BIOENERGETIC STUDIES IN RESIDENTS AT HIGH ALTITUDE (2,850 m) WITH ASYMPTOMATIC CHAGAS’ DISEASE

by

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Summary — Cardiovascular response and working capacity were studied at rest and during a 125 W exercise in residents at high altitude (2,850 m), comparing 21 asymptomatic (normal EKG) but T. cruzi infected subjects (positive serology) to 21 healthy controls (negative serology). Ages, anthropometric, nutritional, and hematological data were similar in the two groups (P > 0.05), indicating the homogeneity of the studied population. Cardiac axis, heart rates, and oxygen uptakes, were not different between the two groups, at rest and/or during exercise (P > 0.05). At rest, diastolic and systolic pressures were significantly lower in the infected group than in the control group (P < 0.05). During exercise and recovery at the 1st and 5th min, diastolic pressure was also significantly lower in infected patients than...
As far as we know, the influence of altitude on Chagas' disease has never been studied, though infected patients are found up to 3,500 m and vectors beyond 4,500 m (Usinger et al., 1966; Flores et al., 1979; personal data). This could be important in some countries, such as Bolivia, where one half of the population lives above 3,000 m and travels often from endemic lowlands to the Andean highlands and conversely.

Therefore the aim of this work was to study the cardiovascular and bioenergetic responses, at rest and during exercise, of residents at high altitude (2,850 m), by comparing an asymptomatic, *T. cruzi*-infected group to an uninfected healthy control group.

Subjects and Methods

Subjects

According to clinical examinations, electrocardiogram leads (EKG), and hematological data (see below), 42 adult male farmers were selected as asymptomatic. They live permanently in Chivisivi, a village located at 2,850 m above sea level, in the valley of Sapahaqui (department of La
Gas' disease has never reached up to 3,500 m and set al., 1979; personal such as Bolivia, where malaria travels often from inversely.

The cardiovascular and cerebral, of residents at high T. cruzi-infected group jram leads (EKG), and others were selected as a village located at lui (department of La endemic. they can be divided into two groups (S). The mean (SD) body mass value (1967).

Bioenergetical studies As the subjects were not familiar with either cycling or wearing a mouth piece, they were accustomed via preliminary bouts of exercise on the days before the experiments. For the final experiment, the subject rested in the sitting position for 30 min, during which the EKG electrodes were attached and the sphyngotensiometer (type Vequez-Laubry) was fixed. Then, the subject mounted the cycle (mechanically braked ergonometer, type Funbec) : the values at rest of the different parameters were measured, and the exercise began at 125 W and lasted 30 minutes. The technical limitations of the locally available facilities imposed a limit to the effort and to the heart rates to reach, particularly in order to avoid occurrence of cardiac fibrilation.

The O2 uptake (V02) was calculated according to the open circuit method : the subject breathed through a mouth piece and the valves were connected with a 120 liters light weight Douglas bag of low permeability to carbon dioxide. Expired gas was collected over a 5 min period at rest and 2 min during exercise, following a preliminary period during which the bag was flushed with expired gas. The expired gas was promptly sampled with a tight syringe and stored over mercury. The O2 and CO2 content were determined in duplicate, according to the Scholander technique. The volume of the bag was measured with a flowmeter (type American Meter Cy.). Determination of VO2 was made twice at rest and twice from the 10th to 25th min of exercise.

Arterial systolic and diastolic pressures were measured, in identical conditions for all patients, just before gas sampling not to disturb O2 uptake measurement. Two additional measures were made during the first and fifth min of recovery. Heart rate was recorded at the same time as arterial pressures but was continuously monitored on a scope (type Thomason Medical).

The maximal O2 uptake (VO2 max) was estimated from heart rate and VO2 according to the technique of Astrand (1960).

Results Homogeneity of the studied population As shown in table 1, the ages, anthropometric (weights, height, body surfaces), nutritional (LBM) and hematological data (hemoglobin concentration and hematocrit) were comparable in the selected two group (P > 0.05).

<table>
<thead>
<tr>
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<th>Infected</th>
<th>Control</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>33.0 ± 8.6</td>
<td>28.9 ± 9.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>59.1 ± 4.9</td>
<td>60.0 ± 7.5</td>
</tr>
<tr>
<td>Size (cm)</td>
<td>163 ± 4.8</td>
<td>162 ± 4.3</td>
</tr>
<tr>
<td>Body Size (m3)</td>
<td>1.64 ± 0.08</td>
<td>1.64 ± 0.11</td>
</tr>
<tr>
<td>Hb (g)</td>
<td>16.8 ± 1.2</td>
<td>16.3 ± 1.0</td>
</tr>
<tr>
<td>Ht (%)</td>
<td>46.3 ± 4.3</td>
<td>45.6 ± 3.6</td>
</tr>
<tr>
<td>LBM (kg)</td>
<td>49.3 ± 3.9</td>
<td>49.0 ± 3.8</td>
</tr>
<tr>
<td>LBM (%)</td>
<td>84.4 ± 3.3</td>
<td>81.4 ± 5.4</td>
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P > 0.05

Ao = body surface area; Ht = hematocrit; Hb = hemoglobin concentration; LBM = lean body mass.
Cardiac and energetic exploration at rest

The mean values of \( A_{QRS} \) in the frontal plane was +37° in the infected group and +47° in the control group and without significant difference (\( P > 0.05 \)), as the mean heart rates and the oxygen uptakes of the two groups.

As shown in table 2, diastolic and systolic arterial pressures were demonstrated significantly lower in the infected group than in the control group (\( P < 0.05 \)).

As shown in table 2, mean diastolic pressure was significantly lower (\( P < 0.05 \)) in the infected group than in control group both during the steady state of exercise and recovery at the 1st min and 5th min. However, the tendency to a lower value of systolic pressure, observed in the infected group at rest, was statistically confirmed, only for the recovery at the 5th min (\( P < 0.05 \)).

The \( O_2 \) uptakes, during the steady state of exercise, were similar in the two groups (\( P > 0.05 \)), as the calculated \( V_{O_2} \max \) and, obviously, the energetic production expressed in percentage of \( V_{O_2} \) max.

Discussion

Bioenergetical and cardiovascular responses at rest and during exercise were compared in two groups of residents at high altitude, one with \( T. \) cruzi infection (asymptomatic chronic form of Chagas' disease) and another without \( T. \) cruzi infection, as a control group.

It is important to point out that the studied population was highly homogeneous, since it was composed only of male farmers, living in the same village, with similar ages and anthropometric data. Moreover, the percentage of LBM compared to the body weight was normal in both groups suggesting a good nutritional state.
arterial pressures were up than in the control

Hg) at rest,
1) groups of subjects

<table>
<thead>
<tr>
<th>1st min.</th>
<th>Recovery 5th min.</th>
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<tbody>
<tr>
<td>P min</td>
<td>P max</td>
</tr>
<tr>
<td>69.4</td>
<td>113.4</td>
</tr>
<tr>
<td>7.9</td>
<td>9.8</td>
</tr>
<tr>
<td>75.0</td>
<td>121.9</td>
</tr>
<tr>
<td>9.9</td>
<td>16.1</td>
</tr>
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</table>

ice (125 W)

in both groups, part-
t rates of both groups
ready state of exercise
rate as well as control
was significantly lower
group both during the
n and 5th min. However
observed in the infected

The physiological effects of altitude were observed from the means of hemoglobin concentration and hematocrit which were higher in the studied groups than in patients living at sea level, in relation to the hypoglobulin
response to the chronic hypoxia of altitude (Brendel & Zink, 1982). Likewise, the observed right deviation of the cardiac axis values can be related to an increase in the pulmonary arterial pressure, as demonstrated in another study with Nepalian patients, for which 3,000 m was a critical altitude to show such modifications (Raynaud et al., 1981).

The absence of difference in the heart rates between the groups, confirmed previous works on infected asymptomatic patients (Macedo et al., 1973; Faria et al., 1978; Palmero et al., 1980, 1981). However in the cardiac form of Chagas' disease, slow heart rates were generally found at rest (Palmero et al., 1981) and during exercise (Gallo et al., 1975).

The blood pressures (minimal and/or maximal) were significantly lower in our infected but asymptomatic subjects than in control group, at rest, during exercise and at recovery. This agrees with the results of Palmero et al., who observed such a difference for both pressures at rest (1979), but only for the diastolic one during exercise (1990), whereas Macedo et al. (1973) and Faria et al. (1978) showed no difference between normal and chagasic patients. Though weak, and only detected by statistical analysis and not increased by exercise, those differences between blood pressures of infected and control subjects could be interpreted as a possible indication of heart functional alteration in relation to Chagas' disease, since, in infected patients with evident cardiopathy, the decrease of blood pressures is a classical observation at rest (Laranga et al., 1956; Anselmi & Moleiro, 1971; Palmero et al., 1979) or during exercise (Marins et al., 1976; Silva et al., 1976).

No difference was evident between the two groups of residents at altitude, neither in O2 uptakes at rest or during exercise at 125 W, nor in VO2 max. This, clearly, shows that the physical ability of asymptomatic patients, infected by T. cruzi, is not altered, and is similar to that of other Bolivian farmers (Paz Zamora et al., 1982) and agrees with the previous work of Macedo et al. (1973), carried out at sea level, on Brazilian patients.
Études bioénergétiques chez des habitants de haute altitude (2,850 m) avec maladie de Chagas asymptomatique.

Résultats — Les réponses cardiovasculaires et la capacité de travail étaient étudiées au repos et durant un exercice de 125 W chez des habitants de haute altitude (2,850 m) en comparant 21 sujets asymptomatiques (ECG normal) mais infectés par Trypanosoma cruzi à 21 sujets témoins non infectés (sérologie négative). Les âges et les données anthropométriques, nutritionnelles et hématologiques étaient similaires dans les deux groupes (P > 0,05), indiquant l'homogénéité de la population étudiée. Les axes cardiaques, les pouls et consommations d'oxygène ne montraient pas de différence entre les deux groupes, au repos ou durant l'exercice. Au repos, les tensions diastoliques et systoliques étaient significativement plus basses dans le groupe infecté que dans le groupe témoin (P < 0,05). Pendant l'exercice et la récupération à la première et la cinquième minute, la tension diastolique était aussi significativement plus basse chez les patients infectés que dans le groupe témoin, tandis que les tensions systoliques étaient significativement plus basses seulement pendant la récupération à 5 minutes. Les VO2 max calculées étaient similaires dans les deux groupes, indiquant une capacité normale de travail pour les patients étudiés, asymptomatiques et infectés. L'altitude ne semble pas affecter les réponses à l'exercice, car les résultats obtenus en haute altitude sont similaires à ceux obtenus au niveau de la mer.

REFERENCES


A work was studied at high altitude (2,850 m) on patients infected with Trypanosoma cruzi and the anthropometric data in the two groups.

The cardiac axes, the systolic and diastolic times were lower in the control group (P < 0.05).

The systolic blood pressure was significantly lower in infected patients than in the control group for the responses obtained at a level of 18.


