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Research Article

# Comparison of Aerobic Capacity and Cardiopulmonary Response to the Leger Test in University of Mexico and Colombia

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## Abstract

**Introduction and objective:** The 20 Meter Shuttle Run Test (20mSRT) is a cardiorespiratory fitness test that measures maximal aerobic power and indirectly maximum oxygen consumption; which, the larger it is, the greater the capacity of that organism to produce energy through aerobic metabolism. The objective was to compare the aerobic capacity and cardiopulmonary response of university students in Puebla, Mexico against university students in Cúcuta, Colombia.

**Materials and methods:** Observational, descriptive and cross-sectional study with 2 groups of 100 participants of average age of 20.5±3 and 21±2 years for Mexicans and Colombians respectively. Anthropometry, vital signs, climatic conditions and the 20mSRT test were obtained. In addition, it was analyzed by means of the non-parametric Mann-Whitney test and then ANOVA with post hoc test using the Scheffe test.

**Results:** 56% (62% Mex and 50.5% Col.) Of the participants had a BMI of normal weight, 9.5% (7% Mex and 6% Col.) Underweight and for overweight and obesity was 26% (28% Mex and 24% Col.) And 8.5% (9% Mex. And 8% Col.) Respectively. Regarding abdominal circumference, 93.73±11.84 and 81.37±12.20 were found for Mexican and Colombian university students, respectively. The VO2max. in the Mexican university students it was 34.7±6.06 with 672.8±385.4 meters and in the Colombian universities it was 32.9±7.12 with 533.8±371.3 meters.

**Conclusion:** No significant differences were found in BMI (p=0.967), abdominal circumference (p=0.258), VO2max. (p=0.089) nor hemodynamic variables such as maximum heart rate (p=0.344), arterial oxygen saturation (p=0.811), TAS (p=0.945) and TAD (p=0.597) post test. In both groups, the results of aerobic capacity were below the "Good" or "Excellent" aerobic capacity.

**Keywords:** Maximum oxygen volume; Leger test; Stress test; Aerobic capacity

## Introduction

Childhood and adolescence are key stages to promote healthy lifestyles, such as the increase of physical activity and the improvement of physical condition [1]; Now, we now find that sedentary lifestyle, the high consumption of energy-rich foods, rich in saturated fats and sugars, represent the lifestyles of a large part of the student population [2]. In this sense, the lack of physical activity and the acquisition of an unhealthy diet are two clear components of risk to develop cardiovascular diseases, being considered as one of the main public health problems of the 21st century [3-5]. And not only for older people but also in young adults who, due to the increase in their bad habits, increase the probability of cardiovascular diseases in the early stages. A factor intimately linked to the level of exercise and/or physical activity is the state of physical condition, which is an integrated measure of all the functions and structures that intervene in the performance of physical-sporting activities [6,7]. The physical condition includes a set of physical qualities such as aerobic capacity (AC), strength, muscle endurance, mobility, joint range, speed of movement,

agility, coordination, balance and body composition; being the aerobic capacity, one of the most important qualities of the physical condition in relation to health [8-11]. In turn, we can say that aerobic capacity is the most studied component of the physical condition related to health and, in turn, represents one of the most important qualities of physical condition related to health, since it constitutes a direct measure of the general degree of health and specifically the state of the cardiovascular, respiratory and metabolic system [12,13].

In addition, it is inversely associated with different health parameters in young people, such as the lipid profile, insulin resistance, lean mass, parameters related to metabolic syndromes and arterial resistance [14-16]. One of the most used tests to determine aerobic capacity is the 20 Meter Shuttle Run Test (20mSRT) or also known as the Leger Test. Highlighting that in a research conducted in Colombia showed that after the 20mSRT test the aerobic capacity of university students was determined and no significant differences were found in the percentage of fat ($p$=0.863), muscle ($p$=0.740) and water ($p$=0.804) of the participants. However, there were significant changes in heart rate, systolic and diastolic blood pressure, red blood cells, white blood cells, lymphocytes, hemoglobin, platelets and glycemia ($p$=0.000). Regarding VO2max. ($p$=0.597) and meters traveled ($p$=0.619) no differences were found according to gender [17]. That said, the great importance of knowing and intervening the aerobic capacity of young people is recognized; however, the systematic review conducted by Gonzales G. Zurita F. San Roman S. (2018) It shows that "The number of articles that face the analysis or treatment focused on aerobic capacity as an essential quality of the physical condition and main indicator of health in students, are scarce in comparison with the total production referring to the subject of study, which focuses on sports populations" [2]. That is why the present research is generated in international cooperation to compare and determine the aerobic capacity and cardiopulmonary response to the Leger Test in university students in Mexico and Colombia.

## Materials and Methods

### Subjects

An experimental study was created in which 200 adult students collaborated. The population was chosen randomly, being all the individuals chosen for being Physiotherapy students in the city of Cúcuta (Colombia) and Puebla (Mexico) of the same socio-economic level. The students collaborated voluntarily after having received in detail the objective and repercussions of the research. The written informed consent of the participants was obtained. The population was divided indifferently into 2 groups of 100 students (H:43 - M:57 from Colombia and H:22 - M:78 from Mexico), each group with the participation of both sexes between ages 18 to 25 years of age. age, with an average age for Colombians of 21.06±2.43 and Mexicans of 20.5±3.

### Measurements

The personal data of each of the students was taken first through a series of fixed questions and mandatory completion. Then, continuing with the taking of anthropometric measurements: The Adult Acrylic Halter Wall Kramer 2104 was used for the size, asking the student to stand with his head on the Frankfort plane. The dyspnea felt and the effort were evaluated by means of the modified Borg scale pre and post test. Aerobic capacity (VO2max) was measured indirectly by Leger's formula (Léger, Mercier, Gadoury, & Lambert, 1988), through the results of a maximal test whose interpretation was based on Pernia's study and the Castillo [18] (Table 1). The test that was used was the 20 Meter Shuttle Run Test (20mSRT) [19]. This test allows assessing the maximum CA of adolescents, being their objectivity, reliability and validity demonstrated in young people [20]. The test is of maximum incremental character and consists of running between two lines 20m following the rhythm that marks the 20mSRT protocol; The initial speed is 8.5 km/h and increases 0.5km/h every minute.

**Table 1:** Aerobic capacity in relation to indirect Vo2.

| **Men** | | | | |
|---|---|---|---|---|
| Low | Regular | Media | Good | Excellent |
| < 25 | 25-33 | 34-42 | 43-52 | > 52 |
| **Women** | | | | |
| Low | Regular | Media | Good | Excellent |
| < 24 | 24-30 | 31-37 | 38-48 | > 48 |
| Taken from: Pernía y del Castillo9 | | | | |

The students were given clear instructions on how to perform the test. All the students carried out the test personally in an open field with suitable climatic conditions and adjusted by the researchers themselves and at the same time (between 08:00 and 11:00 am). The adolescents were advised to limit themselves to carrying out exhausting exercise 24 hours prior to the test. Similarly avoid smoking, drink or ingest any type of drug or medication that could alter their vital signs or performance before the test. Therefore, vital signs were taken pre and post test to follow each of the participants. The heart rate was carried out manually and confirmed with the Nellcor Puritan Bennett pulse oximeter, which was also useful in assessing arterial oxygen saturation. Blood pressure was obtained manually at the beginning, end and after 5 minutes after completing the stress test.

### Geographic and atmospheric conditions

The investigation had 2 groups of which; Group I conducted the investigation in Cúcuta, Colombia at an altitude of 320 meters above sea level; whose geographic coordinates in degrees and decimal minutes are: Latitude: 7°53.6346' N and longitude: 72°30.4692' W. With a temperature during the tests in ranges of 24 to 32°C. For group 2 it was in Puebla, Mexico at an altitude of 2,135 meters above

sea level. With latitude coordinates: 32°33.9924' N and longitude: 115°21.204' W; whose environmental temperature during the tests was between 12 to 16°C.

### Statistic analysis

The figures of the multiple values are shown as mean and standard deviation. To compare the variables with respect to gender, the Welch test was used after verifying the normality of the variables studied. To perform the comparison between groups, the nonparametric Mann-Whitney test and then ANOVA were used. In all the results obtained, multiple post-hoc comparisons were made using the Scheffe test. All data were analyzed using the statistical program SPSS. The level of significance was 5% for all analyzes. The design and development of the research was carried out under the ethical considerations of each country against the recommendations of the Ministry of Health of Colombia and Mexico as research.

## Results

100% of the sample (n=200) were university students where 50% were university students from the first country and the remaining one from the second. From the anthropometric point of view, there were no significant differences when relating the Z score of the Body Mass Index (BMI) (Colombia 23.83±4.40 vs. Mexico 23.77±4.25, $p$=0.159) ; which allowed grouping the sample in underweight, normal weight, overweight and obesity, presenting higher percentages in young Mexicans in the underweight categories (7% vs 6%), overweight (28% vs 24%) and obesity (9% vs 8%); As in the abdominal circumference values (93.73±11.84 vs 81.37±12.20, $p$=0.258). Participants in Colombia demonstrated a higher level of normal weight (62% vs. 56%) than that found in Mexico (Table 2).

**Table 2:** Characteristics of the population.

| Variables | Group 1 | Group 2 |
|---|---|---|
| Age | 21,06±2,43 | 20.5±3 |
| University students | 100% | 100% |
| Infrapeso | 6% | 7% |
| Normopeso | 62% | 56% |
| Overweight | 24% | 28% |
| Obesity | 9% | 8% |
| Abdominal circumference | 81,37±12.20 | 93,73±11.84 |
| Group 1: Young Colombians; Group 2: Young Mexicans | | |

The chronotropic response was greater in the group of Mexicans both in pre and post test. The maximum heart rate of the group of Colombians was 128.9±34.5 lpm in relation to 150.1±31.5 lpm in the group of Mexicans, $p$=0.344. Regarding blood pressure values, we found that Colombians increased their systolic levels by 27mmHg and 7mmHg diastolic; data very similar to those found in Mexico where the participants presented blood pressure averages of 29mmHg for systole and 5mmHg for diastole (Table 3). On the other hand, the period and speed reached in the Test were higher in the group of Mexicans. In this group, the period reached was 5, with a speed of 10.3±1.01 km/h, while Colombians reached period 4, with a speed of 9.9±1.07 km/h (Table 2). Including a higher perception of dyspnea (7.16±1.98 vs. 6.38±1.96) and fatigue (7.48±1.67 vs. 6.99±1.89) compared to the group of Mexicans. However, the VO2max of the group of Mexicans was higher compared to the group of Colombians 34.7±6.06 mL/kg-1/min-1 vs. 32.9±7.1 mL/kg-1/min-1, $p$=0.089.

**Table 3:** Hemodynamic variables and results in 20 Meter Shuttle Run Test.

| Variables | Group 1 | Group 2 | Value of p |
|---|---|---|---|
| Maximum heart rate (bpm) | 128,9 ± 34,5 | 150,1 ± 31,5 | 0,344 |
| Pre-systolic blood pressure | 115.56 ± 10.55 | 115.54 ± 9.40 | 0,874 |
| Post-systolic blood pressure | 142.58 ± 14.28 | 144.46 ± 16.46 | 0,945 |
| Pre-diastolic blood pressure | 72.24 ± 8.91 | 76.70 ± 9.22 | 0,554 |
| Post-diastolic blood pressure | 79.39 ± 12.61 | 81.56 ± 17.52 | 0,597 |
| Oxygen arterial saturation (Pre) | 96.73 ± 3.01 | 96.11 ± 1.90 | 0,829 |
| Oxygen arterial saturation (Post) | 96.5 ± 2.19 | 94.65 ± 9.51 | 0,811 |
| Final dyspnea | 7.16 ± 1.98 | 6.38 ± 1.96 | 0,454 |
| Final fatigue | 7.48 ± 1.67 | 6.99 ± 1.89 | 0,455 |
| Period in test of 20Msrt | 4 | 5 | N/A |
| Speed (km/h) | 9,9 ± 1,07 | 10,3 ± 1,01 | N/A |
| Meters traveled | 533.80 ± 371.34 | 672.87 ± 385.42 | 0,000 |
| Vo2Máx. | 32,9 ± 7,1 mL/kg−1/min−1 | 34,7 ± 6,06 mL/kg−1/min−1 | 0,089 |
| bpm: Beats per minute; 20Msrt: 20 Meter Shuttle Run Test. | | | |

## Discussion

We know that youth and access to the university is a decisive stage that admits an important change in the individual to promote health and generate lifestyles, be they negative or positive. All of this makes this segment of the population a particularly vulnerable group from a nutritional point of view [21]. Since, the population of young adults tends to be directed towards the adoption of risky behaviors and unhealthy lifestyles [22]. These young people are at a critical stage for the development of so-called eating habits, characterized by insufficient time to eat, skipping from one meal to another, or doing it at odd hours, likewise the high consumption of fast food, among others [23]. Added to this, they present a decrease in the practice of physical activity. In addition, there has been an increase in the prevalence of tobacco and alcohol consumption [24], affecting an adult potentially exposed to the evolution of

diseases belonging to this group, such as diabetes, hypertension, overweight and metabolic síndrome [25,26]. On the other hand, physical activity in university students has also been studied. It has been found that, in countries such as Germany, 28.5% perform less than once a week. For the Latin American area, some studies have reported prevalences of sedentary lifestyle in university students from 85 to 90%. A study [27] carried out in Colombian university students found that 77% did little or no physical exercise for at least 30 minutes, often three times a week; results similar to ours with 62%. Values that to a certain extent are shown in the test performed.

Although the differences in VO2max are statistically significant, the aerobic capacity in both groups is within the "Regular" ranges. However, these findings are worrisome when contrasted with previous studies such as that of Laukkanen and collaborators, cited by Boraita [28,29], where the subjects who had a very low fitness (VO2max <27.6 mL/kg/min) and who lasted less than 8 min in a stress test, presented an r=2.76 for death of any type and a r=3.09 for cardiovascular death, evidenced by both aerobic fitness and shorter duration in tests of this type are similar risks to high blood pressure, smoking, obesity and diabetes for both outcomes. In the study conducted by Melo G. and Rueda O. (2007)29 in a sample of university students from Bucaramanga, Colombia in which the aerobic capacity was determined by means of the Mc step test. Ardle-Katch and Katch (2010) was obtained in men 51.7 ml/kg/min-1 and in the study by Carrasco V; Martínez C; Caniuqueo A. and Díaz E. (2014) [30] it was 42.21 mL/kg-1/min-1. Likewise, that reflected by the physiotherapists García A; Pachón A; Garay P. and Santiago L. (2014) [31] who found in their results a VO2max 41.7±4 mL/kg-1/min-1. All these were much higher than those found in our sample, where the values were lower (Col: 34.7±6.06 mL/kg-1/min-1-Mex: 32.9±7.1mL/kg-1/min-1). These results in young Colombians and Mexicans are much lower than those found in studies published in Greece [32], Turkey [33], India [34], Romania [35], Germany [36], Norway [37] and the United States [38] in young athletes. But higher than those shown in the United States with a sedentary population [39] and Croatia [40].

## Conclusion

The aerobic capacity of university students in Colombia was on average lower than the group of Mexican university students. However, in both groups on average, an adequate rating of a good aerobic capacity was not obtained. Therefore, this early identification would allow to create strategies for the prevention of cardiopulmonary diseases in university life.

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