DIETARY SUPPLEMENTATION AND IMPROVEMENT IN PHYSICAL WORK PERFORMANCE OF AGRICULTURAL MIGRANT WORKERS OF SOUTHERN BRAZIL

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SUMMARY

A three-month trial was carried out on 14 agricultural migrant workers *(Bóias-Frias)* residing on the periphery of Ribeirão Preto, an agricultural and industrial town in the interior of the State of São Paulo in southern Brazil. This group can be considered as marginally malnourished. Their nutritional status and physical work performance was measured before and after receiving a supplemented lunch over a three-month period. The main change in their nutritional status during this period was an increase in body weight. Their physical work performance, as measured by a bicycle ergometer test, improved significantly after the supplementation of their traditional diet.

INTRODUCTION

It is now becoming apparent that marginal malnutrition, not easily recognizable without proper assessment, occurs in certain sectors of the socioeconomically deprived populations of southern Brazil (1). One such population, commonly known as *Bóias-Frias* or agricultural migrant workers, living on the periphery of the large towns of Brazil, in increasing rapidly. A survey of *Bóias-Frias* living around Ribeirão Preto –a rapidly growing town in the interior of the State of São Paulo– indicates that the food habits and nutritional status of *Bóia-Fria* families are poor and the socioeconomic and hygienic conditions are deplorable (1). One of the consequences of malnutrition among these families is poor physical growth and development of their children as determined by anthropometric comparisons with their well-to-do counterparts (2). The impact of marginal or moderate malnutrition due to inadequate food intake on the functional impairment of the working individuals and the effect on physical work performance of the migrant workers in Brazil has not yet been assessed. It is only after such critical studies that understanding of steps to be taken for the prevention and amelioration of impaired function consequent to existing malnutrition, can be determined. The present study is an attempt to demonstrate occurrence of malnutrition and low functional ability for physical work performance among agricultural migrant workers of southern Brazil, and the possibility of significant improvement in their nutritional status and work performance by supplementing their traditional diet.

METHODS

Subjects

A group of 14 apparently healthy male agricultural migrant workers, residing in periurban *favelas* of Ribeirão Preto, was invited after their consent to take part in this study. Their ages ranged from 19 to 37 years. A typical work day routine of these *Bóias-Frias* begings at 5 o'clock in the morning, having a simple breakfast of coffee with sugar and bread, and arriving at a fixed pick-up point, with a prepared lunch in a typical aluminum container called *marmita*. *Bóia-Fria* agents, popularly known as *gatos*, then pick them up on a flat-bed truck to a farm *(fazenda)* for harvesting sugar cane. The manual labor begins at 7:00 in the morning and ends between 16:00 and 17:00 hours with short lunch breaks at 9:00 and 13:00 hours during which they eat cold lunch from their own *marmitas* which they bring with them. They are returned back to Ribeirão Preto by their respective agents between 18:00 and 19:00 hours in the evening. Each *Bóia-Fria* is paid weekly depending on the amount of sugar cane he cuts. The average earning per day as of July 1981 was about 500 cruzeiros (equivalent to 5 $ U. S.). Most *Bóias-Frias* work six days a week during harvest season and may be without work for several days or weeks during off season.

Before starting this study and at the end of the supplementation program carried out for a period of three months, the subjects were brought to the Hospital of the University of São Paulo Medical School in Ribeirão Preto for complete examination and to perform a cycloergometric submaximum work performance test. First an electrocardiogram was run to check their cardiac function. Then a fasting blood sample was collected for biochemical analyses, followed by a simple anthropometric examination. Half an hour before the cycloergometric test, subjects were given a cup of coffee with milk and sugar and a piece of bread with margarine. Afterwards, each subject was interviewed to obtain socioeconomic and dietary information.

Anthropometric, Biochemical and Clinical Examination

Brief anthropometry included measurement of height, weight and mid-arm circumference using standard techniques (3).

Biochemical examination of blood included hemoglobin, hematocrit, plasma albumin, plasma vitamin A, plasma β-carotene and plasma cholesterol using standard analytical procedures (4).

Diet of the Subjects

Typical food habits of agricultural migrant workers *(Bóias-Frias)* of southern Brazil have already been reported in detail in a recent publication (1). Subjects of the present study maintained their normal meal pattern except during the three-month supplementation period when their traditional lunch *(almoço)*, consisting of basically rice and beans, was replaced by a supplemented lunch consisting of one more serving of rice and beans and an additional serving of a meat item (beef, chicken, sausage or egg) plus a serving of a vegetable item (potatoes or tomatoes) every day. At home, migrant workers consumed a traditional evening meal of rice and beans or some times white bread and soup containing rice or maccaroni with beans and a small amount of a vegetable such as cabbage *(repolho)* or tomatoes. In the morning most migrant workers had a simple breakfast *(café da manhã)* of white bread and a small cup *(xícara)* of black coffee with sugar before going to work, and some went without any breakfast. A 24-hour estimate of their dietary intake indicated that the subjects under study ingested, on average terms, about 900 to 1200 kilocalories (kcal) in the form of morning and noon meals, and about 800 to 1000 kcal in the form of evening meal. About 5-10o/o of total kilocalories are consumed as alcoholic beverages such as *cachaça* or *aguardente* (crude white rum) and some beer *(cerveja)* on Sundays and holidays.

A proximate analysis of 10 randomly-selected traditional and supplemented lunches was carried out. Protein content was determined from nitrogen content estimated by the standard Kjeldahl procedure. Fat content was determined by the ether extraction procedure in a Soxhlet apparatus, and the amount of carbohydrates was determined by difference. Total calories content was determined by multiplying protein and carbohydrates in g times 4, and fat in g times 9.

The supplemented lunches were served every day in special insulated containers *(marmitas)* which maintained the temperature of food at 50°C up to the time of consumption in the field, as against the temperature of 25-29°C of the traditional *marmitas* used by the *Bóias-Frias*.

Cycloergometric Physical Work Performance Test

The physical work performance of the subjects on traditional lunch and after switching to the supplemented lunch was tested on the basis of elevation in heart rate at known levels of generalized work performed on a bicycle ergometer (Funbec Corporation, Brazil). The protocol of the exercise test was as recommended by the World Health Organization (5). The work performance was tested in the sitting position on a bicycle ergometer with a submaximum work-load program as follows: 0 watts at 0 rpm (revolutions per minute) for a few minutes (rest and stabilization period), 0 watts at 60 rpm for 4 minutes (warm-up period), 25 watts at 60 rpm for 4 minutes (work period) followed by 2 minutes rest, 50 watts at 60 rpm for 4 minutes (work period) followed by 2 minutes rest, 75 watts at 60 rpm for 4 minutes (work period) followed by 2 minutes rest, and so on up to 150 watts at 60 rpm for 4 minutes. The speed of the bicycle was regulated at 60 rpm by a tachometer and the heart rate was monitored continuously on an oscilloscope (Funbec Corporation, Brazil) and recorded on an electrocardiogram during the last 30 seconds of each exercise period. The testing was done at a fixed time in the morning, and the environmental influences on heart rate were kept at a minimum level by maintaining constant temperature (22°C) in a special quiet air-conditioned testing room. Submaximum heart rate in beats per minute was determined for each subject by deducting the respective age, in years, from 195. The submaximum work load was recorded in watts and can be expressed in kilo pond meter (kpm) by multiplying watts by a factor of 6.

Statistical Analyses

The comparison of cycloergometric results before and after supplementation for statistical difference in heart rate was carried out using Student's "t", test, and statistical difference in work load required to reach submaximal heart rate was obtained by using the Wilcoxon non-parametric test.

RESULTS

Diet Analysis

The proximate analysis of randomly selected samples of

traditional and supplemented lunch, as consumed by a selected group of agricultural migrant workers (Table 1), indicated that supplemented lunches contained on the average 367 g of extra food in the form of rice and beans, and an extra serving of meat and vegetables. So far as nutrient contents of these two meals are concerned, the supplemented lunches provided an average of 355 extra calories, 20 g of extra protein, of mixed quality and, 72 g of extra carbohydrates.

TABLE 1

PROXIMATE ANALYSES OF TRADITIONAL AND SUPPLEMENTED LUNCHES OF MIGRANTS UNDER STUDY

Items	Mean ± SD		Difference between traditional and supplemented lunches
	Traditional lunch (n= 10)	Supplemented lunch (n= 10)	
Weight as served (g)	957 ±275	1324± 60	+ 367
Total calories (kcal)	1033 ±283	1388± 64	+ 355
Protein (g)	32.7 ±11.1	52.9± 2.5	+ 20
Fat (g)	6.5 ∓ 5.8	4.2± 0.2	— 2
Carbohydrates (g)	212.6 ±58.9	284.6± 15.4	+ 72

Nutritional Status

A summary of nutritional status parameters of migrant subjects before and after supplementation, is presented in Table 2. The only change in the anthropometric parameters examined was a mean gain of 2.1 kg of body weight (57.7 vs 59.8) after receiving the supplemented lunch for a period of three months. The hematological and biochemical indices were found to be normal.

Cycloergometric Test for Physical Work Performance

Figures 1 and 2 depict the results of physical work performance on the traditional diet, that is before receiving supplemen-

TABLE 2

SUMMARY OF NUTRITIONAL STATUS PARAMETERS OF MIGRANT SUBJECTS BEFORE AND AFTER SUPPLEMENTATION OF A TRADITIONAL DIET FOR THREE MONTHS

Parameters	Mean values	
	Before supplementation	After supplementation
Age (years)	26	26
Weight (kg)	57.7	59.8
Height (cm)	166	166
Mid-arm circumference (cm)	26.1	26.7
Hemoglobin (g%)	15.2	—
Hematocrit (%)	44.2	—
Plasma albumin (g%)	4.7	—
Plasma vitamin A (μg%)	43.7	—
Plasma β-carotene (μg%)	83.1	—
Plasma cholesterol (mg%)	128.6	—

tation, and after receiving the supplemented lunch every day for a period of three months. Figure 1 shows that at every level of submaximum work load in a cycloergometer test, the subjects demonstrated significant improvement ($p < 0.01$) in the work performance as indicated by lower heart beats after being on the supplemented lunch for a period of three months. Figure 2 shows the submaximum work load (watts) required to reach submaximum heart rate (195 –age in years) for agricultural migrant workers before and after receiving the supplemented lunch over a period of three months. The mean calculated submaximum work load for reaching submaximum heart rate was 68 ± 25 watts on the traditional diet before supplementation which then increased by about 50% to 102 ± 21 watts after supplementation for a period of three months.

The possibility of the learning effect on the results of our cycloergometer test was verified by subjecting five migrant workers, not involved in this study, to the same bicycle test twice over a period of one month. The repeated cycloergometer test gave

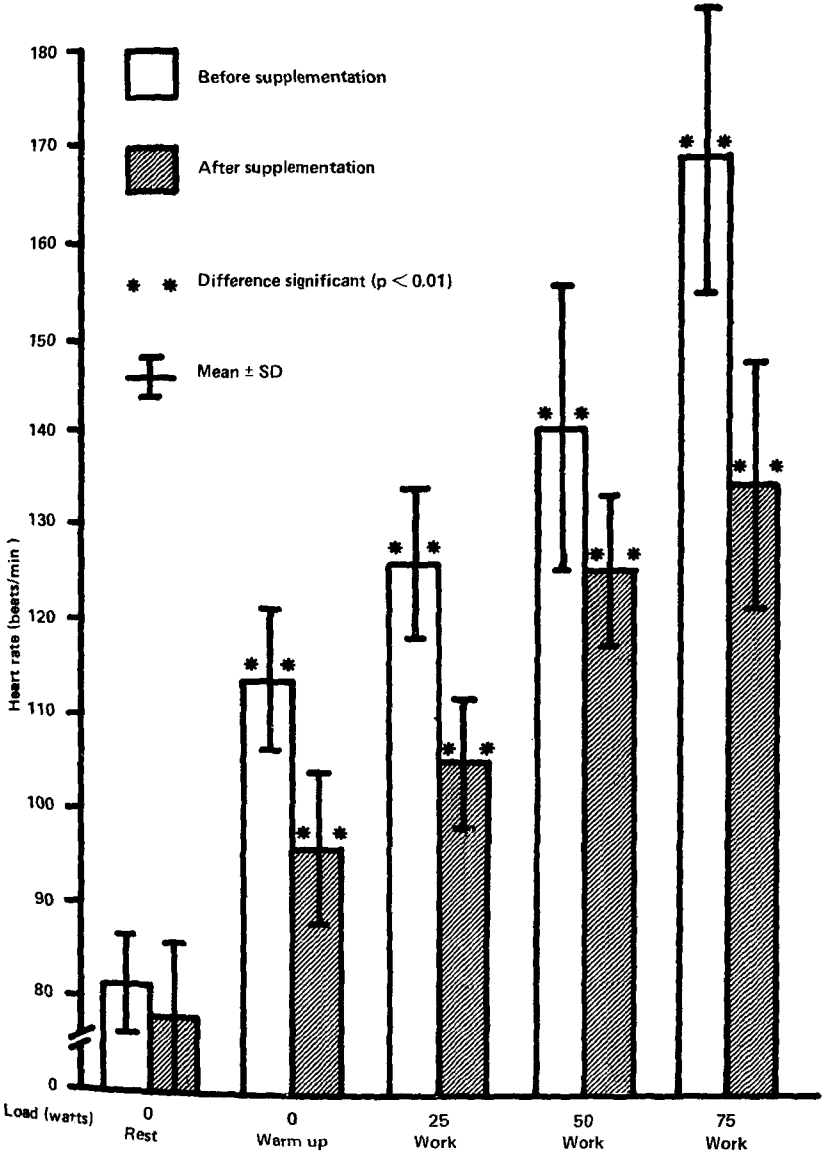

FIGURE 1

Heart-rate response to a cycloergometric work performance test at different levels of submaximum work load before and after supplementation of a traditional diet

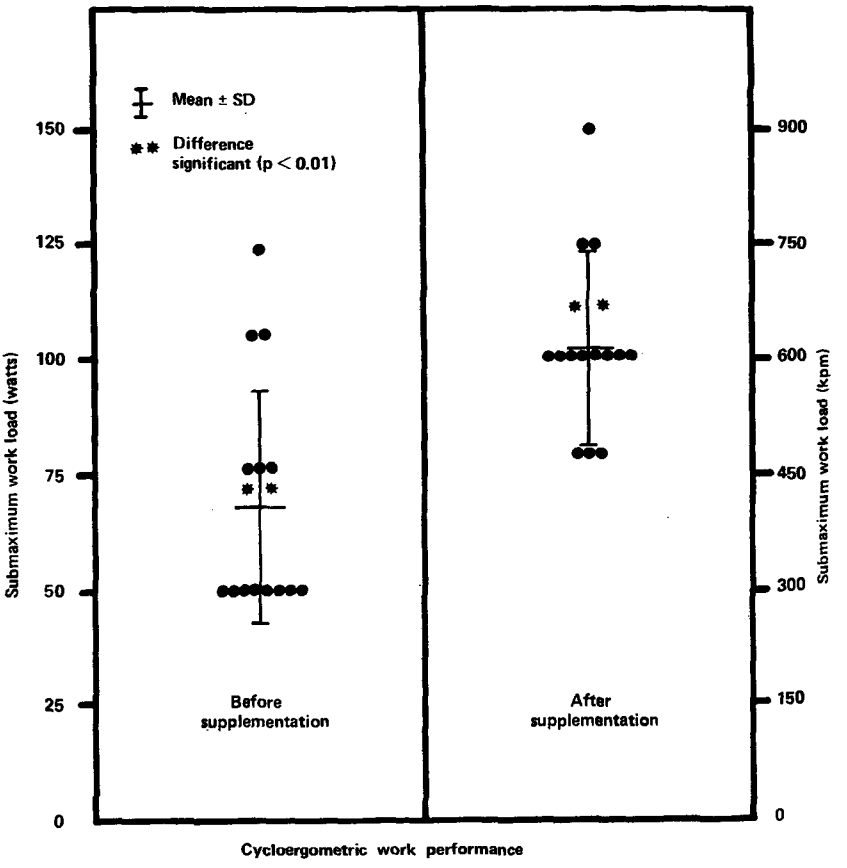

FIGURE 2

Submaximum work load, in watts and kpm, required to reach submaximum heart rate in beats per minute, before and after supplementation of a traditional diet

exactly the same results, indicating thereby that there was no learning effect on the performance of the migrant workers in our study. The validity and usefulness of this cycloergometer test for the assessment of physical work capacity of other groups of people in Brazil, has also been established in previous studies of this type in our laboratories (2, 6, 7).

DISCUSSION

The results of our study clearly demonstrate that the physical work capacity of marginally-malnourished agricultural migrant workers living on the traditional diet of just rice and beans, is quite low and compares only to that of sedentary Brazilians examined previously (6). Simple dietary supplementation to increase their intake of calories and proteins improved their nutritional status as seen from gain in body weight, and also their physical work performance, as tested on a bicycle ergometer.

The relationship between nutritional status and physical work performance has been studied in humans only within the last 20 years. In 1962, the Food and Agriculture Organization of the United Nations (FAO) reviewed the consequences of an inadequate diet on work performance, and found that inadequately nourished workers improved their work output after receiving supplemented rations (8). The improvement in work performance and productivity could be due to the improved weight gain, as observed in our study and in Indian coal miners (9), and due to improved nutritional status, as seen in Jamaican sugar cane cutters (10). Improvement in weight gain, therefore, seems to be a useful index when other biochemical indices of nutritional status do not change.

The studies on Colombian sugar cane cutters and loaders (11, 12) and on chronically undernourished rural workers of Colombia (13) indicated that the markedly depressed work capacity, as measured by maximal oxygen consumption, cannot be improved just by providing adequate calories, but that significant improvement in work capacity occurs only when protein repletion is also instituted in the diet.

It is, therefore, evident that proper improvement of the conventional *Bóia-Fria* diet itself, to obtain better work performance of the agricultural migrant workers of southern Brazil, is highly imperative for the agricultural productivity and economy of

Brazil. Up to a 50% increase in physical work capacity of marginally malnourished *Bóias-Frias* could be achieved by simple food supplementation and without major modifications in their traditional food habit based on locally available foods.

RESUMEN

SUPLEMENTACION DIETETICA Y MEJORAMIENTO EN EL RENDIMIENTO DE TRABAJO FISICO DE PEONES AGRICOLAS MIGRANTES DEL SUR DEL BRASIL

Se llevó a cabo un ensayo de tres meses de duración en 14 peones agrícolas migrantes *(Bóias-Frias)* residentes en la periferia de Ribeirão Preto, ciudad agrícola e industrial situada en el interior del Estado de São Paulo en el sur del Brasil. Este grupo se puede considerar como marginalmente malnutrido. Su estado nutricional y rendimiento en el trabajo físico se midió antes y después de recibir un almuerzo suplementado durante el período mencionado. En ese lapso, el principal cambio observado en su estado nutricional fue un incremento del peso corporal. Según mediciones practicadas utilizando la prueba de bicicleta con ergómetro, su rendimiento en el trabajo físico mejoró en forma significativa después de la suplementación de su dieta tradicional.

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