

A Descriptive Study of Relationship between Body Mass Index and Selected Health Indicators in Females

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Introduction

Body Mass Index (BMI) is typically used to characterise the shape of the body and is a fairly reliable indicator of body fatness for most of the people. It does not measure the body fat directly, but many studies have shown that BMI is strongly correlated to many direct measures of body fat. A decrease in BMI reflects a decrease in the energy intake relative to the energy expenditure and vice versa. BMI is calculated from the weight and height of a person by the formula, $BMI = \frac{\text{Weight in Kg.}}{(\text{Height in metre})^2}$. BMI is also recognised as a simple, less expensive and easy-to-calculate method of screening for weight categories that may lead to health problems. BMI, however, is not a diagnostic tool but it can be used as a screening tool to identify possible health problems related to, especially, among adults. BMI is now increasingly being used to assess the nutritional status of an individual – child as well as adult. It can also be used as a risk factor for the development of many health related problems that have public health relevance.

There are many studies that have analysed the relationship of BMI with a range of health, socioeconomic and biological factors. Kalyanshetti and Kallur (2016) found a positive correlation between anaemia and BMI among medical students but the correlation coefficient was not significant. Hanafi et al (2013) has examined the pattern of haemoglobin level and its relation to BMI among preparatory year female students of a university in the Kingdom of Saudi Arabia. They found that the anaemia was prevalent among female students but among anaemic females, the BMI was normal in 46 per cent females. Ajayi et al (2017) examined the relationship between BMI and some haematological indices. The findings of this study established that the higher the proportion of overweight and obese females, the higher the haematological dyscrasias in the Hb SS subjects. Micozzi et al (1989) studied the relationship between body size and composition and clinical, biochemical and haematological indices in men and women in United States and observed that BMI, skin-fold thickness and lean body mass (LBM) are associated with higher haemoglobin level. Agrawal et al (2017) found

a positive correlation between fasting blood glucose level and BMI in Jharkhand. This study also concluded that food habits, intensive lifestyle modifications and regular exercise may prevent new-onset of diabetes, especially in patients with high BMI and high glucose level. There are also studies that show a link between BMI and the risk of several diseases and premature death (Knight 2011, Zheng et al, 2011). On the other hand, there are studies that suggest that many people with normal BMI, are actually unhealthy based on other health criteria. At the same time, there are many people who are considered obese on the basis of BMI but are actually healthy. It appears that there is a need to analyse the specificity and sensitivity of BMI with respect to selected health related issues facing people. It may be argued that BMI can be used to screen selected health conditions of the people in a simple and straightforward manner that does not require any kind of laboratory investigation. If this is so, then BMI can be used to screen the population at a large scale in a time and cost effective and people friendly manner.

In the present paper, an attempt has been made to examine the relationship between the body mass index (BMI) with three individual health related indicators of the woman - the level of glucose and the level of haemoglobin in the blood and the level of the diastolic and systolic blood pressure - that are particularly relevant to the adult and the old population. The purpose of the present analysis is to explore whether the BMI can be used as a population-based screening tool to identify individuals who are at relatively higher risk of diseases associated with high blood glucose level, low haemoglobin level and high and low systolic and diastolic blood pressure.

Data

The paper is based on the data available through the National Family Health Survey 2015-16 which is a nationwide survey of a statistically representative sample of households of the country. In this survey, 601509 households were selected all over the country, covering all states and Union Territories, in which 699686 women of age 15-49 years and 112122 men of age 15-54 years were found eligible for interview. During the survey, in addition to anthropometric measurements (height and weight), data about the haemoglobin level, the blood pressure and the random glucose level were also collected for the first time. The Seca 874 digital scale and Seca 213 stadiometer were used to measure weight and height of females. For haemoglobin analysis, a battery-operated portable HemoCueHb 201+ analyser was used. Blood pressure was measured by using an Omran Blood Pressure Monitor while random blood glucose level was measured by using Free Style Optium H glucometer with glucose test strips. Before the collection of the anthropometric and the bio-marker data, consent had been taken from the respondents. The present study is restricted to only those females who had given their consent for the collection of the bio-marker data collection. Moreover, currently pregnant women and women who had given birth in the month of interview have also been excluded from the present analysis to have a better understanding of the health and nutritional status. As such, the present analysis is restricted to only 517807 women who met the selection criteria for the present study.

Results and Discussion

Table 1 presents the descriptive statistics of the distribution of females with reference to the health and nutrition related indicators of females in India and in its 20 major states. The average BMI of females in the country and in all states included in the study falls within the normal BMI range, although it varies across states - highest in Kerala (23.44) but the lowest in Jharkhand (20.45). On the other hand, the mean haemoglobin level has been found to be below 12.0 g/dl in the country as well as in all states except three states - Jammu and Kashmir (12.34), Kerala (12.32), and Uttarakhand (12.21). Similarly, in the country and in all states, the mean blood glucose level has also been found to be within the normal range. Finally, mean blood pressure level in females of Assam, Punjab and West Bengal has been found to be close to the normal blood pressure level of 120/80 mmHg. The variation across states has been found to be the highest in case of BMI with a coefficient of variation of 0.042 compared to haemoglobin level (0.027); blood glucose (0.023); systolic blood pressure (0.022); and diastolic blood pressure (0.016).

In table 2, mean values of the three health related indicators, along with standard deviation, have been calculated separately for three categories of women - underweight women ($BMI < 18.5$); normal women ($18.5 \leq BMI < 25.0$); and overweight women ($BMI \geq 25.0$). It may be seen from the table that the mean values of all the three health related parameters are the highest in women with $BMI \geq 25.0$ but the lowest in women with $BMI < 18.5$ in the country and in all states. The table reflects the association of the health related parameters of an individual with the BMI of the individual.

Table 3 shows the proportionate change in the mean values of the health parameters between underweight women and normal women, and between normal women and over weight women. In India as a whole, the difference in the average values of the health parameters is more marked between normal women and overweight women as compared to under weight women and normal women. The proportionate difference in BMI between under weight and normal women is found to be the highest in Kerala but the lowest in Jharkhand. In case of haemoglobin level, this difference is found to be the highest in Odisha and Rajasthan but the lowest in Bihar. In case of blood glucose level, this difference is found to be the highest in Kerala but the lowest in Uttarakhand. In case of systolic blood pressure, this difference is found to be the highest in Kerala and Punjab but the lowest in Odisha and Uttar Pradesh. Finally, in case of diastolic blood pressure, this difference is found to be the highest in Tamil Nadu but the lowest in Jammu and Kashmir and Uttarakhand.

On the other hand, the proportionate change in BMI between normal and over weight females is found to be the highest in Gujarat but the lowest in Kerala. In case of haemoglobin level, the proportionate change is found to be the highest in Chhattisgarh but the lowest in Uttarakhand. In case of blood glucose level, this difference is found to be the highest in Andhra Pradesh but the lowest in Haryana. Finally, in case of both systolic and diastolic blood pressure, the proportionate difference between the mean values of normal and over weight females is found to be the highest in Telangana but the lowest in Jharkhand.

Table 4 represents the mean values of health parameters of women on the basis of their socio-demographic characteristics i.e. caste, religion and place of residence. Within caste classification, health indicators of scheduled tribe women are lowest. Health and nutritional status of Muslim women is better than Hindu women but not better than the women of other religions. The mean values of health indicators for the women residing in urban area is found to be better than women residing in rural area.

In table 5, women are classified on the basis of their selected socio-demographic characteristics and the level of BMI. It may be seen from the table that the mean values of the health parameters in all socio-economic categories is the highest in overweight women but the lowest in underweight women.

The proportionate increase in the average values of BMI as well as in all the four health parameters between underweight and normal women and between normal and overweight women with different social and economic characteristics is presented in table 6. The proportionate increase in the haemoglobin level is found to be the highest in Scheduled Tribes women. Similarly, the proportionate increase in the blood glucose level is found to be the highest in rural women.

Finally, table 7 presents the simple zero order correlation coefficient between the proportionate change in BMI and the proportionate change in health parameters across the states of the country and all the correlation coefficients are positive whereas as all but two are statistically significant. This implies that higher the proportionate increase in BMI, the higher the proportionate increase in all the four health parameters.

Conclusions

Non-communicable diseases (NCDs) now account for more deaths than deaths from communicable diseases in India. Major risk factors for NCDs are raised blood pressure, high blood glucose level and high cholesterol level. The present study shows that the increase in BMI is positively associated with the proportionate increase in the blood glucose level and the proportionate increase in the blood pressure. This implies that women with higher BMI have relatively higher chance of having raised blood pressure and higher blood glucose level or the risk of diabetes. In other words, the BMI can be used as the basis for screening women who may be at a higher risk of having non-communicable diseases. Since BMI is very simple to calculate, it can be used as a useful tool for population-based mass screening of women having a relatively higher risk of non-communicable diseases.

References

- Agrawal N, Agrawal MK, Kumari T, Kumar S (2017) Correlation between body mass index and blood glucose levels in Jharkhand population. *International Journal of Contemporary Medical Research* 4(8):1633-1636.
- Ajayi OI, Akinbo DB, Okafor AM (2017) Correlation between body mass index and hematological indices in young adult Nigerians with different hemoglobin genotypes. *American Journal of Biomedical Sciences* 9(1), 38-46.

- Hanafi MI, Abdallah AR, Zaky A et al. (2013) Study of hemoglobin level and body mass index among preparatory year female students at Taibah University, Kingdom of Saudi Arabia. *Journal of Taibah University Medical Sciences* 8(3):160–6.
- Kalyanshetti SB, Kallur R (2016) Association of anaemia with BMI in medical students: a cross sectional study. *Indian Journal of Basic and Applied Medical Research* 6(1):188-94.
- Knight JA (2011) Diseases and disorders associated with excess body weight. *Annals of Clinical & Laboratory Science*, 41(2): 107-121.
- Micozzi MS, Albanes D, Stevens RG (1989) Relation of body size and composition to clinical biochemical and hematologic indices in US men and women. *American Journal of Clinical Nutrition* 50(6):1276-1281.
- Zheng W, McLerran DF, Rolland B, Zhang X, Inoue M, Matsuo K, ... Potter JD (2011) Association between body-mass index and risk of death in more than 1 million Asians. *The New England Journal of Medicine* 364(8), 719–729.

Table 1
Status of health parameters for females in major states of India

States	Body Mass Index		Hemoglobin Level		Glucose Level		Systolic BP		Diastolic BP	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
India	21.51	4.18	11.69	1.62	104.13	28.98	115.16	14.72	78.03	17.82
Andhra Pradesh	23.14	5.03	11.31	1.75	106.20	40.45	111.94	14.94	77.92	18.27
Assam	21.11	3.57	11.93	1.52	105.54	27.79	121.63	16.50	81.81	17.24
Bihar	20.61	3.69	11.47	1.44	101.27	26.31	113.04	14.96	76.47	18.91
Chhattisgarh	20.81	3.64	11.82	1.54	104.67	27.94	115.35	15.39	77.96	17.44
Gujarat	21.62	4.87	11.51	1.64	103.95	29.86	114.98	15.22	78.60	20.94
Haryana	22.29	4.10	11.30	1.66	106.70	25.31	117.73	13.02	78.85	17.97
Jammu and Kashmir	22.47	4.17	12.34	1.79	101.78	25.95	117.82	14.73	78.91	19.26
Jharkhand	20.45	3.55	11.31	1.47	104.33	25.40	114.91	14.63	78.70	20.43
Karnataka	21.94	4.45	11.90	1.69	105.00	32.94	115.95	15.40	78.55	17.91
Kerala	23.44	4.10	12.32	1.34	111.57	35.87	114.22	14.65	75.86	18.48
Madhya Pradesh	20.90	3.90	11.65	1.64	102.53	27.07	114.77	13.85	77.89	17.71
Maharashtra	21.59	4.39	11.91	1.61	102.67	28.51	112.32	14.60	77.56	17.00
Odisha	21.17	4.03	11.66	1.52	104.53	30.34	114.75	15.25	77.78	18.81
Punjab	23.52	4.74	11.74	1.51	108.35	32.46	119.51	14.67	80.19	16.38
Rajasthan	21.07	3.96	11.83	1.67	101.61	22.79	115.08	13.39	77.32	17.69
Tamil Nadu	23.07	4.63	11.55	1.68	107.66	37.89	113.64	15.08	77.78	16.44
Uttar Pradesh	21.40	4.12	11.70	1.63	103.51	27.94	114.70	13.82	77.45	16.18
Uttarakhand	21.97	4.13	12.21	1.69	106.54	27.20	115.28	14.16	78.52	18.00
West Bengal	21.47	3.92	11.38	1.47	104.88	30.32	118.25	15.18	79.24	15.68
Telangana	22.17	4.83	11.39	1.90	104.28	37.04	111.22	18.28	77.45	19.29

Source: Authors' calculations

Table 2

Mean and standard deviation of selected health parameters in females in major states of India, 2015-16

State	BMI		Haemoglobin level		Blood glucose level		Systolic blood pressure level		Diastolic blood pressure level	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Underweight females (BMI<18.5)									
India	17.04	1.11	11.46	1.69	99.79	21.77	110.67	13.80	74.86	17.74
Andhra Pradesh	17.01	1.10	11.03	1.82	96.37	19.39	105.39	12.42	72.38	14.66
Assam	17.13	1.06	11.72	1.60	102.50	24.19	117.31	16.19	79.10	16.47
Bihar	17.07	1.11	11.36	1.47	98.00	20.89	109.59	14.82	73.74	17.72
Chhattisgarh	17.11	1.07	11.60	1.65	101.86	21.76	111.41	15.28	75.57	18.10
Gujarat	16.78	1.21	11.26	1.72	100.15	22.36	110.33	13.95	75.27	20.89
Haryana	17.06	1.11	11.02	1.75	102.50	18.78	111.69	11.37	75.24	18.84
Jammu & Kashmir	17.19	1.04	12.17	1.83	97.52	18.90	112.49	13.19	75.87	18.97
Jharkhand	17.07	1.07	11.13	1.53	101.62	20.62	111.58	14.58	76.51	20.22
Karnataka	16.93	1.13	11.67	1.79	99.12	21.98	110.32	14.33	74.51	16.15
Kerala	17.06	1.15	12.01	1.47	101.45	24.23	106.35	12.64	71.26	17.07
Madhya Pradesh	17.06	1.08	11.47	1.68	99.09	21.94	111.05	12.37	74.89	15.77
Maharashtra	16.91	1.15	11.70	1.70	98.41	20.54	107.30	12.56	73.89	17.67
Odisha	17.04	1.09	11.34	1.59	100.65	24.77	111.28	15.63	75.24	19.52
Punjab	17.00	1.18	11.46	1.64	101.30	27.05	111.08	12.18	74.56	13.96
Rajasthan	17.00	1.11	11.51	1.78	98.76	19.42	111.20	12.70	74.64	18.87
Tamil Nadu	16.95	1.17	11.29	1.84	98.53	22.93	106.53	13.15	72.50	12.68
Uttar Pradesh	17.09	1.07	11.52	1.70	100.00	21.71	110.81	12.92	74.49	16.93
Uttarakhand	17.18	1.07	12.02	1.79	103.04	19.76	110.37	11.90	75.46	19.13
West Bengal	17.03	1.10	11.16	1.48	99.37	23.33	113.71	14.03	76.48	18.69
Telangana	16.89	1.14	11.13	2.01	97.28	22.55	104.92	15.58	72.64	19.57

State	BMI		Haemoglobin level		Blood glucose level		Systolic blood pressure level		Diastolic blood pressure level	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Normal females (18.5≤BMI<25.0)									
India	21.29	1.77	11.71	1.60	103.16	25.97	115.19	13.97	77.82	17.56
Andhra Pradesh	21.58	1.83	11.23	1.76	101.88	33.14	110.43	14.00	76.81	19.93
Assam	21.27	1.75	11.95	1.50	104.89	25.19	121.92	15.88	81.76	17.07
Bihar	21.00	1.73	11.49	1.43	101.21	25.25	113.42	14.33	76.79	19.65
Chhattisgarh	21.07	1.68	11.83	1.49	104.17	26.74	115.98	14.66	77.95	16.44
Gujarat	21.36	1.81	11.53	1.62	102.90	26.59	114.91	14.43	78.24	19.85
Haryana	21.62	1.74	11.27	1.64	105.65	21.97	117.44	12.14	78.42	17.59
Jammu & Kashmir	21.53	1.73	12.32	1.79	100.05	22.46	117.08	14.10	78.15	19.19
Jharkhand	20.98	1.67	11.34	1.43	104.20	24.70	115.74	14.01	79.15	21.20
Karnataka	21.44	1.79	11.91	1.66	103.45	29.22	115.74	14.74	78.26	17.89
Kerala	21.98	1.77	12.34	1.32	109.17	30.89	113.31	14.02	74.75	17.08
Madhya Pradesh	21.10	1.74	11.67	1.63	101.96	24.51	115.07	13.09	78.02	17.93
Maharashtra	21.40	1.79	11.93	1.59	101.65	25.68	112.37	14.28	77.33	15.67
Odisha	21.19	1.77	11.70	1.48	103.91	28.51	114.93	14.75	77.78	18.75
Punjab	21.89	1.78	11.73	1.49	106.12	26.06	118.34	13.32	79.05	16.55
Rajasthan	21.21	1.73	11.88	1.61	101.22	20.21	115.40	12.70	77.21	16.95
Tamil Nadu	21.77	1.79	11.54	1.66	105.59	34.41	112.68	13.92	77.10	17.20
Uttar Pradesh	21.21	1.76	11.70	1.62	102.35	24.53	114.51	12.94	77.08	15.46
Uttarakhand	21.37	1.74	12.24	1.68	105.06	23.90	114.68	13.33	77.75	16.51
West Bengal	21.37	1.80	11.39	1.46	104.83	28.84	118.44	14.53	79.05	14.24
Telangana	21.43	1.83	11.35	1.89	102.31	34.36	110.59	17.31	76.95	18.99

State	BMI		Haemoglobin level		Blood glucose level		Systolic blood pressure level		Diastolic blood pressure level	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	Overweight females (BMI \geq 25.0)									
India	28.47	3.39	11.97	1.56	113.39	42.19	121.35	16.05	83.15	17.67
Andhra Pradesh	29.06	3.62	11.60	1.67	118.52	54.38	118.02	15.50	82.78	16.11
Assam	27.70	2.84	12.19	1.37	114.28	41.03	128.19	17.61	87.03	18.25
Bihar	28.09	3.28	11.69	1.41	110.36	39.27	120.37	15.51	82.14	16.68
Chhattisgarh	28.22	3.38	12.34	1.42	114.15	41.99	121.28	17.06	83.77	19.66
Gujarat	29.04	3.94	11.84	1.53	111.83	42.43	121.70	16.28	84.16	22.38
Haryana	28.40	3.42	11.60	1.61	113.19	35.97	123.29	14.50	82.93	17.67
Jammu & Kashmir	28.50	3.32	12.51	1.76	109.39	35.69	123.34	15.66	82.99	19.01
Jharkhand	28.15	3.23	11.65	1.43	113.83	38.05	120.59	15.87	83.02	14.84
Karnataka	28.63	3.45	12.11	1.64	115.40	46.82	122.48	15.75	83.62	18.55
Kerala	28.11	2.87	12.39	1.31	119.12	44.89	118.37	15.07	79.32	20.69
Madhya Pradesh	28.38	3.34	11.98	1.57	112.55	41.73	121.60	17.01	83.91	19.13
Maharashtra	28.49	3.37	12.16	1.49	111.34	40.94	119.02	15.36	83.22	18.15
Odisha	28.18	3.10	12.07	1.43	113.32	41.48	120.08	14.72	82.10	16.91
Punjab	29.02	3.70	11.86	1.49	115.15	42.17	124.95	15.78	84.48	15.94
Rajasthan	28.39	3.38	12.24	1.55	108.81	34.59	121.34	14.91	83.00	17.10
Tamil Nadu	28.62	3.41	11.71	1.62	116.15	47.33	119.05	16.11	81.76	15.80
Uttar Pradesh	28.47	3.34	11.97	1.54	112.78	41.94	121.19	15.63	83.15	16.06
Uttarakhand	28.53	3.46	12.30	1.64	114.73	39.29	121.95	16.20	83.96	20.30
West Bengal	27.89	2.90	11.65	1.45	112.62	40.42	123.82	16.86	83.66	14.92
Telangana	28.84	3.39	11.73	1.74	115.03	49.27	118.64	19.95	83.14	18.14

Source: Authors' calculations

Table 3

Difference between the mean values of selected health parameters of underweight, normal and overweight females, 2015-16

State	Underweight and normal females					Normal and overweight females				
	BMI	Haemoglobin level	Blood glucose level	Systolic blood pressure	Diastolic blood pressure	BMI	Haemoglobin level	Blood glucose level	Systolic blood pressure	Diastolic blood pressure
India	25.0	2.1	3.4	4.1	4.0	33.7	2.2	9.9	5.3	6.8
Andhra Pradesh	26.9	1.8	5.7	4.8	6.1	34.7	3.3	16.3	6.9	7.8
Assam	24.2	2.0	2.3	3.9	3.4	30.2	2.0	9.0	5.1	6.4
Bihar	23.0	1.2	3.3	3.5	4.1	33.8	1.8	9.0	6.1	7.0
Chhattisgarh	23.1	2.0	2.3	4.1	3.1	34.0	4.4	9.6	4.6	7.5
Gujarat	27.3	2.3	2.7	4.1	4.0	36.0	2.8	8.7	5.9	7.6
Haryana	26.7	2.3	3.1	5.1	4.2	31.4	2.9	7.1	5.0	5.7
Jammu & Kashmir	25.3	1.3	2.6	4.1	3.0	32.4	1.5	9.3	5.3	6.2
Jharkhand	22.9	1.9	2.5	3.7	3.4	34.2	2.7	9.2	4.2	4.9
Karnataka	26.6	2.1	4.4	4.9	5.0	33.5	1.7	11.6	5.8	6.8
Kerala	28.9	2.7	7.6	6.5	4.9	27.9	0.5	9.1	4.5	6.1
Madhya Pradesh	23.7	1.7	2.9	3.6	4.2	34.5	2.7	10.4	5.7	7.6
Maharashtra	26.5	1.9	3.3	4.7	4.7	33.1	1.9	9.5	5.9	7.6
Odisha	24.3	3.2	3.2	3.3	3.4	33.0	3.1	9.1	4.5	5.6
Punjab	28.8	2.3	4.8	6.5	6.0	32.5	1.1	8.5	5.6	6.9
Rajasthan	24.8	3.2	2.5	3.8	3.4	33.8	3.0	7.5	5.1	7.5
Tamil Nadu	28.4	2.1	7.2	5.8	6.4	31.5	1.5	10.0	5.6	6.0
Uttar Pradesh	24.1	1.5	2.4	3.3	3.5	34.2	2.3	10.2	5.8	7.9
Uttarakhand	24.4	1.9	2.0	3.9	3.0	33.5	0.4	9.2	6.3	8.0
West Bengal	25.5	2.0	5.5	4.2	3.4	30.5	2.3	7.4	4.5	5.8
Telangana	26.9	2.0	5.2	5.4	5.9	34.6	3.3	12.4	7.3	8.0

Table 4

Mean and standard deviation of selected health parameters of females by their social and economic characteristics in India

Socio-demographic characteristics		BMI		Haemoglobin level		Glucose Level		Systolic blood pressure		Diastolic blood pressure	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
All		21.51	4.19	11.69	1.62	104.13	28.98	115.17	14.72	78.03	17.82
Caste	Schedule Caste	21.15	3.96	11.61	1.65	103.68	28.96	114.6	14.79	77.68	17.43
	Schedule Tribe	20.25	3.33	11.44	1.63	102.6	25.00	116.20	14.64	78.47	18.39
	OBC	21.54	4.20	11.71	1.61	104.15	29.25	114.75	14.55	77.79	17.96
	Others	22.52	4.57	11.89	1.59	105.42	30.51	115.96	14.97	78.61	17.53
Religion	Hindu	21.38	4.11	11.67	1.62	103.91	28.56	114.95	14.59	77.90	17.77
	Muslim	21.94	4.48	11.83	1.63	104.48	30.83	115.55	15.21	78.41	18.41
	Others	22.49	4.54	11.71	1.58	106.57	30.83	117.35	15.28	79.20	17.34
Residence	Urban	22.89	4.73	11.76	1.61	106.07	33.33	114.74	15.26	78.29	17.49
	Rural	20.97	3.83	11.67	1.63	103.37	27.04	115.33	14.50	77.93	17.95

Source: Authors' calculations

Table 5

Mean and standard deviation of selected health parameters by weight categories of females

Classification of Socio-Demographic Characteristics		BMI		Haemoglobin level		Blood glucose level		Systolic blood pressure		Diastolic blood pressure	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Underweight females											
All		17.04	1.11	11.46	1.69	99.79	21.77	110.67	13.80	74.86	17.74
Caste	Schedule Caste	17.01	1.12	11.42	1.72	99.44	22.13	110.43	14.09	74.70	17.91
	Schedule Tribe	17.04	1.10	11.17	1.66	100.41	21.87	112.86	14.47	76.38	18.32
	OBC	17.04	1.10	11.51	1.67	99.72	21.48	110.14	13.54	74.47	17.59
	Others	17.05	1.11	11.67	1.67	99.80	21.95	110.23	13.22	74.61	17.24
Religion	Hindu	17.04	1.10	11.45	1.69	99.79	21.78	110.67	13.93	74.84	17.71
	Muslim	17.02	1.11	11.59	1.69	99.59	21.50	110.43	12.48	74.87	18.07
	Others	17.05	1.10	11.36	1.66	100.36	22.29	111.39	14.54	75.31	17.55
Residence	Urban	17.00	1.13	11.50	1.72	99.04	21.39	108.07	13.29	73.54	16.88
	Rural	17.05	1.10	11.45	1.68	99.97	21.85	111.30	13.85	75.18	17.93
Normal females											
All		21.29	1.77	11.71	1.60	103.16	25.97	115.19	13.97	77.82	17.56
Caste	Schedule Caste	21.24	1.76	11.62	1.63	103.05	26.43	114.81	14.23	77.60	16.71
	Schedule Tribe	20.96	1.67	11.51	1.59	102.71	24.32	117.04	13.99	78.84	18.20
	OBC	21.30	1.78	11.72	1.59	103.17	26.39	114.74	13.68	77.58	17.70
	Others	21.54	1.79	11.89	1.58	103.54	25.61	115.36	14.22	77.92	17.63
Religion	Hindu	21.26	1.77	11.69	1.60	103.07	25.75	115.05	13.85	77.76	17.58
	Muslim	21.38	1.78	11.84	1.62	102.84	26.80	115.39	14.75	77.92	17.81
	Others	21.56	1.78	11.71	1.55	105.14	27.35	116.70	13.97	78.47	16.69
Residence	Urban	21.63	1.79	11.74	1.59	103.74	28.18	113.89	14.27	77.33	16.94
	Rural	21.17	1.75	11.69	1.60	102.95	25.12	115.66	13.83	78.00	17.78

Classification of Socio-Demographic Characteristics		BMI		Haemoglobin level		Blood glucose level		Systolic blood pressure		Diastolic blood pressure	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
		Overweight females									
All		28.47	3.39	11.97	1.56	113.39	42.19	121.35	16.05	83.15	17.67
Caste	Schedule Caste	28.24	3.20	11.90	1.56	113.79	43.39	121.26	15.66	83.37	17.93
	Schedule Tribe	27.90	3.26	11.95	1.61	110.68	37.45	123.45	16.49	84.22	18.66
	OBC	28.43	3.36	11.94	1.56	113.31	42.25	121.03	16.16	82.97	18.15
	Others	28.76	3.52	12.05	1.53	113.80	42.23	121.50	15.97	83.11	16.57
Religion	Hindu	28.39	3.34	11.95	1.56	113.15	41.91	121.12	15.80	83.01	17.36
	Muslim	28.71	3.50	12.07	1.58	114.06	44.35	121.50	16.89	83.53	19.21
	Others	28.78	3.56	11.97	1.53	114.59	40.88	123.35	16.68	83.82	17.72
Residence	Urban	28.86	3.53	11.95	1.56	114.77	44.69	120.37	16.23	82.99	17.83
	Rural	28.15	3.22	11.98	1.56	112.24	39.94	122.17	15.84	83.29	17.53

Source: Authors' calculations

Table 6

Difference between the mean values of selected health parameters of underweight, normal and overweight females by socio-economic characteristics

Socio-economic characteristics		Underweight and normal females					Normal and overweight females				
		BMI	Haemoglobin level	Blood glucose level	Systolic blood pressure	Diastolic blood pressure	BMI	Haemoglobin level	Blood glucose level	Systolic blood pressure	Diastolic blood pressure
All		25.0	2.1	3.4	4.1	4.0	33.7	2.2	9.9	5.3	6.8
Caste	Schedule Castes	24.9	1.8	3.6	4.0	3.9	33.0	2.4	10.4	5.6	7.4
	Schedule Tribes	23.0	3.0	2.3	3.7	3.2	33.1	3.8	7.8	5.5	6.8
	OBC	25.0	1.8	3.5	4.2	4.2	33.5	1.9	9.8	5.5	6.9
	Others	26.3	1.9	3.7	4.7	4.4	33.5	1.3	9.9	5.3	6.7
Religion	Hindu	24.9	2.2	3.4	4.1	4.0	33.7	2.2	9.9	5.3	6.8
	Muslim	24.9	1.8	3.6	4.0	3.9	33.0	2.4	10.4	5.6	7.4
	Others	23.0	3.0	2.3	3.7	3.2	33.1	3.8	7.8	5.5	6.8
Residence	Urban	25.0	1.8	3.5	4.2	4.2	33.5	1.9	9.8	5.5	6.9
	Rural	26.3	1.9	3.7	4.7	4.4	33.5	1.3	9.9	5.3	6.7

Source: Authors' calculations

Table 7

Statistical tools for testing significant difference between underweight, normal and overweight females

Health Indicators of females	Underweight and normal females	Normal and overweight females
Correlation coefficient between percentage change in health indicators and BMI		
Haemoglobin level	0.051	0.404*
Blood glucose level	0.756**	0.357
Systolic BP level	0.890**	0.486**
Diastolic BP level	0.773**	0.535**

Source: Authors' calculations

Remarks: * p < 0.05.

** p < 0.01.