Cardiopulmonary and hematologic response to the test Course Navette 20 meters in University Students*

Resposta cardiopulmonar y hematológica al test de Course Navette de 20 metros en Estudiantes Universitarios

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ABSTRACT

Introduction: Young people who start the university life face a key stage for the acquisition of habits and lifestyles. The test Course Navette is one of the most used worldwide because of its easy measurement, validity, effectiveness and sensitivity in different age ranks. Material and methods: An observational, descriptive and transversal study with quantitative approach; with 100 students participating (43 men and 57 women) with an average age of 21.06 ± 2.43 at the University of Santander, Cúcuta. For the development of this research, were obtained measurements anthropometric, hematological, physiological and performance on an empty stomach Leger test. Results: 62% of participants had a BMI of normal weight, 24% overweight and obesity and underweight was 8 and 6% respectively. In turn 32% of men and 17.5% of women have high cardiovascular risk according to abdominal circumference. VO$_{2max}$ in the Leger test was 32.92 ± 7.12 with 533.80 ± 371.34 meters traveled. Regarding glycemia before the test was 80.99 ± 11.91 and after 105.59 ± 20.89. Conclusion: No significant differences in fat percentage (p = 0.863), muscle (p = 0.740) and water (p = 0.804) after Leger test. However, there were significant changes in cardiac frequency, TAD, red cells, white cells, platelets and blood glucose levels (p = 0.000). Regarding the VO$_{2max}$ (p = 0.597) and travel meters (p = 0.619) no differences were found by gender.

RESUMEN

Introducción: Los jóvenes que inician la vida universitaria enfrentan una etapa clave y vital para la adquisición de hábitos y estilos de vida. El test de Course Navette es uno de los test más utilizados a nivel mundial, debido a su fácil medición, validez, efectividad y sensibilidad en diferentes rangos de edad. Material y métodos: Un estudio observacional, descriptivo y transversal con enfoque cuantitativo; en el que participaron 100 estudiantes (43 hombres y 57 mujeres) con una edad promedio de 21.06 ± 2.43 de la Universidad de Santander, Cúcuta. Para el desarrollo de esta investigación, se obtuvieron medidas antropométricas, hematológicas, fisiológicas y realización del test de Leger en ayunas. Resultados: El 62% de los participantes tuvieron un índice de masa corporal (IMC) de normopeso, el 24% sobrepeso y para obesidad e infrapeso fue 8 y 6% respectivamente. A su vez el 32% de los hombres y el 17.5% de las mujeres tienen alto riesgo cardiovascular según medidas de circunferencia abdominal. El VO$_{2max}$ en el test de Leger fue de 32.92 ± 7.12 con 533.80 ± 371.34 metros recorridos. Respecto a la glucemia antes del test fue de 80.99 ± 11.91 y después 105.59 ± 20.89. Conclusion: No se encontraron diferencias significativas en el porcentaje graso (p = 0.863), muscular (p = 0.740) y agua (p = 0.804) después del test de Leger. No obstante, hubo cambios significativos en la FC, TAD, glóbulos rojos, blancos, linfocitos, hemoglobina, plaquetas y glucemia (p=0.000). Respecto al VO$_{2max}$ (p = 0.597) y metros recorridos (p = 0.619) no se encontraron diferencias según género.

INTRODUCTION

Initially is important highlight two types of systematics responses to the exercise, one is the acute and the other is the chronic. The first one is about the increase in the oxygen consumption (VO$_2$), and the chronic is about adaptive changes, given at a long term and it can be also seen at rest.1 Hill et al. described for the first time the VO$_{2max}$ as the highest rate
at which the body is able to consume oxygen
during intense exercise.\textsuperscript{2} It is also important
to mention that this VO\textsubscript{2max} varies according
to lean body mass, age, gender and genetic
characteristics of the individual.\textsuperscript{3}

Other authors have defined the VO\textsubscript{2max} as
the maximum amount of oxygen that the body
is able to absorb, transport and consume per
unit of time.\textsuperscript{4,5} Highlighting that the VO\textsubscript{2max} is
the measure used to talk about the intensity of
an exercise, determining that the exhaustive
exercise is above 70\% and the slight exercise
below 40\%.\textsuperscript{3}

Currently, there are many methods to
determine VO\textsubscript{2max}, either in laboratories or
outdoors. Among the field test, the most widely
used worldwide is the Course Navette 20
meters, also known as 20 m Shuttle Run Test,
test round trip in 20 meters or test of Leger.\textsuperscript{6,7}

The test of Course Navette or test of Leger
20 meters after more than 30 years of use and
recognition remains one of the most widely
used to study the cardiorespiratory component,
in both sexes and in a broad age range. This
is because: 1) the correlations obtained with
the direct VO\textsubscript{2max}; 2) the predictive stability
in subjects with different levels of physical
condition; 3) the good test-retest reliability; 4)
the sensitivity to monitor post-training changes;
5) your relationship to health and diagnostic
capacity; 6) the possibility of dosing workloads
correcting the final speed reached and 7)
mainly, the original idea of carrying it out on a
tour round trip in 20 meters.\textsuperscript{5}

On the other hand, the exercise not
only causes changes in VO\textsubscript{2max}, but also in
the different body systems; either acutely
or chronically, but within the relatively less
considered, is the hematological. Of this
latter, the literature refers to changes in blood
volume, in the activity of white blood cell
populations, as well as changes in cellular
and humoral immunity, and in the count and
platelet shape.\textsuperscript{8}

Firstly, as an initial response to the exercise
has shown that during and until one hour
after a strenuous physical exertion, there exist
dehydration and hemoconcentration with
increased in the Hb concentration, in the
hematocrit (Hct) in the erythrocyte count and
decrease in total blood volume (BV) at the
expense of decreased primarily plasma volume
(PV),\textsuperscript{9,10} which can be, with respect to pre-
exercise values of up to 18\%. These changes
are greater as they go longer and the exercise
is intense, and lowers if the degree of training
is higher; likewise, if the exercise is less than
40\% VO\textsubscript{2max} during training sessions tend to not
altered the above hematological parameters.

The World Health Organization and most
medical organizations recommend associate
diet and physical activity to promote health
and reduce the growing incidence of obesity
in the world population.\textsuperscript{11,12} One strategy
that has arisen to increase the «burn» fat is
to perform a moderate intensity exercise and
fasting prior to the session.\textsuperscript{13,14} Understood by
fasting according to the Royal Spanish Academy
as «Abstinence from all food and drink from
twelve o’clock antecedent».

Therefore, during the approach of this
research came the question: What are the
hematological changes and cardiopulmonary
results after the test of Course Navette? In
order to know the physiological changes
that generates this test on students at the
University of Santander, headquarters on
Cucuta-Colombia.

**MATERIAL AND METHODS**

An observational, descriptive and transversal
study was realized that quantifies cardiovascular
risk, VO\textsubscript{2max} and hemodynamic changes through
the test of Leger in a population of 100 (57
women and 43 men) students was performed
with an average age of 21 ± 2.43 years, they
attended the premises of the University of Santander, headquarters on Cucuta-Colombia.
At an altitude of 320 meters above sea level.
Geographical coordinates: 7°54 of north latitude
and 72°30 West of Greenwich.

Participants must be over 16 and under 26
apparently healthy and to sign an informed
consent, supported by the research committee
of Physiotherapy program at the university.
We excluded participants with pain in lower
limb, breathlessness or fatigue bigger than 3,
participants with cardiovascular disorders or
a history of cardiovascular surgical type or
acute myocardial infarction. As retirement
criteria were taken into account hemodynamic
instability during the test and the manifestation of not wanting to continue.

The scheduled day of the test, began with the collection of demographic data (gender, age, ethnicity, personal history, family history and identification of cardiovascular risk factors) using a questionnaire for the identification of cardiovascular risk factors and personal data of the students. Then, the physiological measures (heart rate, blood pressure, blood oxygen saturation, dyspnea and fatigue) were determined pre and post-test Course Navette, using a portable pulse oximeter (Nellcor Puritan Bennett) for heart rate and saturation arterial of the oxygen. Systolic and diastolic blood pressure was taken manually and perceived dyspnea and fatigue by the modified Borg scale.

Anthropometry (weight, height, BMI, abdominal and hip circumference) it was determined by Tezzio TB-30037 digital scale previously calibrated and placed on a flat surface and with a good support, with all of its angles in contact with the floor. And the size with the measuring rod Adult Acrylic Wall Kramer 2104 placing the patient standing with his head in Frankfort plane and shoulders relaxed to avoid lordosis, in an upright position making sure that the back of the heels, calves, buttocks, back and head touched the wall. Z score obtained (Z-score) for BMI (kg/m²) through software Microsoft Excel 15.0, developed on headquarters with the reference of the World Health Organization was obtained. BMI Z score allowed the sample group in underweight, normal weight, overweight and obesity.

For abdominal circumference was necessary that the participant was lightly clothed in a standing position, with the abdomen relaxed and with arms folded across his chest, the examiner surrounded the participant’s waist with metric tape; then, arms goes in a relaxed position and close to the trunk. The measurement was performed at the narrowest level, between the tenth rib and the iliac crest, at the end of a normal expiration without the tape pressing the skin. This measurement was performed with an inextensible anthropometric tape. To determine the normal values of abdominal circumference, the reference values were used according to Buendia et al.15 (Men 91 cm and Women 89 cm).

For cardiopulmonary component the test of Course Navette round trip 20 meters was performed to exhaustion. The race pace was determined by a beep. The initial velocity was 8.5 km/h-1 and increased to 0.5 km/h-1 with one minute intervals, called stages, in the morning time around the synthetic field at the University of Santander, headquarters on Cucuta. It should be noted that the participants were previously informed that they could not consume some kind of food or sugared drink after 7 o’clock at night and that state should remain until 7:00 am on the college campus, to wait for indications from the investigators. However the participants were called the night before the test at 6 pm to remember the instructions of the research. Likewise, could not drink alcohol, coffee, smoke or use any drugs or medication that could interfere with its performance on test day. After completing the anthropometric measures, questionnaires and first sample of blood glucose, the participants performed the test of leger under the parameters previously mentioned. Once the Leger Test is finished, the researchers take vital signs again and the bacteriology the second sample of blood glucose. After the completion of the entire fieldwork process; the participants were given a standard breakfast for their metabolic stabilization and supervision during the following 30 minutes of rest. Aerobic capacity was determined through maximum oxygen consumption VO₂max estimated from the equation Léger (Léger, Mercier, Gadoury, & Lambert, 1988). Also, hematological tests and glycemic were taken before and after the test by a professional Course Navette bacteriologist and then analyzed in the clinical laboratory.

The design and development of the research was conducted under the ethical considerations of the Helsinki Declaration and Resolution No. 008430 of the Ministry of Health of Colombia and under the authorization of the directors and program coordinators physiotherapy at the University of Santander, headquarters on Cucuta.

Statistic analysis

For the description of quantitative variables, it was necessary to express as the arithmetic measure and standard deviation. Regarding
the comparison of pre and post data to the test Course Navette, the ANOVA (analysis of variance one-way) was performed to compare the differences of gender and ages in the different variables studied, in addition to testing post hoc by Tukey test, to see the differences between the different age groups, gender and anthropometry. In all cases the level of significance was established at 5% ($p < 0.05$) and were performed in Stata 12 (Data Analysis and Statistical Software) program.

RESULTS

After analyzing the data obtained during the fieldwork; which it was conducted with a total sample of 100 (57 women and 43 men) students who attended the premises of the University of Santander, headquarters on Cucuta-Colombia, whose sociodemographic characteristics studied allow to identify an average age for both genders of $21 \pm 2.43$; made up of 57% women and 43% men. On the academic level, 100% were undergraduate students at the University of Santander.

The risk factors identified were: arterial hypertension, overweight and/or obesity, cardiovascular risk according to abdominal circumference, diabetes, smoking, family history (diabetes, acute myocardial infarction and hypertension), alcohol intake and fatty foods; being most prevalent family history as hypertension, myocardial infarction, diabetes, cancer and kidney failure. Regarding cardiovascular risk factors in the sample study, it was determined 8% to smoking, 30% alcoholism and intake of fatty foods more than 3 times per week and sedentary lifestyle was 60% and 56% respectively. Similarly, it was identified that 32.6% of men and 17.5% of women have a high cardiovascular risk related with abdominal circumference. With respect to cardiovascular risk associated with abdominal/hip circumference it was found that 18.6% and 40.4% of men and women respectively, present a high cardiovascular risk. And in relation to the abdominal/size circumference was identified that 41.9% of male and 45.6% women have a high risk (Table I).

From the point of view anthropometric the 6% showed underweight, 62% normal weight and 24.5% and 8% overweight and obesity respectively. Next, the results achieved in the test were analyzed by the test of Course Navette obtaining $551.81 \pm 359.01$ meters traveled for men versus $517.19 \pm 382.70$ in women ($p = 0.619$); in $\text{VO}_2\text{max}$ $33.34 \pm 7.14$ was achieved in men compared with $32.60 \pm 7.15$ for women ($p = 0.597$).

Also, according to the body mass index and the meters traveled, in underweight it was $323.33 \text{ m} \pm 124.85$, $559.35 \text{ m} \pm 423.83$ normal weight, $530 \text{ m} \pm 274.29$ overweight and with $505 \text{ m} \pm 286.01$ ($p = 0.524$). When relating with $\text{VO}_2\text{max}$ the students with underweight reached a $\text{VO}_2\text{max}$ of $28.1 \pm 2.51$, $33.46 \pm 7.46$ normal weight, and values of $32.5 \pm 6.33$ and $33.80 \pm 8.50$ for overweight and obesity respectively. With respect to physically active participants, it was determined that participants who exercise more than 3 times a week, run more meters ($727.23 \pm 400.31$ versus $362.26 \pm 238.67$; $p = 0.000$) and greater $\text{VO}_2\text{max}$ ($36.4 \pm 7.34$ versus $29.80 \pm 5.27$; $p = 0.000$) in the Leger test compare to sedentary participants (Table II).

On the other hand, we can stand out that the tests performed were significantly high intensity for participants, since 93% (M: 100% versus W: 94%) mentioned an effort between strong and extremely strong (score of 5 to 10) after the test according to the Borg scale for fatigue; for assessing dyspnea the 90% (M: 88% versus W: 91%) mentioned according to the Borg scale a dyspnea severe to extremely severe (grade 5 to 10) after the Course Navette test of 20 meters.

At the same time, comparing the glycemic levels after the test of Course Navette it was found that before the test was $80.99 \pm 11.91$ and after $105.59 \pm 20.89$ ($p = 0.000$). With respect to the hematological components there were significant changes in red blood cells, white cells, lymphocytes, granulocytes, hemoglobin, hematocrits and platelets ($p = 0.000$) in the samples post-test of Course Navette 20 meters (Table III and IV).

DISCUSSION

Some authors mention that exercise at moderate intensities, combined with a pre-
carbohydrate intake, even in few portions and especially if high glycemic index, significantly decreased lipid oxidation in the exercise, so the recommendation is fasting, where priority is to decrease adipose tissue.\textsuperscript{16} However, various investigations have mentioned that fasting causes problems as favoring protein catabolism, decreased sports performance and the risk of hypoglycemia during exercise.\textsuperscript{13,14,17,18} Oetinger et al\textsuperscript{19} mention that exercise at fasting causes an increase in catecholamines, cortisol and high levels of peptide natriuretrico who plays an important role in exercise-induced lipolysis. In addition, leptin and insulin show a decrease in their concentrations. Being contrary to the results found regarding glycemia, which increased significantly in the undergraduate students evaluated, which is due to run-time test of Course Navette, being this relatively short compared to a moderate-intensity exercise for a minimum of 30 minutes to see these metabolic effects. It is for this reason that Moro C et al.\textsuperscript{20} emphasize that in short periods of exercise exists an increase of glucagon as a hyperglycemic hormone, which would suit the results.

According to VO\textsubscript{2max}. Baez Y. and Agudelo C.\textsuperscript{21} performed Course Navette test in young footballers resulting in 56.09 ± 4.05 mL/kg/min versus 31.80 ± 7.04 mL/kg/min found in our study population with a percentage of 56% of sedentary lifestyle; which shows clearly
a better average \( \text{VO}_2\text{max} \) in young athletes versus sedentary young. Identical results when comparing the performance of young university students evaluated with the research of Silvestre et al. (2006), Oliveira (2007), Moraes & Herdy (2007).

Likewise, Salcido J et al. in his work «Comparison of maximal oxygen uptake,
adjusted to muscle mass, among young overweight and normal weight, with moderate level of physical activity showed similar results in determining that university students with normal weight have a higher average VO\textsubscript{2max} and meters traveled compared with overweight youth.

**CONCLUSIONS**

In this investigation it was possible to conclude that significant changes in heart rate (\(p = 0.000\)), systolic blood pressure (\(p = 0.000\)) and diastolic (\(p = 0.000\)) but not in arterial oxygen saturation (\(p = 0.537\)). From the perception of dyspnea exercise (\(p = 0.000\)) and fatigue (\(p = 0.000\)) according to the Borg scale there were significant changes after test Leger.

Regarding hematological analysis, we conclude that there are no significant differences in monocytes granulocytes (\(p = 0.829\)) and platelet volume (\(p = 0.262\)) after test Leger. However, it can show that there exist significant changes in the levels of white blood cells (\(p = 0.000\)), red blood cells (\(p = 0.000\)), lymphocytes LY (\(p = 0.000\)) and LYM (\(p = 0.000\)), granulocyte (\(p = 0.000\)), hemoglobin (\(p = 0.000\)), hematocrit (\(p = 0.001\)) and platelets (\(p = 0.001\)) after test.

Indeed, it was determined VO\textsubscript{2max} levels in the study population; concluding that there were no differences between men and women regarding VO\textsubscript{2max} (\(p = 0.059\)), speed (\(p = 0.794\)) and meters traveled (\(p = 0.794\)). But there were differences between physically active vs. sedentary participants (\(p = 0.000\)). Likewise, there was a higher consumption of VO\textsubscript{2max} in patients with a higher BMI and/or older.

With respect to blood sugar levels, it was evident an increase (80.99 ± 11.91 versus 105.59 ± 20.89; \(p = 0.000\)) after the Course Navette test.

These results obtained in this research allowed to determine and correctly analyze the fitness level of students at the University of Santander, headquarters on Cucuta-Colombia; indicating the need to implement strategies aimed at improving the fitness level and lifestyle of young university students in the city.

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**Conflict of interests**

The authors declare no to have any conflict of interest.

| Table IV. Hematologic differences pre and post Course Navette test by gender. |
|-------------------------------|--------|--------|--------|
| Men                           | Women  |
| Pre                           | Post   | Value of p |
| White blood cells             | 7.46 ± 1.6 | 12.20 ± 2.6 | 0.000 |
| Lymphocytes (LY)              | 37.09 ± 10.3 | 46.40 ± 9.1 | 0.000 |
| Lymphocytes (LYM)             | 2.74 ± 0.9 | 5.65 ± 1.7 | 0.000 |
| Granulocytes monocytes        | 5.73 ± 1.7 | 5.79 ± 1.5 | 0.949 |
| Granulocytes                 | 57.23 ± 10.3 | 48.15 ± 10 | 0.000 |
| Red blood cells              | 4.55 ± 0.3 | 4.79 ± 0.4 | 0.001 |
| Hemoglobin                   | 14.14 ± 1.4 | 15.09 ± 1.5 | 0.002 |
| Hematocrit                   | 40.77 ± 3.6 | 42.89 ± 4.3 | 0.020 |
| Platelets                    | 252.29 ± 65.3 | 281.57 ± 86.4 | 0.080 |
| Platelet vol.                | 10.73 ± 0.9 | 10.36 ± 1.7 | 0.824 |
| Glycemia                     | 80.19 ± 12.1 | 108.4 ± 21.7 | 0.000 |
| Women                         |        |        |        |
| Pre                           | Post   | Value of p |
| White blood cells             | 7.42 ± 1.7 | 11.53 ± 2.79 | 0.000 |
| Lymphocytes (LY)              | 38.76 ± 7.5 | 46.17 ± 9.08 | 0.000 |
| Lymphocytes (LYM)             | 2.81 ± 0.6 | 5.22 ± 1.38 | 0.000 |
| Granulocytes monocytes        | 5.86 ± 1.7 | 5.79 ± 1.33 | 0.815 |
| Granulocytes                 | 55.56 ± 7.8 | 47.86 ± 8.52 | 0.000 |
| Red blood cells              | 4.39 ± 0.4 | 4.66 ± 0.45 | 0.001 |
| Hemoglobin                   | 13.49 ± 1.4 | 14.32 ± 1.71 | 0.013 |
| Hematocrit                   | 39.4 ± 9.4 | 40.97 ± 4.55 | 0.015 |
| Platelets                    | 272.65 ± 63 | 309.66 ± 86 | 0.003 |
| Platelet vol.                | 9.97 ± 1.4 | 10.47 ± 1.14 | 0.080 |
| Glycemia                     | 81.6 ± 11.8 | 103.4 ± 20.1 | 0.000 |
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