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RESEARCH ARTICLE

Association between reaction time and heart rate variability in adolescents with cardiovascular risk

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ABSTRACT

Background: In obesity and/or family history of hypertension (HT) or diabetes mellitus (DM), there is a higher prevalence of cardiovascular (CV) disease in the subject, which is supposed to be due to autonomic imbalance. The alterations in cardiac autonomic functions can be assessed by heart rate variability (HRV) indicators and there is a relationship between HRV and reaction time (RT) also. **Aims and Objectives:** This study aims to assess the HRV and RT in adolescents with CV risk and also to find the association between these two parameters. **Materials and Methods:** A total of 39 adolescents with CV risk (15 females and 24 males) in the age group of 14–15 years who were obese or/and had family history of HT or DM in parents were selected. Anthropometric parameters, blood pressure, HRV parameters, and RT were recorded. **Results:** HRV was reduced in CV risk groups, both in females and males as compared to normal subjects and lower values were recorded in females as compared to males. There was also a negative correlation of HRV with RT both in males and females but statistically significant only in females. **Conclusion:** Adolescents with CV risk have reduced HRV and such individuals are more prone to CV diseases. RT, which is a marker of cognitive ability, is increased in persons with decreased HRV, and hence, such CV risk adolescents should be followed up and given timely intervention.

KEY WORDS: Heart Rate Variability; Reaction Time; Cardiovascular Risk; Adolescents

INTRODUCTION

Heart rate variability (HRV), which is a non-invasive and objective measure of beat-to-beat variations in heart rate due to modulation of sinoatrial node activity by cardiac autonomic nervous system, is a cardiovascular (CV) risk predictor. In obese and individuals having family history of hypertension (HT), diabetes mellitus (DM), and hyperlipidemia, there is a higher prevalence of CV disease, which is supposed to be due to autonomic imbalance or sometimes due to metabolic disorder. The alterations in cardiac autonomic functions bring out the changes in the HRV, which is an assessing tool for cardiac autonomic functions and considered as standard and reliable.[1]

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Sympathetic and parasympathetic activity modulates heart rate. Effect of change in parasympathetic outflow to the heart occurs very rapidly within 400 ms, so it can control heart rate beat-to-beat variation, which is determined by time domain parameters of HRV analysis which signify resting parasympathetic activity.[2] The effect of change in sympathetic outflow to the heart takes >5 s.[3] Hence, high-frequency (HF) component is considered to be due to resting parasympathetic activity and low-frequency (LF) component is considered to be due to resting sympathetic activity.

Reaction time (RT) is the time taken to respond to a sensory stimulus, which includes perception of stimulus, cognitive processing, and the motor response to the stimulus.[4] It measures neural efficiency.[5] Greater neural efficiency is represented by a faster RT. Slower RT was associated with an increased risk of CV disease mortality[6] and also noted that people with slower RT had lower HRV.[7,8] Greater fluctuations in heart rate are associated with faster RT. Hence, RT is a simple method of assessing the perceptual-cognitive processing capability of the central nervous system and is also helpful in assessing CV risks by knowing its variations with HRV. There are less studies about RT and its association with HRV in adolescents with CV risk. Hence, this study was undertaken to assess the HRV and RT in adolescents with CV risk.

MATERIALS AND METHODS

This was a case series involving a total of 39 adolescents with CV risk, 15 females and 24 males between 14 and 15 years of age, who were obese or/and having family history of HT or DM in parents, who were selected from nearby higher secondary schools. Approval was obtained from the Institutional Human Ethics Committee. After explaining the study to the participants and their parents, their written informed consent was obtained.

All the adolescents were brought to the research laboratory at 9.00 a.m. after having light breakfast and before recording, the procedure was explained to them. Recording was done in a quiet and comfortable room in the morning hours.

Parameters Assessed

Anthropometric parameters such as height, weight, basal heart rate, systolic blood pressure, and diastolic blood pressure were recorded. Blood pressure was recorded by a mercury sphygmomanometer.

Lead II electrocardiogram (ECG) was recorded for 15 min and HRV was analyzed by powerlab (AD Instruments). The sampling rate was kept at 1000 samples per channel. Raw ECG was filtered using a bandpass filter (2–40 Hz). The RR tachogram obtained from the filtered ECG was analyzed for frequency domain and time domain parameters.

Visual RT was recorded by an instrument connected to audacity software. Participants were instructed to release the response key as soon as they perceived the stimulus and the interval between the stimulus and the response was recorded and few practice sessions were given to all the participants before recording the RT by keeping the instrument in front of them.

The time domain parameters were average RR interval, standard deviation of RR interval (SDRR), the square root of the mean of the sum of the squares of the differences between adjacent RR intervals (root mean square of the successive differences [RMSSD]), the number of pairs of adjacent RR intervals differing by >50 ms in the entire recording (RR50), and percentage of RR50 counts (pRR50), given by RR50 count divided by total number of all RR intervals (pRR50). These represent parasympathetic drive to the heart.

The frequency domain parameters include LF (LF: 0.04–0.15), HF (HF: 0.15–0.4), LF in normalized units (LFnu), HF in normalized units (HFnu), and ratio of LF to HF (LF/HF). LF represents sympathetic tone, HF represents parasympathetic tone, and the LF/HF ratio represents sympathovagal balance.[9]

RESULTS

A total of 39 adolescents (15 females and 24 males) aged between 14 and 15 years were examined. The mean height in females was 156.8 cm, weight was 59.33 Kg, and mean blood pressure was 84.4 mmHg; and in males 165 cm, 64.12 Kg, and 82.62 mmHg, respectively. Mean and standard deviation of HRV parameters and RT of all participants are given in Table 1.

There was no significant difference between anthropometric parameters, blood pressure, HRV, and RT parameters between male and female adolescents.

Table 1: HRV parameters and RT in adolescents with CV risk

Parameters	Gender	Mean±SD
PRR50 (in ms)	Male	28.06±22.51
	Female	21.88±20.03
SDRR (in ms)	Male	53.62±18.84
	Female	49.08±20.97
RMSSD (in ms)	Male	49.73±25.87
	Female	44.61±27.54
Aver-RR (in ms)	Male	700.74±238.48
	Female	688.72±81.07
LFnu	Male	45.13±16.40
	Female	44.70±15.94
HFnu	Male	49.82±15.72
	Female	47.85±14.67
LF/HF	Male	90.96±440.49
	Female	11.67±40.76
RT (in ms)	Male	208.83±28.79
	Female	221.67±22.77

HRV: Heart rate variability, RT: Reaction time, CV: Cardiovascular, LFnu: LF in normalized units, HFnu: HF in normalized units, SDRR: Standard deviation of RR interval, RMSSD: Root mean square of the successive differences, RR50: RR interval differing by >50 ms in the entire recording, pRR50: Percentage of RR50 counts , SD: Standard deviation

Correlation of HRV parameters with RT showed negative correlation with SDRR ($P = 0.000$) in both females ($r = -0.58$) shown in Figure 1 and males ($r = -0.25$) shown in Figure 2, but the correlation was statistically significant only in females.

DISCUSSION

This study was directed toward studying HRV in adolescents with CV risk and looking into the association between HRV and RT time in them, i.e., association between autonomic and cognitive ability and also to compare these parameters in males and females.

There was no significant difference between anthropometric parameters, blood pressure, HRV, and RT parameters between male and female adolescents.

Correlation of HRV parameters with RT showed negative correlation with SDRR in both females and males, but the correlation was statistically significant only in females.

When these values were compared with normal group adolescents (normative data taken from a study done in South India by Sharma *et al*.),[10] significant difference was found in relation to SDRR ($P = 0.000$) and RMSSD ($P = 0.004$) parameters in females and in males significant difference was found only with SDRR ($P = 0.000$) parameter. From this, it shows that HRV is reduced in CV risk subjects both in females and males as compared to normal subjects from the study done by Sharma *et al*.[10]

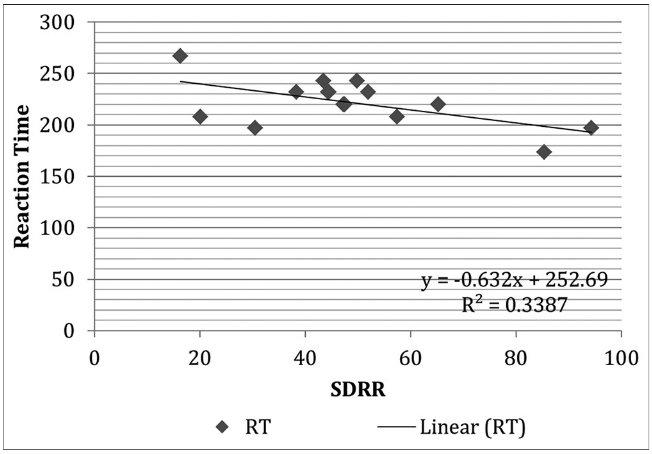

Figure 1: Correlation of standard deviation of RR interval with reaction time in females. Correlation coefficient, $r = -0.58$

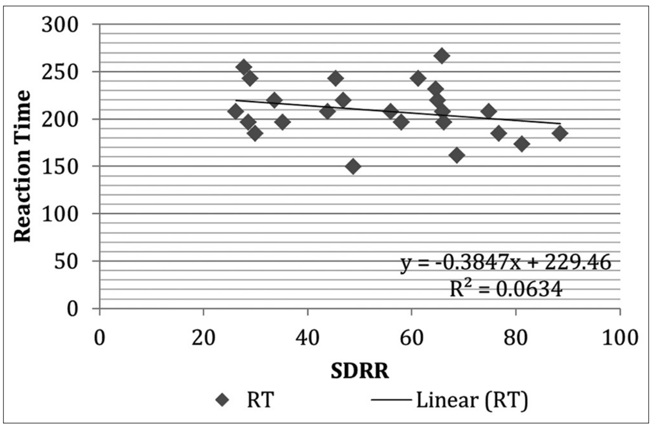

Figure 2: Correlation of standard deviation of RR interval with reaction time in males. Correlation coefficient, $r = -0.25$

In the present study, lower HRV values were observed in females as compared to males, which indicate less HRV in CV risk female adolescents as compared to CV risk male adolescents, thereby making the CV risk female adolescents more prone to CV diseases.

These findings are in contrast to studies done by Silvetti *et al*.[11] and Sharma *et al*.[10] The reason for this could be that our study was on adolescents with CV risk unlike these studies which were on normal adolescents and also may be due to less sample size in our study.

Female adults are considered to have better HRV than males in terms of increased parasympathetic activity and decreased sympathetic activity.[12] According to some authors, better HRV in females as compared to males is considered to be due to difference in their hormonal profile – estrogen, which decreases sympathetic activity, whereas testosterone increases sympathetic activity.[13-15]

Correlation of HRV parameters with RT showed negative correlation with all parameters except with LFnu but was statistically significant only with SDRR ($P = 0.000$) in females. There was a negative correlation in males with all parameters except with HFnu and LF/HF but was not statistically significant. This negative correlation both in males and females, that is, less is the HRV more is the RT, indicates decrease in cognitive ability. Hence, from this study, it indicates that cognitive ability is less in female as compared to male adolescents with CV risk.

The limitations of the present study were – normal control group could have been included; less sample size; number of females not exactly matched with the same number of males; and time domain analysis could have been done for 24 h period, which would yield better results.

CONCLUSION

Adolescents with CV risk have reduced HRV and such individuals are more prone to CV diseases. RT, which is a marker of cognitive ability, is increased in persons with decreased HRV, and hence, such CV risk adolescents should be followed up and given timely intervention.

REFERENCES

1. Stein PK, Kleiger RE. Insights from the study of heart rate variability. Annu Rev Med 1999;50:249-61.

2. Hainsworth R. Physiological background of heart rate variability. In: Malik M, Camm AJ, editors. Dynamic Electrocardiography. New York: Blackwell Futura; 2004. p. 3-12.
3. Levy MN, Martin PJ, Iano T, Zieske H. Effects of single vagal stimuli on heart rate and atrioventricular conduction. Am J Physiol 1970;218:1256-62.
4. Kuppusamy S, Niraimath D, John NA. Assessment of heart rate variability and reaction time in traffic policemen. Int J Med Res Rev 2016;4:1958-64.
5. Wawrzyniak AJ, Hamer M, Steptoe A, Endrighi R. Decreased reaction time variability is associated with greater cardiovascular responses to acute stress. Psychophysiology 2016;53:739-48.
6. Hagger-Johnson G, Deary IJ, Davies CA, Weiss A, Batty GD. Reaction time and mortality from the major causes of death: The NHANES-III study. PLoS One 2014;9:e82959.
7. Ginty AT, Phillips AC, Der G, Deary IJ, Carroll D. Cognitive ability and simple reaction time predict cardiac reactivity in the West of Scotland twenty-07 study. Psychophysiology 2011;48:1022-7.
8. Ginty AT, Phillips AC, Der G, Deary IJ, Carroll D. Heart rate reactivity is associated with future cognitive ability and cognitive change in a large community sample. Int J Psychophysiol 2011;82:167-74.
9. Heart rate variability: Standards of measurement, physiological interpretation and clinical use. Task force of the European society of cardiology and the North American society of pacing and electrophysiology. Circulation 1996;93:1043-65.
10. Sharma VK, Subramanian SK, Arunachalam V, Rajandran R. Heart rate variability in adolescents-nomative data stratified by sex and physical activity. J Clin Diagn Res 2015;9:8-13.
11. Silvetti MS, Drago F, Ragonese P. Heart rate variability in healthy children and adolescents is partially related to age and gender. Int J Cardiol 2001;81:169-74.
12. Ryan SM, Goldberger AL, Pincus SM, Mietus J, Lipsitz LA. Gender - and age-related differences in heart rate dynamics: Are women more complex than men? J Am Coll Cardiol 1994; 24:1700-7.
13. Vongpatanasin W, Tuncel M, Mansour Y, Arbique D, Victor RG. Transdermal estrogen replacement therapy decreases sympathetic activity in postmenopausal women. Circulation 2001;103:2903-8.
14. Minson CT, Halliwill JR, Young TM, Joyner MJ. Influence of the menstrual cycle on sympathetic activity, baroreflex sensitivity, and vascular transduction in young women. Circulation 2000;101:862-8.
15. Sverrisdottir YB, Mogren T, Kataoka J, Janson PO, Stener-Victorin E. Is polycystic ovary syndrome associated with high sympathetic nerve activity and size at birth? Am J Physiol Endocrinol Metab 2008;294:E576-81.

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