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INFLUENCE OF A 12 HOURS-FAST ON MAXIMAL EXERCISE

GUEYE L., SAMB A., SECK D., CISSE F., MARTINEAUD J.P.

Department of Physiology, Faculty of Medicine and National Sports Institute, Dakar-Senegal

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A b s t r a c t

In this experiment, we studied changes induced by a short-term fasting (Ramadan) on heart rate, systemic blood pressure, glucose and developped mechanical work in well-trained young men during a brief maximal exercise with moderately high ambient temperatures. At rest during fast, systolic blood pressure and glucose were significantly lower than with normal dietary conditions. With maximal exercise, glycaemia became identical in the two situations and similarly maximal heart rates were no different. But systolic blood pressure and mechanical performance were decreased in case of fast. These results show that during fasting periods in warm climates, metabolic responses are not impaired. But water deprivation is deleterious for cardiovascular system and sports performance. Then athlets have to be cautious with physical activities in fasting periods and avoid hard training or any form of competition particularly when ambient temperature are elevated.

K e y w o r d s

Fasting, Hot climate, Glucose level, Maximal exercise, Sports performance.

INTRODUCTION

Metabolic responses to physical activities in usual conditions are extensively known but few studies have attempted to assess effects of dictary manipulations on biological modifications and performances in sportsmen, particularly during the ritual fasting (water and nutriments) of Ramadan (*1,2,3,4*).

Aim of the present study was to obtain a better knowledge on eventual alterations in carbohydrate metabolism and performance during a short but intense muscular exercise at elevated ambient temperature after a 12 hours-fasting in well-trained young men.

Results would allow us to inform more surely young sportsmen regularly engaged in training and competitions during periods of diurnal fasting about health risks or poor performances.

MATERIAL AND METHODS

Environmental Conditions

Experiments were carried out in Dakar which is situated on sea-side at 13° North latitude, i.e. in the intertropical zone during the month of march. It was a relatively warm period and in the moment local temperature ranged from 21°C at 6.00 AM to 30 at 6 PM. Simultaneously, relative humidity ranged from 85% to 70. The operative temperature for experiments ranged between 25 and 29°C (mean: 27.4 ± 0.8 °C).

Methodology

12 male and healthy students of the local Sports Institute participated in the study; age: 22.5 ±1.7 y, height: 1.76 ± 0.06 m, weight: 61.5 ± 6.8 kg at the end of the fasting and 68.1 ±. in normal fed conditions, i.e. a weight loss of 6.6 kg. They were well-trained in physical activities and naturally adapted to hot climate.

Experimental Design

Subjects performed a quickly exhausting exercise (duration: 11–17 minutes) twice. First in normal fed conditions, secondly after the ritual fast (breakfast at 5.00 AM and nothing till measurements twelve hours after). In the two situations, they participated in normal activities of the Institute on the morning, including 3 hours of individual or collective sports activities and scholar activities. They rested since 12 AM till 5.30 PM, moment of experiments.

The incremental exercise test was performed on a cycloergometer after a 5min-100 watts warm-up. Work load was increased by 25 w every third minute until exhaustion.

Heart rate and blood pressure were measured during the test, glucose level was determined before and immediately after. Duration of the exercise and maximal sustained mechanical power were noted.

Data are given as mean ± SD. Student's t test on the mean values was used to compare results in the two situations and the difference between was considered significant when probability values were lower than 0.05.

Experimental protocol was explained and informed consent was obtained. The project was approved by the local ethical Committee.

RESULTS

None of the subjects reported any problem as a consequence of the short fasting and none of them was hypoglycemic or even tired by fasting before the test. Nevertheless we have seen in the experimental design that fasting was accompanied by a mean weight decrease of 6.6 kg (food and liquids). There was not any problem with the tests.

At rest, before the tests, physiological and biological values in the two situations are shown in *Table1*. Plasma glucose level was decreased slightly but significantly by the 12 hours-fasting at rest, but not at maximal exercise. Heart rate is presented in *Table 2.* Heart rate values at rest and during maximal exercise were not significantly different between the two nutritional situations.

At the final stage of the maximal exercise diastolic blood pressure lowered by 14% and were not significantly different between the two nutritional situations, but systolic pressure was lesser (by 19%) during the fast. Furthermore, the duration (warm up not included) to obtain exhaustion and final reached power were lesser (by 22%°) in this situation than in normal feeding conditions.

Table 1

The effect of resting condition and maximal exercise under normal diet or fasting on glucose plasma level concentration. Means ± SD and statistical studies: comparisons between points at the same time in two conditions and comparisons with same diet between values at rest and different instantaneous measurements at exercise, * $p < 0.01$, NS non-significant.

	Rest	Maximal exercise
Usual diet	0.93 ± 0.11	0.74 ± 0.06*
Fasting	0.73 ± 0.01 0.73 ± 0.01	0.72 ± 0.11
Statistical test	$p < 0.001$	NS

Table 2

The effect of normal diet or fasting on mean values of heart rate (up, c/min) at rest and maximal exercise and results of statistical studies.

	Rest	Maximal exercise
Usual diet	67.3. ± 5.7	147.9 ± 1.4
Fasting	67.0 ± 6.7	148.2 ± 1.1
Statistical test	NS	NS

DISCUSSION

During a diurnal fasting, according to various levels of activity, differences in diet and different degrees of physical training, a decrease or no change in blood plasma glucose was observed at rest by various authors (*5,6,7*). In our experiment, with normal activities in young sportsmen, a moderate but significant decrease is observed at rest. But it is not worsened by a brief maximal activity. This is certainly the most relevant result of our study: in an unfavorable environment a ritual fasting during 12 hours does not decrease at all glucose level during maximal exercise but leads to a diminished systolic blood pressure; similarly developed mechanical power is lowered. Generally in physiological studies, a 24 h-fasting results in a reduction of performance capacity and a shorter time before exhaustion (*6*).

Then we can observe, as well as other authors (*7*), that mobilization of liver glycogen and gluconeogenesis are quite efficient with warm environment for main-

taining a sufficient blood glucose for exhausting muscular activity. But the water lack, after a 12 h-fasting only, leads to some depression in cardiovascular function explaining the lesser performance: in this study, we can speculate on a deficiency of water by 4 liters approximately. We must consider also the fact that the physical performance was carried out in hot climate. Our experiments were carried out in the intertropical area of western Africa: Senegal. I our previous study we have determined the influence of increased ambient temperatures on temperature in man and its modifications with normal alimentation or during fasting (*8, 9, 10, 11*). The studies were carried out in the intertropical zone during winter and summer seasons and they demonstrated that the circadian cycle of body temperature was present in all circumstances. This increase of human temperature was at least partially due to the food intake, particularly proteins inducing a specific thermogenesis. Further increase of human temperature is connected with physical activity (*12,13*). The human organism becomes again a strict homeotherm, especially for high temperature, showing the limits of physiological adaptations to the thermic stress. The results with the maximum exercise show that, during fasting periods in warm climates, metabolic responses are not impaired. But water deprivation is deleterious for cardiovascular system and sports performance. Then athletes have to be cautious with physical activities in fasting periods and avoid hard training or any form of competition particularly when ambient temperatures are elevated (*14, 15*).

In spite of a maintained glucose level, a 12 h-fasting of liquids associated to the lack of nutriments induces a lesser efficiency in physical performance due to unsuitable cardiovascular responses during maximal exercise. And the feature would be certainly made worse in harder environmental conditions.

These results have to make us very cautious with young sportsmen who want go on with their training in spite of diurnal fasting, in hot climates with excessive water losses because thermoregulatory requirements.

L.Gueye, A. Samb, D. Seck, F. Cisse, J. P. Martineaud

VLIV 12 HODIN HLADOVĚNÍ NA MAXIMÁLNÍ FYZICKÝ VÝKON

Souhrn

V této práci jsme studovali změny vyvolané krátkodobým hladověním (Ramadan) na srdeční frekvenci, krevní tlak, glykémii a fyzický výkon u dobře trénovaných zdravých mužů během krátkodobé maximální zátěže při vysoké teplotě zevního prostředí. V klidu v průběhu hladovění, systolický krevní tlak a glykémie byly signifikantně nižší než při běžném příjmu potravy. Při maximální zátěži byla hodnota glykémie shodná při hladovění i při běžném příjmu potravy, maximální dosažená srdeční frekvence se rovněž významně nelišila. Systolický krevní tlak a výkonnost klesaly v podmínkách krátkodobého hladovění ve srovnání s podmínkami obvyklého příjmu potravy. Výsledky ukazují, že v průběhu krátkodobého hladovění metabolické odpovědi organizmu nejsou postiženy. Nedostatek vody je závažný pro kardiovaskulární systém a sportovní výkonnost. Atleti musí být opatrní s fyzickými aktivitami v období krátkodobého hladovění a snížit intenzivní trénink zvlástě když je okolní teplota vysoká.

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