.28 billion adults (30–79 years) from low- and middle-income countries suffer from high blood pressure. Several studies have analysed the risk determinants of hypertension, such as low intake of fruits and vegetables, consumption of tobacco and excessive salt. According to World Health Statistics (2021), the overall prevalence of obesity among adults has increased by 50% from 2000 to 2016, while in women, there is a 70% increase in obesity. This is mainly due to insufficient physical inactivity among men and women[2]. The National Family Health Survey (NFHS-5) findings show that the proportion of overweight and obesity is 30.4% among the women of Himachal Pradesh (HP), India and the prevalence of hypertension is 22.2% (ref. 3). Thus, hypertension has become a silent killer in India and its incidence is increasing each year considerably, as estimated by NFHS-5.

In view of the above background, the present study aims to analyse the prevalence of overweight and obesity, and lifestyle as the risk factors of hypertension among women in Lahaul valley, HP.

Analytical framework

Study population and sampling

This is a cross-sectional study conducted in five villages of Lahaul valley. Multistage sampling has been used in this study to identify the households. In the first stage of sampling, Lahaul district was selected being a high-priority district of HP. In the second stage, on the basis of population, highly populated villages were selected, viz. Keylong, Udaipur, Jispa, Sissu and Koksar. In the third stage, households were chosen using a random number table. A group of 230 women were surveyed from August 2021 to November 2021 through face-to-face interviews. Furthermore, the sample size was determined using Yamane's formula as follows[4]

$$n = \frac{N}{1 + N\,(e)^2},$$

where n is the sample size, N the population size and e is the level of precision assumed to be 0.05. Using this formula, the sample size was determined as 241 and 230 women had participated in the study. The rest of the participants were unwilling to participate due to personal reasons. Data

*For correspondence. (e-mail: mandeepbhatia456@gmail.com)

analysis was done with the help of RStudio Team (2020). RStudio: Integrated Development for R. PBC, Boston. Descriptive analysis such as mean and standard deviation was carried out to determine height, body weight, body mass index (BMI), systolic blood pressure (SBP) and diastolic blood pressure (DBP). In addition, the women were categorized into five different age groups (21–30, 31–40, 41–50, 51–60 and 61–70 years). The cross-tabulation method was used to determine the relationship among different categories of BMI, SBP and DBP. To determine the risk of hypertension, a binary logistic regression technique was employed to find significant outcomes.

Anthropometric factors and lifestyle risk factors

The WHO STEPwise approach was used to measure the risk of non-communicable diseases[5]. The anthropometric measurements of weight, height, SBP and DBP were carried out according to WHO guidelines. The height of the participants was measured on the Frankfurt plane to the nearest millimetre and weight was measured using a digital weighing machine. The physiological measurements of blood pressure were recorded using a fully automatic digital blood pressure monitor (Omron HEM 7120, digital sphygmomanometer). The blood pressure was measured on the left arm in the sitting position. The cut-offs of SBP and DBP were classified according to the WHO guidelines for the pharmacological treatment of hypertension in adults[6].

Hypertension in adults is defined as SBP of 140 mm mercury (Hg) or higher and DBP of 90 mm Hg or higher. Prehypertension is defined as an SBP from 120 to 139 mm Hg or DBP (from 80 to 89 mm Hg). Hypertension stage I is defined as SBP from 130 to 139 mm Hg or a DBP from 80 to 89 mm Hg. Hypertension stage II is defined as SBP of 140 mm Hg or higher, and DBP of 90 mm Hg or higher. BMI is classified based on WHO classification[7]. The BMI categories of women participants are as follows: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese (>30.05 kg/m^2).

The lifestyle risk factors were analysed according to the WHO STEPwise approach to the non-communicable diseases risk factor surveillance guidelines[5]. Tobacco users are those who consume tobacco products at least once a day. The participants who smoked regularly were considered as smokers. Data on salt intake was collected and classified as 'intake of extra salt' and 'no extra salt'. In the case of physical activity, individuals engaged in moderate to vigorous intensity activities were considered physically active participants. WHO recommends that people do at least 600 metabolic equivalent minutes of physical activity, the equivalent of 150 min a week of brisk walking or 75 min of running[8]. WHO also recommends 400 g of edible fruits and vegetables per day in order to prevent the risk of non-communicable diseases.

Results

Table 1 elucidates the descriptive characteristics of BMI among the different age groups of women participants in this study. At first, five different age groups were formed with a gap of ten years. Among 230 women participants, the average height and weight were 159.8 ± 5.76 cm and 56.5 ± 5.48 kg respectively, whereas the average BMI value was 21.75 ± 3.11 kg/m^2. On the other hand, the maximum mean value of height was observed to be 162.0 ± 6.33 cm among women in the age group of 21–30 years and minimum mean height was 154.3 ± 5.81 cm in the older age group of 61–70 years. In the case of body weight, the opposite was observed, with maximum mean value of weight (61.0 ± 4.51 kg) found in the age group of 61–70 years and minimum mean value of weight (52.8 ± 5.12 kg) lying in the age group of 21–30 years. However, the average BMI value was found at the normal stage (18.5–24.9 kg/m^2) among women in four age groups, viz. 21–30, 31–40, 41–50 and 51–60 years. In the older age group, BMI was 25.6 ± 4.12 kg/m^2 (overweight). Thus the data indicate that as the age of women participants increases, their height decreases and body weight increases; this may become a risk factor for non-communicable diseases[9].

Table 2 shows the descriptive data on SBP and DBP among women participants in Lahaul valley. The maximum mean value of SBP and DBP was 141.5 ± 18.91 mm Hg and 83.6 ± 16.89 mm Hg respectively, in the age group of 61–70 years. The minimum mean value of SBP and DBP

Table 1. Descriptive statistics on height, body weight and body mass index (BMI) among females in different age groups

Age (years)	n	Height (cm) Mean ± SD	Body weight (kg) Mean ± SD	BMI (kg/m^2) Mean ± SD
21–30	65	162 ± 6	52 ± 5	20 ± 2
31–40	69	161 ± 6	54 ± 6	20 ± 3
41–50	46	159 ± 5	59 ± 5	23 ± 1
51–60	32	158 ± 5	60 ± 6	24 ± 3
61–70	18	154 ± 5	61 ± 4	25 ± 4
Total	230	159 ± 5	56 ± 5	21 ± 3

Source: Field survey. Note: Author's calculation.

Table 2. Descriptive statistics on systolic blood pressure (SBP) and diastolic blood pressure (DBP) among females in different age groups

Age (years)	n	SBP (mm HG) Mean ± SD	DBP (mm HG) Mean ± SD
21–30	65	106 ± 12	72 ± 13
31–40	69	108 ± 11	78 ± 12
41–50	46	125 ± 15	80 ± 14
51–60	32	131 ± 14	80 ± 11
61–70	18	141 ± 18	83 ± 16
Total	230	119 ± 16	77 ± 15

Source: Field survey. Note: Author's calculation.

was 106.5 ± 12.50 mm Hg and 72.4 ± 13.56 mm Hg respectively, in the age group of 21–30 years. However, the overall values SBP and DBP were observed to be normal among women in this study. Moreover, the risk of high SBP and DBP has been observed among older women participants in the present study.

Table 3 shows the distribution of female respondents in different categories of BMI, SBP, DBP and other lifestyle factors. With respect to BMI, the maximum number of women were found in the normal category (57.4%), followed by overweight (19.5%) and obesity (12.2%). A meagre proportion of women participants (10.9%) were underweight. In the case of SBP, maximum number of women had normal SBP (48.3%), 36.9% were found at the prehypertension stage, 8.3% in hypertension stage I and 6.5% women were in hypertension stage II. In the case of DBP, 53.5% of the

Table 3. Distribution of females among different categories of BMI, SBP, DBP and other lifestyle factors

Variable	n	Mean (%)
BMI		
Underweight	25	10.9
Normal	132	57.4
Overweight	45	19.5
Obese	28	12.2
Total	230	100.0
SBP		
Normal	111	48.3
Pre-hypertension	85	36.9
Hypertension stage I	19	8.3
Hypertension stage II	15	6.5
Total	230	100.0
DBP		
Normal	123	53.5
Pre-hypertension	76	33.0
Hypertension stage I	20	8.7
Hypertension stage II	11	4.8
Total	230	100.0
Physical activity		
Active	108	47.0
Inactive	122	53.0
Total	230	100.0
Intake of fruits and vegetables		
400 g per day	170	74.0
> 400 g per day	60	26.0
Total	230	100.0
Smoking habits		
Smoker	13	5.7
Non-smoker	217	94.3
Total	230	100.0
Consumption of salt		
Intake of extra salt	26	11.30
No extra salt	204	88.7
Total	230	100.0
Usage of tobacco		
Yes	11	4.8
No	219	95.2
Total	230	100.0

Source: Field survey. Note: Author's calculation.

women had normal DBP, 33.0% suffered from prehypertension, 8.7% were in hypertension stage I and 4.8% in hypertension stage II. According to the guidelines of the WHO STEPwise survey, five other lifestyle factors were analysed in the present study. Out of 230 women participants, 53% were found to be physically inactive, 26% consumed vegetables and fruits less than 400 g per day, 5.7% were smokers, 11.3% consumed extra salt and 4.8% consumed tobacco products at least once a day.

Table 4 shows the results of cross-tabulation between BMI and SBP. In case of underweight BMI category, 72.0% women had normal SBP, 28.0% were in prehypertension stage, while no respondent suffered from higher stages of hypertension. With respect to normal BMI category, 26.5% women suffered with prehypertension, 2.3% in hypertension stage I and 0.8% in hypertension stage II. With regard to overweight and obesity, no women respondent had a normal SBP level. Out of 45 overweight women, 62.2% were suffered from prehypertension, 22.2% were in hypertension stage I and 15.6% in hypertension stage II. With respect to obesity, 53.6% of the women suffered from prehypertension, 21.4% were in hypertension at stage I and 25% in hypertension stage II. Hence, the incidence of high SBP level was more in the overweight and obesity categories of BMI (>25.0 kg/m^2).

Table 5 examines the relationship between BMI and DBP. Under the category of underweight BMI, 56% women had normal DBP level, 40% suffered from prehypertension and 4% were in hypertension stage I. In the case of normal BMI group, 18.9% women were in the prehypertension stage and 0.8% in hypertension stage I. With regard to overweight and obesity, a greater risk of hypertension was observed. About 75.6% of overweight women suffered from prehypertension and 50% of obese women suffered from hypertension stage I. Moreover, 21.4% of the women were in hypertension stage II. Hence the older women population suffered from high DBP level.

Table 6 shows the results of odds ratio of hypertension with respect to BMI and other lifestyle factors among the women participants. Binary logistic regression was applied to predict the effect of hypertension (predicted variable) on predictor variables. The odds ratio of overweight women respondents had 2.84 times higher risk of hypertension compared to normal BMI women respondents (CI = 1.35–6.07, $P < 0.005$). Similarly, the odds ratio of obese females showed 2.91 times more risk of hypertension compared to the normal category of BMI (reference category; CI = 1.02–8.39, $P < 0.005$). However, the odds ratio for the underweight BMI category was not found significant at 5% level (OR = 1.73, CI = 0.59–2.38, $P > 0.005$). In other words, women in the underweight category of BMI had meagre risk of hypertension. Thus, being obese and overweight results in a greater chance of hypertension. Women participants who were less physically active had 3.32 times more chance of hypertension compared to physically active women (CI = 1.89–7.54, $P < 0.005$). Furthermore, there

Table 4. Cross-tabulation between BMI and SBP

BMI	SBP				
	Normal	Pre-hypertension	Hypertension stage I	Hypertension stage II	Total
Underweight	18 (72.0)	7 (28.0)	0	0	25
Normal	93 (70.4)	35 (26.5)	3 (2.3)	1 (0.8)	132
Overweight	0	28 (62.2)	10 (22.2)	7 (15.6)	45
Obese	0	15 (53.6)	6 (21.4)	7 (25.0)	28
Total	111	85	19	15	230

Source: Field survey. Note: Author's calculation.

Table 5. Cross-tabulation between BMI and DBP

BMI	DBP				
	Normal	Pre-hypertension	Hypertension stage I	Hypertension stage II	Total
Under weight	14 (56.0)	10 (40.0)	1 (4.0)	0	25
Normal	106 (80.3)	25 (18.9)	1 (0.8)	0	132
Overweight	2 (4.4)	34 (75.6)	4 (8.8)	5 (11.2)	45
Obese	1 (3.6)	7 (25.0)	14 (50.0)	6 (21.4)	28
Total	123	76	20	11	230

Source: Field survey. Note: author's calculation.

Table 6. Calculation of odds ratio by binary logistic regression

Variables	Lower bound	Exp (B)	Upper bound	df	Significance
BMI					
Underweight	0.59	1.73	2.38	1	0.348
Overweight	1.35	2.84	6.07	1	0.002
Obese	1.02	2.91	8.39	1	0.003
Normal		1			
Physical activity					
Active		1			
Inactive	1.89	3.32	7.54	1	0.004
Intake of fruits and vegetables					
400 g per day		1			
<400 g per day	0.65	1.08	4.59	1	0.232
Smoking habits					
Smoker	0.98	1.56	3.47	1	0.320
Non-smoker		1			
Consumption of salt					
Intake of extra salt	1.67	2.34	8.94	1	0.001
No extra salt		1			
Usage of tobacco					
Yes	0.24	0.94	4.65	1	0.002
No		1			

Source: Field survey. Note: Author's calculation.

was no significant risk of hypertension among women participants who consumed less fruits and vegetables per day (OR = 1.08, CI = 0.65–4.59, $P > 0.005$) and had smoking habits (OR = 1.56, CI = 0.98–3.42, $P > 0.005$). On the contrary, there was a significant relationship between the risk of hypertension and the consumption of excessive salt. The odds ratio of women participants who consumed extra salt had a 2.34 times higher risk of hypertension compared those who did not consume extra salt (CI = 1.67–8.94, $P < 0.005$). Likewise, the odds ratio of tobacco

users had 0.94 times higher risk of hypertension compared to non-tobacco users (CI = 0.24–4.65, $P < 0.002$). Hence, BMI, physical activity, intake of excessive salt and tobacco use were significant contributing factors for hypertension.

Discussion

The outcomes of anthropometric variables were similar to the previous findings. In the present study, maximum number of participants were found to be in the normal BMI category,

30% in the overweight or obese category and 10.9% in the underweight category, which is more or less similar to the Lahaul and Spiti district fact sheet (NFHS-5)[9] of 26.9% overweight category (BMI $\geq$ 25.0 kg/m²), and 9.9% are underweight category (BMI < 18.5 kg/m²).

In the case of SBP, approximately 52% of women participants suffered from different stages of hypertension (SBP > 40 mm Hg) and the risk was more in the older age groups (51–60 and 61–70 years) in comparison to the younger age group (21–30 years). For DBP, 46.5% of women participants suffered from DBP > 90 mm Hg. According to the data of NFHS-5, in Lahaul and Spiti district, 27.3% of women suffered from different stages of hypertension[10].

Furthermore, previous studies also showed a significant relationship between hypertension and BMI. Talukdar *et al.*[11] found that in India, one in five women (15–49 years) suffered from undiagnosed hypertension and risk factors are overweight, age, illiteracy, high income and caste. Kumar and Mishra[12] had estimated various factors related to the risk of hypertension with the help of the NFHS-4 database. Overall prevalence of hypertension among the women participants was found to be 11.56% and the risk of hypertension increased with age[12]. The present study also shows a significant relationship between BMI and hypertension through logistic regression analysis. It has been found that overweight and obese women had a greater risk of hypertension (P < 0.005) compared to normal BMI category women. Further, physical activity and intake of excessive salt have also affected hypertension. Physical activity is a strikingly important parameter in reducing the risk of hypertension[13] and the odd ratio of physically inactive women participants was 3.32 times more at risk of hypertension. In the case of excessive salt consumption, the odd ratios was 2.34 times more at risk of higher SBP and DBP. Several studies have identified the close relationship between sodium intake and hypertension globally[14,15]. According to WHO, high salt intake (>2 g/day) and insufficient potassium intake (<3.5 g/day) can increase the risk of hypertension, cardiovascular diseases and stroke[15]. In Lahaul valley, the women who consumed tobacco products were at risk of hypertension (OR = 0.94, CI = 0.24–4.65, P < 0.002). Many studies have established the relationship between smoking tobacco products and hypertension, and smoking is positively associated with hypertension[16,17]. Mungreiphy *et al.*[18] found a significant positive correlation between BMI, SBP and DBP among the Nagas males in North East India. The odds ratio showed that overweight and obese men had a greater risk of hypertension than those with normal BMI[18].

Conclusion

The present study analysed the overall prevalence and risk factors of hypertension such as BMI and other lifestyle factors among women in Lahaul valley. The study reveals that only 57.4% of women have normal BMI, while approximately 32% are overweight and obese. Half of the women participants suffered from different stages of SBP and DBP. Moreover, there was a significant relationship among BMI, excessive consumption of sodium, use of tobacco, lack of physical activity and hypertension. Therefore, women should consider these factors in order to decrease the incidence of hypertension, which is also a leading cause of other non-communicable diseases such as heart attack, diabetes and stroke. Thus, the present study provides useful information regarding the risk of hypertension.

Limitations

The major limitation of this study is that the entire Lahaul and Spiti district was not covered. The study focused only on Lahaul valley and its major highly populated villages. Field surveys in Spiti valley are challenging due to its climate and terrain. Also, men were not considered in this study because of their migration in search of employment opportunities.

Conflict of interest: The authors declare no conflict of interest.

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