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Research Article

CORRELATION OF BODY MASS INDEX WITH HS-CRP IN NORTH INDIAN OVERWEIGHT AND OBESE HEALTHY ADULTS

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ABSTRACT

Introduction: Obesity is being considered as a worldwide health threat and understanding its mechanism and its correlation with hsCRP can lead to an insight into timely intervention in lifestyle to prevent the complications of it. Obesity is a low grade chronic inflammatory state, suspected to promote cardiovascular diseases, diabetes mellitus, atherosclerosis etc.

Aim: To determine, if there is any association between obesity and High-sensitivity C-Reactive Protein (hs-CRP)

Materials and Methods: Fifty obese and overweight subjects were included in study after following inclusion and exclusion criteria strictly. Anthropometric parameters were measured which included height, weight, hip circumference, waist circumference, W:H ratio. BMI was calculated and after following Asia Pacific standard overweight and obese were selected. hs CRP levels were measured . The data was expressed as mean and standard deviation (SD) or median, range and percentage as appropriate. Continuous variables in two groups were compared by t- test. Pearson's correlation was used for correlation. The p-value <0.05 was considered as significant. The statistical analysis was done using SPSS 23.0 version (Chicago, Inc., USA) windows software

Results: .The mean age of study cases was 38.82±7.81 years in which the mean age of females was 39.18±8.38 years and of males was 38.64±7.62 years.

The mean height of study cases was 163.62±8.33 cm in which the mean height of females was 155.06±5.43 cm and of males was 168.03±5.70 cm.

The mean weight of study cases was 89.29±9.43 kg and found to be relatively more in females compared to males, while the mean waist circumference was 102.38±9.79 cm and found to be relatively more in males compared to females, but the Hip circumference was more in females. The mean W: H ratio of the study cases was 1.00±0.11, the mean BMI was 33.46±3.19 kg/m^2.

The systolic and diastolic blood pressures had the mean 130.60±5.98 mmHg and 129.53±6.58 mmHg respectively.

The hs-CRP was significantly negative correlated with height whereas, significantly positive correlated with BMI and Diastolic BP.

Conclusion: A correlation pattern of inflammatory biomarker protein hs-CRP in obese human subjects was found. This may have a long-term impact in enabling us to know the methods for lowering hs-CRP levels that may help combat the issue of obesity in population throughout the world

INTRODUCTION

Obesity is a major public health problem. The prevalence of overweight and obesity is continuously increasing worldwide (1). In addition, the prevalence is alarmingly increasing in developing countries like India (2). Obesity is defined as a state of excess fat deposition in adipose tissues to the extent that health is impaired. (3). By following Asia Pacific classification system for the diagnosis of overweight (BMI ≥ 23), obesity (BMI ≥ 25), it has been found that Indians have a high prevalence of overweight and obesity (4). The genetic predisposition also contributed in making Indians more prone to have a high risk of overweight/obesity, type 2 diabetes mellitus (T2DM), cardiovascular diseases (CVD) and premature death, mainly in the younger age group (3,5). The people suffering from obesity in India is more than 135 million. It varies with respect to age, gender, geographical environment, socio-economic status etc. (6). In 2015, the ICMR-INDIA study reported that the prevalence rate of obesity and central obesity varies from 11.8% to 31.3% and 16.9%-36.3%, respectively. In addition, abdominal/central obesity is one of the major risk factors for CVDs (7).

Anthropometry is the study of the measurement of human body in terms of dimensions of bone, muscle, and adipose (fat) tissue. Measures of adipose tissue are important because

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individuals with high values are reported to be at increased risks for hypertension, diabetes mellitus type 2, cardiovascular diseases, gallstones, arthritis, and various forms of cancers. Combined with the dietary and relevant questionnaire data, and the biochemical determinants, anthropometry is essential and critical information needed to assist in describing the data collected from persons in the NHANES III sample.

Overweight/obese people have a high risk of adverse consequences. Several studies have suggested that the presence of low-grade inflammation in white adipose tissue is the leading cause of overweight/obesity. In this regard, high sensitivity C - reactive protein (hs-CRP) may play a key role in early screening and prevention of overweight/obesity. It is a well-known inflammatory marker (9).

The hs-CRP has high sensitivity to detect the low CRP levels which indicates low-grade inflammation. In 1930, Tillett and Francis discovered the CRP in the patient's serum with acute inflammation by the reactivity of "c" carbohydrate antibody and the capsule of pneumococcus (10). CRP is synthesized by the liver. It is a pentameric protein. Its level generally rises in response to inflammation. hs-CRP is usually reported in mg/L. The thresholds for classifying hs-CRP levels were set according to American Heart Association/Centers for Disease Control and Guidelines (those with hs-CRP <1 mg/L should be considered low risk, hs-CRP 1 to <3 mg/L as intermediate and ≥3 mg/L as high risk), (11,120). hs-CRP values in these ranges have shown sensitivity and specificity for early detection of overall vascular events such as in coronary arteries (13). Several studies have reported that hs-CRP is strongly associated with overweight/obesity and its complications (14, 15).

The excess of macronutrients in the adipose tissues stimulates them to release inflammatory mediators such as tumor necrosis factor α (TNF-α) and interleukin 6(IL-6) and reduces the formation of adiponectin, which predispose to pro-inflammatory state and oxidative stress. The raised level of IL-6 stimulates the liver for the production and secretion of CRP (15). In addition, when free fatty acids accumulates it causes activation of pro-inflammatory serine kinase cascades, such as IkB kinase and c-Jun N-terminal kinase, which promotes adipose tissue to release IL-6 and causes hepatocytes to synthesize and secrete inflammatory marker CRP (16). Inflammation plays a pivotal role in the development of CVD, atherosclerosis, metabolic syndrome, insulin resistance (IR), and T2DM. It also plays role in the development of psoriasis, depression, cancer, and renal diseases.

Therefore, the present study is planned to envisage the levels of hs-CRP in an early stage so that it may be helpful for preventing complications which may develop as a result of obesity.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Physiology and Pathology of King George's Medical University, Lucknow from September2019 to April 2020. Total fifty healthy obese/overweight adults of 18-50 years of age were included in this study. Subjects less than 18 years or ≥50 years of age, with anatomical deformity, known systemic illness, pregnancy and individuals on medications were excluded from the study. An informed written consent was taken from each subject on prescribed consent form after ethical approval from Institutional Ethical Committee (ref. code: 97th ECM II B-Thesis/P18).

Anthropometric measurements

Nhanes Anthropometry Procedure Manual was taken as reference.

Height, weight, waist circumference (WC), hip circumference (HC) were measured accordingly and waist to hip ratio (WHR) was calculated

BMI (kg/m2): Body mass index was calculated using the following formula:

BMI= weight (kg)/height (m^2) also called as quetelet's index. (2)

According to Asia pacific classification the subjects were categorized as underweight (<18.5 kg/m2), normal BMI (18.5–22.9 kg/m2), overweight (23.0 –24.9 kg/m2) and obese (≥25 kg/m2).

Blood pressure measurement (mm of Hg)

Blood pressure was measured by standardized mercury sphygmomanometer (Diamond deluxe apparatus, Pune, India)

CRP level estimation by ELISA

Under aseptic conditions venous blood (2ml) was collected in plain vial. Serum was separated by centrifugation and stored at -20 0C for further analysis. Serum hsCRP levels were measured using ELISA (Enzyme Linked Immunosorbent Assay) with a kit provided by Calbiotech Life Sciences Company (Catalog No. CR375C) El Cajon, CA 92020

Statistical Analysis

The data was expressed as mean and standard deviation (SD) or median, range and percentage as appropriate. All the categorical data was compared by using chi square test. Continuous variables in two groups were compared by t- test. Pearson's correlation was used for correlation. The p-value <0.05 was considered as significant. The statistical analysis was done using SPSS 23.0 version (Chicago, Inc., USA) windows software.

RESULTS

Table 1 shows the anthropometric parameters of the participants. The mean±SD of Age (years), Height (cm), Weight (Kg), BMI (Kg/mt2), W.C. (cm), H.C. (cm), WHR, Systolic BP (mmHg) and Diastolic BP (mmHg) were 38.58±7.47, 163.36±8.42, 84.48±13.28, 31.67±4.64, 101.40±10.81, 104.34±14.39, 0.98±0.13, 130.04±6.40 and 86.24±4.95, respectively. Out of 50, total 32 (64%) participant were male and 18 (36%) were female. On the basis of BMI, total 7 (14%) participant were overweight and 43 (86%) were obese. Anthropometric parameters like Waist circumference, only 6 (12%) subjects were at lower risk, the other 9 (18%) were at moderate risk and the remaining 35 (70%) were at a high risk. Considering this to be a cross-sectional study, amongst a population with higher 'n', 70% were at a high risk, 18% were at moderate risk and remaining 12% are at low risk. On the basis of waist to hip ratio, total of 38 (76%) were found to be in high risk zone, 4 (8%) subjects were found to be in the moderate risk zone and 8 (16%) people were found in the low risk zone.

Table 1 Anthropometric parameters of the participants

	Mean±SD
Age	38.58±7.47
Height (cm)	163.36±8.42
Weight (Kg)	84.48±13.28
BMI (Kg/mt^2)	31.67±4.64
W.C. (cm)	101.40±10.81
H.C. (cm)	104.34±14.39
WHR	0.98±0.13
Systolic BP (mmHg)	130.04±6.40
Diastolic BP (mmHg)	86.24±4.95
Gender	n (%)
Male	32(64%)
Female	18 (36%)
BMI (kg/m^2)	
Overweight (23-24.9)	07 (14%)
Obese (≥25)	43 (86%)
Waist circumference (cm)	
Low (<90 M, <80 F)	06 (12%)
At Risk (90-100 M, 80-90 F)	09 (18%)
At High Risk (>100 M, >90 F)	35 (70%)
Waist to Hip Ratio (WHR)	
Low (<0.90 M, <0.80 F)	08 (16%)
At Risk (0.90-1.0 M, 0.80-0.90 F)	04 (8%)
At High Risk (>1.0 M, >0.90 F)	38 (76%)

The high sensitivity C reactive proteins (hs-CRP) of participant are shown in Table 2. The values are expressed as mean, median, ±SD, minimum and maximum. Range of hs-CRP was 2.0 to 14.0. The mean±SD of hs-CRP was 9.09±3.24 with 10.50 median.

Table 2 Circulatory Level of hs-CRP in Subjects

	Mean	SD	Minimum	Maximum	Median
hs-CRP (mg/l)	9.09	3.24	2	14	10.50

The correlation between WHR, BMI, SBP & DBP are shown in Table 3. The WHR and BMI expressed strong correlation with a value of 0.78 which was found to be significant (p=0.043). WHR and Systolic Blood Pressure exhibited a value of 0.1548 correlations, whereas Diastolic BP showed a correlation of 0.2353 with WHR. Both the systolic as well diastolic BP values were not found significantly correlated with WHR. BMI was found to be correlated with both systolic as well as diastolic BP at a correlation value of 0.1663 and 0.2871. Amongst these two, only the correlation between BMI and Diastolic BP was found to be significant (p=0.001). SBP and DBP are correlated with other at a correlation value of 0.1872., but this correlation was not found to be significant.

Table 3 Matrix Correlation between WHR, BMI, SBP & DBP in Subjects

Parameters	WHR	B.M. I	SBP	DBP
WHR	1	0.7800***	0.1548	0.2353
BMI		1	0.1663	0.2871*
SBP			1	0.1872
DBP				1

*p= 0.043, ***p= 0.001

Pearson's Correlation Between hs-CRP and anthropometric parameter of subjects are shown in Table 4. The hs-CRP was significantly negative correlated with height whereas, significantly positive correlated with BMI and Diastolic BP. Moreover hs-CRP was not significantly correlated with the weight, Waist circumference, Hip circumference, waist to hip ratio and systolic BP as shown in Table 5.

Table 4 Pearson's Correlation Between hs-CRP and Anthropometric Parameter of Subjects

Correlation parameter	R- Value	p- value
hs-CRP vs Height	-0.2992	0.0348*
hs-CRP vs Weight	0.06048	0.6037
hs-CRP vs BMI	0.3197	0.0236*
hs-CRP vs W.C.	0.01262	0.9307
hs-CRP vs H.C.	-0.1641	0.2547
hs-CRP vs WHR	0.1324	0.3595
hs-CRP vs Systolic BP	-0.05907	0.6836
hs-CRP vs Diastolic BP	0.2819	0.0473*

*=Significant (p<0.05)

Pearson's correlation between hs-CRP and overweight (BMI= 23-24.9 kg/m2) and obese (BMI ≥25 kg/m2) are shown in Table 5. The hs-CRP was significantly positive correlated with obese. Whereas as the hs-CRP was not significantly correlated with overweight.

Table 5 Pearson's Correlation Between hs-CRP and Overweight (BMI= 23-24.9 kg/m^2) and obese (BMI ≥25 kg/m2)

Correlation parameter	R- Value	p- value
hs-CRP vs Overweight	-0.06355	0.8923
hs-CRP vs Obese	0.3045	**0.047***

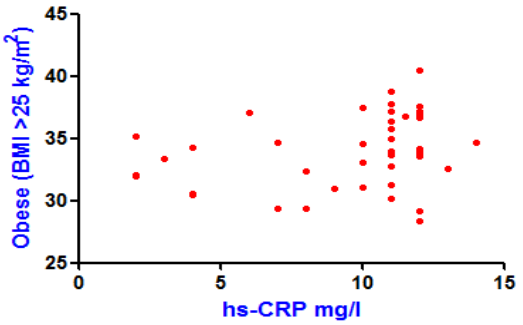

Figure 1 Pearson's Correlation Between hs-CRP and Obese (BMI ≥25 kg/m^2) of Subjects

DISCUSSION

Obesity is a complex, multifactorial disease which is now considered to be a leading health problem in many developed and developing countries. Lifestyle in a modern era supplemented to the weight gain of the entire population affecting almost all age groups. Obesity became such a big threat that World Health Organization had to establish a subsidiary unit named "International Obesity Task Force" (IOTF) in year 1996. The severity of the situation can be easily understood by the fact that obesity is now a prime contributor to a plethora of disease etiologies.

Chronic low-grade inflammation has been documented to play regulatory roles in various metabolic diseases and cardiovascular disease (CVD) under both physiological and patho-physiological conditions. Obesity is an important cause of chronic diseases and is also considered a state of chronic low-grade inflammation. Therefore, the evaluation of an individual's inflammatory status by measuring a biomarker could be helpful for predicting obesity-related health problems and decrease chronic disease burden in the population. (17)

We initiated this study with a notion to explore whether high sensitive C-reactive protein (hs-CRP) biomarker is more in overweight and /or obese subjects. Previous studies have enabled us to understand that levels of hs-CRP in human subjects are directly proportional to the level of inflammation present in the tissues (18,19) In our study, we observed that the

mean age of subjects was around 38.58years as is shown in (Table 1).

Anthropometric parameters

Various Anthropometric parameters were measured as depicted in Table 1. We utilized conventional methods of calculating height, weight, BMI, waist circumference, waist circumference to hip circumference ratio (WHR; waist hip ratio), and Systolic and Diastolic blood pressure. The analysis revealed that most of the subjects (irrespective of gender) were obese (86%). As per waist circumference, 70% were falling under the category of high-risk zone with respect to CVDs. Similar was the case with waist to hip ratio where 76% were at the high risk of having CVDs in later life. Both systolic and diastolic blood pressures were in normal range for all the human subjects in the study. Similar findings are found in previous studies conducted in past taking Asia Pacific classification for diagnosing overweigh and obesity.

Circulatory Level of High Sensitive C- Reactive Proteins

As depicted in Table 2, in our study mean level of hs-CRP of all subjects was found to be 9.09mg/l. This finding is in accordance with many previous studies. Mariusz Stępień *et.al*., found higher mean hs-CRP levels in obese individuals (20),

Pearson's Correlation Between hs-CRP and Overweight (BMI= 23-24.9 kg/m^2)

As already stated, this study was initiated to provide an insight into relationship of levels of hs-CRP component in blood with overweight (n=7) and obese (n=43) human subjects (Table 5). Here we found no significant Pearson's correlation between the overweight and circulatory levels of hs-C-reactive protein with a p value of 0.8923. Shilpa B *et al* found a positive correlation in overweight participants. Their findings are not in accordance to our study findings. (21) Possibility can be that number of overweight individuals were too less in our study. Various other studies have reported similar findings but there are very limited studies on North Indian overweight population.

Pearson's Correlation Between hs-CRP and Obese (BMI ≥25 kg/m^2)

Our study reported correlation pattern of biomarker protein hs-CRP with Obese (BMI ≥25 kg/m2) of Subjects (n=43) (Table 5). As we observed that p value for hs-CRP in subjects with BMI higher than 25kg/m^{2}was 0. 047.The possible mechanism may be that adipose tissue is the main source of cytokines, including IL6 which is the major determinant of hepatic synthesis of hs-CRP.

Bahceci M *et al* observed hs-CRP level was significantly higher in obese with and without diabetes as compared to healthy controls. (22). Kasukurti Lavanya *et al* found positive correlation of hs-CRP with BMI.(23). AN Klisic *et al* observed circulatory level of hs-CRP significantly higher in overweight postmenopausal women as compared to normal weight postmenopausal women. Positive correlation of hs-CRP was found with BMI in the overweight postmenopausal women group (24).

Bennett *et al*. found prevalence of higher hs-CRP raised with body mass index. In logistic regression models controlling for sex and parental education, high WC was associated with significantly higher odds of increased hs-CRP (OR 7.8, 95% CI 4.8–12.9, p < 0.001). They concluded that increased hs-CRP is common among Jamaican young adults and is strongly associated with central obesity (25). S. Firdous found high CRP and TG in most obese and pre-obese patient. His study suggested that 1 unit increase in BMI increases CRP by 0.239 times. This supports the fact that obesity, dyslipidemia and raised CRP can co-exist and are interrelated (26).

Wu DM *et al* in a correlation study found hs-CRP levels are positively related to BMI in study population (16). Similar observation found in present study that hs-CRP level is positively associated with BMI (Table 4).

Park HS *et al*., studied on the relationship of obesity with CRP and examined 46 obese (BMI 25 kg/m^2) and 54 non-obese (BMI < 25 kg/m^2) subjects between the age of 20–60 years (30 males and 70 females) from the department of Family Medicine at Asian Medical Center, Seoul, Korea. In this study they observed positive correlation with CRP in obese subjects with R value 0.50 and p= < 0.005 (27), which favors the correlation study between the hs-CRP and Obese (BMI ≥25 kg/m2).

Another study which support our observation is a short report study by Sanip Z *et al*., who examined the correlation of serum hs-CRP with obesity indices and metabolic markers in overweight and obese female subjects. The mean BMI of subjects was 32.93 kg/m2 and circulatory level of hs-CRP was 12.16 mg/l in overweight and obese female subjects. In the Pearson's correlation study, they observed hs-CRP level was positively correlated with BMI with R=0.281 and p= 0.007 (28).

Study by Ebrahimi *et al*, showed that all the obese subjects had a higher level of serum hs-CRP >3 mg/dl as compared to their non-obese counterparts (29).

Limitations of the study

In this study we took cross-sectional data, so causal relationship could not be established. The sample size was 95 subjects initially, which after exclusion/inclusion analysis and COVID 19 pandemic was reduced to a total of 50 apparently healthy human subjects. Thus, we can say that selection bias may exist in the data. Another limitation is that this study was restricted to a special demographical region in North India. Further larger population studies are required to establish hs-CRP as a biomarker to fulfil our objective

CONCLUSION

The most powerful factor regarding obesity is the fact that obesity is preventable. In the scenario of chronic obesity, it can easily be reversed by making healthier dietary choices along with being physically active. Our study gives an insight on the correlation between obesity and hsCRP as a crucial surrogate biomarker which can have immense benefits for letting know the future trends in diagnosis, prevention and treatment of obesity, thus decreasing burden of metabolic syndrome on society and avoiding other complications related to obesity. We further recommend that such studies if conducted at an adolescent stage can help to reduce the burden of obesity in our society.

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