

Association between Blood Pressure, Body Mass Index, and Thyroid Hormone Levels among Northern Indians

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Abstract

Background: Maintaining blood pressure (BP) and body mass index (BMI) are the important indicators of health, especially when it comes to heart related problems. Frequent increase in BP and weight can affect the metabolism of the body that may lead to hypertension and obesity, universal contributors of most common endocrine disorders, subclinical hypothyroidism (ScH). The present study was conducted to find out the association between BP, BMI, and thyroid hormone level in blood donors.

Method: A total of 1018 healthy people who voluntarily come for blood donation in the hospital were participated in this study. Out of which 966 were included in which 97.6% were males and 2.4% were females aged between 18-59 years and 52 were excluded. Blood pressure, height, weight, BMI and blood group (BG) were measured using standardized protocol by trained nursing staff. Blood samples were taken for the estimation of free triiodothyronine (FT3), free thyroxine (FT4) and thyroid stimulating hormone (TSH) by chemiluminescence method on Vitros 56002355 clinical chemistry analyzer. Descriptive data and Pearson correlation coefficient were calculated by using SPSS (version 23.0).

Result: There were highly significant positive correlations between BP and BMI ($p < 0.0001$); SBP and FT3, FT4 ($p < 0.005$); FT3 and FT4 ($p < 0.0001$). And a negative significant correlation was found between FT4 and TSH ($p < 0.05$).

Conclusion: Study found a significant relationship between BMI subgroups and blood pressure indices among the participants. There is a need for prevention of weight gain for reducing the problem of hypertension. Regular physical activity and reduced dietary fat intake could be achieved by small life style changes for prevention of obesity-associated hypertension.

Keywords: Blood pressure, Body Mass Index, Thyroid hormone level, Blood donor.

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Introduction

Understanding blood pressure (BP) and maintaining it under normal range are important for overall health and longevity. After all, it's one of the most important indicators of health, particularly when it comes to the heart. It is possibly affected by certain factors like age, medication, life style modification and sometimes even gender. Having blood pressure outside the normal range is a risk factor for serious medical issues. If it is too high, hypertension, patients are at risk of heart attacks

and stroke and if it's too low, hypotension, can be life-threatening in severe cases. Globally, high BP was estimated to cause 7.1 million deaths, about 13% of total [1]. India in a process of rapid economic development and modernization with changing life style factors has an increasing trend of hypertension especially among urban populations. The number of adolescents suffering from hypertension is increasing over the years, in no small part because there has been a striking shift

in the lifestyle of children and teenagers. Doctors prescribe hypertension patient to reduce consumption of foods containing cholesterol, sugar and fat. Sugar results in easy weight gain, a major cause of high BP [2]. Body mass index (BMI), calculated as weight in kilogram (kg)/height (m²), is the simplest acceptable tool for determining relative body fatness in both clinical and epidemiological studies and was recommended as universal criterion of overweight and obesity [3,4]. Overweight and obesity represent a rapidly growing threat to the healthy populations in an increasing number of countries [5] and is becoming a global epidemic [6]. Obesity is considered as a gateway disease, which can lead to heterogeneous diseases such as hypertension, diabetes, metabolic syndrome, gastrointestinal, respiratory disease and certain types of cancers [7, 8].

Positive relationship between BP and BMI has been reported among Asian populations [9,10]. The Framingham heart study, a famous study for 44 years, estimated that excess body weight (including overweight and obesity) accounted for approximately 26% of cases of hypertension in men and 28% in women, and for approximately 23% of cases of coronary heart disease in men and 15% in women [11].

Obese individual have an increase in fatty tissues that increase their vascular resistance and in turn increases the work the heart has to do to pump blood throughout the body. Obesity was associated with hypertension and hypertension was associated with several medical conditions including endocrine disorder, subclinical hypothyroidism.

Subclinical hypothyroidism (ScH) has been more frequently found in developing countries including India; its prevalence varies from 9% to 12% [12]. ScH is defined as individuals having TSH level is higher above the reference range along with normal serum concentration of FT3 and FT4 [13]. It is well known that the thyroid hormones lead to increase the basal metabolic rate (BMR) and patient with hypothyroidism are characterized by increased body weight [14]. It is believed that increased BMI is known to play an important role in developing thyroid disorder [15].

Despite a growing burden of obesity, hypertension, and thyroid disorder in India, there is limited information on the association between BP and BMI and thyroid hormone levels.

The present study was therefore undertaken to examine the prevalence of normal, overweight and obesity on the basis of BMI, Hypertension and hypotension on the basis of BP and subclinical hypothyroidism and hypothyroidism on the basis of thyroid hormone levels.

And to investigate whether there is an association between BP, BMI, and thyroid hormone levels in blood donor in a tertiary care hospital.

Material and Method

The present study was conducted in the department of clinical biochemistry laboratory and the blood bank of the multispecialty hospital, Medanta - The Medicity, Gurugram, India for a period of one year. The study involved 1018 healthy individuals who were voluntarily came for blood donation at the hospital. 52 of them were excluded as they were having family history of thyroid illness, known and uncontrolled hypothyroidism or hyperthyroidism, Anti- TPO positive persons were also excluded from the study, only euthyroid healthy volunteers, 966 donors with the age group between 18 to 59 years were included for the study. The patients were briefed about the objectives of the study before taking their written consent. Copies of consent form were used to obtain and record information about gender, blood pressure, height, weight and previous history of any diseases of the participants. Data of thyroid hormone levels (FT3, FT4, TSH), age groups (N=966) categorized as \leq 20 years (N=31), 20-29 years (N =428), 30-39 years (N=332), 40-49 years (N=134), \geq 50 years (N=41) and gender (943 Male and 23 Female), were collected.

Anthropometric parameters including weight (WGT) was measured while the donor was standing on a balance scale with bare feet and light clothes. Participant were placed in the anatomical position, head, eyes facing forward and upright position, foot slightly apart and palms of hand facing forward. Height (HGT) was measured by using a stadiometer with the participants in standing position without shoes. Height was recorded by standing in front of the participants noting the corresponding level of vertex of head on the meter. BMI was calculated as weight in kilograms over height in meters squared.

The BMI was classified for Asian Indian¹⁶ as underweight if <18 kg/m², normal weight if 18.0-22.9 kg/m², overweight if 23.0-24.9 kg/m² and obese if ≥ 25.0 kg/m². Blood pressure (SBP and DBP) measurements were taken on the right arm while the participants were in a seated position by following a standardized procedure using digital devices with appropriately sized cuffs. Hypertension was defined as if SBP ≥ 140 mmHg or DBP ≥ 90 mmHg.

Subsequently, donors were divided into eight groups as per their blood groups (A Positive, n=17; A Negative, n=200; B Positive, n= 25; B Negative, n=342, O Positive, n=27; O Negative, n=306; AB Positive, n=08; AB Negative, n=41) Serum thyroid hormone levels (FT3, FT4, TSH) were estimated

on venous blood sample by using chemiluminescence method on VITROS 56002355 clinical chemistry autoanalyzer (Ortho Diagnostic, USA). A familiarization phase was completed prior to reference interval testing and calibrating all assays and establishing QC limits for each analyte. QC samples were analyzed every time and only when they are within limits then sample analysis begin. Blood donors were then divided into two groups according to their TSH level as normal if TSH range is between 0.465-4.68 μ IU/mL and subclinical hypothyroidism when TSH range is \geq 4.70 μ IU/mL and serum FT3, FT4 were in normal range.

Statistical Analysis: Results of present study were expressed in frequency and percentage. Median, Standard deviation (Stdev), standard error of mean (SEM), Range, Minimum (Min) and Maximum (Max) were used to summarize the description details of the blood donors. Pearson correlation coefficient was used to analyze the association between BP, BMI and thyroid hormone levels among donors. The level of significance was set at ($p < 0.05$). Data was analyzed by using Statistical package for the social sciences software (SPSS), version 23.0.

Results and Observations

A total of 966 healthy individuals with the age group of 18-59 years who were voluntarily come for blood donation camp at multi super-specialty

hospital, Medanta-The Medicity, Gurgaon were involved in the present study. Conventional BMI cutoff points were applied to categorize the subjects into normal, overweight and obese. Similarly, BP was also categorized subjects into normal and hypertensive and also, thyroid hormone level was categorized subjects into normal and subclinical hypothyroidism as per literature classification for Asian Indian population.

Table 1 (a) showing the frequency (in percentage) as per different categories of BMI subgroups showing 71.6% blood donors were obese and 18.6% were overweight. 1(b) showing blood pressure as SBP in which 29% were hypertensive,1(c) showing DBP, in which 26% were hypertensive,1(d) showing 10.2 % donors were suffering from subclinical hypothyroidism. Descriptive data including median, Stdev, SEM, range, min and max values of ages, height in meter, weight in kilogram, BMI, BP in mmHg including SBP, DBP and thyroid hormone levels including FT3, FT4, TSH of all blood donors were presented in Table 2. Pearson correlation coefficient between all the studied parameters of blood donors were shown in Table 3. There are positive significant correlations ($p < 0.01$) of age with height, weight, BMI, DBP and a significant negative correlation of age and FT3, height and BMI, FT4 and TSH. There were also positive significant correlations of BMI with SBP, DBP and SBP with DBP, FT3, FT4 and DBP with, FT3 and FT3 with FT4.

Table 1: Descriptive data of BMI, SBP, DBP and serum thyroid hormone levels, 1(a) showing Frequency of BMI (Normal/Overweight/Obese), 1(b) SBP (Normal/Hypertensive), 1(c) DBP (Normal/Hypertensive), 1(d) Normal/ Subclinical Hypothyroidism

Parameters	Categories	N=966	Percentage (%)
1(a) Body Mass Index (BMI)	Normal (18-22.9)	94	9.7
	Overweight (23-24.9)	180	18.6
	Obese (\geq 25)	692	71.6
1(b) Systolic Blood Pressure (SBP)	Normal (120-139 mmHg)	686	71
	Hypertensive (\geq 140 mmHg)	280	29
1(c) Diastolic Blood Pressure (DBP)	Normal (80-89 mmHg)	729	74.5
	Hypertensive (\geq 90 mmHg)	237	25.5
1(d) Serum Thyroid Hormone levels	Normal (TSH range:0.465-4.68 μ IU/mL)	867	89.8
	Subclinical Hypothyroidism (TSH range: \geq 4.70 μ IU/mL, serum FT3, FT4 were in normal range)	99	10.2

Table 2: Showing Descriptive data of blood donors (N=966) of northern Indian

	Anthropometric Parameter				Blood Pressure		Thyroid Hormone Levels		
	AGE	HGT	WGT	BMI	SBP	DBP	FT3	FT4	TSH
Median	30	170	77	27.28	132	82	3.72	1.24	2.33
Stdev	8.69	8.48	12.38	5.04	11.80	9.16	0.46	0.21	1.50
SEM	0.28	0.27	0.39	0.16	0.38	0.29	0.015	0.0065	0.048
Range	41	60	111	44.52	80	110	3.68	1.55	9.36
Min	18	130	28	18.72	100	30	2.23	0.79	0.45
Max	59	190	139	63.24	180	140	5.91	2.34	9.81

Table 3: showing Pearson correlation among Age, HGT, WGT, BMI, BP, and Thyroid Hormone levels (FT3, FT4, TSH) of blood donor (N=966)

		HGT	WGT	BMI	SBP	DBP	FT3	FT4	TSH
AGE	r-value	0.085**	0.141**	0.085**	0.033	0.151**	-0.185**	-0.029	0.031
	p-value	<0.001	<0.001	<0.001	0.309	<0.001	<0.001	0.369	0.338
HGT	r-value		0.160**	-0.399**	0.042	0.055	-0.032	0.028	-0.012
	p-value		<0.001	<0.001	0.194	0.087	0.316	0.380	0.711
WGT	r-value			0.795**	0.155**	0.209**	0.035	-0.022	0.044
	p-value			<0.001	<0.001	<0.001	0.283	0.501	0.176
BMI	r-value				0.110**	0.166**	0.036	-0.045	0.056
	p-value				<0.001	<0.001	0.258	0.162	0.083
SBP	r-value					0.552**	0.104**	0.079*	0.028
	p-value					<0.001	<0.001	<0.001	0.385
DBP	r-value						0.083*	0.039	0.051
	p-value						<0.001	0.226	0.114
FT3	r-value							0.281**	-0.036
	p-value							<0.001	0.270
FT4	r-value								-0.069*
	p-value								<0.05

p- Value <0.05 is considered as statistically significant, <0.001 is highly statistically significant

Discussion

The results presented provide considerable insight into the relationship between BMI, BP and TSH level. These results analyses, based on prospective data from 966 individuals, demonstrate the significant correlation between BMI (HGT and WGT) and BP (SBP, DBP, MAP, PP) and FT4 and TSH. Further we found that risk of hypertension was linked to change in BMI, but with the strongest effect in obese individuals.

Our data showed the strong correlation between obese subjects and DBP, this association is significant as $p < 0.01$. The increase of DBP with increasing BMI confirmed by other studies as well [17]. The overall BMI characteristics of the participants in the present study are similar to the study by Manjeet Kaur et al. (2016) conducted on 300 students in Amritsar, India. The MAP is an indication of the rate of perfusion of blood through the arteries and veins to the organs. Normal values range from 70-110 mm Hg. Present data showed that mean value of MAP was highest in obese person (border line) and lower in normal subjects. Study population in overweight groups was highly correlated (strongest correlation coefficient) with MAP and this correlation was significant as $p < 0.05$. Studies conducted on the relationship between body mass index and blood pressure in Asia, Africa, Europe and the United States were found to be similar to this study [10,18,19]. A prospective cohort study held on 22071 individuals in Harvard school also revealed a positive relationship between body mass index and blood pressure [20]. SBP was highest in normal subjects and least in obese subjects. This is contra dory to the findings of Ravisankar et al. (2005) who determined the highest correlation between

overweight and SBP whereas lowest correlation between underweight and SBP [21]. This contradiction can be explained by lifestyle modification or people are more aware of hypertension prevalence nowadays. Mungreiphy et al. (2011) also reported a significant correlation between body mass index and blood pressure (SBP and DBP) among Tangkhul Naga Tribal males of Northeast India. The body mass index and blood pressure in overweight participants showed statistically significant relationship. This is contrary to the findings of Manjeet Kaur et al. (2016) who determined no statistically significant relationship between overweight subjects and blood pressure (SBP and DBP) in the population of 300 student of age 17-19 years. In a large study, Huang et al [22] included 82473 US nurses and studied the relationship between change in BMI and incident cases of hypertension based on self-report and recall of body weight, and found that increase in body weight substantially increased the risk for hypertension.

Explanations for this positive correlation of BMI-BP include the change in lifestyle, less interest in physical activities, more uptake of salt. In obesity and hypertension, abnormal kidney function initially is due to increased tubular sodium reabsorption, this result in sodium retention and expansion of blood volumes. Thus, the higher level of BP required by the obese individuals to maintain sodium fluid homeostasis. Sympathetic nervous system activation, rennin- angiotensin-aldosterone system activation and compression of kidney are several potential mechanisms that could mediate the sodium retention and hypertension associated with obesity. A controlled consumption of salt from the early months of life, fighting excess weight from the first year of life, and always encouraging

the practice of physical activity in children and adolescents are feasible healthy options.

The strength of our study was the participation of large number of populations, permitting a prospective design. To the best of our knowledge, very rare studies have conducted in India to show the correlation between BMI subgroups and blood pressure indices. Most of the surveys were performed very long time ago and new studies should re-examine the strength of BMI-BP relationship. An effect of accommodation of individuals to BP measurement could possibly account for some of the difference in BP level between 2016 and 1990s. Such effect would be unlikely to affect the BMI-BP relationship differentially in 2016 from 1990s.

The result of this study should be interpreted bearing in mind the limitations of this research. BP was measured only at one visit, according to NHBP criteria BP should be measured at least on three occasions. This could have affected the estimation of hypertension prevalence in sampled subjects. Additionally, our study showed the positive correlation between DBP and normal subjects but not statistically significant ($p < 0.05$). Salt intake and urinary sodium excretion of the participants were not assessed.

In conclusion, BMI is closely and positively correlated with BP. Mean BP level increase with increasing BMI categories. Similarly, TSH is also significantly correlated with FT4 but there was no significant correlation between FT4 with BMI, BP except SBP. The risk of hypertension prevalence is higher among groups with overweight and obesity.

In this regard, intervention measures should be instituted to control the rising trend of overweight and obesity in children and adolescents. Such preventive measures would decrease the prevalence of associated diseases, including hypertension.

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