*Ann. Soc. belge Méd. trop.*
1985, 65, Suppl. 1, 51-57

# 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 healty 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 in control group whereas systolic pressure was significantly lower only during recovery at 5th min. The calculated $VO_2$ max were similar in the two groups, indicating a normal working capacity for the studied asymptomatic infected patients. The altitude does not seem to affect the responses to exercise, since the results obtained at high altitude were similar to those obtained at sea level (Macedo *et al.*, 1973).

KEYWORDS : Chagas' Disease, Asymptomatic; *Trypanosoma cruzi*; Altitude; Bioenergetics.

## Introduction

Twenty-four million people are estimated to be infected by *Trypanosoma cruzi* and 65 millions are living at risk in areas endemic for Chagas' disease, which involves long term cardiac and digestive pathologies (WHO, 1982). Indeed the demonstration of a decrease in the physical ability of infected patients could have important economic consequences in developing countries where this parasitosis is endemic. Therefore attention was mainly focused on the cardiovascular response of infected patients to exercise at the cardiac chronic phase of Chagas' disease (Gallo *et al.*, 1975; Marin Neto *et al.*, 1975; Marins *et al.*, 1976; Silva *et al.*, 1976; Siqueira *et al.*, 1976; Faria *et al.*, 1978; Hirschhaut & Aparicio, 1978; Palmero *et al.*, 1980; Molina *et al.*, 1981; Wajngarten *et al.*, 1982). On the contrary, the demonstration of a normal working capacity, at least in patients with asymptomatic form of Chagas' disease, would prove unjustified the elimination of workers based only on serological data as observed in some countries. However, if cardiovascular responses to exercise of infected but asymptomatic patients have been studied (Pereira *et al.*, 1976; Siqueira *et al.*, 1976; Faria *et al.*, 1978; Palmero *et al.*, 1980; Almeida *et al.*, 1982), the working capacity of such patients was scarcely studied and only at sea level (Macedo *et al.*, 1973).

As far 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

### *Bioenergetical studies*

As the subjects were not familiar with either cycling or wearing a mouth piece, thye were accustomed via preliminary bouts of exercise 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 Vaquez-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 $O_2$ uptake ($VO_2$) 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 $O_2$ and $CO_2$ 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 $VO_2$ 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 $O_2$ 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 Thomson Medical).

The maximal $O_2$ uptake ($VO_2$ max) was estimated from heart rate and $VO_2$ 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 1

**Ages, anthropometric, hematological and nutritional data of the two groups of subjects**

| Subjects | | Age years | Weight kg | Size cm | $A_D$ $m^2$ | Hb g % | Ht | LBM kg | LBM/weight % |
|---|---|---|---|---|---|---|---|---|---|
| Infected | 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 |
| Control | 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 | > 0.05 | > 0.05 | > 0.05 | > 0.05 | > 0.05 | > 0.05 | > 0.05 | > 0.05 |

$A_D$ = body surface area; Ht = hematocrit; Hb = hemoglobin concentration; LBM = lean body mass.

*Cardiac and energetic exploration at rest*

The mean values of $\hat{A}_{QRS}$ 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 ($P < 0.05$).

TABLE 2

**Systolic (Pmax) and diastolic (Pmin) pressures (mm Hg) at rest, during the steady state of exercise and recovery, of the two groups of subjects**

| Subjects | | Rest | | Exercise | | Recovery 1st min. | | Recovery 5th min. | |
|---|---|---|---|---|---|---|---|---|---|
| | | P max | P min | P max | P min | P max | P min | P max | P min |
| Infected | m | 112,5 | 66,3 | 144,1 | 68,8 | 130,3 | 69,4 | 113,4 | 68,1 |
| | sd | 8.0 | 5.0 | 16.3 | 9.8 | 16.4 | 7.9 | 9.8 | 7.0 |
| Control | m | 120,3 | 74,2 | 150,8 | 76,7 | 137,2 | 75,0 | 121,9 | 74,4 |
| | sd | 11.2 | 6.0 | 14.5 | 8.4 | 14.9 | 9.9 | 16.1 | 9.2 |
| | P | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |

*Cardiac and energetic studies at exercice (125 W)*

The EKG leads remained normal during exercise in both groups, particularly ventricular beats were not observed. Heart rates of both groups were without statistical difference during the steady state of exercise ($P > 0.05$) and infected subjects recovered normal rate as well as control ones ($P > 0.05$).

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 $VO_2$ max and, obviously, the energetic production expressed in percentage of $VO_2$ max.

## Discussion

Bioenergetical and cardiovascular responses at rest and during exercise were compared in two groups of residents at high altitude, one with *T.*

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 hyperglobulic 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 (1980), whereas Macedo

**Etudes bioénergétiques chez des habitants de haute altitude (2.850 m) avec maladie de Chagas asymptomatique.**

*Résumé* — 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 $VO^2$ 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.

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