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Comparison of self-perceived cardiovascular disease risk among smokers with Framingham and PROCAM scores: a cross-sectional analysis of baseline data from a randomised controlled trial

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ABSTRACT

Objectives: Previous studies suggest that smokers have a misperception of their 10-year cardiovascular risk. We aimed to compare 10-year cardiovascular risk self-perception and calculated risk among smokers willing to quit and assess the determinants of a possible misperception.

Design: Cross-sectional secondary analysis of baseline data from a randomised controlled trial of smoking cessation.

Participants: 514 participants, mean age 51.1 years, 46% women, 98% Caucasian. Eligible participants were regular smokers, aged between 40 and 70 years, with a consumption of at least 10 cigarettes per day for at least a year. None of them had experienced cardiovascular disease before. Exclusion criteria comprised a history of myocardial infarction, coronary heart disease, stroke, heart failure, peripheral vascular disease, carotid atherosclerosis or cardiac arrhythmia. Participants with renal or liver failure, psychiatric disorders, substance and alcohol abuse and with smoking cessation therapies were excluded.

Interventions: Participants were asked to estimate their 10-year cardiovascular risk using a 3-item scale corresponding to high-risk, moderate-risk and low-risk categories. We compared their risk perception with Framingham and Prospective Cardiovascular Munster Study (PROCAM) scores. We used multivariable-adjusted logistic regression models to determine characteristics of participants who underestimate their risk versus those who correctly estimate or overestimate it.

Results: Between 38% and 42% of smokers correctly perceived their 10-year cardiovascular risk, and 39–50% overestimated their 10-year cardiovascular risk while 12–19% underestimated it compared with their calculated 10-year cardiovascular risk depending on the score used. Underestimation of 10-year cardiovascular risk was associated with male gender (OR 8.16; CI 3.83 to 17.36), older age (OR 1.06; CI 1.02 to 1.09), and the presence of hyperlipidaemia

Strengths and limitations of this study

- This study carefully assessed self-perceived cardiovascular disease (CVD) risk among smokers and compared self-perception with two validated cardiovascular scores in a cross-sectional secondary data analysis of baseline data collected in a randomised controlled trial assessing the effect of carotid plaque screening on smoking cessation.
- The study highlights predictors of underestimation of CVD risk among smokers: male gender, older age, and the presence of hyperlipidaemia and diabetes mellitus.
- The analyses are restricted to smokers and no comparison is possible between CVD perception of smokers, non-smokers or former smokers.
- The analyses are restricted to smokers who underestimated their cardiovascular risk and predictors of overestimation were not assessed.

(OR 2.71; CI 1.47 to 5.01) and diabetes mellitus (OR 13.93; CI 3.83 to 50.66).

Conclusions: Among smokers, misperception of their 10-year cardiovascular risk is common, with one-fifth underestimating it. These findings may help physicians target patients with such characteristics to help them change their health behaviour and adherence to risk-reduction therapy.

Trial registration number: NCT00548665; Post-results.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death worldwide. Ischaemic heart disease and stroke are responsible for 13.2% and 11.9% of deaths, respectively.[1] Smoking is the most important modifiable risk factor

for CVD and smoking cessation prevents cardiovascular mortality and morbidity in a rapid and effective manner.[2] Thus, the main strategy for CVD prevention is based on controlling modifiable risk factors such as smoking through population-wide interventions. These include smoking bans in public places, tax raises on cigarette packs as well as individual healthcare interventions such as counselling and medication for smokers willing to quit.

An adequate perception of CVD risk might be required to better understand the goal of preventive interventions and adhere to CVD prevention. Studies assessing CVD risk using questionnaires, registration form, visual analogue scale and self-rated measurements, conducted in general practices by Frijling et al[3] and van der Weijden,[4] have suggested that smoking predicted higher levels of risk perception. Smokers' perception of health risks is complex and underestimation or overestimation of CVD risk depends on how risk perception is assessed.[5] For instance, Weinstein[5] has reported that smokers consistently acknowledged that smoking increased their risk of developing heart disease, lung cancer, bronchitis and stroke but within a smaller range compared with non-smokers. Furthermore, smokers tended to minimise their health risks. Individual misperception of smokers has also been described in another study that showed that only 29–39% of smokers perceived themselves at higher risk than the average for myocardial infarction.[6] One could argue that smoking, as part of a complex addiction mechanism, might be the cause of misperception but CVD risk is also difficult to assess for physicians.[7] To the best of our knowledge, few studies focused on CDV risk perception among smokers,[3 4] and little or no information about CVD risk (calculated by scores) was provided.

Prediction scores such as Framingham,[8] PROCAM[9] or European Scores[10] have been developed to estimate the 10-year CVD risk. These prediction models are increasingly used to identify high-risk patients who would benefit from interventions on one or several risk factors and to motivate others to adhere to risk-reduction therapy. Based on previous publications, the PROCAM score seems to be the most appropriate score in Switzerland.[9 11] However, the Framingham score is still often used for clinical or research purposes (it is the one used in International Lipid guidelines[12]) despite its tendency to overestimate the cardiovascular risk in European populations.

Awareness of CVD risk associated with cigarette smoking might have changed during the past two decades with more prevention and information campaigns. Moreover, whether smokers have a correct perception of their own CVD risk compared with calculated CVD risk prediction scores has never been assessed and little is known about determinants that could explain the potential misperception of smokers.

The primary objective of this study was to assess the accuracy of perception of CVD risk among smokers and identify determinants associated with potential misperception in a single-centre study conducted with smokers in Switzerland.

METHODS
Study population
We did a cross-sectional secondary analysis of the baseline data of the CAROtid Plaque Screening on Smoking cessation (CAROSS) trial, a randomised controlled trial assessing the effect of carotid plaque screening on smoking cessation.[13] Participants were recruited in the general population using advertisements in newspapers in multiple recruitment waves.

Eligible participants were regular smokers, aged between 40 and 70 years, with a consumption of at least 10 cigarettes per day for at least a year and no periods of smoking abstinence of at least 3 months in the previous year. None of them had experienced CVD before, as exclusion criteria comprised a history of myocardial infarction, coronary heart disease, stroke, heart failure, peripheral vascular disease, carotid atherosclerosis or cardiac arrhythmia. Participants with renal or liver failure, psychiatric disorders, substance and alcohol abuse, and those taking smoking cessation therapies were also excluded.

All participants provided written informed consent. The study was approved by the local ethic commission of the University of Lausanne, Switzerland.

Variables of interest
Data on medical and smoking history, home and work environment, education and medication use were collected using questionnaires. At baseline, a nurse trained in smoking cessation asked each participant about his or her perception of CVD risk. The question was standardised to avoid influencing the participants and worded as: 'How do you perceive your risk of heart attack in 10 years?'. The possible responses were 'none or low risk', 'intermediate risk', 'high risk', 'don't know' and 'refuse to answer'. Participants who 'did not know' or 'refused to answer' were invited once to reconsider their choice. In this study, we restricted the analysis to participants who answered the self-perceived CVD risk question and had complete baseline data.

To determine the reliability and reproducibility of the CVD risk perception assessment, we asked a consecutive convenience subsample of participants (n=48) to reassess their CVD risk 1 month after the last evaluation.

We calculated Framingham scores based on ATP III guidelines.[14] We used the following variables at baseline to calculate the score: sex, age, cholesterol, smoking status, blood pressure, high-density lipoprotein (HDL)-cholesterol, triglyceridaemia and being treated with antihypertensive drugs. The Framingham score was then encoded and CVD risk was computed for each participant.

According to Framingham scores, men with scores ≤11 were classified as low risk (10-year risk of

cardiovascular events 8%), those with scores between 12 and 14 as intermediate risk (10-year risk of cardiovascular events 10–16%), and those with scores ≥15 as high risk (10-year risk of cardiovascular events ≥20%). For women, low, intermediate and high risk corresponded to Framingham risk scores of 19 (10-year risk of cardiovascular events 8%), 20–22 (10-year risk of cardiovascular events 11–17%) and ≥23 (10-year risk of cardiovascular events ≥22%) points, respectively.

The following variables at baseline were used to calculate the PROCAM score: sex, age, low-density lipoprotein (LDL)-cholesterol, HDL-cholesterol, triglyceridaemia, blood pressure, diabetes, CVD before age 60 years among relatives. The PROCAM score was encoded based on a PROCAM study[9] and CVD risk was computed for each participant. Low, intermediate and high risk was defined as 10-year risk of cardiovascular events of <10%, between 10–20% and ≥20%, respectively. By convention, women had their risk divided by four.

Professional activity was initially classified as 'employed', 'unemployed or on social security' and 'retired'. For the need of the multivariable-adjusted analysis and assuming that 'retired' participants were once 'employed', we secondarily merged 'employed' and 'retired' participants and obtained two categories 'employed or retired' and 'unemployed or on social security'. Education was dichotomised by <12 and ≥12 years of education. Both of these variables were used as a proxy for socioeconomic status.

Weight and height were measured at baseline as well as blood pressure in a sitting position with an appropriately sized cuff according to guidelines. Fasting glucose and lipid levels were measured at baseline. We defined cardiovascular risk factors as follows: hypertension as ≥140 systolic mmHg and/or 90 diastolic mmHg[15], except for participants with diabetes mellitus ≥130 and/or 80 mm Hg; hyperlipidaemia according to ATP-III guidelines[16] as LDL-cholesterol ≥2.6 mmol/L, ≥3.4 mmol/L, ≥4.1 mmol/L for high-risk (>20%), moderate-risk (10–20%) and low-risk (<10%) participants, respectively; and diabetes mellitus as fasting blood glucose ≥7.0 mmol/L.[17]

Statistical analysis

The primary outcome was misperception of CVD risk. For statistical convenience, we merged participants who correctly estimate or overestimated their risk together, believing that correct estimation or overestimation is less detrimental than underestimation in terms of preventive medicine. We compared participants who underestimated their 10-year CVD risk with those who correctly estimate or overestimate it. The comparison between the baseline characteristics of both groups was performed using χ^2 tests and analysis of variance (ANOVA) or Fisher tests.

We first used univariable logistic regression to obtain the OR and 95% CIs and identify potential predictors of underestimation, compared with correct estimation or overestimation of 10-year CVD risk. Variables that were significant with a p value <0.05 (sex, age, education, working status, hypertension, hyperlipidaemia, diabetes, cardiovascular medication) were then integrated in a multivariable-adjusted analysis. Multivariable-adjusted logistic regression was used to identify variables associated with underestimation of the CVD risk compared with correct estimation or overestimation.

We considered p values <0.05 as significant. All data were processed with STATA V.10 software (StataCorp, College Station; Texas, USA).

RESULTS

The study included 536 participants, among whom 22 (4%) had incomplete baseline data (18 without self-perceived CVD risk, and 4 whose high triglycerides prevented calculation of LDL-cholesterol level). Among the 514 remaining participants, 98% were Caucasians and 234 (46%) were female (table 1). Mean age at baseline was 51.1±7.3 years. Most participants were employed or retired (92%), the rest being unemployed or on social security. About two-third had lower education (<12 years; apprenticeship or no education). Participants were smoking an average of 24.5 (9.8 SD) cigarettes per day for a mean duration of tobacco smoking of 32.1 (7.9 SD) years, corresponding to 39 (20 SD) pack-years. Two hundred and fifty-eight (50%) participants had hyperlipidaemia, whereas 27% had hypertension and 3.5% had diabetes.

Using the Framingham score, half of the participants (51%) were classified as low risk at 10 years, 38% as intermediate risk and 11% as high risk (table 2). Using the PROCAM risk score, the proportion of low-risk participants was 76%, medium risk 13% and high risk 11% (table 3). Participants perceived themselves at low risk for 38% of them, intermediate risk for 34% and high risk for 28% of them, using the self-perceived CVD risk questionnaire. In a subsample of 48 participants, reassessment of CVD risk perception (by telephone, 1 month after the initial evaluation) showed 83% of consistent answers (40/48) (data not shown).

According to the Framingham score, less than half of the participants (42%) correctly estimated their CVD risk, 39% overestimated it and 19% underestimated it (table 2). According to the PROCAM score, 38% correctly estimated their CVD risk, 50% overestimated it and 12% underestimated it (table 3).

Among high-risk participants, 62–69% underestimated their CVD risk (depending on the score used), whereas 33–34% underestimated it among intermediate-risk participants (tables 2 and 3).

Using the Framingham score, male gender (OR 9.45; CI 4.9 to 18.2), older age (OR 1.05; CI 1.02 to 1.08), body mass index (BMI) (OR 1.09; CI 1.03 to 1.14), hyperlipidaemia (OR 5.71; CI 3.34 to 9.76), diabetes (OR 9.27; CI 3.39 to 25.38) and being on CVD medication (OR 1.75; CI 1.08 to 2.82) were associated with underestimation of CVD

Table 1 Characteristics of study participants

	Overall (n=514)	
Demographics		
Age (years) (mean± SD)	51.1	**7.3**
Women (n, %)	234	**45.5**
Education (n, %)		
<12 years	381	**74.1**
≥12 years	133	**25.9**
Professional activity (n, %)		
Employed*	433	**84.2**
Unemployed or on social security	40	**7.8**
Retired	41	**8.0**
Cardiovascular medication (n, %)		
No treatment	390	**75.9**
Aspirine, statine, anti-HTA, anti-diabetic	124	**24.1**
Cardiovascular variables		
Systolic blood pressure (mmHg± SD)	123.0	**15.4**
Systolic blood pressure (per 10 mm Hg)		
Categories (n, %)		
Low blood pressure†	376	**73.2**
High blood pressure†	138	**26.8**
BMI (kg/m^2) (mean±SD)	24.9	**4.1**
Hyperlipidaemia‡ (n, %)	258	**50.2**
Treated (n, %)	60	**11.7**
Diabetes type 2§ (n, %)	18	**3.5**
Tobacco smoking		
Number of cigarettes per day (mean±SD)	24.5	**9.8**
Number of pack-years (py±SD)	39	**20**
Fagerström score for nicotine dependence mean±SD (0 low dependence–10 very high dependence)	5.0	**2.1**

*Full time, part time, independent or at home.
†Low blood pressure defined as <140/90 mm Hg; high blood pressure defined as ≥140 and/or 90, ≥130 and/or 80 mm Hg if diabetic.
‡Definition of hyperlipidaemia:
▶ Any treated patient (statin or fibrate);
▶ For high-risk patients when LDL-cholesterol ≥2.6 mmol/L;
▶ For intermediate-risk patients when LDL-cholesterol ≥3.4 mmol/L;
▶ For low-risk patients when LDL-cholesterol ≥4.1 mmol/L.
§Fasting glycaemia ≥7 mmol/L or glycaemia ≥11.1 mmol/L.
BMI, body mass index; LDL, low-density lipoprotein; HTA, hypertension.
Bold figures in this table refer to the standard deviation or percentage depending on the variable.

Table 2 Meshing table between perceived CVD risk and calculated CVD risk according to the Framingham score

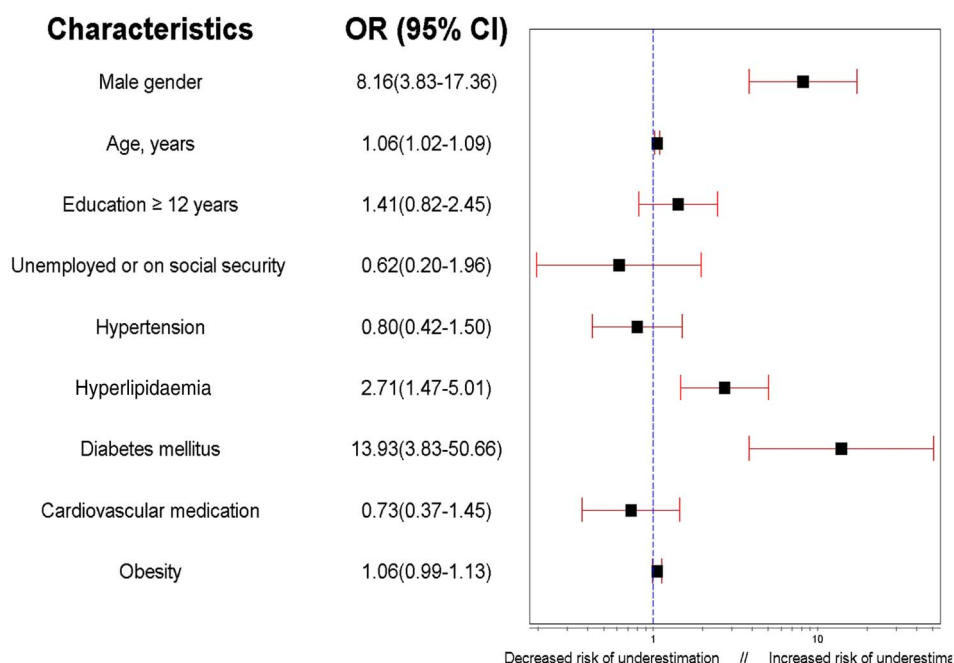| Perceived CV risk T0	Framingham risk score			Total
	Low	**Intermediate**	**High**	
Low risk	111	64	22	197 (38.3)
Intermediate risk	79	81	14	174 (33.8)
High risk	70	51	22	143 (27.8)
Total	260 (50.5)	196 (38.1)	58 (11.2)	514 (100)

Numbers in absolute; () is percentage of total, in column.
Underestimated CVD risk 19%.
Correctly estimated CVD risk 42%.
Overestimated CVD risk 39%.
CV, cardiovascular; CVD, cardiovascular disease.

risk in univariate analysis (data not shown). In the multivariable-adjusted analysis, underestimation of CVD risk was associated with male gender (OR 8.16; CI 3.83 to 17.36), older age (OR 1.06; CI 1.02 to 1.09), hyperlipidaemia (OR 2.71; CI 1.47 to 5.01) and diabetes mellitus (OR 13.93; CI 3.83 to 50.66) (figure 1). We found no association between underestimation and BMI, socioeconomic status, hypertension or being under CVD medication in the multivariable-adjusted analysis. Using the PROCAM risk score, we found similar results (table 4).

Table 3 Meshing table between perceived CVD risk and calculated CVD risk according to the PROCAM score.

| Perceived CV risk T0 | PROCAM risk score | | | |
	Low	Intermediate	High	Total
Low risk	153	23	21	(38.3)
Intermediate risk	130	27	17	174 (33.8)
High risk	109	17	17	143 (27.8)
Total	392 (76.3)	67 (13.0)	55 (10.7)	514 (100)

Numbers in absolute; () is percentage of total, in column.
Underestimated CVD risk 12%.
Correctly estimated CVD risk 38%.
Overestimated CVD risk 50%.
CV, cardiovascular; CVD, cardiovascular disease.

Characteristics	OR (95% CI)
Male gender	8.16(3.83-17.36)
Age, years	1.06(1.02-1.09)
Education ≥ 12 years	1.41(0.82-2.45)
Unemployed or on social security	0.62(0.20-1.96)
Hypertension	0.80(0.42-1.50)
Hyperlipidaemia	2.71(1.47-5.01)
Diabetes mellitus	13.93(3.83-50.66)
Cardiovascular medication	0.73(0.37-1.45)
Obesity	1.06(0.99-1.13)

Decreased risk of underestimation // Increased risk of underestima

Figure 1 Determinants of underestimation (Framingham). 'The ORs and respective 95% CIs are presented on a log scale. Values above 1.0 (right of the dashed vertical line) present an increased risk of underestimating cardiovascular risk according to Framingham risk score,[8] while values below 1.0 (left of the dashed line) present a decreased risk of underestimating cardiovascular risk. All characteristics were analysed as categorical variables, except for age in years as a continuous variable. The presence of hypertension was defined as a blood pressure ≥140/90 mm Hg in patients without diabetes and ≥130/80 mm Hg in patients with diabetes. The presence of hyperlipidaemia was defined according to the level of cardiovascular risk: the threshold for patients with high, intermediate and low cardiovascular risk was ≥2.6 mmol/L, ≥3.4 mmol/L and ≥4.1 mmol/L, respectively. The presence of diabetes was defined by levels of fasting glucose ≥7 mmol/L or glucose at any time ≥11.1 mmol/L. Obesity was defined as a body mass index ≥30 kg/m^2 (weight in kilograms divided by height in meters squared)'.

DISCUSSION

In the present study, between 58% (for the Framingham score) and 62% (for the PROCAM score) of participants had a misperception of their CVD risk at 10 years. Results were almost similar when low, intermediate and high CVD risk categories were taken separately. A minority of participants (12–19%) underestimated their CVD risk, whereas 39–50% overestimated it, depending on the score used for the evaluation of cardiovascular risk. Only 3% of participants could not provide an estimation of their CVD risk.

A majority of participants had inadequate perception of CVD risk, which is consistent with previous studies. In

our study, the CVD risk was perceived inappropriately in 62–69% of high CVD risk participants and 57–61% of low-risk participants, whereas van der Weijden et al[4] found that 80% of high-risk and 20% of low-risk participants had a misperception of their CVD risk in general practices.

The use of the PROCAM risk score generated a higher proportion of low-risk participants compared with the Framingham risk score, but a lower proportion of medium-risk participants. The proportion of high-risk participants was similar using both scores. As a consequence, compared with Framingham, a smaller proportion of participants underestimated their CVD risk when

Table 4 Determinants of underestimation according to the Framingham or PROCAM score

Variables	Framingham		PROCAM	
	OR	(95% CI)	OR	(95% CI)
Male gender	8.16	3.83 to 17.36	38.82	7.28 to 206.91
Age, years	1.06	1.02 to 1.09	1.22	1.15 to 1.30
Education ≥12 years	1.41	0.82 to 2.45	0.70	0.31 to 1.60
Unemployed or on social security	0.62	0.20 to 1.96	0.52	0.09 to 3.10
Hypertension	0.80	0.42 to 1.50	0.35	0.14 to 0.89
Hyperlipidaemia	2.71	1.47 to 5.01	4.49	1.59 to 12.70
Diabetes mellitus	13.93	3.83 to 50.66	192.49	24.82 to 1493.12
Cardiovascular medication	0.73	0.37 to 1.45	0.29	0.11 to 0.80
Obesity	1.06	0.99 to 1.13	1.10	1.00 to 1.21

Bold figures refer to the odds ratio.

using the PROCAM risk score (61 vs 100 participants, respectively), probably reflecting a better accuracy of this score in a European population. Table 4 compares the determinants of underestimation of the cardiovascular risk as calculated with Framingham or PROCAM scores. Of note, important differences between CIs width occurs in the male gender and diabetes variables in PROCAM compared with Framingham. Interestingly, these two variables remain statistically significant even though the strengths of association were less robust mainly due to the smaller proportion of participants in PROCAM and the few patients with diabetes in our study (n=18). In fact, both of these scores consider type 2 diabetes as a high CVD risk regardless of other factors. Thus, patients with diabetes were automatically considered in the highest risk category, which could explain why diabetes has such a high OR. Further studies in a population with diabetes specifically are needed.

We found that older age, male gender, hyperlipidaemia and diabetes were determinants of underestimation of CVD risk. Our results contrast at least with two other studies. Three quarter of participants with hypertension or diabetes overestimated their CVD risk in the study of Frijling et al.[3] Similarly, van der Weijden et al[4] highlighted that men and participants with diabetes were more likely to perceive their CVD risk inappropriately. However, caution is advised when comparing these studies because the design and the baseline population differ substantially. First, only 29% and 20% of participants were smokers in the studies of van der Weijden et al and Frijling et al, respectively. Second, participants in our study responded to an advertisement inviting them to a study to help them quit smoking, whereas Frijling et al gave questionnaires to patients visiting the general office who fulfilled inclusion criteria. The fact that the participants in our study needed to actively respond to an advertisement in order to be recruited might explain why motivation, as well as health awareness, might have been higher in the participants of this study than in the general population of long-term smokers who do not want to quit. This could also explain the low percentage of participants who failed to provide an estimation (correct or wrong) of their CVD risk.

Interestingly, more participants overestimated their CVD risk (too pessimistic) than underestimated it in our study. Nonetheless, we decided to focus on those who underestimated their CVD risk (too optimistic), assuming it to be more detrimental than overestimation. In our opinion, underestimation of CVD risk might decrease compliance with treatment or lifestyle modifications as well as reduce the efficacy of primary prevention and thus increase the absolute risk of CVD event. Overestimation may cause increased stress, medical seeking or overmedication, which can affect the quality of life rather than the absolute CVD risk.

To our surprise, diabetes was a determinant of underestimation of CVD risk, even though participants with diabetes presumably have had regular medical interaction and lifestyle education. However, caution is advised considering the small proportion of participants with diabetes (4%) in our study. Hyperlipidaemia was also a determinant of underestimation, whereas other CVD risk factors such as hypertension or BMI were not associated with underestimation. Finally male gender was also associated with higher odds of underestimation. Studies suggest that men are less health conscious compared with women and might be less susceptible to seek medical help.[18]

Our study carefully assessed self-perceived CVD risk among smokers and compared it with two validated calculated risk score. However, since our study was limited to current smokers, we could not compare smokers' misperception with that of non-smokers or former smokers. It would be interesting to assess risk perception among non-smokers in our general population to better contrast CVD risk perception between smokers and non-smokers.

We assessed CVD risk perception asking about the risk of developing a heart attack within 10 years. It would also have been interesting to assess whether the self-perceived risk of heart attack versus stroke would have been different in smokers. However, we used the perceived risk of heart attack as a proxy for the overall cardiovascular risk and did not collect any data about stroke.

Patients with psychiatric disorders are known to be at risk for substance abuse and have a high prevalence of smoking, and consequently are exposed to high

morbidity.[19] These patients were excluded from the CAROSS trial to ensure that consent was fully informed and that participants would carefully follow the smoking cessation advices. This understudied population would benefit from future trials specifically aimed at new approaches for smoking cessation.

Clinicians widely use clinical scores to estimate CVD risk in order to discuss primary prevention. This approach is only efficient when patients understand and adhere to risk reduction therapy. Smokers represent a challenge for general practitioners due to strong nicotine dependence and denial of personal risk from smoking (optimistic bias).[6]

We found that 12–19% of smokers have a misperception of their 10-year CVD risk in the form of an underestimation, which may hinder the efficiency of interventions aimed at reducing or preventing CVD risk factors. This could lead to an increase in morbidity and mortality. Therefore, clinicians must be aware that about one-fifth of smokers underestimate their 10-year CVD risk and that men as well as people suffering from hyperlipidaemia or diabetes are at increasing risk of underestimating their 10-year CVD risk.

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