

Original article

Cardiac autonomic function tests in overweight adolescents

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Abstract:

Obesity is a global problem, prevalence of which is in the rise in nearly every country because of physical inactivity. Health implications of obesity are becoming more evident in children and adolescents. Childhood obesity affects virtually every organ system in an adverse manner. Autonomic nerve dysfunction may co exist with few recognised complications such as cardiovascular disorders in overweight and obese person. Objectives: To assess the cardiac autonomic function tests in overweight adolescents and compare with the normal weight subjects of same age.

Keywords: adolescents, cardiac autonomic function tests, overweight

Introduction:

Obesity is a global problem, prevalence of which is in the rise in nearly every country because of physical inactivity (1). Teenagers are more exposed to media and it is clear that the media, particularly TV play an important role in the etiology of obesity (2). Children and teenagers who use a lot of media/ who watch more TV may tend to be more sedentary in general (3), consume more calories or eat higher fat diet (4). Health implications of obesity are becoming more evident as the prevalence of childhood and adolescent obesity is increasing. Many obesity related health disorders are now commonly seen in children and adolescents with increasing frequency. These health conditions were once thought applicable only to adults (5).

Researchers observed that childhood obesity affects virtually every organ system in an adverse manner (6). Many of the complications remain silent and often go undiagnosed. However, children and adolescents are at high risk for development of early morbidity (7). Obesity can harm the cardiovascular system and that being overweight during childhood, adolescence and young adulthood may accelerate the development of heart

disease (5). Autonomic nerve dysfunction may also co exist in addition to few recognised complications such as cardiovascular disorders in overweight and obese persons (8). With this background we assessed the cardiac autonomic function tests in overweight adolescents and compared with the normal weight subjects of same age.

Materials and Method:

This study was conducted in Department of Physiology, J.J.M. Medical College, Davangere with 140 subjects of the age group 17-19 years (females=70, males=70) after obtaining their informed consent for the study. These subjects were the healthy attendants of patients who visited the college hospital. Ethical clearance was obtained from Institutional Ethical Clearance Committee.

Subjects included did not have history of Diabetes mellitus, Hypertension, other cardiovascular diseases, surgery, chronic medication, any muscular disorder, hand pain or arthritis as per history. Height was measured to the nearest 0.5 cm with wall mounted scale and weight measured to the nearest 0.5 kg using a beam balance scale in light indoor clothing. Body mass index (BMI) was

calculated by Quetelet's index, $BMI = \text{Weight (kg)}/\text{Height (m)}^2$. Subjects were classified into two groups based on the BMI values as follows:

Normal weight ($BMI 18.5 - 24.9 \text{ kg/m}^2$)

Overweight ($BMI 25-29.9 \text{ kg/m}^2$)

Each subject was given verbal instructions and demonstration before being tested and further instructions were provided at the time of the test. Tests for autonomic function were performed 2-3 hours after a light breakfast.

Tests for cardiac parasympathetic functions (9)

1. Heart rate response to postural change (30:15 ratio)
2. Heart rate response to Valsalva maneuver (Valsalva Ratio)

Tests for sympathetic functions (9)

1. Blood pressure response to postural change (orthostatic tolerance test (OTT))
2. Blood pressure response to sustained isometric handgrip (IHG)

The subjects were made to rest for 15 minutes in the supine position. 5 to 10 minutes resting time given to subjects in between two tests. Heart rate response to postural change (30:15 ratio) Participants rested in a supine position for 15 minutes and then were asked to stand up unaided as quickly as possible (within 3 seconds) with continuous ECG recording for at least 30 seconds. The ratio of the longest RR around 30th beat after standing to the shortest RR interval around 15th beat after standing were calculated for result of 30:15 ratio. Heart rate response to Valsalva maneuver

The subject was instructed to exhale forcefully through the mouth piece of a modified mercurial sphygmomanometer and to maintain pressure in the manometer up to 40 mmHg for 15 seconds. ECG was recorded during the maneuver and continued for about 30 seconds after the performance. The ratio of the longest RR interval after blowing to the

shortest RR interval during blowing was calculated as Valsalva Ratio

Orthostatic tolerance test (OTT)

Basal blood pressure was recorded. Then the patient was asked to stand up and the blood pressure was recorded immediately. The difference of the systolic blood pressures between the one recorded during lying supine and in erect posture was calculated. The fall in systolic pressure was used as the result of the OTT.

Blood pressure response to sustained isometric handgrip (IHG)

The subject was asked to perform maximum grip of the handgrip dynamometer with his dominant hand and the maximum capacity was noted down. After 5 min in the sitting position, the subject was asked to hold his grip with 30% of the maximum capacity for 5 min or as long as he can and the blood pressure was recorded just after release of the grip. The rise in diastolic blood pressure was calculated and taken as the result of IHG test.

Statistical analysis:

Descriptive data are presented as mean \pm standard deviation. Results were compared between the groups by Student's unpaired 't' test. Results were considered to be significant taking 5% as the level of significance. The data was analysed by using SPSS version 17.

Results

The mean age of subjects was 18.12 ± 0.63 years (70 females & 70 males). There was no significant difference in age between the Normal weight and Overweight groups.

Mean weight and BMI were significantly higher ($p < 0.001$) in overweight subjects compared to normal weight subjects. (Table 1) Overweight subjects had significantly lower 30:15 Ratio ($p = 0.002$) and Valsalva ratio ($p < 0.001$) than normal weight subjects (Table 1) OTT and IHG were higher in overweight subjects but not

statistically significant (Table 1) Table 1: Comparison of anthropometric parameters and cardiac autonomic function tests in normal weight and overweight subjects

Parameters	Normal weight(n =80)	overweight(n =60)	p value
Weight (Kilograms)	54.61 ± 6.24	71.6 ± 10.06	<0.001**
Height (Metres)	1.61 ± 0.08	1.61 ± 0.89	0.786
BMI(kg/m ²)	20.97 ± 1.79	27.24 ± 2.1	<0.001**
30:15 Ratio	1.19± 0.14	1.11± 0.21	0.002*
Valsalva Ratio	1.54± 0.33	1.33± 0.26	<0.001**
OTT	6.55± 5.19	7.63± 4.67	0.215
IHG	15.06± 8.13	16.3± 6.25	0.329

** highly significant , * significant

Discussion:

Our results showed significantly lower values of 30:15 Ratio and Valsalva Ratio in overweight subjects when compared to normal weight subjects indicating reduced vagal or parasympathetic activity. Similar findings were reported in previous studies (8,10, 11) We did not find significant difference in sympathetic function tests in overweight and normal weight subjects. Similar to our study Yakini et al (12) reported normal activity of sympathetic and hypoactivity of parasympathetic nervous system, implying parasympathetic nervous system dysfunction as a risk factor or associated finding in childhood obesity. Cardiac parasympathetic dysfunction present in obese subjects could be associated with higher carbohydrate intake and lower fat and protein intake which results in parasympathetic abnormality (13).

The hypothalamus is a regulatory center of satiety and of the ANS. Therefore, abnormalities in the hypothalamus may cause obesity and autonomic dysfunction and it is uncertain whether this dysfunction is a consequence of obesity or facilitates their development (14). A reduction in vagal activity is associated with an increased risk for morbidity and mortality and for the development of several risk factors (15).

Reduced cardiac vagal activity was observed in obese children and adolescents when cardiac

spontaneous barreflex sensitivity (BRS) was measured (16). Bedi et al (17) and Pal and Soni(18) reported reduced sympathetic activity in overweight and obese subjects. On the other hand, Nagai et al (19) reported that obese children have both lower sympathetic and parasympathetic activity compared to children within the normal weight range. These discrepancies in the results by different researchers may be due to the difficulty in controlling variables such as gender, age, family history, other medical complications, diets, behavioural habits, level of physical activity and emotional stress (19). Small sample size and unable to study the autonomic functions separately in males and females may be few shortcomings of this study.

Conclusions:

Our results clearly suggest that overweight adolescents exhibit modifications in the ANS characterized by a reduction in parasympathetic activity. This finding strongly indicates the need for the early holistic care of these adolescents to allow them to avoid the onset of future complications. Hence, assessment of autonomic nerve functions can be considered as an easy and a dependable clinical test for early identification of adolescents at risk.

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