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Autonomic Reactivity Differs in Young Adults Classified using Revised Indian and WHO Guidelines for Obesity

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ABSTRACT

Introduction: Many studies have reported alteration in autonomic activity in obesity. However, there is paucity of literature comparing autonomic reactivity using different guidelines of obesity. As Indian guidelines were revised recently and WHO states that countries should use all categories of BMI for reporting purposes, it is prudent to compare physiological state in different categories of BMI.

Aim: The aim of the present study was to compare the autonomic alteration in young adults using revised Indian and WHO guidelines for obesity.

Materials and Methods: A battery of autonomic tests (Valsalva Manoeuvre (VM), Deep Breathing Test (DBT), Lying to Standing Test (LST) and Hand Grip isometric exercise Test (HGT) was conducted on 34 overweight and obese and 30 normal weight volunteers categorised using revised Indian guidelines of body mass index. Same participants were regrouped and analysed using WHO guidelines of BMI and waist hip ratio (WHR).

Results: For analysis, participants were grouped into 3 categories of normal, overweight and obese using revised Indian guidelines for obesity. Same participants were regrouped according to WHO guidelines. E:I ratio during DBT, 30:15 ratio during LST, Valsalva ratio during VM and increase in DBP during HGT were compared in different subgroups. There was no difference in sympathetic and parasympathetic activities in participants classified according to revised Indian guidelines. In participants classified using WHO criteria, sympathetic reactivity in overweight subjects was significantly less as compared to normal subjects ($p<0.05$).

Conclusion: Autonomic alterations might be more related to body fat percent rather than BMI. Indian guidelines are based on the observation that Asian population has more adipose tissue in WHO range of BMI. As the guidelines of BMI are applicable to all age groups and do not consider physical activity profile, they might still not be a good predictor of body fat.

Keywords: Body mass index, Parasympathetic activity, Sympathetic activity, Waist-hip ratio

INTRODUCTION

Obesity is considered to be a risk factor for a variety of cardiovascular conditions like hypertension, ischemic heart disease and stroke [1] and is characterized by haemodynamic and metabolic alterations [2]. It has reached epidemic proportions in India with 88 million overweight and 135 million obese individuals with generalized obesity [3]. Obesity has been called "New world syndrome" and is a reflection of social, economic and cultural problems faced by developing as well as developed countries [4].

The ultimate cause of obesity is an imbalance between energy intake and expenditure resulting from complex interaction of genetic, physiological, behavioural and environmental factors [5]. As energy metabolism as well as regulation of cardiovascular system is influenced by autonomic nervous system [6,7], so obesity and its clinical consequences may be promoted by altered Autonomic Nervous System (ANS).

The assessment of ANS requires recording the response of an end organ to physiological maneuvers [8]. Stimuli that raise Blood Pressure (BP) activate sympathetic outflow and are a reflection of sympathetic activity. Changes in heart rate, by a stimulus, reflect parasympathetic modulation and activity [9]. Together, they determine autonomic activity.

Conflicting results have emerged over the nature of autonomic activity in obese individuals. In 2009, Bedi et al., found that there is decreased sympathetic activity in obese children compared to controls but no change in parasympathetic activity [10]. These findings are supported by earlier reports [11,12]. This reduced sympathetic reactivity may disturb homeostasis and lead to excess storage of energy [13]. On the contrary, an increase in body weight is associated with increased sympathetic and decreased parasympathetic activity. At young age (average of 9 years), obesity is significantly associated with lower Heart Rate Variability (HRV), indicative of impaired cardiac autonomic modulation in the direction of sympathetic overflow and reduced parasympathetic modulation [14]. Brunetto et al., reported decreased parasympathetic response to head up tilt manoeuvre in obese adolescents [15]. It has also been demonstrated that parasympathetic activity increases with weight loss in obese subjects [16]. Rajalakshmi R et al., demonstrated a decreased HRV, higher sympathetic and lower parasympathetic nerve activity in obese subjects [17]. BMI was the major determinant for the changes in time as well as frequency domain indices.

Body Mass Index (BMI) as well as Waist Hip Ratio (WHR) is used for classifying obesity in order to determine the autonomic activity in obese individuals.

Many studies [10-12] have reported the relationship between BMI and autonomic functions but almost all of them have used WHO criteria for classifying people with obesity. WHO states, wherever possible, countries should use all categories of BMI for reporting purposes to facilitate international comparisons (i.e., 18.5, 20, 23, 25, 27.5, 30, 32.5 kg/m^2) [18]. According to revised Indian guidelines of BMI, 18.5 kg/m^2 - <22.9 kg/m^2 is categorized as normal, 23 kg/m^2 – 24.9 kg/m^2 as overweight and ≥25 kg/m^2 is categorized as obese [19]. However, there is paucity of literature on autonomic function in obese using revised Indian criteria.

Additionally, if obesity is redefined using WHR instead of BMI, the proportion of people categorized at risk of heart attack increases threefold worldwide [20]. Many studies have reported that the indicators of central obesity are more sensitive than the indicator of general obesity [21-23].

In this context, we evaluated autonomic activity in young Indian obese adults using WHR and revised Indian and WHO guidelines of BMI.

MATERIALS AND METHODS

This cross-sectional study was approved by Institutional Ethics Committee and conducted from April 2014 to June 2014. For sample size calculation, previous studies on same population were searched for mean and variability in the parameters being studied. Effect size was determined from a study which reported autonomic tests in obese individuals using revised Indian guidelines [24]. A sample size of 16 in each group was sufficient to detect the determined effect size in the parameters at 5% level of significance with 80% power of the study.

The present study was conducted on 34 overweight and obese and 30 normal weight volunteers aged 18–25 years classified using Indian guidelines [19]. Subjects suffering from any chronic disease like hypertension, diabetes, CAD were excluded from the study. Other exclusion criteria included subjects with a history of smoking, alcoholism, drug abuse, patients taking medication e.g., vasodilators, α blocker, β blockers, barbiturates, opiates, tricylic antidepressants and phenothiazines that could affect autonomic functions.

After taking informed consent, participants were instructed not to consume alcohol the night before reporting and come at 9:00 am in fasting state without tea or coffee.

Height of the participants was taken to the nearest 0.1 cm and weight was recorded on calibrated digital weighing machine. Height and weight was used to calculate BMI. Participants were classified into normal, overweight and obese based on revised Indian guidelines.

Waist circumference was measured at the midpoint between lower margin of the last rib and top of the iliac crest, using a stretch resistant measuring tape. Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. Waist and hip circumference were used to calculate WHR. WHR ≥ 0.90 in males and ≥ 0.85 in females were considered as cut-off level [25].

To evaluate autonomic activity, Valsalva Manoeuvre (VM), Deep Breathing Test (DBT), Lying to Standing Test (LST) and Handgrip isometric exercise test (HGT) were done [26-28]. Sympathetic reactivity was assessed by increase in Diastolic Blood Pressure (DBP) during handgrip test and parasympathetic reactivity was assessed by E:I ratio during DBT, Valsalva Ratio (VR) during VM and 30:15 ratio during LST.

STATISTICAL ANALYSIS

The data was analysed using SPSS version 16. Normality of the data was checked using Kolmogorov - Smirnov tests. The data was not normally distributed. Owing to it and small sample size Kruskar Wallis and Mann Whitney tests were used as tests for significance. The $p<0.05$ was considered as statistically significant.

RESULTS

For analysis, the participants were divided into 3 BMI categories of normal, overweight and obese using revised Indian guidelines. The participants were also regrouped on the basis of WHO BMI guidelines and WHR. The subject parameters are given in [Table/Fig-1].

Using Indian BMI Guidelines

Median values and Intra-Quartile Range (IQR) of E:I ratio, 30:15 ratio, VR and increase in DBP are given in [Table/Fig-2]. Mann-Whitney test was done to compare E:I ratio, 30:15 ratio, VR and increase in DBP during handgrip test in normal BMI (18.5 - <23 kg/m^2) with those of increased BMI participants (> 23 kg/m^2). There was no significant difference between the groups.

Kruskar Wallis test was done to compare E:I ratio, 30:15 ratio, VR and increase in DBP in 3 groups of normal (18.5 - <23 kg/m^2) with overweight (23 - <25 kg/m^2) and obese subjects (>= 25kg/m^2). There was no significant difference among the subgroups.

Using WHO BMI Guidelines

As none of the participants had BMI >= 30kg/m^2, only 2 groups of normal (<25 kg/m^2) and overweight (>= 25kg/m^2) were formed.

Baseline parameters	Indian criteria BMI (kg/m^2)			WHO criteria BMI (kg/m^2)		WHR	
	<23	≥ 23 - <25	≥ 25	18.5- <25	≥ 25	< cut-off	≥ cut-off
n[a]	30 (M=16, F=14)	8 (M=4, F=4)	26 (M=15, F=11)	38 (M=20, F=18)	26 (M=15, F=11)	36 (M=14, F=22)	28 (M=21, F=7)
BMI / WHR	21.82±1.79	24.56 ±.04	29.37±3.83	22.28±1.6	29.8±3.8	0.81±0.04	0.91±0.04
Age (yr)	90.4 ±1.6	20.1 ± 1.4	19. 6 ± 1.3	20.4 ± 1.6	19.6 ± 1.3	20±1.5	20.1±1.6

[Table/Fig-1]: Mean and standard deviation of BMI, WHR[b] and age in different groups.
[a]overall sample size is n = 64
[b]BMI = Body mass index; WHR = waist hip ratio
M= Male, F = Female

Autonomic reactivity	Indian criteria BMI (kg/m^2)				WHO criteria BMI (kg/m^2)	
	<23	≥ 23	≥ 23 - <25	≥ 25	18.5 - <25	≥ 25
E:I ratio during DBT	1.58 (0.33)	1.50 (0.24)	1.50 (0.25)	1.50 (0.26)	1.55 (0.31)	1.50 (0.26)
30:15 ratio during LST	1.31 (0.28)	1.32 (0.27)	1.32 (0.42)	1.32 (0.26)	1.31 (0.28)	1.32 (0.26)
Valsalva ratio (VR)	1.39 (0.32)	1.35 (0.41)	1.29 (0.33)	1.39 (0.47)	1.38 (0.30)	1.39 (0.47)
Increase in DBP (mm Hg) during HGT	20.0 (16.0)	19.0 (14.5)	20.0 (23.0)	17.0 (12.5)	20.0 (16.0)	17.0 (12.5)*

[Table/Fig-2]: Autonomic reactivity in participants categorised as normal, over weight and obese using revised Indian and WHO criteria. Median (intraquartile range) of E: I ratio during deep breathing test (DBT), 30: 15 ratio during lying to standing test (LST), Valsalva ratio (VR), increase in diastolic blood pressure (DBP) during isometric exercise test (HGT).
p-value is associated with two-tailed independent samples Mann-Whitney test. Variable tagged with asterisk (*) denotes p < 0.05

Median values and intra-quartile range (IQR) of E: I ratio, 30:15 ratio, VR and increase in DBP are given in [Table/Fig-2].

The groups were compared using Mann-Whitney test. A significant decrease in handgrip response was seen in overweight and obese ($p < 0.05$) as compared to normal participants.

Using WHR

Mann-Whitney test was done to compare E:I ratio, 30:15 ratio, VR and increase in DBP during handgrip test in normal WHR with those of increased WHR participants. There was no significant difference between the groups.

DISCUSSION

Previous studies have reported both reduced and increased sympathetic activity in obese subjects. It has been suggested that decreased sympathetic activity might lead to obesity in children [10-12,29]. On the other hand, increased sympathetic activity has been found in middle aged obese men [17,30] and obese adolescents [15]. None of these studies used revised Indian guidelines for studying the autonomic function changes in new overweight category in the age group of 18-25 years.

According to Indian guidelines, people with BMI 23 - < 25kg/m^2 are classified as overweight and > 25kg/m^2 as obese. Present study has outlined no difference in autonomic activity between individuals when the overweight group was clubbed with obese individuals of Indian guidelines. However, when the same group was clubbed with normal BMI group, as in WHO guidelines, a significant decrease in sympathetic activity was found in individuals with BMI > 25kg/m^2. Indian guidelines are revised on the observation that Asian population has more adipose tissue in the WHO normal range of BMI [31]. As the guidelines are applicable to all age groups and do not consider physical activity profile, they might still not be a good predictor of body fat. This is especially true for the participants of present study as physical inactivity is less likely in this age group. A decrease in HRV parameters associated with progressive increase of body fat mass has been demonstrated by earlier workers [32,33]. As autonomic alterations might be more related to body fat percentage rather than BMI which does not differentiate between fat weight and fat free weight, simply classifying the 23 - <25kg/m^2 BMI group in risk category may not be appropriate.

In the present study, there was no difference in parasympathetic reactivity between the groups. Decreased parasympathetic response has been previously reported in people with obesity [15,34]. The difference may be due to variation in the duration of obesity and physical activity profile of the subjects which predominantly determine cardiorespiratory fitness and hence parasympathetic activity. This is supported by previous studies where greater parasympathetic cardiac activity has been found to be associated with higher levels of cardio respiratory fitness in girls as well as boys [35].

Also, there was no significant difference in sympathetic and parasympathetic reactivity when WHR was taken as criteria for obesity. Previous studies have shown lower parasympathetic modulation in female children with central obesity [36]. Standing sympathetic activity and supine parasympathetic activity are found to be significantly greater in upper body obesity than in lower body obesity [37]. The observations of present study can be explained on the basis of WHR being a ratio of waist and hip circumference. Because of the equation used to determine this value, both lean and massively obese individuals may end up having the same WHR [38], so any difference in autonomic activity in subjects will not be highlighted.

To the best of our knowledge this is one of the few studies to assess the relation of BMI with autonomic functions using both revised Indian guidelines and WHO guidelines. The validity of new BMI cut-offs in children is already being questioned [39]. Whether, it needs to be further studied in young adults is a question posed by the present study.

As our study was cross-sectional and limited in sample size, we recommend studying autonomic functions in overweight and obesity using revised Indian guidelines in a larger population of different age groups. We also recommend considering the parameters of physical activity for future studies to highlight the relationship of obesity with body fat. These studies will facilitate development of appropriate preventive interventions to address the public health problem posed by obesity [40].

CONCLUSION

Autonomic alteration might be more related to body fat percentage rather than BMI. The guidelines for obesity using BMI apply across all age groups and do not consider physical activity profile which can be a major determinant of body fat mass. Therefore, classifying 23-<25kg/m^2 of BMI group in risk category, especially in young adults, may not be appropriate.

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