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Effectiveness of the Heart Age tool for improving modifiable cardiovascular risk factors in a Southern European population: a randomized trial

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Abstract

Aims: To test whether communicating cardiovascular diseases (CVD) risk using a novel risk assessment tool (Heart Age) will be able to motivate a population to adopt healthier lifestyles and improve CVD risk profile over the use of a traditional percentage-based tool.

Methods: A single-blind randomized intervention study was carried out in a Caucasian population. A total of 3153 subjects were randomly allocated to one of three study groups: control (conventional medical advice was given to the subjects), Framingham REGICOR (10-year percentage risk score, calibrated to Spanish population was given to the subjects), or Heart Age group (Heart Age tool was administered to the subjects). Anthropometrical and metabolic parameters were measured and lifestyle habits were recorded at recruitment and 12-months post intervention.

Results: Both the Framingham REGICOR and the Heart Age intervention groups demonstrated significant decreases in their risk scores at post intervention compared to the control group, with the improvement being of a greater magnitude in the Heart Age group. No differences per gender were observed in the Heart Age group.

Conclusions: Informing patients about their CVD risk expressed as the new Heart Age tool results in a reduction in their CVD risk higher than the one observed when the Framingham REGICOR risk score was used.

Keywords

Cardiovascular disease, gender, heart age, prevention, risk communication, risk factors

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Introduction

The cardiovascular disease (CVD) epidemic is a worldwide public health challenge. In Europe, CVD accounted for up to 47% of total mortality in 2012.[1] The World Health Organization (WHO) estimates that 80% of CVD-related premature deaths could be avoided if primary CVD causative factors (smoking, dyslipidaemia, hypertension, diabetes, and obesity)[2] were reduced through adoption of a healthier diet, exercising and smoking habit cessation.

A key factor to successfully motivate adoption of healthier life styles in patients at risk of developing CVD is the patient's own risk perception.[3] Studies have shown that patients considering themselves to be at higher risk of suffering a stroke are more likely to

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successfully participate in stroke prevention programmes than those that do not.[4] However, it has been reported that up to 40% of the general population underestimate their CVD risk,[5,6] with this 'optimistic bias' effect in relation to CVD risk being higher in women.[7]

Therefore, the ability to communicate an individual's CVD risk is of great medical relevance, especially in the field of public health, in order to establish adequate prevention and treatment policies. However, and despite having the ability to effectively measure CVD risk, translation into medical advice is not being successful in avoiding the increase in the prevalence of CVD risk factors in the general population.[8] In fact, current communication has not translated into a reduced prevalence of CVD risk factors in the general population.

The Framingham Heart Study risk score is well established and allows physicians to calculate the probability a patient has of developing a cardiovascular event in the following 10 years considering seven risk factors: gender, age, cholesterol, high-density lipoprotein cholesterol (HDL), systolic blood pressure and blood pressure medication, smoking status.[9] However, using this formula to express risk is difficult for people to understand.[10] Communicating a low absolute risk score could even provide false peace of mind if, for instance, the individual is young but with modifiable risk factors that worsen with age if they are not controlled. Therefore, it has been suggested that new methods for communicating the risk in a more graphical and understandable way could have a higher emotional impact.[11]

The Heart Age tool is novel, based on the Framingham risk score and developed specifically to help people understand their CVD risk in order to motivate them to implement changes in their lifestyles leading to a lower CVD risk.[12] An individual's heart age is the chronological age of someone with same CVD risk score but with normal modifiable risk factors. This means that the heart age could be higher than the individual's own chronological age if CVD risk factors are elevated. A study carried out in the UK has demonstrated that using the Heart Age tool is more effective than 10-year percentage risk score in aligning the patient's risk perception with their actual risk.[12]

The aim of this work was to test whether informing a study population of their CVD risk using the Heart Age tool will be able to engage and motivate them to adopt a healthier lifestyle that will therefore result in an improvement in their cardiovascular risk profile over the use of a percentage-based tool, such as the Framingham score calibrated for the Spanish population (Framingham REGICOR score).

Methods

Study populations and intervention

A single-blind randomized intervention study was carried out in a Caucasian population. All participants were workers from the public sector in the Balearic Islands (Spain). Recruitment started in January 2008 and follow-up interviews were completed in December 2011. Subjects in the study were invited to participate during their annual work health assessment. Exclusion criteria were having been diagnosed with an impaired ability to fully understand medical advice or cardiovascular risk implications or heart age, lacking a permanent work contract, refusing to sign the informed consent, or failing to attend the two scheduled visits to the medical doctor 1 year apart.

In order to reach a final sample size of 2900 subjects, 3500 workers were invited to participate. Among them, 3153 subjects agreed to participate. Participants signed informed consent prior to enrolment. After acceptance, a complete family and personal medical history was recorded. The study design was in accordance with the Declaration of Helsinki and received approval from the Balearic Islands Clinical Research Ethical Committee.

Using a computerized random number generator, the 3153 participants were randomly allocated to one of the three study groups: control ($n = 1057$), Framingham REGICOR (FR, $n = 1051$) or Heart Age (HA, $n = 1045$). A total of 2844 participants (52.3% women and 47.7% men) completed the study (control group, $n = 975$; FR group, $n = 955$; HA group, $n = 914$). In the control group, patients were given the conventional medical advice as customary in the annual health checks, including general guidelines on healthy lifestyle. In the FR group, patients were scored for their 10-year CVD risk according to the Framingham REGICOR model calibrated for the Spanish population,[13] and their risk value was communicated and explained to them, together with the conventional medical advice as in the control group. In the HA group, 'heart age' was calculated using the Heart Age calculator.[14] The necessary parameters for completing the heart age tool are: age, gender, height (cm), weight (kg), waist circumference (cm), family history and age of onset of CVD, presence or absence of diabetes, smoking habits, blood total cholesterol and HDL cholesterol levels, blood systolic pressure, and absence or presence of hypertension drug treatment. Participants were informed of their heart age value and its meaning was explained to them. The number of 'lost years' (difference between heart age and the chronological age) was also determined and communicated to the participants from the HA group. They were also provided with the customary medical advice as in the control and

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FR groups. Researchers and clinical assistants involved in this first interview were trained to ensure a standard communication of the individual risk. Furthermore, to allow the single blind design, the researchers and clinical assistants who did the follow-up interviews and measurements were not the ones involved in the first interview and they were not aware of the information previously received by each participant.

Measurements

Baseline measurements were collected during the recruitment interview upon acceptance to participate in the study. Follow-up measurements were taken 12 months later, during the annual health assessment interview.

All anthropometrical measurements were made in the morning after an overnight fast, and according to the recommendations of the International Standards for Anthropometric Assessment.[15] Furthermore, all measurements were performed by well-trained researchers to minimize coefficients of variation. Each measurement was made three times and the average value was calculated. Body weight (electronic scale Seca 700; Seca, Hamburg, Germany), height (stadiometer Seca 220 CM Telescopic Height Rod for Column Scales, precision 0.5 cm; Seca) and abdominal waist circumference (flexible steel tape, Lufkin Executive Thinline W606, precision 1 mm) were determined according to recommended techniques mentioned above. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. Overweight was defined following the criteria from WHO.[16]

Blood was collected during the same session and in the same place, after an overnight fast of 12 hours. Serum was immediately obtained and total cholesterol, HDL cholesterol, glucose, and triglycerides were measured using an automated analyser (Technicon DAX system).

Blood pressure was measured with a calibrated automatic sphygmomanometer (Omron M3). Measurements were repeated three times with a pause of 1 min between measurements and the average value was recorded.

To calculate physical activity practice, self-reported number of sessions of physical activity per week was obtained.

Classification of the participants in the study according to CVD risk was done following the Framingham REGICOR guidelines: >10%, high-risk CVD; 5–9.9%, moderate-risk CVD; <5%, low-risk CVD.[17]

Statistical analysis

Continuous data are presented as means, standard deviations, and 95% confidence intervals. Categorical data are shown as frequency counts and percentages. The statistical analysis was performed using the statistical software package SPSS 20.0. The chi-squared test was applied to assess differences between groups in categorical variables. One-way ANOVA was used to analyse changes across treatment groups with post-hoc Tukey test. The effects of the gender on the changes induced by the interventions were tested by a two-way ANOVA with intervention and gender as ANOVA factors. $p \leq 0.05$ was considered statistically significant in all tests performed.

Results

Patient population

Table 1 summarizes the baseline characteristics of participants in the study. The FR and HA groups' average ages were higher (1 and 1.1 years older, respectively) than the control group's average age. No significant differences in weight, height, BMI, and physical activity practice were found among the study groups. A higher proportion of smokers was found in the control group than in the FR and HA groups. At baseline, the HA group showed higher glucose, cholesterol, and triglyceride levels than the control and FR groups. On the other hand, the FR group presented higher blood pressure and HDL cholesterol levels than the control and HA groups. The HA group showed higher baseline CVD risk levels compared to the control and FR group, and a higher Heart Age value than the control (+1.6 years) and FR (+0.3 years) groups.

Changes in modifiable risk factors

A general deterioration in the metabolic parameters measured at the 12-month follow up (Table 2), with increased blood systolic and diastolic pressure and glucose, cholesterol, and triglyceride levels and lower HDL cholesterol levels, was observed in the control group. Conversely, metabolic parameters showed a general improvement in both FR and HA groups, which was clearly more accentuated in the HA group. Systolic and diastolic pressure and glucose, cholesterol, and triglyceride levels decreased versus baseline values in the FR and the HA groups. Furthermore, while body weight increased in the control group, patients in the FR group showed a slight decrease (−0.2 kg) whereas in the HA group a weight loss of 0.8 kg was observed.

The percentage of smokers at follow up increased in the control group, as a consequence of a relapse of exsmokers (data not shown). Conversely, the percentage of smokers slightly decreased in the FR group (−0.4%) and a more marked decrease was observed in the HA group (−1.8%). The number of physical

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Table 1. Baseline characteristics of the study participants

Characteristic	All ($n = 2844$)	Control ($n = 975$)	FR ($n = 955$)	HA ($n = 914$)	p-value
Male sex (%)	47.7	47.3	48.9	46.9	0.659
Age (years)	46.1 ± 7.1	45.4 ± 7.0	46.4 ± 7.4	46.5 ± 7.0	<0.001
Weight (kg	73.1 ± 15.4	72.4 ± 15.6	73.7 ± 15.4	73.1 ± 15.2	0.197
Height (cm)	166.7 ± 8.7	166.5 ± 8.6	167.1 ± 8.9	166.5 ± 8.7	0.190
Waist circumference (cm)	88.8 ± 13.7	89.4 ± 13.5	89.6 ± 13.4	87.2 ± 14.0	<0.001
BMI (kg/m^{-2})	26.2 ± 4.6	26.0 ± 4.6	26.3 ± 4.5	26.2 ± 4.6	0.363
<18.5	1.3	1.8	0.8	1.1	
18.5–25	43.1	44.8	43.2	41.1	
25–30	38.6	36.1	38.4	41.6	
≥30	17.0	17.2	17.5	16.2	
Systolic BP (mmHg)	123.9 ± 17.6	122.1 ± 15.0	125.1 ± 17.3	124.7 ± 20.1	<0.001
Diastolic BP (mmHg)	78.2 ± 11.5	75.7 ± 9.7	79.9 ± 11.7	79.1 ± 12.7	<0.001
Glucose (mg/dl)	90.1 ± 20.4	88.7 ± 17.2	90.8 ± 21.7	91.0 ± 22.1	<0.05
Total cholesterol (mg/dl)	204.7 ± 35.8	201.7 ± 35.6	205.4 ± 36.1	207.1 ± 35.5	<0.05
HDL cholesterol (mg/dl)	52.9 ± 13.1	51.1 ± 13.0	54.7 ± 13.3	52.7 ± 12.5	<0.001
Triglycerides (mg/dl)	108.5 ± 75.8	106.3 ± 71	105.4 ± 73.7	114.1 ± 82.5	<0.05
Physical activity (sessions/week)	2.70 ± 2.08	2.58 ± 2.03	2.80 ± 2.08	2.72 ± 2.11	0.398
Current smoking	30.8	33.3	31.1	27.7	<0.001
Framingham risk score	2.68 ± 2.17	2.58 ± 2.20	2.63 ± 2.04	2.82 ± 2.26	<0.05
Low CVD risk	84.8	86.4	84.5	83.6	
Moderate CVD risk	13.6	12.2	14.6	14.1	
High CVD risk	1.5	1.4	0.9	2.3	
Heart Age (years)	49.6 ± 14.0	48.7 ± 13.9	50.0 ± 13.5	50.3 ± 14.6	<0.05
Lost years (years)	3.58 ± 10.1	3.25 ± 10.5	3.65 ± 9.7	3.87 ± 10.1	0.389

Values are mean ± SD or %. $p < 0.05$ was considered statistically significant (one-way ANOVA).; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; FR, Framingham REGICOR; HA, Heart Age; HDL, high-density lipoprotein.

activity practice sessions per week decreased in the control group at follow up, while it similarly increased in both the FR and the HA groups.

In accordance with their worsened metabolic profile at the 1 year follow up, the control group presented an increased Framingham REGICOR score (0.24%), and a Heart Age that was increased 1.2 years over the initial value. However, the FR group showed slight improvements in the risk scores (Framingham REGICOR score −0.2; Heart Age 0.3 years younger than at baseline). Finally, the HA group, in agreement with the improvements observed in their metabolic profile, showed higher improvements in both the Framingham REGICOR risk score (−0.4%) and the Heart Age value (1.5 years younger than at baseline).

Framingham REGICOR risk score at 12-month follow up according to gender

Table 3 presents the difference in the Framingham REGICOR risk score at the 12-month follow up as a function of the participants' gender. A significant interaction between the intervention and the gender was found. In the control group, a higher increase in the Framingham REGICOR score was observed in men than in women. The reduction in CVD risk attained in the FR group was higher in men than in women. However, due to higher basal risk in men than in women, these reductions expressed as percentages were similar in both genders (6.9% in men vs. 6.6% in women). No significant differences between genders were observed in the improvements found in the HA group.

Discussion

Here, we present the first results showing that the use of the Heart Age tool to raise awareness of CVD risk promotes behavioural changes that result in a decrease of CVD risk. We also demonstrate that this tool proves to be more effective than the Framingham REGICOR risk score in engaging the participants to adopt healthier attitudes. Although part of the outcome of the study could be determined by the deterioration in

Table 2. Change in characteristics of the study participants at 12-month follow up

Characteristic	All ($n = 2844$)	Control ($n = 975$)	FR ($n = 955$)	HA ($n = 914$)	p
Weight (kg)	−0.08 ± 1.39 (−0.13 to −0.02)	0.72 ± 1.15 (0.65 to 0.79)	−0.22 ± 1.21 (−0.30 to −0.15)	−0.77 ± 1.38 (−0.86 to −0.68)	<0.001
Waist circumference (cm)	−0.02 ± 0.5 (−0.04 to −0.01)	0.13 ± 0.46 (0.11 to 0.16)	−0.05 ± 0.45 (−0.08 to −0.03)	−0.15 ± 0.61 (−0.19 to −0.11)	<0.001
BMI (kg/m^2)	−0.04 ± 0.63 (−0.06 to −0.01)	0.25 ± 0.58 (0.21 to 0.29)	−0.11 ± 0.67 (−0.15 to −0.07)	−0.27 ± 0.52 (−0.30 to −0.24)	<0.001
Systolic BP (mmHg)	−1.83 ± 5.06 (−2.02 to −1.64)	1.02 ± 3.58 (0.80 to −1.25)	−2.31 ± 3.88 (−2.56 to −2.07)	−4.37 ± 5.90 (−4.75 to −3.99)	<0.001
Diastolic BP (mmHg)	−1.07 ± 4.07 (−1.22 to −0.92)	1.31 ± 2.91 (1.13 to 1.50)	−1.77 ± 3.67 (−2.01 to −1.54)	−2.88 ± 4.32 (−3.16 to −2.60)	<0.001
Glucose (mg/dl)	−0.99 ± 6.89 (−1.25 to −0.74)	2.03 ± 6.12 (1.64 to 2.41)	−1.56 ± 7.0 (−2.01 to −1.12)	−3.62 ± 6.3 (−4.03 to −3.21)	<0.001
Total cholesterol (mg/dl)	−1.39 ± 10.4 (−1.77 to −1.01)	5.36 ± 9.47 (4.76 to 5.95)	−3.36 ± 6.87 (−3.79 to −2.92)	−6.54 ± 10.6 (−7.23 to −5.85)	<0.001
HDL cholesterol (mg/dl)	0.25 ± 1.81 (0.18 to 0.31)	−0.92 ± 1.52 (−1.02 to −0.83)	0.47 ± 1.10 (0.40 to 0.54)	1.27 ± 1.99 (1.14 to 1.39)	<0.001
Triglycerides (mg/dl)	−1.04 ± 11.1 (−1.45 to −0.63)	4.38 ± 9.41 (3.78–4.97)	−2.65 ± 7.64 (−3.13 to −2.16)	−5.14 ± 13.2 (−6.00 to −4.28)	<0.001
Physical activity (sessions/week)	3.09 ± 2.13 (3.01–3.17)	2.23 ± 2.01 (2.11–2.36)	3.48 ± 2.07 (3.35–3.62)	3.60 ± 2.02 (3.47–3.73)	<0.001
Current smoking (%)	−0.5	0.9	−0.4	−1.8	<0.001
Framingham risk score	−0.10 ± 0.86 (−0.13 to −0.07)	0.24 ± 0.78 (0.19 to 0.29)	−0.18 ± 0.66 (−0.22 to −0.14)	−0.37 ± 0.99 (−0.44 to −0.31)	<0.001
Heart Age (years)	−0.17 ± 2.85 (−0.27 to −0.06)	1.19 ± 2.21 (1.06 to 1.33)	−0.28 ± 2.45 (−0.44 to −0.13)	−1.50 ± 3.18 (−1.70 to −1.29)	<0.001
Lost years (years)	−1.20 ± 2.57 (−1.29 to −1.10)	0.23 ± 1.88 (0.11 to 0.35)	−1.34 ± 2.11 (−1.47 to −1.20)	−2.57 ± 2.84 (−2.75 to −2.38)	<0.001

Values are mean ± SD (95% CI). $p < 0.05$ was considered statistically significant (one-way ANOVA). Significant differences were found between the three groups in all parameters.; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; FR, Framingham REGICOR; HA, Heart Age; HDL, high-density lipoprotein.

Table 3. Change in 10-year Framingham REGICOR risk score at 12-month follow up according to gender

	All ($n = 2844$)	Control ($n = 975$)	FR ($n = 955$)	HA ($n = 914$)	ANOVA
Men	−0.08 ± 1.00 (−0.14 to −0.03)	0.37 ± 0.97 (0.28 to 0.46)	−0.24 ± 0.76 (−0.31 to −0.17)	−0.40 ± 1.09 (−0.50 to −0.29)	<0.001
n	1357	461	467	429	
Women	−0.11 ± 0.70 (−0.15 to −0.08)	0.12 ± 0.53 (0.07 to 0.16)	−0.12 ± 0.53 (−0.17 to −0.07)	−0.35 ± 0.89 (−0.43 to −0.27)	<0.001
n	1487	514	488	485	

Values are mean ± SD (95% CI). $p < 0.05$ was considered statistically significant (two-way ANOVA) and indicates a significant interaction between gender and group.; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; FR, Framingham REGICOR; HA, Heart Age; HDL, high-density lipoprotein.

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the control group, it is noteworthy that in the Heart Age group this deterioration was not only prevented but also a healthier status was observed at 1-year follow up. The deterioration observed in the control group supposes a modest deterioration in risk factors after 1 year, which represents a likely scenario if lifestyle changes are not made

We hypothesize that the efficacy of the Heart Age tool is based on its ability to increase CVD risk perception due to its simplicity and the use of concepts that are easy to understand for the general population, such as chronological age. In fact, in a very similar way, the concept of cardiovascular risk age, which also gives information in terms of increased age due to presence of risk factors, has been recently recommended.[18] It is not known whether cardiovascular risk age has the same motivational impact and gives the same risk factor reduction as heart age. It also does not use, among other factors, HDL cholesterol within the calculation, which may be particularly important in determining a risk age in young women whose high total cholesterol values may be misleading due to higher HDL levels. It has been suggested that risk perception plays an important role in health behaviour. Kreuter and Strecher[4] reported that smokers that are informed about their increased CVD risk and perceive an increased stroke risk have a higher probability of successfully quitting smoking compared to those that were not informed or underestimated their stroke risk.

Although experiences using this new tool in cardiovascular preventive programmes are still scarce, a previous study by Soureti et al.[12] demonstrated that perceived CVD risk increases in those individuals receiving their Heart Age score as a part of a therapeutic counselling programme over those that receive their risk score in the form of percentage 10-year CVD risk. This increased risk perception resulted in greater intention to change unhealthy habits in the Heart Age group, especially in those individuals presenting more elevated risk scores.[12] Our results would demonstrate that this 'intention to change' translates into de facto lifestyle modifications that lead to an improvement in the participants CVD risk. Interestingly, and while Soureti et al.[12] did not find significant differences ($p = 0.09$) in the intention to quit smoking between the percentage CVD and Heart Age communication groups, we found a striking difference in the proportion of participants quitting the smoking habit, with the smoking cessation rate being more than 4-times greater in the Heart Age group compared to the Framingham REGICOR group. Similar observations were made by Parkes et al.[19] when they used the concept of 'lung age' to report to smokers their spirometry results: those smokers who were told their results using the lung age score presented a cessation rate much higher than the group who were told their raw spirometry data. However, and contrary to the results obtained with the Heart Age tool,[12] the likelihood of quitting the habit was not related to presenting a worse lung age score. This would suggest that the mere fact of presenting the patients with information that is easy to understand has a positive effect in engaging them to take preventive action.

Our results suggest that the impact of informing patients of their CVD risk using the 10-year percentage risk score is limited, in agreement with other studies showing that percentage risk scores only have a minor impact on risk perception.[20] A recent systematic review has shown that providing patients with CVD risk education results only in minor reductions in predicted risk scores, even when the interventions are long lasting (up to 7 years).[21] It has been argued that this could be caused by two phenomena: first, the general population finds it difficult to comprehend mathematical concepts;[22] second, when risk is presented with small probabilities (that is, an absolute risk of 5% at 10 years), patients tend to underestimate its impact as it leads to a false peace of mind. On the other hand, the concept of an ageing heart is more concrete and easy to understand and therefore, seems to provoke a greater emotional impact.

A limiting factor of this study is that the follow-up period was of only 1 year, which is a limited time in which to evaluate improvements in health status in response to behavioural changes. It could be argued that the motivating impact of receiving a CVD risk score could be lost in the long term, and therefore further reinforcement activities might be necessary to maintain the initial emotional impact in order to see a sustained effect. Thus, it would be interesting to evaluate if the changes attained in the Heart Age group are durable in the longer term. Moreover, it should be evaluated whether receiving an improved heart age score after intervention would result in further reinforcement and motivation to maintain a healthier lifestyle. On the other hand, we did not target a high CVD risk population, which might have led to an underestimation of the reduction in CVD risk attainable by the use of this tool, given that improvements in CVD risk in subjects with an already low risk are expected to be marginal.

CVD is the first cause of mortality in women in Europe[1] and in the USA.[23] Furthermore, it has been recently showed that, in young individuals, high CVD risk is almost as common in women as in men.[24] However, it has been reported that only 13% of women in the USA are aware of this.[23] Therefore, strategies to effectively raise awareness of CVD risk specifically in women are required. Results of the present study suggested that the Heart Age tool could induce a similar effect in both genders and, thus, could increase the risk perception in women.

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It is worth highlighting that the significant improvement in CVD risk seen in this study in the Heart Age group was reached with no intervention other than informing participants of their Heart Age. This strategy is simple, economical, and not time consuming (about 5 min per patient on average). We believe that the greatest strength of this score relies in its simplicity, which makes it an ideal tool to be used in the primary care setting, given that it provides the general practitioner with a risk score that is easy and quick to calculate, with an expression that makes it readily understandable by the patient. Nonetheless, further improvement could probably be attained through a more intensive intervention that included also tailored counselling and health education, as was done in the EUROACTION programme.[25]

In conclusion, informing patients about their CVD risk expressed as 'heart age' is a cost- and time-effective strategy to motivate patients towards adopting a healthier cardiovascular lifestyle that results in a reduction in their CVD risk. The simplicity of the tool and the fact that it is easy to understand for the general population could be the main causes for its high effectiveness.

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Conflict of interest

The authors declare that there is no conflict of interest.

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