EFFECT OF OBESITY ON CARDIOVASCULAR AUTONOMIC FUNCTIONS IN SCHOOL CHILDREN

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ABSTRACT

Obesity is a disorder with a multifactorial etiology resulting from a complex interaction between the environment, behaviour and genetic susceptibility. It is conceivable that one or more sub groups of obesity have an alteration in their autonomic nervous system that may promote obesity and account for several clinical consequences of obesity. In this study we performed AFT on obese and non obese children. The result of our study shows reduced E:I (Expiration: Inspiration) ratio in obese children as compared to the normal children p= 0.0485 in boys and p= 0.0009 in girls. Our study also indicates higher baseline diastolic blood pressure and systolic blood pressure prior to isometric handgrip exercise and blood pressure response on lying to standing in obese group children which shows the reduced sympathetic activity in obese children (p= 0.0001 for both orthostatic hypotension test and hand grip test in boys and girls.).The prevalence of obesity from our study comes 17.3% in Bikaner district.

AIMS AND OBJECTIVE:-. Comparative study is done to investigate the cardiovascular autonomic function test in obese school children.

RESULT:-Our study shows reduced parasympathetic activity (E:I ratio) and reduced sympathetic activity (orthostatic hypotension and hand grip test) of obese children.

CONCLUSION:- If the autonomic nervous system dysfunction is diagnosed early by doing autonomic function test, it may prove an important aid in identification of those prone to weight gain and are at higher risk of cardio vascular complication resulting for autonomic dysfunction

INTRODUCTION :-

Obesity is a disorder with a multifactorial etiology resulting from a complex interaction between the environment, behaviour and genetic susceptibility.[1] As the prevalence of this disorder grows worldwide, obesity is increasingly considered a major public health problem.[2–4]With continued rise in standards of living, obesity is emerging as a global epidemic in both children and adults. This has been called “New world syndrome” and is a reflection of massive social, economic and cultural problems currently facing developing and developed countries.The consequences of obesity in childhood and adolescence include arterial hypertension, atherosclerosis, dyslipidemia, diabetes, obstructive sleep apnea, alterations in the musculoskeletal system, depression and a reduction in quality of life.[5,6]Since autonomic nervous system is involved in energy metabolism and regulation of cardiovascular system.[7,8] It is conceivable that one or more sub groups of obesity have an alteration in their autonomic nervous system that may promote obesity and account for several clinical consequences of obesity.

Although studies demonstrate important modifications in the autonomic control of obese adults and adolescents, there is scarce information on obese children, and the findings remain inconclusive. So this study is done to investigate the cardiovascular autonomic function test in obese school children.

Subjects and eligibility:

250 School children were randomly selected to obtain mixed group of children belonging to mixed socioeconomic status of age group 9-16 from various schools of Bikaner. Then they were screened to exclude underweight children by using lower cut-off limits of BMI. 50 underweight children were excluded and remaining 200 children were selected for the study. Now these 200 children were again segregated into two groups: Obese group (44) and Non obese group (156). This segregation was done using international obesity task force cutoffs because the IOTF group combined the childhood and adult definitions of overweight and obesity prevalent then, by taking at age 18 years, those percentiles that corresponded to the BMI’s of 25 and 30 Kg/m^2, and using these same percentiles throughout the age range for specifying overweight and obesity in childhood in girls and boys separately.

Inclusion criteria:

1. Children with age ranging between 9 – 16 years of both the gender.
2. Physically and mentally fit.
3. Cooperative and capable of understanding the procedure.

Exclusion criteria:

1. Children suffering from medical ailments or anxious, apprehensive and uncooperative.
2. Any systemic illness that is likely to affect cardiovascular autonomic functions
3. Any major psychiatric illness.

BMI Classification tables:

Age (years)	Boys	Girls
9	14.35	14.28
10	14.64	14.61
11	14.97	15.05
12	15.35	15.62
13	15.84	16.26
14	16.41	16.88
15	16.98	17.45
16	17.54	17.91

Table 1: International cut-off points for BMI for thinness grade 3 by sex for ages between 9 and 16 years, defined to pass through BMI of 18.5 at age 18.[9]

Age (years)	Boys	Girls
9	19.10	19.07
10	19.84	19.86
11	20.55	20.74
12	21.22	21.68

13	21.91	22.58
14	22.62	23.34
15	23.29	23.94
16	23.90	24.37

Table 2: International cut off points for body mass index for overweight and obesity by sex between 9 and 16 years, defined to pass through body mass index of 25 kg/m^2 at age 18.[10]

The protocol of the study was approved by the ethics committee and departmental research committee, Sardar Patel Medical College, Bikaner.

Method:

Informed written consent was obtained prior to data collection both from the school authorities and from the parents of the children after explaining the objectives and the method of study. Two days prior to data collection a pre tested proforma was distributed amongst the subjects to get the information on family characteristics like type of residence, type of family, education, occupation and income of parents etc. The exact age of the child was verified from the school records and rounded to the completed years. Anthropometric measurements were done utilizing the standard equipments and methodology. Weight was recorded using spring weighing machine approximated to the nearest kilogram and height was recorded using the stadiometer attached to the wall to the nearest centimetre. All the measurements were done after removing shoes and all the loose outfits of the child.

Blood pressure (BP) was recorded from the left arm in supine position after giving adequate rest to the child measured with sphygmomanometer. Body mass index (BMI) was calculated as weight in kilograms / (Height in meter)^2. International Obesity Task Force (IOTF) classification was utilized for the estimation of obese subjects.

Materials:

Autonomic function tests carried out by using:

1) Electro cardiograph

2) Sphygmomanometer

3) Hand grip dynamometer

Analysis of Observations:

Standard statistical methods were applied for analysis of the observation. The mean values of various parameters were calculated separately in various groups of the subjects.

The quantitative data was expressed as Mean ± S.D. and the student's 't' test was used to compare the differences between the respective means. All p values were 2 tailed, p value of <0.05 was considered significant.

Observations:-

	Boy	Girl	Total
Non-Obese	95	61	156
Obese	26	18	44
Total	121	79	200

Distribution of subjects

Category	**Mean ± Standard Deviation**
Non-obese Boys	18.25 ± 1.915
Obese Boys	25.94 ± 4.208
Non-Obese Girls	17.7 ± 1.891
Obese Girls	24.07 ± 4.932

Mean BMI of the group

TESTS		Normal 95		Abnormal 26		t-value	P value
		Mean	SD	mean	SD		
1	30:15 ratio	1.392284	0.175183	1.399616	0.256908	0.1697	0.8655
2	Valsalva ratio	1.615921	0.296032	1.668544	0.400987	0.7408	0.4603
3	E:I ratio	1.485395	0.151245	1.411192	0.220571	1.9932	0.0485
4	Orthostatic hypotension test	6.042105	2.75185	13.07692	4.353602	10.0693	0.0001
5	Hand grip test	14.06316	2.009607	8.384615	2.3337	12.3236	0.0001

Comparison of autonomic function tests in non obese and obese boys

TESTS		Normal 61		Abnormal 18		t-value	P value
		Mean	SD	mean	SD		
1	30:15 ratio	1.389446	0.200928	1.322357	0.11609	1.3479	0.1817
2	Valsalva ratio	1.636951	0.265198	1.505988	0.242474	1.8753	0.0645
3	E:I ratio	1.492089	0.180604	1.331999	0.141933	3.4537	0.0009
4	Orthostatic hypotension test	6	2.804758	11.88889	3.968833	7.083	0.0001
5	Hand grip test	13.60656	2.471698	8.333333	1.847096	8.3722	0.0001

Comparison of autonomic function tests in non obese and obese girls

Parasympathetic activity:-

The result of our study shows reduced E:I(Expiration: Inspiration) ratio in obese children as compared to the normal children. A reduction in parasympathetic activity among obese children has also been reported by other authors.

The possible mechanisms are:

1. The hypothalamus is a regulatory centre of satiety and of the ANS. Therefore, abnormalities in the hypothalamus may cause obesity and autonomic dysfunction.[11,12] This may explain the alterations observed in the heart rate variability indices.

2. The exact mechanism that may cause impairment of parasympathetic nerve function has not yet been clearly established. Some researchers suggested that gradual development of insulin resistance in target tissues with the beginning of excess weight gain in obesity is responsible for subsequent development of hyperinsulinaemia. This hyperinsulinaemia has got a role in low cardiac vagal activity in obese person. Though the relationship between insulin resistance and parasympathetic dysfunction is not clear, but several researchers made various suggestions such as high insulin level or insulin resistance may cause damage to autonomic nerves at any level of their reflex arc, insulin resistance may cause a deterioration of microcirculation in many tissues including nerves which may lead to neural ischemia and thereby damage of cardiac parasympathetic nerve terminals occur at the level of cardiac muscle or vascular wall.[13,14]

3. Valensi et al, [15]observed cardiac parasympathetic dysfunction present in the obese subjects could be associated with higher carbohydrate intake and lower fat and protein intake which result in parasympathetic abnormality.

4. A reduction in vagal activity is associated with an increased risk for all-cause morbidity and mortality and for the development of several risk factors. Therefore, the reduction observed in obese children may be an early sign for the prediction of the risk for cardiovascular and metabolic disease.

5. In cardiac autonomic neuropathy, the disruption of parasympathetic nervous system is usually detected earlier than that of the sympathetic nervous system. Decrease in heart rate variability is noticed as first indicator of cardiac neuropathy and *decrease in Expiration: Inspiration ratio is considered to be a sign of parasympathetic dysfunction*.[16]

6. Our result is also supported by Rissanen et al,[17]who documented that cardiac parasympathetic activity increases with weight loss in obese women. This increase may not be maintained long term if body weight is regained. The rise of cardiac parasympathetic activity is correlated with decrease of body fat mass, abdominal fat, serum insulin, and heart rate. Cardiac parasympathetic activity is not related to resting energy expenditure.

Sympathetic activity:-

The results of our study indicates higher baseline diastolic blood pressure and systolic blood pressure prior to isometric handgrip exercise and blood pressure response on lying to standing in obese group children which shows the reduced sympathetic activity in obese children

The possible mechanisms are:

1. It is well established that stimulation of sympathetic system results in increase in arterial pressure either due to

(i) increase in heart rate and force of contraction, leading to increase in cardiac output and blood pressure or alternately

(ii) vasoconstriction and resultant increase in total peripheral resistance and blood pressure, or both.

The first effect is due to increased activity in cardiac sympathetic fibers and second due to increased activity in peripheral vasoconstrictor fibers. Such preferential activation of peripheral vasoconstrictor fibers has been attributed to cause cold induced vasoconstrictor response in normotensive population and in hypertensive.[18] The isometric exercise induced increase in heart rate, cardiac output and blood pressure, reported in the literature[19] can be explained on the basis of activity in the cardiac sympathetic fibers. The obese children showed truncated response in cardiac sympathetic activity resulting in borderline response to isometric exercise.

2. Piccirillo et al,[20] reported that obesity was associated with decreased sympathetic responsiveness. Obese subjects showed a higher presynaptic activation level as indicated by plasma norepinephrine levels. At the same time, postsynaptic sympathetic responsiveness was diminished in these subjects. The decreased sympathetic reactivity to stress was thought to be a contributing factor to the higher mortality rates.

3. Peterson et al,[21] report an association between the increase in body fat and hypoactivity of sympathetic and parasympathetic components of ANS. The authors state that lower sympathetic activity is related to lower energy expenditure and, consequently, to a positive energy balance and increase of body weight.

4. Nagai et al,[22] observed that obese children possess reduced sympathetic as well as parasympathetic nerve activities. He concluded that autonomic depression, which is associated with the duration of obesity, could be a physiological factor promoting the state and development of obesity.

5. The peripheral sympathetic nervous system is a key factor in the regulation of energy balance in humans. Differences in sympathetic nervous system activity may contribute to

variations in 24 h energy expenditure between individuals. beta-Adrenoceptors play a more important role than alpha-adrenoceptors in this regulation. The involvement of both beta 1- and beta 2-adrenoceptor subtypes has been demonstrated, the role of the beta 3-adrenoceptor subtype is not yet clear. Normal or increased levels of sympathetic nervous system activity and reduced reactivity appear to be present in established obesity. Furthermore, the sensitivity for beta-adrenoceptor stimulation is impaired in obesity. The blunted reactivity and sensitivity may contribute to the maintenance of the obese state. There are data to suggest that they may also play a role in the aetiology of obesity, because the impairments often remain after weight reduction. Furthermore, a negative correlation between baseline sympathetic nervous system activity and weight gain during follow-up has been found in Pima Indians. Recently, genetic evidence about the involvement of adrenoceptors in obesity has become available. Although the results of association and linkage studies on polymorphisms in the beta 2-, beta 3- and alpha 2-adrenoceptor genes are inconsistent, the functional correlates of some of these polymorphisms (changes in agonist-promoted down-regulation, protein expression levels, lipolytic sensitivity, basal metabolic rate, sympathetic nervous system activity) suggest that they may be important in the aetiology of obesity.[23]

So if the autonomic nervous system dysfunction is diagnosed early by doing autonomic function test, it may prove an important aid in identification of those prone to weight gain and are at higher risk of cardio vascular complication resulting for autonomic dysfunction.

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