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UNIVERSITE DE LAUSANNE - FACULTE DE BIOLOGIE ET DE MEDECINE
Department of Ambulatory Care and Community Medicine

Association between income and control of cardiovascular risk factors after acute coronary syndromes: an observational study

THESE

préparée sous la direction du Docteur David Nanchen
(avec la collaboration des Docteurs et Professeurs Baris Gencer, Reto Auer, Karine Moschetti, Olivier Muller, Christian M. Matter, Thomas F. Lüscher, Francois Mach, Nicolas Rodondi et Patrick Bodenmann)

et présentée à la Faculté de biologie et de médecine de
l'Université de Lausanne pour l'obtention du grade de

DOCTEUR EN MEDECINE

par

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Association between income and control of cardiovascular risk factors after acute coronary syndromes: an observational study

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Summary

BACKGROUND: The role of income in cardiovascular disease prevention after an acute coronary syndrome (ACS) remains unclear. We aimed to assess the association between income and control of cardiovascular risk factors one year after an ACS in a country with universal health insurance.

METHODS: Between 2013 and 2014, we studied 255 consecutive patients with ACS in an observational study in a university hospital in Switzerland in which self-reported household income was assessed. We classified patients into two categories based on the median income in Switzerland: higher than CHF 6000 (€ 5300) or less than or equal to CHF 6000 (€ 5300) per month. One year after discharge, patients were evaluated for the achievement of lipid and blood pressure targets, smoking cessation and drug adherence. Multivariate odds ratios (OR) were adjusted for age, sex, education, living status and working status.

RESULTS: Overall, 52.2% (n = 133) of patients with ACS were in the low-income category and 47.8% (n = 122) were in the high-income category. One year after discharge, high-income patients had higher rates of smoking cessation (64.2 vs 30.1%, multivariate-adjusted odds ratio (OR) 3.82, 95% confidence interval (CI) 1.58–9.24) and blood pressure target achievement (78.6 vs 60.2%, multivariate-adjusted OR 2.19, 95% CI 1.09–4.41) compared to those in the low-income category. There were no differences regarding adherence to drugs or lipid control between the two income groups.

CONCLUSION: A high household income was associated with a higher rate of smoking cessation and better control of blood pressure one year after ACS, independently of education, living status and working status.

Keywords: *income, acute coronary syndrome, hypertension, dyslipidaemia, smoking cessation*

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Introduction

Socioeconomic status is a major determinant of a healthy life. In Europe and worldwide, socioeconomic status has been associated with cardiovascular events and mortality in many observational studies [1–10]. However, the mechanisms underlining these associations are debatable because socioeconomic status encompasses many components, including education and professional, familial and cultural status. In particular, few studies have focused on the relationship between income and cardiovascular disease, maybe because many industrialised countries, including Switzerland, have implemented universal health insurance. The concept of universal health insurance is to extend access to health care as widely as possible, limiting the impact of individual wealth.

Switzerland is a rich country, with a median salary of CHF 6189 (€ 5683) in 2014 according to the Federal Statistical Office [11]. Moreover, universal health insurance coverage is compulsory in Switzerland in order to protect the population against the renunciation of private health care. In this context, we aim to assess the association between income and control of cardiovascular risk factors one year after an acute coronary syndrome (ACS).

Methods

Study population

Between 28 January 2013 and 12 August 2014, we recruited 277 patients hospitalised with ACS in a university hos-

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pital in Switzerland as part of the SPUM-ACS cohort [12]. The inclusion criteria were a main diagnosis of ACS with increased troponins, modifications of electrocardiography and the presence of atherosclerosis in angiography. An exclusion criterion was the refusal to participate in the one-year follow-up visit.

Household income assessment

Self-reported household income was defined as the income of all the people living under the same roof and after the deduction of compulsory social insurance contributions, pension funds and child allowances. In the questionnaire, patients could choose to state their annual income in two different ways. They could directly state their net household income, or they could select from predefined income categories: less than CHF 3000 (€ 2560); less than CHF 4500 (€ 3413.30); more than CHF 4500 (€ 3413.30); less than CHF 6000 (€ 5120); less than CHF 6000 (€ 5120); less than CHF 9000 (€ 7680); less than CHF 9000 (€ 7680) (table S1 in appendix 1). We excluded 22 patients for whom income information was missing. The final sample was 255 patients. We then classified patients into two income categories: high-income (higher than CHF 6000 (€ 5120) per month) and low-income (less than or equal to CHF 6000 (€ 5120) per month), based on the median monthly income in Switzerland of CHF 6189 (€ 5683) [11].

Covariables

Demographic and socioeconomic status were assessed with a validated self-reported questionnaire at baseline and/or at one year. Education was categorised into high-school level or higher, or less than high-school. Marital status was classified as married or not. Living status was classified as living alone or with someone. Working status comprised full time, part time and unemployed. Smoking status was categorised into never, former and current smoker. Health insurance deductibles was categorised in two groups: low, defined as CHF 300 or 500 (€ 256 or € 426.60), and high, defined as CHF 1000, 1500, 2000 or 2500 (€ 853.30, € 1280, € 1706.60 or € 2133.30). Hypertension was defined as systolic blood pressure >140 mm Hg and diastolic >90 mm Hg or use of antihypertensive drugs. Physical activity was measured with the International Physical Activity Questionnaire (IPAQ). We used a validated self-assessed questionnaire, the 20-items Center for Epidemiologic Studies Depression Scale (CES-D), to screen for depression (score ≥16) during hospitalisation [13]. The cut-off values used to stratify the variables were based on standards used for cardiovascular disease prevention in clinics [14].

Outcomes

One year after hospital discharge, control of cardiovascular risk factors was assessed during a face-to-face clinical visit with a study nurse. Lipid profile was measured and processed locally using standardised and certified dosage methods. LDL cholesterol was calculated using the Friedewald formula when triglyceride levels were below 4.5 mmol/l. Targets for cardiovascular risk factors one year after discharge included:

1. Optimal lipid target, defined as LDL cholesterol below 1.8 mmol/l or a 50% decrease from baseline, or the use of high-dose statin (atorvastatin 40 mg or rosuvastatin 20 mg).
2. Optimal blood pressure target, defined as blood pressure below 140 mm Hg for systolic and below 90 mm Hg for diastolic blood pressure.
3. Smoking cessation for current smokers at baseline. Smokers with missing information at one year were considered as continuous smokers. A sensitivity analysis considering smokers with missing information about one-year smoking cessation as non-smokers is reported in table S2 (appendix 1).
4. Optimal drug adherence according to guidelines, defined as the concomitant use of aspirin, statin and either angiotensin-converting enzyme inhibitors, angiotensin-receptor blockers or beta-blockers.

Statistical analysis

Baseline characteristics are presented as means ± standard deviations or frequencies and percentages. To assess the association between income and control of cardiovascular risk factors one year after hospitalisation, we used unadjusted and multivariate adjusted logistic regression models for each outcome and reported odds ratios (ORs) with 95% confidence intervals (95% CIs). In model I, crude analysis was performed. In model II, we adjusted for age and sex, and in model III we further adjusted for education, living status and working status to take into account major socio-demographic variables. The variables included in the multivariate-adjusted model were not determined according to statistical significance, but based on their potential socioeconomic impact. To avoid overadjustment, marital status was not included in the model, because married patients had a higher household income that patients who lived alone. Due to the observational nature of the study, no formal sample size calculation was performed, but all available patients with information on income were included. All hypothesis tests were two-sided, and the significance level was set at 5%. Statistical analyses were performed using STATA 14® (STATA Corp, College Station, TX, USA).

Medical Ethics Committee

The Medical Ethics Committee of Lausanne approved the study and all participants gave written informed consent to participation in the study.

Results

Overall, 52.2% (n = 133) of patients with ACS were in the low-income category, and 47.8% (n = 122) in the high-income category. A monthly household income of below CHF 3000 (€ 2560) was reported by 29(11.4%) of patients. This is close to the threshold of poverty in Switzerland, defined as below CHF 2500 (€ 2133.30). The baseline characteristics of the study population by income category are reported in table 1. Patients in the low-income category were older and more frequently men than those in the high-income category. Patients in the low-income category also had a lower level of education, more frequently lived

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alone, and worked full-time less frequently compared to patients in the high-income category.

One-year rates of ideal cholesterol management did not differ significantly between the two income categories, although there was a trend, with 82% achieving ideal cholesterol management for the high and 69.8% for the low-income category (age- and sex-adjusted OR 1.6, 95% CI 0.84–3.03, p = 0.15) (table 2 and fig. 1). In contrast, more patients in the high-income category reached blood pressure targets than in the low-income category (78.2% vs 60.2%, age- and sex-adjusted OR 2.37, 95%CI 1.25–4.52, p = 0.008). This association was slightly modified after further adjustment for education, living status and working status (multivariate-adjusted OR 2.19, 95% CI 1.09–4.41, p = 0.029). One year after hospital discharge, more baseline smokers in the high-income category had stopped smoking than in the low-income category (64.2% vs 30.1%, age- and sex-adjusted OR 4.74, 95% CI 2.13–10.59, p <0.001; multivariate-adjusted OR 3.82, 95% CI 1.58–9.24, p = 0.003). There were no differences in the rates of treatment adherence between the two income categories, with 88% for the high- and 84.9% for the low-income category (age- and sex-adjusted OR 1.08, 95% CI 0.49–2.38, p = 0.86; multivariate-adjusted OR 1.27, 95%CI 0.55–2.94, p = 0.58).

Visits to a primary care physician one year after acute coronary syndrome did not differ significantly between the two income categories, with 98.3% for the high- and 97.6% for the low-income category (p = 0.71) (table 3). In contrast, more patients in the high-income category visited a cardiologist than in the low-income category (96.6 vs 82.9%, p = 0.001). One year after hospital discharge, there was no significant difference for cardiac rehabilitation between the two income categories, with 79.8% for the high- and 72.6% for the low-income category (p = 0.19). There was no difference in use of hypertensive drugs between the two income categories, with 97.6% for the low- and 94% for the high-income category (p = 0.16).

Discussion

Among patients with ACS from a university hospital living in the French-speaking part of Switzerland, with universal health insurance coverage, we found that long-term control of cardiovascular risk factors was worse among patients with an income below the Swiss median compared to those

Table 1: Baseline characteristics by household income status (n = 255).

		Low income* (n = 133)	High income† (n = 122)	p-value
Demographics	Age, years	64.2 (13)	59.8 (10.4)	**0.004**
	Men, no. (%)	91 (68.4)	111 (91)	**<0.001**
	Caucasian, no. (%)	131 (98.5)	120 (98.4)	0.51
Education (n = 253)	High school or higher, no. (%)	29 (22.1)	56 (45.9)	**<0.001**
Marital status	Married, no. (%)	57 (42.9)	88 (72.1)	**<0.001**
Living status (n = 229)	Alone, no. (%)	53 (39.9)	18 (14.9)	**<0.001**
Working status (n = 253)	Full time, no. (%)	41 (30.8)	62 (51.7)	**0.003**
	Part time, no. (%)	16 (12)	11 (9.2)	
	Unemployed, no. (%)	76 (57.1)	47 (39.2)	
Health insurance	Monthly premium, CHF (n = 253)	425 (149)	416 (129)	0.63
	Low deductible‡, no. (%) (n = 247)	102 (80.9)	78 (64.5)	**0.004**
	Supplemental private, no. (%) (n = 154)	45 (54.2)	52 (73.2)	**0.015**
Smoking status	Never, no. (%)	41 (30.8)	44 (36.1)	0.33
	Former, no. (%)	23 (17.3)	26 (21.3)	
	Current, no. (%)	69 (51.9)	52 (42.6)	
Elevated alcohol use§, no. (%) (n = 248)		31 (24.0)	32 (26.9)	0.6
Low physical activity¶, no. (%) (n = 221)		20 (18.2)	15 (13.5)	0.34
Comorbidities	Hypertension‖, no. (%)	69 (51.9)	54 (44.3)	0.22
	Systolic blood pressure, mm Hg	134 (22)	130 (25)	0.2
	LDL cholesterol, mmol/l	3.2 (1.0)	3.5 (1.2)	0.08
	Diabetes**, no. (%)	23 (17.3)	16 (13.1)	0.35
	Obesity, no. (%)	26 (19.5)	26 (21.3)	0.73
	Depression††, no. (%) (n = 246)	36 (27.7)	27 (23.3)	0.42
Medication before hospitalisation	Statins, no. (%)	27 (20.3)	38 (31.2)	**0.047**
	High-dose statins, no. (%)	7 (5.3)	9 (7.4)	0.49
	Antihypertensive drugs, no. (%)	68 (51.1)	45 (36.9)	0.022

LDL = low density lipoprotein; MET = metabolic equivalent
Data are given as means (standard deviations) unless otherwise indicated.
* Low household income: CHF 6000 (€ 5120) or less.
† High household income: more than CHF 6000 (€ 5120).
‡ Defined as CHF 300 or 500 (€ 256 or 426.60), compared to CHF 1000, 1500, 2000 or 2500 (€ 853.30, € 1280, € 1706.60 or € 2133.30).
§ Defined as more than 14 units of alcohol per week.
¶ Defined as less than 500 MET-min per week.
‖ Defined as a systolic blood pressure ≥140 mm Hg, a diastolic blood pressure ≥90 mm Hg, or use of blood pressure lowering drugs.
** Based on patients' self-reporting, use of antidiabetic medication/insulin, or a haemoglobin A1c of ≥6.5%.
†† Defined as a score ≥16 on the 20 items Centre for Epidemiologic Studies Depression Scale (CES-D).

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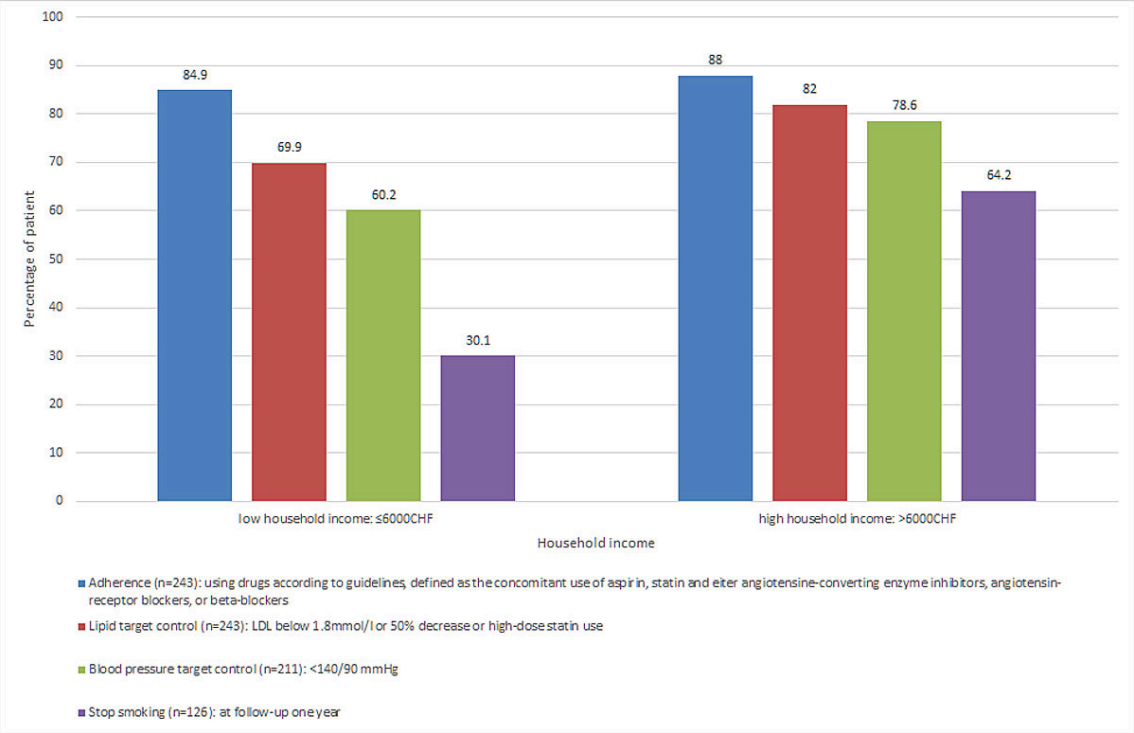
Figure 1: Association between income and control of cardiovascular risk factors one year after acute coronary syndrome.



with an income above the Swiss median. One year after hospital discharge for ACS, rates of smoking cessation and blood pressure control were lower among patients with a lower income than patients with a higher income, even after adjusting for other socio-demographic variables such as education, living status and working status.

Several studies have previously reported an association between socioeconomic status and cardiovascular outcomes among patients with pre-existing cardiovascular disease [7,

Table 2: One-year control of cardiovascular risk factors and household income

	n	Achieved target (n)	OR (95% CI)	p-value	R^2	Age- and sex-adjusted OR	p-value	R^2	Multivariate-adjusted OR*	p-value	R^2
Lipid target†	243										
Low income		88	1.00	NA		1.00	NA		1.00	NA	
High income		96	1.97 (1.08–3.62)	0.02	0.02	1.60 (0.84–3.03)	0.15	0.04	1.72 (0.86–3.45)	0.12	0.05
Blood pressure target‡	211										
Low income		65	1.00	NA		1.00	NA		1.00	NA	
High income		81	2.44 (1.33–4.48)	0.004	0.03	2.37 (1.25–4.52)	0.008	0.04	2.19 (1.09–4.41)	0.029	0.06
Stop smoking	126										
Low income		22	1.00	NA		1.00	NA		1.00	NA	
High income		34	4.15 (1.96–8.80)	<0.001	0.08	4.74 (2.13–10.59)	<0.001	0.11	3.82 (1.58–9.24)	0.003	0.16
Adherence§	243										
Low income		107	1.00	NA		1	NA		1.00	NA	
High income		103	1.31 (0.62–2.74)	0.48	0.003	1.08 (0.49–2.38)	0.86	0.02	1.27 (0.55–2.94)	0.58	0.05

CI = confidence interval; LDL = low density lipoprotein; NA = not available OR = odds ratio; R^2 = goodness of fit Low household income: CHF 6000 (€ 5120) or less; high household income: more than CHF 6000 (€ 5120). * Adjusted for age, sex, education, living status and working status. † LDL below 1.8 mmol/l, 50% decrease or high-dose statin use. ‡ Blood pressure <140/90 mm Hg. § Using drugs according to guidelines, defined as the concomitant use of aspirin, statin and either angiotensin-converting enzyme inhibitors, angiotensin-receptor blockers or beta-blockers.

Table 3: Quality of care measured one year after discharge, by household income

	Low income* (n = 133)	High income† (n = 122)	p-value
Visit to a primary care physician, no. (%) (n = 242)	122 (97.6)	115 (98.3)	0.71
Visit to a cardiologist, no. (%) (n = 240)	102 (82.9)	113 (96.6)	**0.001**
Cardiac rehabilitation, no. (%) (n = 238)	90 (72.6)	91 (79.8)	0.19
Use of hypertensive drugs, no. (%) (n = 243)	123 (97.6)	110 (94.0)	0.16
Use of statins, no. (%) (n = 243)	115 (91.3)	113 (96.6)	0.09
Use of aspirin, no. (%) (n = 243)	119 (94.4)	113 (96.6)	0.42

* Low household income: CHF 6000 (€ 5120) or less † High household income: more than CHF 6000 (€ 5120).

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9, 15]. These studies showed that patients with low socioeconomic status face worse cardiovascular outcomes and have a worse lifestyle compared to patients with a high socioeconomic status. However, only a few studies have examined the income of patients in the context of ACS [1, 3, 8, 9, 15, 16]. In these studies, the outcomes that were evaluated were mainly the recurrence of cardiovascular events or mortality, but not many studies reported comprehensive data on the control of cardiovascular risk factors. A previous study from Canada examined the association between income and one-year use of statins and antihypertensive drugs after ACS [1]. They found that patients with lower incomes had a lower use of statins and antihypertensive drugs one year after ACS compared to those with higher incomes. One study of healthy participants in the USA showed that among that group both income and education were independently associated with systolic blood pressure [16]. Consistent with these studies, we also found a worse one-year control of blood pressure in the low-income group compared to the high-income group, even though baseline levels of systolic blood pressure were not different. However, we did not find major differences in drug adherence between the two income categories one year after ACS. Therefore, it remains unclear whether patients in the high-income category better control their blood pressure through lifestyle changes or through optimal drug adherence.

We found that one-year smoking cessation was more commonly achieved by patients in the high-income category than those in the low-income category, even after adjustment for socio-demographic variables. Previous studies performed in the general population have reported a consistent association between income and smoking cessation rates [17, 18]. However, among patients with ACS, the specific role of income for smoking cessation has been studied less. Similar to our results, one previous study among patients with ACS from the USA found that smokers with higher household incomes had substantially higher odds of quitting than low-income smokers, but the follow-up duration was limited to eight months [17]. Among patients undergoing percutaneous coronary intervention, a study from Luxembourg found that smoking cessation was also significantly associated with income, but less than 20% of these patients had ACS [18]. Consistent with these studies, we also found a lower rate of smoking cessation in the low-income group than in the high-income group among ACS patients. Furthermore, we were able to demonstrate that income remained significantly associated with smoking cessation rates even after adjustment for education, living status and working status, thus demonstrating the specific role of income. The reason for this strong effect of income compared to social status or education remains unclear. It is possible that income better reflects social status and lifestyle than other parameters in today's society.

Our study has several limitations. Firstly, information on income was obtained using a self-reported questionnaire. Although most previous studies have examined outcomes with self-reported questionnaires rather than with administrative records, we cannot exclude a misclassification bias in our study [19, 20]. In fact, one review highlighted the many possible contributors to inaccurate reporting during the measurement of income in surveys [20]. However, in our study we measured household income rather than the income of individuals in order to take into account the family situation and to avoid someone claiming the income of the main earner as his or her own income. This is a strength of our approach. Secondly, we had a relatively small sample of ACS patients with income information available. Therefore, we could not examine the interactions between all confounding factors. Still, we were able to adjust our results for important social variables such as education, working status and living status. Furthermore, we examined the impact of income after an ACS in a country with universal health insurance, in which patients have access to health care independently of their income.

Conclusions

Among patients with ACS who have mandatory universal health insurance, the optimal control of cardiovascular risk factors one year after hospital discharge differed according to household income. Inequalities were evident for smoking cessation and blood pressure control, but not for the use of recommended drugs after ACS, or for attaining a lipid target. Universal health insurance coverage may limit the impact of income inequality regarding drug use after ACS, but not regarding changes in lifestyle and behaviour.

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Potential competing interests

TL has received research or educational grants and/or honoraria from AstraZeneca, Amgen, Daiichi-Sankyo, Sanofi and Novartis.

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Appendix 1

Supplementary data

Table S1: Income categories based on the original self-reported questionnaire (n = 255).

	Number	Percentage (%)
<CHF 3000 (<€ 2560)	29	11.4
CHF 3000 (€ 2560)	7	2.7
CHF 3000 to 4500 (€ 2560 to € 3840)	37	14.5
CHF 4500 (€ 3840)	8	3.1
CHF 4500 to 6000 (€ 3840 to € 5120)	52	20.4
CHF 6000 (€ 5120)	12	4.7
CHF 6000 to 9000 (€ 5120 to € 7680)	59	23.1
CHF 9000 (€ 7680)	6	2.4
>CHF 9000 (>€ 7680)	45	17.6

Table S2: One-year smoking cessation and household income, according to different scenarios for missing information.

	n	Achieved target (n)	OR (95% CI)	p-value	R^2	Age- and sex-adjusted OR	p-value	R^2	Multivariate-adjusted OR*	p-value	R^2
Stop smoking†	126										
Low income		22	1.00	NA		1.00	NA		1.00	NA	
High income		34	4.15 (1.96–8.80)	<0.001	0.08	4.74 (2.13–10.59)	<0.001	0.11	3.82 (1.58–9.24)	0.003	0.16
Stop smoking‡	126										
Low income		26	1.00	NA		1.00	NA		1.00	NA	
High income		37	4.18 (1.96–8.91)	<0.001	0.08	4.59 (2.07–10.18)	<0.001	0.10	4.15 (1.71–10.07)	0.002	0.15

CI = confidence interval; NA = not available OR = odds ratio; R^2 = goodness of fit
Low household income: CHF 6000 (€ 5120) or less; high household income: more than CHF 6000 (€ 5120).
* Adjusted for age, sex, education, living status and working status.
† considering the seven smokers with missing information for smoking cessation at one year as current smokers (worst case scenario).
‡ considering the seven smokers with missing information for smoking cessation at one year as non-smokers (best case scenario).

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