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ORIGINAL ARTICLE

Agreement Between Cardiovascular Risk Stratification Instruments in Geriatric Patients

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Abstract

Background: Elderly patients are more likely to develop cardiovascular events. Tools for risk stratification serve as support to prevent threats of events and assess eligibility for statin use.

Objectives: Evaluate the degree of concordance between tools for cardiovascular risk stratification in elderly patients.

Methods: Cross-sectional, observational, descriptive, analytical study, with secondary data from 124 medical records of patients treated at a geriatric outpatient clinic in the South of Santa Catarina, Brazil. Variables present in the cardiovascular disease (CVD) risk stratification instrument were analyzed. Subsequently, the tools were compared. Inferential analysis was carried out with a 95% confidence interval and significance level $\alpha = 0.05$. The Shapiro-Wilk and Kolmogorov-Smirnov tests were applied to determine the normal distribution of quantitative variables. The degree of concordance between CVD risk stratification instruments was calculated using the kappa concordance index.

Results: Most patients were classified as high risk. There was a discrepancy regarding SCORE2/SCORE-OP, as it proved to be highly sensitive to the threat of cardiovascular events (99.2% of patients were high risk). These outcomes relate to the fact that the sample was geriatric patients, with age being an independent risk factor. There was a significant p value ($p < 0.001$) when comparing ACC/AHA tools and the Framingham Score.

Conclusion: CVD risk estimate and its comparison in different stratification tools presented an important concordance between AHA tools and the Framingham score. However, when assessing SCORE2/SCORE-OP, lower concordance was observed.

Introduction

Cardiovascular disease (CVD) continues to be the most frequent cause of mortality, despite advances in management.[1] In Brazil, it is the leading cause of death, due to higher food intake, lower caloric expenditure, populational aging, higher life expectancy, and a lower natality rate.[2]

It is known that cardiometabolic, behavioral, environmental, and social factors are the main causes of CVD.[3] Of the classic factors associated with the pathophysiology, the following have been highlighted: smoking, obesity, systemic hypertension, dyslipidemia, diabetes mellitus (DM), positive family history for CVD, and, especially, age.[4,5] In the Multi-Ethnic Study of Atherosclerosis (MESA), conducted in 2000, age was the most significant predictor factor for all-cause mortality.[6]

Identifying atherosclerotic cardiovascular risk is the first step in recognizing CVD risk.[7] In order to do so, scoring tools are used to predict cardiovascular threat and assess eligibility for statin use.[8] In Brazil, it is recommended to use the global risk score derived from the Framingham Heart Study (FHS), which estimates the chance of acute myocardial infarction, stroke, heart failure, or peripheral vascular insufficiency in 10 years.[9-11]

The tools have their own limitations, making it necessary to manage other factors. Risk factors are related

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Central Illustration: Agreement Between Cardiovascular Risk Stratification Instruments in Geriatric Patients

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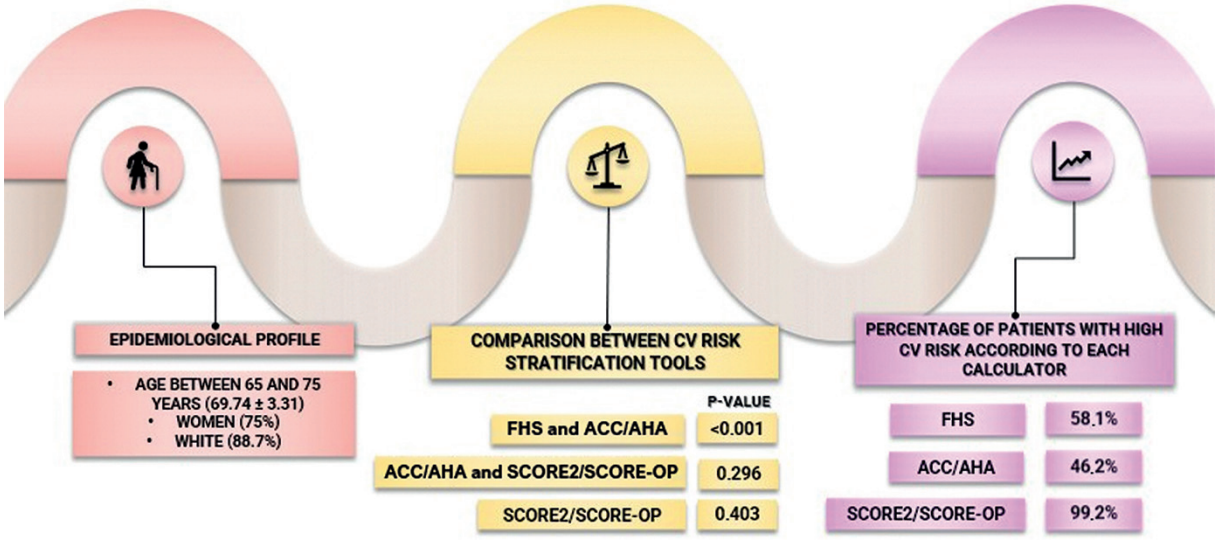

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Source: Elaborated by the authors, 2022. ACC: American College of Cardiology; AHA: American Heart Association; CVD: cardiovascular disease; FHS: Framingham Heart Study; SCORE2: European Systematic Coronary Risk Evaluation 2; SCORE-OP: European Systematic Coronary Risk Evaluation for Older Persons.

to population genetics.[12] Hence, the European CVD risk calculation tools, recommended by the European Society of Cardiology (ESC), were used in this study, as part of the sample population has a genetic relation to Europe, associated with migration to the South Region of Brazil in the nineteenth century. To facilitate preventive interventions and increase reliability, this study used the American College of Cardiology/American Heart Association (ACA/AHA) tool, which estimates the risk of atherosclerotic CVD in 10 years.[13]

This study aimed to evaluate the degree of concordance between tools for CVD risk stratification in patients between 65 and 75 years of age, who were treated at a geriatric outpatient clinic between 2017 and 2021.

Methods

This was a cross-sectional, retrospective study, with quantitative approach and secondary data collection. The study was conducted at a geriatric outpatient clinic at a university, using medical records of patients seen from 2017 to 2021. The study included patients aged 65 to 75 years. The records that did not have sufficient data for application in CVD risk stratification tools were excluded. The final sample was 124 individuals.

This study analyzed variables present in the global CVD risk stratification instrument (derived from the 2008 FHS),[10] the ACC/AHA tool (2013),[13] and the ESC score (2021).[12,14] These include age, sex, race, smoking, low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol (TC), systolic blood pressure (SBP), diastolic blood pressure (DBP), use of statin, presence of significant atherosclerotic disease with or without clinical events or obstruction ≥ 50%, history of DM, treatment for hypertension, and use of aspirin.

The data were used to stratify CVD risk using the global CVD risk stratification calculator derived from the 2008 FHS,[10] the stratification calculator derived from the 2013 ACC/AHA guidelines,[13] and the stratification calculators recommended by the ESC. In 2021, the ESC recommended the Systematic Coronary Risk Evaluation 2 (SCORE2)[14] and, as a stratification score for elderly patients, the Systematic Coronary Risk Evaluation for Older Persons (SCORE-OP).[12]

Regarding the calculators recommended by ESC, SCORE2[14] is aimed at individuals between 40 and 69 years of age, while SCORE-OP[12] was designed for those aged 70 and above. Therefore, in this study, the patients under 70 years were stratified by SCORE2,[14] and those aged 70 or over by SCORE-OP.[12] The patients were considered

from a region with very high CVD risk, in order to bring reliable results to the study.[3,15] Subsequently, the tools were compared.

The proposed cutoff point to identify individuals with low, intermediate, and high CVD risk differs for each of the CVD risk stratification instruments used in the study, as well as the variables and outcomes analyzed, as shown in Table 1.

Statistical analysis

Quantitative variables were described using mean and standard deviation, and qualitative variables were described by absolute and relative frequencies. All results were expressed through tables. All quantitative tables presented normal distribution.

Inferential analysis was carried out with a 95% confidence interval and significance level $\alpha = 0.05$. The Shapiro-Wilk and Kolmogorov-Smirnov tests were applied to determine the normal distribution of quantitative variables. The degree of concordance between CVD risk stratification instruments was calculated using the kappa concordance index.

The Kolmogorov-Smirnov and Shapiro-Wilk tests compare the sample scores to a set of normally distributed scores with the same mean and standard deviation. However, Field (2009) asserts that the Kolmogorov-Smirnov procedure has greater power in cases of large samples, while the Shapiro-Wilk procedure has greater power in smaller samples. Given this disagreement regarding the power of the tests, combined with the lack of a definition of a clear cutoff to distinguish large samples from small samples, we chose to observe the results of both procedures and define that the observed distribution followed normality only when both tests showed agreement.[16]

This study was approved by the Human Research Ethics Committee of the University of the Extreme South of Santa Catarina (CAAE 5.172.106).

Results

The sociodemographic and clinical-laboratory profile of the sample analyzed is shown in Table 2.

Table 3 presents CVD risk stratification. CVD risk classification, using the respective instruments, underwent a combination of the group "borderline risk" with "intermediate risk," since, in the AHA instrument, the value considered borderline is 5% to 7.4%.[13] In both the FHS calculator[13] and SCORE2/SCORE-OP,[12,14]

Table 1 – Characteristics of CVD risk stratification tools according to age range, variables used, cutoff points proposed for classifying individuals with high CVD

CVD risk stratification tools	Age range	Variables used	Cutoff point	Outcomes assessed in 10 years
FHS10	30-74	Age, sex, SBP, antihypertensive use, TC, HDL, DM, smoking	≥ 20%	Fatal and non-fatal CVD (coronary disease, cerebrovascular disease, heart failure, intermittent claudication)
ACC/AHA[13]	40-79	Age, sex, SBP, antihypertensive use, TC, HDL, DM, smoking	≥ 7.5%	Fatal coronary heart disease, non-fatal AMI, and fatal or non-fatal stroke
SCORE2 (very high risk region)[14]	40-69	Age, sex, SBP, DM, TC, HDL, smoking	≥ 7.5% (< 50 years); ≥ 10% (50-69 years)	Cardiovascular death (coronary disease, stroke, arrhythmia, aortic aneurysm, or peripheral vascular disease), non-fatal myocardial infarction, and non-fatal stroke
SCORE-OP (very high risk region)[12]	≥ 70 years	Age, sex, SBP, DM, TC, HDL, smoking	≥ 15%	Cardiovascular death (coronary disease, stroke, arrhythmia, aortic aneurysm, or peripheral vascular disease), non-fatal myocardial infarction, and non-fatal stroke

Source: Research data, 2022. AHA: American Heart Association; AMI: acute myocardial infarction; CVD: cardiovascular disease; DM: diabetes mellitus; HDL: high-density lipoprotein; LDL: low-density lipoprotein; SBP: systolic blood pressure; SCORE2: European Systematic Coronary Risk Evaluation 2; SCORE-OP: European Systematic Coronary Risk Evaluation for Older Persons; TC: total cholesterol.

Table 2 – Epidemiological characteristics of patients at a geriatric outpatient clinic

	n (%); mean ± SD	CI (95%)
Age, years	69.74 ± 3.3	69.15 – 70.33
Sex		
Female	93 (75.0)	-
Male	31 (25.0)	-
Race		
White	110 (88.7)	-
Black	9 (7.3)	-
Other	5 (4.0)	-
Smoking		
Yes	29 (23.4)	-
No	95 (76.6)	-
ASCVD		
Yes	27 (21.8)	-
No	97 (78.2)	-
Diabetes mellitus		
Yes	50 (40.3)	-
No	74 (59.7)	-
Blood pressure		
SBP	134.81 ± 17.51	131.69 – 137.92
DBP	82.85 ± 11.09	80.88 – 84.83
Lipid profile		
TC	194.15 ± 43.59	186.4 – 201.9
HDL	48.84 ± 11.00	46.88 – 50.79
LDL	118.36 ± 38.27	111.56 – 125.17
On aspirin		
Yes	33 (26.6)	-
No	91 (73.4)	-
Statin		
Yes	61 (49.2)	
No	63 (50.8)	
Treatment for hypertension		
Yes	86 (69.4)	
No	38 (30.6)	

Source: Research data, 2022. ASCVD: presence of significant atherosclerotic disease with or without clinical events or obstruction greater than 50%; CI: confidence interval; DBP: diastolic blood pressure; HDL: high-density lipoprotein; LDL: low-density lipoprotein; SBP: systolic blood pressure; SD: standard deviation; TC: total cholesterol.

Table 3 – Cardiovascular risk stratification in patients at a geriatric outpatient clinic

	n (%); mean ± SD	CI (95%)
Framingham		
Low risk	5 (4.0)	-
Intermediate risk	47 (37.9)	-
High risk	72 (58.1)	-
AHA		
N/A	7 (5.6)	-
Low risk	2 (1.6)	-
Intermediate risk	54 (43.5)	-
High risk	54 (43.5)	-
Borderline risk	7 (5.6)	-
SCORE2/SCORE-OP		
Low risk	0 (0.0)	-
Intermediate risk	1 (0.8)	-
High risk	123 (99.2)	-

Source: Research data, 2022. AHA: American Heart Association; CI: confidence interval; N/A: not applicable; SCORE2: European Systematic Coronary Risk Evaluation 2; SCORE-OP: European Systematic Coronary Risk Evaluation for Older Persons; SD: standard deviation.

a similar value falls under low and intermediate risk, respectively. This confirms that the borderline value falls into the intermediate category. Those classified as not applicable by the ACC/AHA[13] tool had to be disregarded due to the lack of applicability.

Table 4 displays the concordance evaluation between the instrument derived from the FHS[10] and the ACC/AHA[13] calculator.

Table 5 displays the concordance analysis between SCORE2/SCORE-OP[12,14] and the ACC/AHA[13] calculator.

Table 6 expresses the concordance evaluation between SCORE2/SCORE-OP[12,14] and the FHS global risk score.[10] According to the kappa and p value, there was no significant difference.

The Central Illustration illustrates the information above.

Discussion

This study observed that age directly interfered in the risk of a cardiovascular event. Since the sample included

Table 4 – Analysis of agreement between the Framingham score and the AHA calculator

	Framingham score			κ	p value
	Low risk	Intermediate risk	High risk		
AHA					
Low risk	2	7	0	0.427	<0.001
Intermediate risk	2	31	21		
High risk	0	7	47		

Source: Research data, 2022. AHA: American Heart Association; κ: kappa concordance measure.

Table 5 – Analysis of agreement between SCORE2/ SCORE-OP and the AHA calculator

	SCORE2/SCORE-OP			κ	p value
	Low risk	Intermediate risk	High risk		
AHA					
Low risk	0	0	9	−0.016	0.296
Intermediate risk	0	0	54		
High risk	0	1	53		

Source: Research data, 2022. AHA: American Heart Association; SCORE2: European Systematic Coronary Risk Evaluation 2; SCORE-OP: European Systematic Coronary Risk Evaluation for Older Persons; κ: kappa concordance measure.

geriatric patients, most of the studied population had a high CVD risk.[17-19]

Moreover, 40.3% of patients had DM. This pathology is a factor related to CVD risk and is associated with 90% of cases with obesity, which is related to diets containing high atherogenic foods that contribute to atherosclerosis. DM is a common finding in the elderly population because skeletal muscle is important in insulin-induced glucose metabolism. Furthermore, sarcopenia, which is common in elderly patients, is responsible for insulin resistance and metabolic syndrome, factors directly associated with CVD risk.[20-22]

Clinical trials for elderly patients with high TC or LDL levels have shown that this population benefits from their reduction, especially patients aged 50 to 75 years.[23-26] In addition, the average LDL level analyzed in this study was 118.36 ± 38.27 mg/dL. Comparing this finding with the target published by the *Journal of the American College of Cardiology* in 2018, it is worrying that this target is not equivalent to the levels present in similar research. For example, the study by Cruz et al. observed LDL levels similar to those in the current study, namely, 122.86 mg/dL in men and 145.37 mg/dL in women.[27]

Half of the studied population did not use statins (50.8%). It is worrying that these patients were not receiving therapy, even though, according to all the calculators, most of them had an indication.[28-31] However, it is noteworthy that the reduced use of statin is perhaps due to the patients' profile, and it would be necessary to assess the medication's cost-effectiveness in patients with reduced life expectancy associated with multimorbidity.[32] In these cases, most cardiovascular and geriatric specialists deal with multimorbid individuals, which end up limiting the use of certain drugs.[33]

Hypertension was found to be a predictor of cardiovascular events.[34] This study observed that 69.4% of patients had treated hypertension, and the overall average of the studied group was SBP of 134 mmHg and DBP of 82 mmHg, which is within the stipulated target for elderly patients.[35] This finding is in agreement with the research conducted by Santana et al. in 2019, which analyzed the blood pressure profile of elderly patients, in which 56.4% had predominantly controlled blood pressure.[36] This can be explained by the fact that the patients assessed in the current study receive more adequate monitoring and control of their comorbidities, since community interventions and monitoring of risk factors are closely related to good performance in controlling cardiovascular threats.[20]

For the best assessment of CVD risk in elderly patients, it is important to compare different instruments since, according to Mach et al. (2020), reliability in analysis instruments is related to the adaptation by region, risk level, and incidence of cardiovascular events.[37] Thus, when including SCORE2/SCORE-OP for the analysis of the study population due to genetic influence, it was observed that 88.7% of patients were White, being compatible to the population in the region, which is mostly of European descent.[38]

When analyzing CVD risk through the stratification tools, there was a predominance of high CVD risk in all

Table 6 – Analysis of agreement between the SCORE2/ SCORE-OP and the Framingham score

	SCORE2/SCORE-OP			κ	p value
	Low risk	Intermediate risk	High risk		
Framingham score					
Low risk	-	0	5	−0.015	0.403
Intermediate risk	-	0	47		
High risk	-	1	71		

Source: Research data, 2022. SCORE2: European Systematic Coronary Risk Evaluation 2; SCORE-OP: European Systematic Coronary Risk Evaluation for Older Persons; κ: kappa concordance measure.

the scores. However, there is a large variation between the proportion of the total population classified as high risk for each instrument. The proportion of individuals classified as high risk by SCORE2/SCORE-OP was higher than the others. Therefore, the concordance between the scores and the distribution of individuals according to risk stratification varies according to the instrument.[39] This is because SCORE2/SCORE-OP emphasize that patients over 50 years have risk of a rapid CVD progression, justifying the rigor in classifying patients as high risk, given that the tools estimate cardiac events in 10 years.[40] In addition, the scores produced by the ESC were developed for a low-risk population; when applied to people from other regions, the variables end up being extremely sensitive to designate high CVD risk, which would indicate the need to recalibrate the tool for application in these populations.[12]

The lack of concordance between the different CVD risk calculators, as seen in the present study, has been elucidated before. According to Bazo-Alvarez et al. (2015), the low similarity regarding CVD risk estimation by the instruments emphasizes the uncertainty regarding the choice of any of these tools in practice.[41,42]

Moreover, a study comparing the FHS calculator with similar, albeit calibrated tools showed that the FHS score underestimates the risk of coronary disease in elderly patients. This is reinforced by the current study, considering that 41.9% of the elderly patients were stratified as low/intermediate CVD risk in comparison to SCORE2/SCORE-OP, which stratified 99.2% as high CVD risk.[43,44]

When comparing between the FHS and ACC/AHA tools, a similarity was observed. The association between these calculators is also in line with the study by Garg et al. (2017), in which the similarity presented by these instruments also proved to be significant, and both showed poor performance when predicting high CVD risk.[8] Furthermore, a study[43] conducted in Peru using 6 CVD risk stratification tools showed a concordance of 44% between the FHS and AHA/ ACC tools, corroborating the findings of the present study.

When comparing the ACC/AHA and SCORE2/SCORE-OP tools, a variation was observed due to the high sensitivity of the European calculator. The analysis of concordance between SCORE2/SCORE-OP and the FHS score also presented similarity. Thus, it can be perceived that the ACC/AHA and FHS calculators have similarities, while the instruments proposed by the ESC have a greater sum of their variables in determining high CVD risk for elderly people. It is noteworthy that there are no previous studies involving the comparison between SCORE2/SCORE-OP and other CVD risk stratification tools, since these instruments were derived from a recent guideline.

It should be highlighted that the scores have limitations, as they not only evaluate different outcomes with different weights, but also assess the risk in 10 years, which may underestimate the lifetime risk.[41] Besides, the variables in the calculators derive from studies conducted in different populations, usually in a non-geriatric age group and from regions with high socioeconomic levels.[41,45]

A study from the United States analyzing the territorial relationship between disadvantaged neighborhoods and the risk of events related to atherosclerotic CVD concluded that the CVD risk was underestimated in these populations. This demonstrates the importance of including ethnic and socioeconomic factors in the process of estimating cardiovascular events.[46]

There are significant divergences regarding the definition of the cutoff point for each risk score to classify high CVD risk. The FHS[10] defined CVD risk as high when the estimated risk was greater than or equal to 20%. The guideline released by the ACC/AHA[13] in 2013 stipulated values ≥ 7.5% as the cutoff for high CVD risk, increasing the proportion of individuals present in this category. SCORE2[14] refers to high CVD risk values ≥ 7.5% in individuals under 50 years of age; for patients aged 50 to 69 years, the value increases its tolerance to ≥ 10%. As for SCORE-OP,[12] designed by the ESC especially for elderly patients over 70 years old, the cutoff point was even more tolerant than SCORE2,[14] with values ≥ 15% being considered high CVD risk.[12]

Consistent, comparable, and systematic analysis of long-term trends and patterns in global CVD is essential to guide public policy and provide references to those who will make therapeutic decisions.[3] Therefore, the presence of discrepancies between CVD risk stratification tools corroborates the poor indication of statin use, as well as the different cutoff points of the instruments, especially regarding elderly individuals.[47]

As long as there is no tool designed specifically for the Brazilian population, with a focus on the elderly, there will still be a need to use one of the instruments to estimate patients' CVD risk and assess eligibility for pharmacological primary prevention, as recommended by the World Health Organization.[48] In addition, when choosing a score to estimate CVD risk, it must be considered that the concordance between these tools is low. Therefore, when stratifying the CVD risk of elderly patients, a more careful assessment is required.

Some limitations deserve consideration. Given that the variables add up to determine an individual's risk of having a cardiovascular event and that each calculator determines a different percentage for every variable, converting it into its respective classification, the ACC/AHA tool did not provide researchers with the percentage of patients' calculated CVD risk; it only stratified patients according to their classification. Therefore, it was not possible to use the CVD risk percentages in the analyzed sample. In addition, the power of comparison between the CVD risk tools used in the study may be affected by the differences regarding the definition of CVD risk predictors and outcomes of the scores.

The researchers are aware that analysis of CVD risk tools with different cutoff points, as per current recommended guidelines, is limited. However, it is worth emphasizing that this study aimed to compare the scores to demonstrate the importance of understanding the definition used in these tools and the impact of their limitations.

Conclusion

In the studied population, there was a moderate concordance between the FHS instrument, ACC/AHA's recommended score, and SCORE2/SCORE-OP in estimating global CVD risk in 10 years.

The risk scores studied attribute divergent significance to different variables, which end up being influenced by the population that originated the tool. It is relevant to note the differences present in the tools in clinical practice, as well as the need for calibrated scores aimed at the Brazilian population, recognizing their diversities and vulnerabilities.

Author Contributions

Conception and design of the research, obtaining financing: Colombo MPR, Ubiali LG, Keller GS, Salvaro RG; acquisition of data: Colombo MPR, Ubiali LG; analysis and interpretation of the data: Colombo MPR, Ubiali LG, Grings LR; statistical analysis: Colombo MPR, Ubiali LG, Keller GS, Grings LR; writing of the manuscript and critical revision of the manuscript for intellectual content: Colombo MPR, Ubiali LG, Keller GS, Grings LR, Salvaro RG

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Universidade do Extremo Sul Catarinense under the protocol number 5.172.106. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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