BIOENERGETIC AND CARDIOVASCULAR RESPONSES TO EXERCISE IN RESIDENTS AT 2.850 M, WITH ASYMPTOMATIC CHAGAS' DISEASE

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Abstract. Cardiovascular and energetic responses at rest, during 30 min of exercise (mechanical output: 125 watts) and for a subsequent recovery period of 5 min were compared in two groups, each comprising 21 residents at an altitude of 2.850 m. One group was in the asymptomatic phase of Chagas' disease with positive serological tests for *T. cruzi*, whereas the other was without Chagas' disease (negative serological tests). The two groups were similar as regards age, weight-for-height, blood parameters, nutritional status and heart and lung functions, including heart rate and frontal plane QRS axis determinations.

At rest, they differed in that maximal and minimal arterial blood pressures were slightly but significantly lower in the group with Chagas' positive serological tests than in the controls. During exercise and recovery, the only differences between them and the controls were that their minimal diastolic arterial blood pressure was significantly lower. In absolute values, the rises in arterial pressure due to exercise were exactly the same in the two groups. Maximal O_2 uptake was identical in both groups, as was

3.500m, and vectors, up to 4.500m [8, 9]. The effect of altitude on work performance could be of consequence in countries like Bolivia, where half the population lives at altitudes above 3.000m, and moves up and down from the Andean highlands to the lowlands, where Chagas' disease is endemic.

In the present study, the energetic and cardiovascular responses to exercise were compared in two groups of residents in a high-altitude region. One group was in the asymptomatic stage of Chagas' disease (with positive serological tests for *T. cruzi*), whereas the other group was without Chagas' disease; in all other respects, the groups were similar.

Materials and Methods

Subjects The study included two groups of 21 male adults born and living permanently in Chivisivi, a village located at 2.850m in the Sapahaqui valley (district of La Paz in Bolivia). They were Quechua Indians working in agriculture. All the clinical examinations and experiments were carried out in Chivisivi.

One group was *T. cruzi* infested, since the results of their serological tests (see below) were positive. The other was the control group, since their serological test results were negative. The two groups will be respectively referred to below as 'Chagas positive' and 'Control' subjects.

All subjects exhibited normal physical activity and showed no evidence, either of disease on routine clinical examination of height, weight, skin colour, systemic arterial pressure, and pulmonary and cardiac auscultation, or of abnormal heart or lung conditions, assessed by functional tests, simplified on account of the technical limitations by local facilities. Accordingly, the infested subjects with positive serological data could be considered as asymptomatic in all respects.

Subjects were tested at rest for serology, heart and lung function, and nutritional status, and during exercise, by measurement of heart rate, O_2 uptake and blood pressure.

Measurements at rest A blood sample was drawn from an antecubital vein for determination of the hematocrit and hemoglobin concentration, and for serological tests.

Hematocrit and hemoglobin Hematocrit was measured in one portion of the sample by centrifugational

Blood arterial pressure. These were measured with a Vaquez-Laubry sphygmotensiometer in identical conditions for all patients.

Pulmonary function tests. These, including measurement of pulmonary volumes, forced expiratory flow and maximal breathing capacity were conducted with a Warren and Collins type spirometer, after subjects had become familiar with the necessary procedures.

Measurements during exercise As the subjects had never either cycled or worn a mouth piece, they became accustomed to both in preliminary bouts of exercise during the days before the experiment. In the course of that period, various intensities of exercise were tested in order to find a reasonable level, i.e. an exercise power sufficiently high to elicit clear responses but not severe enough to risk causing heart disorders. A mechanical output of 125 watts was chosen. The final experiment was conducted in the morning. On that day, the subject was given the usual breakfast; he then rested in the sitting position for 30 min, during which the ECG electrodes were attached and the sphygmotensiometer was adjusted.

The subject then mounted the cycle, a Funbec model, equipped with a mechanically braked ergometer. The resting values of the different parameters were measured, and the exercise began at 125 watts and lasted 30 minutes.

O_2 uptake (VO_2) was calculated by the open circuit method: the subject breathed through a mouthpiece and valves connected with a 120-liter light-weight Douglas bag of low carbon dioxide permeability. The bag was flushed with expired gas for a preliminary period before the actual collection, and the gas was then collected over a 5 min period at rest, and for 2 min during exercise. The gas thus collected was promptly sampled with a tight syringe and stored over mercury. O_2 and CO_2 concentrations were determined in duplicate according to the Scholander technique. The volume of the bag was measured with a flowmeter (American meter, Cy model). VO_2 was determined twice at rest and twice during the period between the 10th to 25th minutes of exercise.

Maximal systolic and minimal diastolic blood pressure (Pmax and Pmin) were measured just before gas sampling, so as not to disturb O_2 uptake measurement. Two more measurements were made during the first and fifth minutes of recovery.

ECG was continuously monitored on a Thomson Medical scope and recorded simultaneously together with blood pressure.

Maximal O_2 uptake (VO_2 max) was estimated from the heart rate and VO_2, according to Astrand's technique [12].

Statistical comparisons between the group with Chagas' disease and the controls were made by the Student t-test; the level of $p < 0.05$ was taken as the threshold of statistical significance. Means are given ± SD.

Results

Table 1 shows that the Chag. pos. and control groups were comparable for age, weight, height, body surface area, ventilatory [illegible]

Table 1. Ages and anthropometric, hematological and nutritional data for the subjects with Chagas' positive serological tests and Controls (AD: body surface area estimated according to Dubois: Ht: hematocrit; Hb: hemoglobin concentration; LBM: lean body mass)

Subjects		*Age* *Yrs*	*Weight* *kg*	*Height* *cm*	*AD* m^2	*Hb* *g%*	*Ht*	*LBM* *kg*	*LBM/weight* *%*
Chag. pos.	m	33.0	59.1	163.5	1.64	16.8	46.3	49.5	84.4
	SD	8.6	4.9	4.8	0.08	1.2	4.3	3.9	3.9
Controls	m	28.9	60.0	162.1	1.64	16.3	45.6	49.0	81.4
	SD	9.7	7.5	4.3	0.11	1.0	3.3	4.5	5.4
	P	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Ventilatory data for subjects with Chagas' positive serological tests and Controls (RR: respiratory rate; VT: tidal volume; VC: vital capacity; ERV: expiratory reserve volume; IRV: inspiratory reserve volume; MBC: maximal breathing capacity; FEV1: forced expiratory volume in the 1st sec)

Subjects		*RR* min^{-1}	*VT* l_{BTPS}	*VC* l_{BTPS}	*ERV* l_{BTPS}	*IRV* l_{BTPS}	*MBC* $l_{BTPS} \cdot min^{-1}$	*FEV1* $l_{BTPS} \cdot s^{-1}$	*FEV1/VC* *%*
Chag. pos.	m	14.47	0.48	5.25	2.06	2.31	168.7	4.25	81.6
	SD	4.47	0.18	0.61	0.52	0.71	17.7	0.45	10.0
Controls	m	15.69	0.57	4.92	1.72	2.22	161.4	4.04	82.5
	SD	4.27	0.22	0.61	0.52	0.51	20.6	0.52	7.0
	P	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Heart rates (beats.min-1) at rest, during exercise steady state and during recovery in subjects with Chagas' positive serological tests and controls

Subjects		*Rest*	*Exercise*	*Recovery* *1st min*	*5th min*
Chag. pos.	m	65.2	130.7	88.6	77.8
	SD	12.7	21.8	19.8	14.6

Table 4. Resting O_2 uptake (VO_2), calculated VO_2 max obtained by Asdtrand's method, and exercise steady state (VO_2), in absolute values and in percentages of VO_2 max, in subjects with Chagas' positive serological tests and controls

Subjects	*Rest*	*VO_2 max*	*VO_2 max kg^{-1}*	*VO_2 exercise*	*% VO_2 max*

Discussion

Physiological characterization

the asymptomatic Chag. pos. group. This result agrees with those of Palmero [4] who reported variations in minimal arterial pressure. In the present study the fact that absolute increase during exercise was the same in the Chag. pos. group as in control subjects, meant that their response to exercise was normal. It should be emphasized that these moderate reductions in arterial pressure only had statistical significance in relation to a control group studied under the same conditions. In the absence of a reference group, isolated low pressure values should be interpreted with caution and at most be considered as no more than an alarm signal.

The present study results allow the following conclusions to be drawn about the asymptomatic subjects with positive *T. cruzi* serological tests: 1) the altitude did not affect their responses to exercise, since they resembled those of normal subjects living at the same altitude; 2) exercise did not sensitize any particuliar cardiac or energetic response, so that a difficult costly exercise test does not seem to be of interest; and 3) their work capacity did not alter. Consequently, any elimination of asymptomatic workers based on serological data only is arbitrary and unjustified. However, as the evolution of Chagas' disease is unpredictable, regular clinical examinations may be recommended for such patients, particularly ECG and arterial pressure measurement, for detection of possible Chagas' disease cardiopathy.

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