Brazilian J Med Biol Res (1989) 22: 909-911 *SHORT COMMUNICATION*

VAGAL ACTIVITY: EFFECT OF AGE, SEX AND PHYSICAL ACTIVITY PATTERN

C.G.S. ARAÚJO*,**, A.C.L. NOBREGA** and C.L.B. CASTRO*

**Serviço de Cardiologia, Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro, 21941 Rio de Janeiro, RJ, Brasil*
***Departamento de Fisiologia, Instituto Biomédico, Universidade Federal Fluminense 24033 Niteroi, RJ, Brasil*

Heart rate response to a short (4 s) bicycle exercise test during maximal inspiratory apnea was used to assess vagal activity (VA). This study aims to evaluate the role of age, sex and physical activity pattern on VA. A total of 148 subjects, divided into athletes (N = 90) and non-athletes (N = 58) were tested. No correlation was found between age (range from 15 to 42 years) and VA in the male and female athletes ($P>0.05$). No gender effect could be identified. In spite of a slight tendency toward higher VA in athletes, no significant differences could be found between the two groups.

Key words: exertion, heart rate, exercise test, vagal tone, sports.

Heart rate is modulated by the autonomic nervous system. An impaired autonomic control of heart rate has been described for some diseases (1,2) determining direct clinical relevance for this physiological issue.

Many physiological procedures have been standardized and studied in order to be used as autonomic function tests (3-5). However, most of the maneuvers seem to simultaneously evaluate parasympathetic and sympathetic branches of the autonomic nervous system (e.g. Valsalva), sometimes making the clinical interpretation of the results difficult.

The acute physiological response of heart rate to physical exercise reflects very rapid changes in the autonomic activity, i.e., decreased vagal and increased sympathetic components (6). However, there is a different time response for the two branches, so that the tachycardia observed in the very first seconds of exercise is due to vagal inhibition (7,8).

Classically, it has been accepted that aging decreases and physical training increases the magnitude of vagal activity while the influence of gender has been less studied (9,10); however, these concepts have been questioned (11,12) on occasion. We have now standardized and developed an exercise test consisting of a short (4 s) bout of sudden physical effort in order to study the integrity of the vagal component.

The aim of the present work was to use the 4-s exercise test to analyse the effects of age, sex and physical activity pattern on heart vagal activity.

Presented at the IV Annual Meeting of the Federação de Sociedades de Biologia Experimental, Caxambu, MG, June 28 - July 2, 1989.
Research supported by CNPq fellowships (Nos. 302356/84 and 820525/87.1). C.L.B.C. is a recipient of a graduate scholarship from CAPES.
Correspondence: Dr. C.G.S. Araújo, Serviço de Cardiologia, HUCFF, UFRJ, 21941, Rio de Janeiro, RJ, Brasil.

A total of 148 subjects performed the test. The individuals were classified into two groups according to their physical activity pattern. The first group consisted of 90 athletes, 64 men and 26 women, members of the Brazilian team to the XXIV Olympic Games in Seoul/1988. These athletes were studied as part of a full medical examination performed a few weeks before the Games. This group corresponds to about 51% of the total number of Brazilian athletes attending the Games. The second group was formed by 58 non-athletic subjects, 42 men and 16 women, including students, laboratory staff and hospital patients without known autonomic diseases, ranging from sedentary to physically active (non-competitive). None of the individuals tested was using medication that could modify the test results.

The 4-s exercise test was carried out on a Monark bicycle ergometer. The subjects sat in a conventional and comfortable position and their ECG was monitored with a modified bipolar lead (CC_5). After a full, detailed explanation of the procedure, subjects held their breath during 12 s in a maximal inspiratory position, cycling the ergometer from the 4th to the 8th second, i.e., during exactly 4 s. Subjects were requested to cycle "very fast" with no load set on the ergometer (0 watts). A small battery-powered electronic device which was periodically calibrated provided an auditive and visual (LED) signal at 4-s intervals facilitating the execution of the test. An ECG tracing was obtained during about 30 s, beginning just before the inspiratory effort and finishing at least 15 s after the end of expiration.

R-R intervals in ECG tracings were carefully measured and rounded to the nearest 20 ms. A relationship between two R-R intervals, denominated B/C, was determined for each subject, where B refers to the last R-R interval before the exercise started and C represents the shortest R-R interval during the 4 s of exercise. The magnitude of B/C is considered to reflect the heart vagal activity and was used as an index of global vagal activity.

Comparisons between group means were made using the Student t-test. Regression analyses were performed for age and vagal activity for each of the two groups. A significance level of $P = 0.05$ was set to determine statistical significance.

Interestingly, none of the coefficients of determination estimated for the regression of age and vagal activity were significant. The values obtained (men and women analyzed separately) were, in fact, zero. Thus, over the limited age range (15 to 42 years) in the athletes studied, we were unable to find an effect of age on vagal activity. These findings permit the direct comparison of athletes and non-athletes and the male and female subjects, in spite of age differences among the groups. Group results separated by sex are presented in Table 1. No significant differences were found between male and female subjects, either in the athlete or non-athlete groups ($P>0.05$).

Table 1 - *Results of the B/C relationship assessing vagal activity in athletes and non-athletes of both sexes.*

Results are reported as means ± SD. N, number of subjects.

Group	N	B/C
Male athletes	64	1.51 ± 0.30
Female athletes	26	1.47 ± 0.30
Male non-athletes	42	1.44 ± 0.38
Female non-athletes	16	1.41 ± 0.23

The comparison of results of athletes and non-athletes in the 4-s exercise test corroborates the idea that vagal activity is not increased by physical training, even when athletes attaining a very high degree of physical training are studied.

Theoretically, the label "athletes" encompasses a large and hetereogeneous group of individuals whose physical activity patterns are also very distinct. There is no doubt that energy requirements and thus the chronic physiological cardiovascular effects should be different among weight lifters, swimmers, rowers and fencers.

We tested this possibility using the maximal oxygen uptake relative to body weight (estimated through heart rate response to submaximal exercise) to divide male athletes into quartiles. The comparison between the first and third quartiles, each consisting of 16 subjects, again showed no significant difference ($P>0.05$) although the athletes with higher maximal aerobic power exhibited values slightly higher (1.56) than those with lower values (1.46). Analysis of these findings suggests that if there is any effect of physical activity pattern on vagal activity, it is much less relevant than previously supposed (10).

Only 4 athletes (2 judoists, 1 cyclist and 1 yachtsman) and 2 non-athletes (1 moderately active man and 1 sedentary woman) presented outlying values (more than 1.96 standard deviations from the mean) which in practical terms represent B/C values above 2 and may reflect vagal hyperreactivity.

In addition to examining the role of age, gender and physical activity on vagal activity, this study provides useful information for the future establishment of reference data in the 4-s heart rate response to exercise.

Acknowledgments

The authors thank the Brazilian Olympic Committee, AMIL and Dr. Eduardo Henrique de Rose, medical coordinator of Seul/COB/AMIL project, for support and permission to use the athletes' data.

References

1. Rothschild M, Rothschild A & Pfeifer M (1988). *American Journal of Cardiology*, 62: 637-639. 2. Ewing DJ, Campbell IW & Clarke BF (1980). *Quarterly Journal of Medicine*, 49: 95-108. 3. Hilsted J (1983). *Acta Neurologica Scandinavica*, 67: 193-201. 4. Jeyarajah R, Samarawickrama P & Jameel MMM (1986). *Journal of Chronic Disease*, 39: 479-484. 5. Eckberg DL (1980). *American Journal of Physiology*, 239: H581-H593. 6. Petro JK, Hollander AP & Bouman LN (1970). *Journal of Applied Physiology*, 29: 794-798. 7. Maciel BC, Gallo Jr L, Marin Neto JA, Lima Filho EC & Martins LEB (1986). *Clinical Science*, 71: 457-460. 8. Araújo CGS (1985). *International Journal of Sports Medicine*, 6: 68-73. 9. Pfeifer MA, Weinberg CR, Cook D, Best JD, Reenan A & Halter JB (1983). *American Journal of Medicine*, 75: 249-258. 10. Frick MH, Elovainio RO & Somer T (1967). *Cardiologia*, 51: 46-54. 11. Maciel BC, Gallo Jr L, Marin Neto JA & Martins LEB (1989). *Brazilian Journal of Medical and Biological Research*, 22: 225-232. 12. Badeer HS (1975). In: Roy P-E & Rona G (Editors), *Recent Advances in Studies on Cardiac Structure and Metabolism - The Metabolism of Contraction*. Vol. 10, University Park Press, Baltimore, 553-560.

Received March 13, 1989
Accepted April 12, 1989