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ORIGINAL

Correlation between heart age and other scales and parameters related to cardiovascular risk

Correlación entre edad del corazón y otras escalas y parámetros relacionados con riesgo cardiovascular

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Abstract

Background: To assess the use of heart age as new tool to evaluate cardiovascular risk, measuring correlation with classical tools (REGICOR, SCORE) and with other cardio-vascular parameters.
Methods: An observational, transversal and descriptive study was conducted in 6788 volunteers (3885 women and 2903 men, 35 - 65 years) between January 2018 and December 2019. The "Heart age calculator" considered the following parameters: age, sex, height, weight, waist perimeter, familiar history of cardiovascular disease, presence of diabetes, tobacco consumption, levels of total and HDL cholesterol and systolic blood pressure values. Cardiovascular risk was assessed using Framingham calibrated for Spanish population (REGICOR) and SCORE models.
Results: Overweight, obesity, adiposity, metabolic syndrome and diabetes were significantly more prevalent in men than in women ($p < 0.05$). A high correlation was observed between heart age and cardiovascular risk (absolute and relative) measured according to REGICOR model, with correlation coefficients of 0.6 - 0.8, higher in men than in women. As relative risk increased, heart age was worsening. Finally, a relationship between heart age and cardiovascular parameters (waist perimeter, BMI, adiposity and metabolic syndrome) was also established.
Conclusions: Heart age can be a useful tool to assess the cardiovascular risk, at least in these peruvian population.

Keywords: Heart age, cardiovascular disease, obesity, metabolic syndrome, diabetes.

Resumen

Introducción: Para evaluar el uso de la edad del corazón como nueva herramienta para valorar el riesgo cardiovascular, se determina la correlación con las herramientas clásicas (REGICOR y SCORE) y con otros parámetros cardiovasculares.
Métodos: Estudio observacional, transversal y descriptivo, realizado en 6.788 voluntarios (3.885 mujeres y 2.903 hombres) de 35 a 65 años entre Enero de 2018 y diciembre de 2019.
La "Calculadora de edad del Corazón" considera los siguientes parámetros: edad, sexo, altura, peso, perímetro de la cintura, historia familiar de enfermedad cardiovascular, presencia de diabetes, consumo de tabaco, niveles de colesterol total y HDL y presión sistólica. El riesgo cardiovascular se evaluó a través de Framingham calibrada para la población española (REGICOR) y el modelo SCORE.
Resultados: El sobrepeso, la obesidad, la grasa corporal, el síndrome metabólico y la diabetes fueron significativamente más frecuente en hombres que en mujeres ($p < 0,05$). Una alta correlación fue observada entre la edad del corazón y el riesgo cardiovascular (absoluto y relativo), medido de acuerdo al modelo REGICOR, con coeficientes de corre-lación de 0,6 - 0,8, mayor en hombres que en mujeres. A medida que aumenta el riesgo relativo, la edad del corazón va empeorando. Por último, se estableció una relación entre la edad del corazón y los parámetros cardiovasculares (perímetro de cintura, índice de masa corporal, obesidad y síndrome metabólico).
Conclusiones: La edad del corazón puede ser una herramienta útil para evaluar el riesgo cardiovascular, al menos en esta población peruana.

Palabras clave: Edad del corazón, enfermedad cardiovascular, obesidad, síndrome metabólico, diabetes.

Introducción

Cardiovascular disease is a public health problem in most countries and not only in industrialised countries, with almost 80% of cardiovascular disease deaths in 2005 occurring in countries traditionally considered as non-affluent[1]. The high prevalence of certain risk factors is the cause of this situation.

Hypertension currently affects about 800 million people worldwide[2] and is expected to affect 1.56 billion by 20253. Unhealthy diets high in saturated fats and low in polyunsaturated fats increase cholesterol levels. The WHO predicts a significant increase in LDL-cholesterol concentrations in the populations of many developing countries by 2020[2].

Globally, more than 1.6 billion adults are overweight and at least 400 million of them are obese. Since 1980 the rate of obesity has tripled or more in many parts of the world[4].

Over the last decade smoking has declined in many Western countries, but prevalence remains high in many others and, globally, the number of smokers is expected to rise to between 1.4 and 1.8 billion by 2030[2].

It is therefore of great medical and especially public health importance to be able to catalogue cardiovascular risk using the different existing scales, as this stratification will enable appropriate prevention and treatment policies to be established. In our environment, the most widely used scales are the Framingham scale, which assesses morbidity and mortality, and the SCORE scale, which determines mortality.

For several authors, the Framingham scales overestimate the risk in those southern European countries where the incidence of cardiovascular problems is lower[5-10], a situation that led to the need to create their own scales[11-12], and so in Spain the Framingham scale was calibrated to create the REGICOR scale[13-14].

The main advantage of the age of the heart over the classic risk scales (Framingham, SCORE) is that patients and health professionals find it more comprehensible to speak of a numerical value (years), with which they are more familiar, than to speak of a percentage of risk.

The aim of this study is to assess whether heart age (CE) as a new tool in the study and approach to cardiovascular risk correlates well with the classic tools (REGICOR, SCORE) and with other related parameters (BMI, waist circumference, body fat or metabolic syndrome).

Methods

A descriptive and cross-sectional study is conducted in 6788 people (3885 women and 2903 men) from different regions of Peru between January 2018 and December 2019. The age range of the participants is 35 to 65 years.

The people were recruited during occupational medical examinations in different companies. As medical examinations are mandatory in these companies, selection bias is avoided. All workers between 35 and 65 years of age who attended the medical examinations were included, except those who did not want to participate. All participants were asked to sign an informed consent form.

To calculate the age of the heart, the tool called "Heart age calculator" was used, which in its Spanish version is available on the web page: www.quiereatucorazon.com. This tool was developed by Unilever in collaboration with researchers from the Framingham Study at Boston University. The weight of each of the parameters analysed on the age of the heart is similar to that of the same factors in the determination of cardiovascular risk according to the Framingham model.

The calculation of all heart ages is performed twice, by a different person, to avoid errors.

The parameters necessary to calculate the age of the heart are the following: age, sex, height (in centimetres), weight (in kilograms), waist circumference (in centimetres), history of cardiovascular disease in the mother or father and their age when they first suffered from it, presence or absence of diabetes, tobacco consumption (if they do not currently smoke, they are also asked whether they have stopped smoking in the last year), total cholesterol and HDL cholesterol values and finally systolic pressure values and whether they are currently receiving antihypertensive treatment. With all these parameters a numerical value in years is obtained which has to be compared with the biological age. The final result will be the number of years gained (represented by a minus sign in front and indicating that the heart age is lower than the biological age) or lost (heart age worse than the biological age).

To determine the different anthropometric parameters, international recommendations are followed. BMI was obtained using the Quetelet index. Height and weight were determined using an approved scale-measuring device. Abdominal waist circumference was calculated with a tape measure placed parallel to the ground at the level of the last floating rib, i.e. the natural waist circumference measured between the top of the hip bone (iliac crests) and the lower rib, measured during normal breathing with the subject standing and with the abdomen relaxed.

Total cholesterol and triglycerides were determined by automated enzymatic methods, HDL-C was determined by precipitation with dextran-sulphate Cl2Mg and glucose by an enzymatic method. Blood collection was performed at the same session and at the same location, after an overnight fast of 12 hours. Samples were sent

to the reference laboratory and processed within a maximum of 48-72 hours, stored at -20ºC.

Blood pressure was determined after a resting period of about 10 minutes in the supine position using a calibrated OMRON M3 automatic sphygmomanometer.

Body fat values were determined using the Tanita BF-350 Body Composition Analyzer bioimpedance meter with two stainless steel electrodes located on the lower platform for Body Compartment analysis. The patient stands on the electrodes with bare feet and in 15 seconds the results are obtained. To obtain reliable results, the manufacturer's instructions were followed.

To classify people according to parameters associated with overweight, the recommendations of the different scientific societies are followed:

- SEEDO[15] (Spanish Society for the Study of Obesity) criteria according to BMI values.
- NCEP ATPIII[16] (National Cholesterol Educational Program Adult Treatment Panel III) criteria for metabolic syndrome (MS). MS was considered when at least three of these criteria were present.
- Body fat values were classified according to the criteria established by Gallagher[17] as low, normal, high and very high.
- High waist circumference values were established according to the criteria established in the metabolic syndrome16 (≥ 88 cm in women and ≥ 102 cm in men).

Measurements in all three centres are performed by specially trained healthcare personnel to avoid interobserver bias as much as possible. The sphygmomanometers used are of the same brand and are perfectly calibrated, as are the bioimpedance meters and the scales. The analytical determinations were performed in two laboratories using similar equipment as they belonged to the same company.

Cardiovascular risk according to the Framingham model calibrated for the Spanish population is called the REGICOR scale and is calculated using the computer tool available at: http://www.regicor.org. This scale is applicable from the age of 35 years and uses age, sex, total cholesterol, HDL cholesterol, systolic and diastolic blood pressure, diabetes and tobacco consumption as parameters. Both absolute and relative risk are determined. Relative risk is calculated by dividing the absolute risk of the individual by the theoretical risk of an individual of the same age and sex with optimal exposure to cardiovascular risk factors.

Cardiovascular risk using the SCORE scale is determined by using the calculator available at http://registrocardioib.com/public/testCalculadora.aspx

In the descriptive analysis, after testing for normal distribution using the Kolmogorov-Smirnov method, the mean value, standard deviation and 95% confidence interval were used. For the analysis of two parametric variables, the mean difference (Student's t-test) was used. The chi-square test with 95% confidence level was used to test proportions. To assess the correlation between cardiac age and cardiovascular risk values according to the REGICOR and SCORE models, Pearson's correlation coefficient was used. All analyses were performed with the SPSS 27.0 statistical package.

The study was approved by the research ethics committee. All participants signed the informed consent form.

Results

Table I shown the characteristics of the people who participated in the study in relation to the different parameters related to cardiovascular risk.

Table I: Characteristics of the sample according to the different parameters related to cardiovascular risk.

	Women (n 3885)			Men (n 2903)			
	Mean	SD	95% CI	Mean	SD	95% CI	p-value
Age (years)	45.2	6.8	45-45.4	46.7	7.4	46.4-46.9	< 0.05
SBP (mm Hg)	117.6	16.2	117.1-118.2	132	17.2	131.4-132.6	< 0.05
DBP (mm Hg)	74.5	10.4	74.2-74.9	81.6	11.1	81.2-82	< 0.05
Weight (kg)	64.7	11.9	64.3-65.1	82.2	13.1	81.8-82.7	< 0.05
Height (cm)	160.9	6.3	160.7-161.1	173	7.1	172.8-173.3	< 0.05
BMI (kg/m²)	25	9.4	24.7-25.3	27.5	4.5	27.1-27.8	< 0.05
Total Cholesterol (mg/dl)	197.2	36	196-198.4	208.2	36.9	206.9-209.6	< 0.05
HDL-c (mg/dl)	58	12	57.6-58.4	47.8	9.9	47.4-48.2	< 0.05
% Smokers	32.5		31-34	33.6		31.9-35.3	> 0.05
% Diabetes	3.5		2.9-4.1	8.9		7.9-9.9	< 0.05
Waist circumference (cm)	81.2	12.6	80.8-81.6	95.2	11	94.8-95.6	< 0.05
% body fat very high	16.7		15.1-18.3	27.1		25-29.2	< 0.05
% Metabolic syndrome	6.7		5.9-7.5	15		13.7-16.3	< 0.05
Heart age	1.2	9.8	0.9-1.5	3.7	2.3	3.6-3.8	< 0.05
REGICOR absolute risk	1.1	0.6	1.1-1.2	1.7	0.9	1.6-1.7	< 0.05
REGICOR relative risk	0.3	0.6	0.2-0.3	1.9	1.9	1.8-1.9	< 0.05
SCORE scale(*)	1.2	9.8	0.9-1.5	7.7	8.1	7.4-8	< 0.05

(*) The SCORE scale can only be calculated from 40 years of age onwards.

As a first step we determine the cardiac age of the people in our study and, more importantly, we quantify how many years they have gained or lost. Years gained, i.e. when the heart age is lower than the biological age, are expressed as negative, while years lost (heart age higher than the biological age) are expressed as positive.

As indicated above, heart age calculations are based on the data obtained in the Framingham study, so it is reasonable to think that there should be a good correlation between the two instruments for measuring cardiovascular risk. To support this, in our study we performed a correlation study using logistic regression, calculating the Pearson correlation coefficient between heart age data and cardiovascular risk data, both in absolute risk and relative risk, according to the Framingham model calibrated for the Spanish population (REGICOR).

In a first analysis, heart age is compared with the relative risk of the REGICOR scale. The data for this correlation are shown in **table II**.

In order to confirm the relationship between the relative risk of the REGICOR scale and the age of the heart more reliably, the years gained or lost are studied in both women and men according to the value of the relative risk. It can thus be seen that, in both sexes, the higher the relative risk, the worse the determination of the heart age parameter (**table III**). In the table, the mean, standard deviation and confidence interval refer to the difference in years between heart age and biological age.

Pearson's correlation index between heart age and absolute cardiovascular risk is also calculated with the REGICOR and SCORE scales in men and women and according to age groups. The results are shown in **table IV**.

It is also interesting to know the relationship between heart age values and the different parameters related to cardiovascular risk, i.e. waist circumference, BMI,

Table II: Pearson correlation index between heart age and relative risk according to the REGICOR scale.

	Heart age		
	Total	Women	Men
Total	0.7225	0.6637	0.7561
35-39 years	0.7528	0.6344	0.7919
40-44 years	0.7032	0.6405	0.7737
45-49 years	0.7454	0.7184	0.7715
50-54 years	0.69	0.6222	0.7271
≥ 55 years	0.6482	0.6002	0.6705

Table III: Relationship between heart age and relative risk according to the Framingham model calibrated for Spain by sex.

Relative risk	Women			Men		
REGICOR	Mean	SD	95% CI	Mean	SD	95% CI
< 1	-5.2	6.1	-5.5;-4.9	-2	4.8	-2.5;-1.4
1-1,99	1	8.3	0.6;1.4	4.5	5.8	4.2;4.8
2-2,99	13.3	6.5	12.8;13.8	13.8	5.1	13.5;14.2
≥3	18.6	5.5	17.3;20	19	2.5	18.7;19.3

Table IV: Pearson correlation index between the age of the heart and the REGICOR and SCORE scales.

	REGICOR						SCORE					
	Women	n	Men	n	Total	n	Women	n	Men	n	Total	n
35-39 years	0.63	941	0.79	605	0.72	1546	no*	941	no*	605	no*	1546
40-44 years	0.65	991	0.79	636	0.69	1627	0.13	991	0.72	636	0.52	1627
45-49 years	0.72	928	0.8	599	0.75	1527	0.54	928	0.61	599	0.56	1527
50-54 years	0.65	598	0.73	544	0.69	1142	0.61	598	0.62	544	0.54	1142
55-59 years	0.64	324	0.7	406	0.66	730	0.58	324	0.65	406	0.52	730
≥ 60 years	0.61	103	0.58	113	0.62	216	0.46	103	0.60	113	0.53	216

(*) The SCORE scale can only be calculated from the age of 40.

Table V: Relationship between heart age and other parameters related to cardiovascular risk.

		Women					Men				
		Mean	SD	95% CI	n	p-value	Mean	SD	95% CI	n	p-value
Waist circumference	**Risk**	5.5	9.9	4.8-6.1	1023	< 0.05	10.5	7.9	9.9-11.1	666	< 0.05
	No risk	-0.3	9.2	-0.7;0	2862		6.9	8	6.6-7.2	2237	
Metabolic syndrome	**Yes**	13.8	7.7	12.8-12.8	260	< 0.05	15.4	5.9	14.9-16	434	< 0.05
	No	0.3	9.2	0-0.6	3625		6.4	7.7	6.1-6.7	2467	
	Underweight	-2.7	8.4	-3.6;-1.8	343	< 0.05	5.2	8.9	1.9-8.6	28	< 0.05
Body mass index	**Normal**	-0.8	9.1	-1.2;-0.4	1933		5.3	8	4.8-5.9	789	
	Overweight	3.4	9.8	2.8-4	1118		7.9	7.9	7.5-8.3	1433	
	Obesity	6.8	9.6	6-7.4	481		10.4	7.8	9.8-11	653	
	Low	-2.4	9.6	-4.2;-2.5	217	< 0.05	5.1	8.6	2.1-8	60	< 0.05
Body fat	**Normal**	-1.4	9.3	-2;-0.8	1810		6.6	8.3	5.9-7.3	1033	
	High	1	9.9	0.2-1.8	1208		8.6	8.3	7.9-9.3	1023	
	Very high	4.4	10.1	3.4-5.5	650		9.7	8.1	9-10.5	787	

body fat and metabolic syndrome. For this purpose, the number of years of heart age gained or lost is calculated according to the value of the different parameters under study. **Table V** shows that in all cases the heart age values worsen as the parameters related to cardiovascular risk also worsen. This occurs in both women and men. In all cases there are statistically significant differences. In the table, the mean, standard deviation and confidence interval refer to the difference in years between heart age and biological age.

Discussion

The main conclusion of the study is that the heart age values calculated using the Heart age calculator tool correlate very well with the values obtained with the Framingham equation, in this case with the Framingham modality calibrated for the Spanish population, a fact that was expected, since both models have a similar basis for calculating risk. The comparative data with the SCORE scale suggest that there is a relationship, although it is somewhat lower. In both cases the correlations are higher in men than in women.

It is also interesting to note the close relationship observed between heart age and other parameters related to cardiovascular risk and overweight such as BMI, body fat, waist circumference and metabolic syndrome.

One of the strengths of the study is that it is the first to make comparisons between heart age and other validated and widely used tools for estimating cardiovascular risk. This fact will prevent the results from being compared with those obtained by other authors, but it will allow this work to constitute a starting point for future studies and allow this tool to enter into the work methodology of other authors when assessing cardiovascular risk parameters.

The fact that there are no previous studies with data on heart age forces us to compare our results with those of other authors who assess the correlation between other cardiovascular risk scales. Thus, several studies consulted show good correlation between classic Framingham and REGICOR[18-20] and between classic Framingham and SCORE[21]. However, the data from all these studies must be evaluated with caution as it is difficult to compare them since the methodology used has not always been the same and the characteristics of the population also differ. In general, most of the studies focus on populations with a predominantly high cardiovascular risk, which implies an initial bias in terms of the target population.

With the data obtained indicating initially a good correlation with the classical cardiovascular risk scales as well as with the other parameters studied, we believe that heart age can be a useful tool for assessing cardiovascular risk, at least in our population. However, in order to extrapolate this situation to other populations, further studies are needed.

Interests conflict

The researchers declare that they have no conflict of interest.

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