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Asociación entre el riesgo cardiovascular y el nivel de actividad física en universitarios.

Association between cardiovascular risk and the level of physical activity in university students.

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Abstract

Heart rate variability (HRV) is an indicator of cardiovascular risk and its total values ??show a tendency to decrease in the absence of physical activity (PA). With the objective of comparing HRV between athletic and physically inactive university students from the city of Pasto (Colombia), this non-experimental descriptive correlational study was carried out it included a sample of 64 athletes and 100 non-athletes or physically inactive people. Non athletic or inactive individuals had 11.4 times more cardiovascular risk than athletes. It was determined that 19.3% of the athletes and 80.7% of the physically inactive people had high cardiovascular risk; 43.6% of the athletes and 56.4% of the physically inactive people had medium risk, and 81.1% of the athletes and 18.9% of the physically inactive individuals were at low risk. Therefore, an association was observed between levels of physical inactivity and cardiovascular risk (p = 0.000). The athletes had a mean HRV of 60.92 ± 8.7, and the inactive group had a median HRV of 52. Therefore, it could be stated that high levels of PA serve as a protective factor for the cardiovascular system. High and medium cardiovascular risk is more present in inactive university students and less in athletes.
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Keywords: heart rate, heart disease risk factors, physical activity.

Resumen

La variabilidad de la frecuencia cardíaca (VFC) es un indicador de riesgo cardiovascular, sus valores totales muestran una tendencia a disminuir en ausencia de actividad física (AF). Con el objetivo de comparar la VFC entre universitarios deportistas y físicamente inactivos de la ciudad de Pasto (Colombia), se realizó este estudio descriptivo, correlacional, no experimental que incluyó una muestra de 64 deportistas y 100 no deportistas. La población inactiva presentó 11,4 veces más riesgo cardiovascular que los deportistas. Se determinó que 19,3% de los deportistas y 80,7% de los inactivos físicos presentaban riesgo cardiovascular alto; 43,6% de los deportistas y 56,4% de los inactivos físicos presentaban riesgo medio; 81,1% de los deportistas y 18,9% de los individuos físicamente inactivos presentaron bajo riesgo; observando una asociación entre los niveles de inactividad física y el riesgo cardiovascular (p = 0,000). Los deportistas tenían una VFC media de 60,92 ± 8,7 y el grupo inactivo una mediana de VFC de 52. Por lo tanto, se podría afirmar que los niveles elevados de AF sirven como factor protector del sistema cardiovascular. El riesgo cardiovascular alto y medio está más presente en universitarios inactivos y es menor en deportistas.

Palabras clave: frecuencia cardíaca, factores de riesgo de enfermedad cardiaca, estudiantes universitarios.

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Introduction

Heart rate variability (HRV) is the variation in the time elapsed between the recording required (RR) intervals of the electrocardiogram, and it reflects the autonomic nervous system activity on cardiac function[1]. Increase in HRV is considered to be a protective factor for the heart, and its measurement could be an early predictive or diagnostic tool in cardiovascular diseases[2]. The autonomic nervous system exerts inotropic and chronotropic effects on cardiac function, which in turn can increase or decrease this variability[3].

The World Health Organization (WHO) has reported that cardiovascular diseases (CVD) are the leading cause of death worldwide[4]. Every year, more people die from CVD than from any other cause. It is estimated that 17.9 million people died from this disease in 2019, which represents 32% of all recorded global deaths. According to WHO reports, at least 60% of the world population does not perform the necessary physical activity (PA) to obtain health benefits[5]. The university stage is considered to be a critical stage in acquiring healthy lifestyle habits. However, it has been evidenced that students go from a routine of regular PA in childhood and adolescence to significantly reduced PA and increased sedentary habits during their university life[6,7]. With regard to the specific relationship between HRV and physical activity levels (PALs), PALs are among the lifestyle-related factors that affect HRV[8]. Changes in HRV due to physical exercise occur as a result of an acute event or as an adaptive response to a chronic stimulus, as is the case with physical training[8,9]. It is known that PA, regardless of the action, which may vary from one individual to another, changes HRV[10].

This concept can be explained via the analysis of the temporal and frequency domains in various populations[3]. which shows that physical exercise produces a chronic adaptive response and an increase in HRV[11].

This study aimed to investigate the association between heart rate variability (HRV) and physical activity levels in collegiate athletes and physically inactive students at the Universidad Mariana of Pasto, Colombia.

Methodology

This research adopted a quantitative approach and its design was non-experimental. A descriptive, correlational and cross-sectional study was carried out, which sought to clarify the uncertainties raised by the researchers in relation to their variables, establishing the degree of relationship or association between them in a particular sample or context.

A convenience sampling was carried out, which included 64 university athletes from the Universidad Mariana sports teams, as well as a group of 100 non-athlete students, all residing in the city of Pasto (Colombia).

Pasto is the capital of the department of Nariño, located in the southwest of Colombia, at an altitude of 2527 meters above sea level[12]. The average annual temperature is 13.9 degrees Celsius, however, the participants in this study were evaluated in the month of February 2021 with an average temperature of 18 - 22 degrees Celsius.

The characteristics of the sample of athletes were university students belonging to the sports teams of the Universidad Mariana. Sports included soccer, indoor soccer, basketball and volleyball. Students had to have belonged to the teams for at least 8 months and trained 3 times a week, as required by the head coaches. On the other hand, the non-athletic university students, did not practice any type of sports discipline, neither at the Universidad Mariana nor anywhere else, and they did not do PA on a regular basis. The group was made up of university students classified as physically inactive according to the Global Physical Activity Questionnaire (GPAQ) version 2[12], who did not have previously diagnosed cardiovascular diseases or were pregnant in the case of women, or who were consuming any type of medication that could alter HRV measurements.

The university students were evaluated in the consulting room of the Universidad Mariana´s Simulated Hospital, which has international certification from the American Heart Association (AHA). After signing the informed consent, heart rate variability was evaluated and the GPAQ instrument was applied in both groups. The university students were evaluated in the morning hours between 8:00 and 10:00 am. The participants' evaluators were four health and sports professionals: a physiotherapist, a nutritionist, and two physical educators, all with postgraduate degrees in sports and physical activity. The evaluators were blinded to the group of students they would be assessing, and similarly, the participants were unaware of who would be evaluating them.

Inclusion Criteria

- Being actively enrolled at the Universidad Mariana in the first academic period of the year 2021.
- For the group of university athletes, they should have been linked for more than 8 months to the sports teams of the Universidad Mariana and have participated in competitions.
- Residing in the city of Pasto (Colombia).

Exclusion Criteria

- Pregnancy
- Consumption of medications that could alter HRV
- University students who had undergone surgical procedures, had wounds, or had been previously diagnosed with diseases of the musculoskeletal or cardiovascular system that could alter the results of the evaluation.

Instruments

Evaluation of HRV

Polar H10 is a high-precision and quality heart rate sensor, includes the Polar Pro elastic. Polar H10 offers electrical measurement without interference. "Polar H10 connects and transfers data via Bluetooth® and ANT+™, and offers an excellent range of connection options with sports watches, smartwatches and training apps" [13].

The Polar H10 sensor (Polar, Finland, 2017) and HRV Elite software (USA, 2014) were utilized for analysis. This system has been endorsed by research studies, including Moya-Ramon and others [14], which demonstrated strong correlations and supported its reliability for HRV assessment. The small effect sizes support the validity of the Polar Heart Rate Monitor to measure RR intervals and perform the subsequent HRV analysis in the supine position. The study by Pereira and others, concluded that the Polar Heart Rate Monitor can be used as an alternative to the ECG[15]. The use of HR monitors expands the possibilities of application, although it is worth noting that its use does not replace the ECG in cardiac diagnosis. Similarly, some studies concluded that modern Polar® MFCs, including the H10 and further versions, are a valid and useful alternative to the ECG for acquiring data on inter-beat interval time series. Furthermore, the HRV parameters calculated from the data on inter-beat interval time series obtained from Polar® MFC accurately reflect the ECG-derived HRV measurements when the inter-beat interval data are processed and assessed[16,17].

For the correct use of Polar H10, the transmission strap was moistened with water and then tied around the person's chest. Subsequently, the Elite HRV application was configured, with data pertaining to the participant who performed the test and the type of RR intervals. Accordingly, the recording of the data began, ensuring that the Elite HRV had the H10 sensor linked.

The intensity of PA is among the recommendations and factors that affect monitoring and its subsequent analysis because this should be moderate to low if our objective was to measure the baseline state of HRV. Also, it was important to avoid alcohol and/or nicotine consumption 12-24 hours before the measurement and avoid taking the measurement after meals as well as avoiding the consumption of caffeine[15,18].

The protocol applied to the sample consisted of a 5-minute rest in a seated or supine position to stabilize the heart rate. Then, 15 seconds of preparation are added, as established by the application, and later 1-5-minute monitoring in one of the aforementioned positions.

Regarding the timing of the measurement, Pereira and others[15], recommends the measurement to be always obtained in the same position, either seated or supine, and not to move, yawn, or swallow during the process and for the measurements to be taken for 1-5 minutes to obtain the vagus nerve activity.

These data were subsequently loaded into the Elite HRV software. Subsequently, all data that showed the behavior of the total HRV and the RR interval were saved for statistical analysis.

For the analysis and classification of cardiovascular risk measured based on the RR interval, the data obtained were compared with some reference values that showed normal parameters.

Some suggested cut-off values (measured in milliseconds (ms)) that may indicate a high, moderate, or low risk are as follows: RR interval: <750 ms high risk, 50-900 ms moderate risk, >900 ms low risk; SDRR: <50 ms high risk, 50-100 ms moderate risk, >100 ms low risk; pRR50: <3% high risk, >3% low risk; SDARR: <8 ms risk high, 8-12 ms moderate risk, >12 ms low risk; SDRR index: <25 ms high risk, 25-40 ms moderate risk, >40 ms low risk[19,20].

To classify the risk of the study population, the RR interval was obtained, and the subjects were classified as being high, medium, and low risk. The total HRV value calculated with the Elite HRV App, which was measured on a scale from 1 to 100, was quantitatively determined and expressed as mean or median values according to the normal distribution. It is worth mentioning that regarding the different variables and measurements addressed in HRV, a range is used to qualify people, with the understanding that the HRV can be found to be in a range of 0-100 and that its use and interpretation are intended for untrained people and athletes wishing to learn how training or PA affects their health. Considering the latter and delving more into the HRV measurements, more parameters were found where it was determined that the higher the HRV level, the better the health or training status of the person[14,20,21].

GPAQ V2.0.

This questionnaire collects statistical data on the time that people declare that they perform moderate and intense PA, from the first hour in the morning, at work, during transport, while studying, and in all types of activities requiring energy expenditure or that cause slight or rapid heart rate acceleration. GPAQ was the program used for the analysis of data derived from GPAQ Epi Info[22].

This study classified the PA level considering the energy expenditure and the time spent on the PA, adding the PA performed in all domains. Participants were classified as vigorously active, moderately active and physically inactive according to the criteria of the GPAQ[22].

Analysis Plan

The data collection, processing, and analysis were performed using SPSS version 25 software licensed by the University of Cauca and Microsoft Excel.

First, the absolute and relative frequencies of the qualitative variables were calculated and expressed as percentages. Next, an exploratory analysis of normality (Kolmogorov-Smirnov test) was conducted to determine if the quantitative variables followed a normal distribution.

For variables with a normal distribution, the mean and standard deviation were calculated as measures of dispersion. For variables that did not follow a normal distribution, the median and interquartile range were calculated.

Finally, to determine which factor or factors under study were associated with cardiovascular risk in the study population, a simple logistic regression model was used to calculate the crude odds ratio (cOR) with a 95% confidence interval (95% CI) and p-values at a significance level of 5% ($p < 0.05$). Additionally, the adjusted odds ratio (aOR) was calculated.

For this final analysis, university students were categorized by age groups. The age ranges (18-25, 26-35, and 36-45) were chosen based on life transitions and cardiovascular development that occur during these periods, as well as homogeneity and relevance to the university population. These ranges enable the analysis of trends in cardiovascular risk over time, the evaluation of how risk factors change with age, and the comparison of results with other studies that have used similar population and age ranges.

Ethical Considerations

According to the Republic of Colombia's resolution 008430 of October 4, 1993, in its article 11 on risk classification, this investigation was classified as being minimum risk[23]. HRV analysis and survey were conducted for a population of athletic and nonathletic university students who reported no previous diagnosis of pathology or pregnancy status and whose health condition at the time of the study was not compromised at no point.

All the principles and ethical considerations of the Declaration of Helsinki[24] and Resolution number 8430 of 1993 were observed. All participants signed the informed consent form after the research details were explained to them. They were also informed that they could withdraw from the study at any time at their will, and the confidentiality of their data was maintained. Moreover, this research was approved by the Universidad de Cauca's Committee of the School of Natural, Exact, and Education Sciences via resolution No. 331 dated August 06, 2020.

Results

Sociodemographic Characteristics

In this study, 164 university students were assessed, and their ages ranged between 18 and 45 years. It was found that 84.1% of the university students were between 18 and 25 years of age, women constituted a higher proportion 56,1%, and 39% were university athletes.

Regarding the total HRV classification, the group of athletes had a normal distribution according to Kolmogorov-Smirnov test and was, therefore, represented with the mean; in contrast, the physically inactive group was not normally distributed according to the Kolmogorov-Smirnov tests and was, therefore, represented with the median (table 1). The total HRV of the group of athletes presented higher total values than those of the group of nonathletes.

The cardiovascular risk classification based on the RR interval of HRV revealed that 19.3% of the athletes and 80.7% of the physically inactive students belonged to high cardiovascular risk, whereas 43.6% of the athletes and 56.4% of the physically inactive subjects were found to be at medium risk. Finally, 81.1% of the athletes and 18.9% of the physically inactive students were found to be at low risk, which indicates that the group of athletes presents a lower cardiovascular risk than the group of physically inactive individuals (Table 2).

Regarding the level of PA evaluated with the GPAQ, it was found that 21 athletes belonged to the level of vigorous PA, representing 100% of the vigorous level. Athletes were found within the level of moderate PA (n = 43 athletes). Moreover, no nonathletic university students found within the vigorous level. In the inactive level of PA, 100 nonathletic university students were found, representing 100% of this level. No athletes were found in this inactive level (Table 3).

Using simple logistic regressions intended to establish which factors or variables were associated with cardiovascular risk, the crude OR was obtained with 95% CI and p values $\leq$ 0.005. A statistically significant association was found with sex, with men being 0.32 times less likely to have cardiovascular risk than women. Regarding the PA level, a statistically significant association was found, with the physically inactive students being 14.6 times more likely to show cardiovascular risk compared with those who were vigorously active (group of athletes). No difference could be found in terms of the age range in years with respect to students with low- or high-medium cardiovascular risk, and it was not statistically significant. There were no differences regarding the level of moderate PA (group of athletes) with respect to students at low or high-medium cardiovascular risk, and it was not statistically significant (Table 4).

To identify the independent variables that best explain the association with cardiovascular risk, an adjustment was performed using multivariate logistic regression, taking into account the Omnibus test of model coefficients, with a p value $\leq$ 0.05. The factors or variables that met this criterion were sex and PA level, as shown in Table 5.

Table 1. Total heart rate variability classification of athletes and physically inactive university students. Universidad Mariana. Pasto, Colombia, February 2021.

Total heart rate variability					
*Athletes	**Mean**	**SD**			**Kolmogorov–Smirnov normality tests**
	60.92	8.7			≥ 0.12
**Physically inactive	**Median**	**IQR**	**Q1**	**Q3**	
	52	7	48	52	< 0.005

SD: Standard deviation; IQR: Interquartile range; Q1: Quartile 1; Q3: Quartile 3.

Table 2. Classification of cardiovascular risk using heart rate variability recording intervals in athletes and physically inactive students. Universidad Mariana. Pasto, Colombia, February 2021.

Classification of cardiovascular risk based on recording required interval	Athletes		Physically inactiv
	N	%	N
High risk	17	19.3	71
Medium risk	17	43.6	22
Low risk	30	81.1	7
Total	64		100

Table 3. Level of physical activity measured with Global Physical Activity Questionnaire version 2 among university students from Universidad Mariana. Pasto, Colombia, February 2021.

PA classification according to Global Physical Activity Questionnaire				
PA level	Athletes		Physically Inactive	
	N	%	N	%
Vigorous	21	100	0	0
Moderate	43	100	0	0
Inactive	0	0	100	100
Total	64		100	

PA: physical activity

When evaluating the ORc and the ORa, no confounding variables were found that could affect the association between the evaluated factors and cardiovascular risk. PA level had a stronger association with cardiovascular risk, and students who had an inactive PA level were 11.4 times more likely to have cardiovascular risk than those with a vigorous PA level. Sex was statistically significant, However, the cardiovascular risk was classified as insignificant based on the EM (effect magnitude) measured with the OR, as shown in Table 5.

Discussion

This study determined the presence of cardiovascular risk measured with HRV, which revealed that this risk was present in a considerable part of the study population. The physically inactive population presented 11.4 times higher cardiovascular risk compared with to people with a vigorous level of physical activity. HRV values were higher within the group of university athletes compared with inactive university students.

Table 4. Factors associated with cardiovascular risk among university students. Universidad Mariana. Pasto, Colombia. February 2021.

Characteristics	Cardiovascular risk (low)		Cardiovascular risk (high–medium)		OR	95% CI
	N	%	N	%		
Sex						-
Female	13	14.1	79	85.9	1	[0.15; 0.70]
Male	24	33.3	48	66.7	0.32	
PA level						
Vigorous	11	52.4	10	47.6	1	-
Moderate	19	44.2	24	55.8	1.38	[0.48; 3.95]
Inactive	7	7	93	93	14.61	[4.62; 46.17]
Age range in years						
18–25 years	30	21.7	108	78.3	1	-
26–35 years	7	30.4	16	69.6	0.63	[0.23; 1.68]
36–45 years	0	0	3	100	4487430 12	[0.000]

* Statistically significant ($p < 0.05$). The vigorous and moderate PA correspond to the group of athletes; the inactive values correspond to the group of nonathletic and physically inactive university students.

PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval.

Next, the study's findings regarding the association between physical activity and cardiovascular risk in university students will be discussed, taking into account the results obtained from the comparison of HRV between athletes and non-athletes. The possible physiological mechanisms explaining this association will be analyzed, as well as the practical implications for the prevention and control of cardiovascular risk in this population. Additionally, the study's limitations and potential future directions for research in this field will be discussed.

As for the classification of cardiovascular risk estimated based on the RR interval of HRV, values or cut-off points were established as stipulated by several authors[3,19,20]. To determine the risk, they established parameters that, according to the results, can indicate a high, moderate, or low risk: RR interval <750 ms: high risk, RR 750-900 ms: moderate risk, RR interval > 900 ms, low risk. It was determined that 19.3% of the athletes and 80.7% of the physically inactive students presented high cardiovascular risk. Furthermore, 43.6% of the athletes and 56.4% of the physically inactive subjects had medium risk, and 81.1% of the athletes and 18.9% of the physically inactive students presented low risk. Melo and others[25], reported similar findings in their study, which compared sedentary and physically active groups among young and adult populations. The active individuals in the young group exhibited significantly higher RR interval values of heart rate variability (HRV) (mean RR: 1034 ± 100.3 ms) compared to their sedentary counterparts

Table 5. Associated factor that best explains cardiovascular risk in university students. Universidad Mariana. Pasto, Colombia.

Characteristics	cOR	95% CI	aOR	95% CI	Omnibus $p \leq 0,05$	EM
Sex				-		
Female	1	-	1	[0.27; 1.62]		
Male	0.32	[0.15; 0.70]	0.66		0.000	Insignificant
PA level		-				
Vigorous	1		1	-		
Moderate	1.38	[0.48; 3.95]	1.21	[0.40; 3,57]		
Inactive	13.6	[4.62; 46,1]	11.44	[3.37; 38.78]	0.000	Large

PA: physical activity; cOR: crude odds ratio; aOR: adjusted odds ratio; 95% CI: 95% confidence interval.

The magnitude of the effect (ME) reflects the strength of association between the event and the specified risk: If the OR is less than 1.68, its magnitude is considered insignificant; if it is between 1.68-3.47, small; between 3.47-6.71, moderate; and if it is greater than 6.71, large.

(mean RR: 874 ± 123.8 ms). Similarly, in the older age group, active individuals displayed a higher mean RR interval (1109 ± 186.3 ms) compared to sedentary individuals (mean RR: 893 ± 93.8 ms). These results are consistent with the findings of the present study, which revealed a mean RR interval of 890.5 ± 101.6 ms in athletes and an interval of 705 ms in the physically inactive group, with an interquartile range of 75 ms (761.3 ms). The data from both studies suggest that regular physical activity is associated with increased HRV, as evidenced by a longer RR interval, resulting from enhanced parasympathetic nervous system activity and improved vagal tone. Conversely, physical inactivity is linked to decreased HRV, potentially indicating elevated cardiovascular risk. Notably, Melo and others study did not provide sociodemographic data on the participants, precluding further comparative analyses[25].

Similarly, the study in gym-goers and age-matched sedentary individuals by Ashok and others[26], clearly determined that an active lifestyle can significantly increase HRV values when compared with a sedentary lifestyle. The following data come from a study comparing normal HRV values at rest in a young Mexican population. The mean HRV values reported in women athletes was 993.47 ± 134.01, whereas more active untrained women had a mean of 905.9 ± 117.38. Among men, athletes had a higher mean HRV of 977.3 ± 129.35 compared with the more active untrained men, with a mean of 874.67 ± 118.49. All these findings provide evidence that HRV values are higher in people undergoing sports training than in those who are physically inactive or do not practice structured sports training[27]. Several authors highlight the benefits of exercise or regular PA on HRV, blood pressure and mood. It also covers improvements in baroreflex sensitivity and insomnia as well as the benefits on emotional regulation, among other aspects[6, 27-31].

Other studies have also reported and concluded the aforementioned findings. The health condition or state of well-being along with the benefits from adapting to sports training and a healthy physical condition, are related to variability in the RR interval. In contrast, poor adaptations to training, excessive weight-bearing, burnout, fatigue, overtraining, or poor physical condition are related to a reduction in the variability[8,10,32-36].

Heart Rate Variability (HRV) is considered a valuable tool for assessing cardiac autonomic function and predicting cardiovascular risk in diverse populations, both physically active and inactive. However, few studies in the general literature have investigated the relationship between physical activity level and HRV. Nevertheless, some studies were identified that allowed for comparison of results and methodological processes.

Initially, a comparison will be made between populations with similar characteristics, specifically active and inactive university students, and subsequently, with different populations. This approach will enable exploration of the relationship between physical activity and cardiac autonomic function, and evaluation of HRV as a marker of cardiovascular risk in diverse populations.

According to the study conducted by Sun and others[37], on male university students, a comparison of Heart Rate Variability (HRV) results was possible. Although the methodological process differed due to the longitudinal nature of the study, the results showed that after implementing a 6-week aerobic gymnastics training program, applied three times a week, with 90-minute sessions, and moderate intensity (60%-70%), a statistically significant increase in HRV was found ($P<0.01$). The study allowed for the assertion that aerobic training can improve cardiac function. Furthermore, it identified that the HRV behavior was the same in the physically active university students of the present study, despite the transversal nature of this study.

Given that heart rate and heart rate variability are inversely proportional, the study by Dou and others[38], was included, which leveraged big data technology and utilized the GA-CART algorithm to extract data on fitness and physical function indices from university students who participated and did not participate in qigong exercises (aerobic-type exercise) applied over 12 weeks. This allowed them to analyze the influence of qigong physical exercise practice on heart rate (HR) in university students. The results showed that, in the university students who applied the exercise, a decrease in HR of 6.31 beats/min in women and 5.51 beats/min in men was found, however, these changes were not significant. The authors refer that the duration of the qigong exercise program was not sufficient to achieve significant changes, nevertheless, the study confirmed that qigong fitness has a positive effect on improving heart rate.

As can be observed, changes in Heart Rate Variability (HRV) follow the same pattern in relation to physical activity or exercise, regardless of life cycle and health condition; its increase signifies lower cardiovascular risk, and its decrease represents higher cardiovascular risk. The present study found that physically inactive participants have 11.44 (aOR) times higher odds of cardiovascular risk compared to subjects with vigorous physical activity levels. Similar results were found in the study by Córdova and others[39], although the study was conducted in children, the results presented the same behavior regarding cardiovascular risk and physical activity level. In this study, 137 physically active and inactive children, aged 12 ± 1 year, from León, Spain, participated. The authors determined that children with higher levels of physical fitness had a significantly lower odds ratio of presenting elevated cardiovascular risk factors. Cardiovascular risk values were lower in the group of children who practiced sports compared to sedentary children.

Multivariate analysis determined for this study that there was an association between sex and cardiovascular risk as determined by Heart Rate Variability (HRV), however, the level of risk interpreted with Odds Ratio (OR) was irrelevant[40].

Dai-Yin and others[41], conducted a study on patients with Cardiac Syndrome X, and although the population presented a specific health condition, it is essential to highlight that the study reported similar results to those found in the present study regarding associations. After linear regression analysis, no substantial association was found within the subgroups regarding age and sex. However, among the study population, 129 subjects with impaired exercise capacity presented significantly lower HRV indices than those with higher aerobic capacity. Although the characteristics of the participants differed, it can be observed that HRV can be an essential predictor of cardiovascular morbidity and mortality in any population.

In contrast, regarding the association between age and sex with cardiovascular risk determined by Heart Rate Variability (HRV), the study by Voss and others[42], conducted a longitudinal investigation with a high degree of methodological rigor in 1906 young subjects, stratified into age cohorts by decades (25-34, 35-44, 45-54, 55-64, and 65-74 years). The results revealed statistically significant differences related to age in most domains (linear and nonlinear) in the age ranges of 25-34, 35-44, and 45-54 years. However, these associations attenuated with age. Additionally, a significant interaction between age and gender was observed in the age ranges of 45-54 and 55-64, with more pronounced differences in women than in men, suggesting a gender-dependent modulation of HRV indices. However, these gender differences decreased with aging, especially in the age range of 55-64 years, which could be attributed, at least in part, to the influence of menopause in women[43]. However, this aspect remains a topic of debate in the scientific community, as aging-related changes, such as decreased estrogen levels, have been linked to autonomic alterations in postmenopausal women, suggesting a possible hormonal influence on autonomic nervous system modulation with age. Research suggests that aging-related changes, such as decreased estrogen levels, contribute to autonomic alterations observed in postmenopausal women[44]. Furthermore, according to the HRV analysis methods employed in the study, gender influences were found to be significantly weaker than those of age, suggesting that age is a more determining factor than gender in HRV modulation. The differences found regarding the association between cardiovascular risk determined by HRV and sex and age may possibly be attributed to the sample size, which for this study was significantly larger compared to the sample of the present study.

Consequently, it can be concluded that this scientific literature is consistent with the findings of our study and supports the conclusion that low levels of physical fitness (AF) and, therefore, poor physical condition lead to a lower overall heart rate variability (HRV) value.

Several cross-sectional studies on training in which the effects of regular exercise on cardiovascular function were assessed have tried to explain the association of PA and/or sports practice with the reduction of cardiovascular risk expressed with higher HRV values. The most replicable effect of aerobic training on cardiac function is a decrease in Heart Rate. Since there is an ongoing debate on the nature of autonomic nervous system changes accompanying regular PA, there are many studies that have implied increased vagal tone with the health benefits of exercise[45-47]. A cross-sectional study has reported that regular PA was associated with higher levels of measured HRV in both men and women[18]. In 2,334 men and 994 women from the Whitehall II study on British civil servants, moderate and vigorous PA was associated with higher vagal tone (in men) and lower resting HR (in men and women) compared with those who reported low levels of PA, measured after adjusting for age and smoking and alcohol consumption[48]. Another study among young adults also found that high frequency power increased after 12 weeks of aerobic exercise[49]. Overall, numerous studies have reported that physical inactivity constitutes an important risk in lifestyle and CVD factors and that it is associated with decreased vagal tone.

Similar conclusions have been drawn by studies reporting that HRV represents an easy and fast recording system that applies currently available technology and offers interesting possibilities for an immediate, noninvasive clinical diagnosis that can provide high sensitivity when differentiating a healthy and unhealthy status. It is an objective, fast, and quantifiable measurement of analysis, as determined by the study of y Schaffarczyk and others[17], and Capdevila and others[50], who stated that the use of the Polar H10 device in conjunction with the Elite HRV App permitted a valid recording of the RR interval, an easy storage of data, and a rapid acquisition of the most standardized HRV parameters in addition to the easy understanding of the data obtained, meaning it can be used by anyone.

In terms of physical inactivity, a higher value is observed among the non-athlete group than that reported in the global adult population (23%) and the Americas region (32%)[4]. The results recorded in this study differ significantly from those of a series of studies published and analyzed in a meta-analysis, which determined a range of physical inactivity prevalence in the university population of 86.6% in 106 American university students aged between 18 and 50 years[51], 75.3% in a study conducted in 215 Saudi female university students with a mean age of 19 years[52], 53.9% in Mexican university students whose sample consisted of 370 university students aged between 20.9 years ± 2 years[53], and 32.1% of the students participating in a study conducted in 131 Colombian university students aged between 18 and 32 years[54]. By observing the specific population to which each result refers, it can be appreciated that the prevalence of physical inactivity varies significantly among different university groups, suggesting that it is important to consider factors such as age, gender, and geographic region when interpreting the results, as well as implementing personalized intervention strategies for each specific university population.

It is important to mention that this study was performed during the time of pandemic and quarantine owing to the COVID-19 health emergency. The findings corroborate that the nonathletic university population of Universidad Mariana exhibits a level of vulnerability that must be taken into consideration so that the institution may begin promotion and intervention programs among this population through regular and healthy PA. It is also important to highlight that compared with the group of university athletes, the nonathletic university population did actually present levels of vigorous or moderate PA, possibly because of their virtual training during the pandemic. In this context, Bravo-Cucci and others[55], have mentioned that the social isolation imposed by COVID-19 tends to increase the likelihood of acquiring unhealthy lifestyles, such as physical inactivity and increased sedentary behavior. These factors could increase the risk of suffering from long-term noncommunicable diseases and brings negative health consequences in the face of the pandemic. Similarly, Mera and others[56], have stated that social isolation during the COVID-19 pandemic includes confinement at home, which results in an increase in physical inactivity and sedentary behavior, thus favoring physical deconditioning. People who are not in a good physical condition face metabolic and systemic alterations due to this poor physical condition.

Scopes of the study

Consequently, and based on the results of the current study, the same system of evaluation and analysis based on the HRV record is recommended for monitoring health in the general population, whether athletes or untrained subjects. It is worth mentioning that HRV is a very expansive tool widely available to health personnel and in sports sciences and PA. Regarding the values obtained and their analysis methodology, the use of the time domain pertaining to the RR interval is recommended with the aim of establishing cardiovascular risk processes associated with the health and prevention component (RRSD, RMSSD, pNN50, and SDNN), along with using the components of the frequency domain for training processes and sports control (LF, HF, and LF-HF Ratio)[57-60].

Conclusions

This study allows us to explicitly conclude from the observed results that high levels of PA and participation in sports training processes serve as a protective factor on the cardiovascular system, which is specifically evidenced in terms of high HRV values. College athletes have much lower cardiovascular risk in comparison with physically inactive college students. When comparing the total HRV values, it was possible to observe that those people who are considered to be active according to the GPAQ have higher HRV values, surpassing the HRV results obtained from inactive people.

Regarding the cardiovascular risk measured with

HRV, it is possible to confirm that high and medium cardiovascular risk occurs to a great extent in physically inactive university students and to a very limited extent in university athletes. In the same way, the value of RR interval is higher in college athletes than in physically inactive ones.

Regarding the level of PA, it can be concluded that the university athletes present vigorous and moderate levels of PA, whereas the physically inactive students present low levels of PA.

According to the logistic regression analysis using the crude and adjusted OR, the variable that best explains the presence of this cardiovascular risk factor in the study population is physical inactivity. Similarly, the existence of a statistically significant relationship between cardiovascular risk and the level of PA could be established.

Strengths, limitations and future research

This study is relevant owing to the scarce number of investigations that relate the values of HRV and levels of PA. This work is also a pioneering study when compared with the literature reviewed as it associates several variables, such as changes in the duration of the inter-beat intervals, the functioning of the autonomic nervous system framed within the study of HRV, and the levels of PA that a person can exhibit.

It is essential to highlight that studies evaluating cardiovascular risk through heart rate variability (HRV) with RR interval among physically active and inactive individuals, which also employ linear regression statistical analyses with cOR and aOR, are extremely scarce, particularly in the Latin American region. Therefore, it is even more crucial to conduct further research of this type to provide stronger scientific support for these methods, technologies, and analyses. The integration of mobile applications and accessible technologies for the general population could provide a heart rate biomarker (HR) to monitor overall health and athletic performance.

This study demonstrates that measuring HRV using sensors like the Polar H10 and software like HRV Elite is economically viable for implementation in community-based public health settings, considering the long-term benefits of cardiovascular disease prevention and optimization, as well as resource allocation. Although the initial cost may be high, early detection of cardiovascular risks could lead to reduced costs in the long term and increased efficiency in resource utilization. However, detailed studies and analyses are required to determine the cost-effectiveness of this program and evaluate its economic viability in the context of public health.

The limitation of this study was the use of a convenience sampling method; therefore, a randomized sampling design is recommended for future studies to increase the validity and representativeness of the results.

Conflict of interests

As researchers, we declare that we have no conflicts of interest of any kind in this study.

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