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Assessment of Autonomic Function Activity in Obese Children

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Abstract: There is much evidence regarding autonomic dysfunction in obesity in adults, but information on autonomic status in obese children is scant. In the present study autonomic function tests were conducted in 30 normal and 30 obese children aged between 5 and 10 years. We performed tests for parasympathetic function (resting heart rate, S:L ratio (standing to lying ratio), 30:15 ratio and Valsalva ratio) and tests to assess sympathetic function (blood pressure response to hand grip test and cold pressor response). The children were classified as normal and obese on the basis of BMI (body mass index). Children with BMI between 20 to 24.9 were classified as normal and those with BMI > 30 as obese. The mean values of hand grip test and cold pressor response were significantly lower in the study group compared with controls (P < 0.05), however the Valsalva ratio was higher in the obese compared with normal children. Hence, our study showed compromised autonomic nervous system functions in the obese group compared with controls

Keywords: Obesity, autonomic function tests, children.

INTRODUCTION

There is much evidence regarding autonomic dysfunction in obesity in adults [1], but information on autonomic status in obese children is scant. Childhood obesity is a harbinger of obesity in later life. It may lead to multisystem disorders in children like growth and puberty disorders, and abnormal insulin, glucose and lipid metabolism. Also, there is close association of obesity and obstructive sleep apnea [1]. In addition there is also evidence of autonomic dysfunction in malnourished children [2] but little information is available as regards to the autonomic status is in obese children. Obesity results from a chronic imbalance between energy intake and energy expenditure. The energy balance is largely affected by the autonomic nervous system (ANS) activity of the individual. Thus, the present study was conducted in obese children to look at their status of the ANS compared with normal children.

METHODS

The study was conducted over a period of 1 year (August 2006 to August 2007) on 30 normal children (group A) aged 5-10 years (6.9 ± 1.2 years) and 30 obese children (group B) of the same age group (7.0 ± 1.4 years). The study was conducted in the Department of Physiology, Maulana Azad Medical College, New Delhi, India.

Children in the control group were selected from a school on the campus. The 30 obese were recruited from the pediatric clinic and from the relatives of staff members. In both groups care was taken to ensure that none of the children had any neuropsychiatric disorders or other systemic illness.

Height was measured in cm with the help of a scale with a sensitivity of 0.5 cm. Weight was recorded in kg using an Avery scale with a capacity of 120 kg and a sensitivity of 0.05 kg. All anthropometric measurements were done in duplicate.

The children were categorized as normal or obese on the basis of classification used by Garrow [3]. BMI was calculated as weight (kg)/height $(m)^2$. The BMI range of 20 to 24.9 was classified as normal. Children with BMI of 30 and above were classified as obese.

Before starting the study, each child was informed about the procedures and informed verbal consent was obtained from the children's parents or teachers.

The parasympathetic and sympathetic autonomic functions were tested separately for both the groups. They were done on Polyrite -8-Medicare machine (Ambala, India). All the tests were done on thermo-neutral conditions and at the same time of day on all subjects. Subjects were allowed to acclimatise to the experimental and environmental conditions. All the readings were recorded by a single observer so that interpersonal differences were eliminated. An average of 3 readings were taken for each subject for all the autonomic function tests as well as blood pressure (BP) recordings.

The following autonomic function tests were performed:

1. For Assessing Parasympathetic Activity

(i) Resting heart rate was calculated from ECG using standard limb leads [4].

(ii) The S:L (standing to lying) ratio was taken as the ratio of the R-R interval during the 5 beats before lying down to the shortest R-R interval during the 10 beats in the ECG after lying down [5].

(iii) The 30:15 ratio was calculated as the ratio between the R-R interval at beats 30 and 15 of the ECG recorded immediately upon standing [6].

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(iv) The Valsalva ratio. Subjects were asked to exhale into a mouthpiece connected to a mercury manometer and to maintain the expiratory pressure at 40 mmHg for 15 sec. During this manoeuvre and 45 sec afterwards, ECG was recorded. The Valsalva Ratio was calculated between the maximum R-R interval (after release of strain) and the minimum R-R interval (during strain) [7].

2. For Assessing Sympathetic Activity

(i) BP response to static exercise (hand grip test (HGT)). BP was recorded with the help of a sphygmomanometer and the diastolic BP (DBP) was taken as the point of muffling of sounds. The subject remained seated throughout. Resting BP was recorded 3 times in each of the subjects. The BP response to static exercise was studied by asking the subject to apply pressure on a standardized hand grip dynamometer at 30% of the maximum voluntary contraction for 1 min. BP was recorded simultaneously on the non-exercising arm. This was repeated 3 times with an interval of rest between each episode. The change in BP was taken as the difference between the mean of the BP reading during dynamometry and that during rest for both systolic (SBP) and diastolic BP (DBP) [8].

(ii) Cold pressor response (CPR) : Resting BP was recorded with the subject sitting comfortably. Subject was then asked to immerse his hand in cold water (temperature of water maintained at 4-6 ^{o}C) throughout the procedure. BP measurements were made from the other arm at 30 sec intervals for a period of 2 min after which the subject was asked to remove his hand. Maximum increase in systolic and diastolic pressure was determined. In any condition where there is deficient sympathetic outflow the cold pressor test will show a smaller rise in BP [9].

For each variable group, mean and SD were calculated. Intergroup mean differences were tested for significance by student's t test.

RESULTS

The general characteristics of the subjects are shown in Table **1.**

The results of the comparative study of autonomic functions are shown in Tables **2** and **3**. The mean values for HGT DBP, HGT SBP and CPR DBP (sympathetic function tests) were significantly lower in the study group compared with

Table 1. Baseline Characteristics of Subjects. Values are Expressed as Mean ± SD

Variable	Control (n =30)	Obese (n = 30)
Age (years)	6.9 ± 1.2	7.0 ± 1.4
Height (cm)	109.8 ± 6.3	113.8 ± 5.0
Weight (kg)	18.5 ± 1.7	21.1 ± 3.0
BMI (kg/m^2)	23.6 ± 2.7	32.1 ±1.4

BMI: body mass index.

Table 2. Comparison of Parasympathetic Function Tests. Values are Expressed as Mean ± SD

Variable	Control	Obese	p value
HR (beats/min)	82.6 ± 5.5	86 ± 6.7	0.23
S:L	1.3 ± 0.04	1.24 ± 0.03	>0.05
30:15	1.28 ± 0.11	1.26 ± 0.77	>0.05
Valsalva ratio	1.25 ± 0.04	1.29 ± 0.06	>0.05

HR: heart rate; S:L: standing to lying ratio.

Table 3. Comparison of Sympathetic Function Tests. Values are Expressed as Mean ± SD * indicates 'p' value < 0.05

Variable	Controls	Obese	p value
HGT DBP (mmHg)	13 ± 2.2	11.2 ± 1.4	<0.05*
HGT SBP (mmHg)	13 ± 1.4	11.4 ± 1.6	<0.05*
CPR DBP(mmHg)	14 ± 2.3	12 ± 1.6	<0.05*
CPR SBP (mmHg)	13 ± 2.6	12 ± 1.6	>0.05

HGT: hand grip test; CPR: cold pressor response; DBP: diastolic blood pressure; SBP: systolic blood pressure.

controls. However, the Valsalva ratio was higher in the obese compared to normal children.

DISCUSSION

A large volume of data is available as regards the indirect role of ANS in obesity but a comprehensive study of the autonomic status is not available especially in obese children [1,10,11]. Our study endeavors to show the status of sympathetic and parasympathetic nervous system in obese children.

In our study, the obese children showed a significant change in DBP and SBP after hand grip testing compared with the control group. In hand grip testing the DBP increase was less than that of controls indicating sympathetic insufficiency in obese children.

Another test of sympathetic function showed a significant change in DBP after cold pressor response test. The afferent fibres for this response are the pain fibres (which are stimulated by placing the hand in cold water) and the efferent fibres are the sympathetic fibres. A lesser increase in the DBP after the cold water immersion thus points towards sympathetic insufficiency in obese children [9].

Sympathetic insufficiency was also associated with obesity by Valensi *et al*. [12]. They showed that glucose-induced inhibition of the lipid oxidation rate in obese women is greater in the patients with autonomic dysfunction. This could be because of decrease in sympathetic activity.

A study conducted by Nargai provided evidence of autonomic depression in obese children which was associated with duration of obesity [13].

Decreased sympathetic activity may result in a disordered homeostatic mechanism thus promoting excessive storage of energy as suggested by Peterson [14].

The hand grip and cold pressor tests show reactivity to stress in conditions of isometric exercises and cold stress, respectively. It has been proposed that there may be reduced reactivity in established obesity which contributes to maintenance of the obese state [15].

The main goal of our study was to assess changes in sympathetic and parasympathetic nervous system activity in obese children. An increase in body weight was expected to accompany sympathetic activation [1]. But in our study there was decreased sympathetic activity. No change in parasympathetic nervous system functioning was found in obese children as opposed to controls. This was also reported by others [1, 16].

Thus, our study shows decreased sympathetic activity in obese children as compared with controls.

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