

Personality and smoking: individual-participant meta-analysis of nine cohort studies

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ABSTRACT

Aims To investigate cross-sectional and longitudinal associations between personality and smoking, and test whether socio-demographic factors modify these associations. **Design** Cross-sectional and longitudinal individual-participant meta-analysis. **Setting** Nine cohort studies from Australia, Germany, the United Kingdom and the United States. **Participants** A total of 79 757 men and women (mean age = 50.8 years). **Measurements** Personality traits of the five-factor model (extraversion, neuroticism, agreeableness, conscientiousness and openness to experience) were used as exposures. Outcomes were current smoking status (current smoker, ex-smoker and never smoker), smoking initiation, smoking relapse and smoking cessation. Associations between personality and smoking were modelled using logistic and multinomial logistic regression, and study-specific findings were combined using random-effect meta-analysis. **Findings** Current smoking was associated with higher extraversion [odds ratio per 1 standard deviation increase in the score: 1.16; 95% confidence interval (CI) = 1.08–1.24], higher neuroticism (1.19; 95% CI = 1.13–1.26) and lower conscientiousness (95% CI = 0.88; 0.83–0.94). Among non-smokers, smoking initiation during the follow-up period was predicted prospectively by higher extraversion (1.22; 95% CI = 1.04–1.43) and lower conscientiousness (0.80; 95% CI = 0.68–0.93), whereas higher neuroticism (1.16; 95% CI = 1.04–1.30) predicted smoking relapse among ex-smokers. Among smokers, smoking cessation was negatively associated with neuroticism (0.91; 95% CI = 0.87–0.96). Socio-demographic variables did not appear to modify the associations between personality and smoking. **Conclusions** Adult smokers have higher extraversion, higher neuroticism and lower conscientiousness personality scores than non-smokers. Initiation into smoking is associated positively with higher extraversion and lower conscientiousness, while relapse to smoking among ex-smokers is associated with higher neuroticism.

Keywords Cohort study, five-factor model, meta-analysis, personality, smoking.

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INTRODUCTION

Despite the known harmful effects of smoking on health [1], approximately 31% of men and 11% of women world-wide continue to smoke tobacco regularly [2]. In the United States, 67% of regular smokers have considered quitting smoking, and 52% had attempted to do so during the past year [3]. While there are many effective smoking cessation programmes, such as behavioural support and pharmacological treatments [4], people's attempts to quit smoking tend not to be successful over the long term [3,5].

Several psychological and social risk factors for smoking have been identified, including parental socio-economic status, parental smoking and peer smoking [6]. Previous research has also reported differences in personality characteristics—which refers to individual differences in feelings, thoughts and actions [7]—between smokers and non-smokers [8,9]. A meta-analysis of 25 published cross-sectional studies of extraversion and neuroticism (34 738 non-smokers and 12 764 smokers) reported that smokers had higher neuroticism and higher extraversion than non-smokers [10]. Another meta-analysis of

published cross-sectional studies on health correlates of conscientiousness ($n = 46\,725$) reported that smoking was more common among individuals with low compared with high conscientiousness [11]. In addition, a cross-sectional association between low agreeableness and current smoking was reported in a meta-analysis that was based on nine published studies ($n = 4730$) [12]. In sum, current smokers are characterized by high neuroticism, high extraversion, low agreeableness and low conscientiousness.

The role of personality in future smoking behaviours has also been examined. In prospective studies, high neuroticism has been shown to be associated with smoking initiation in some [13–15], but not in all studies [16]. Low conscientiousness has been shown to be associated with smoking initiation [13,16], while the evidence of the association between high openness to experience and smoking initiation is mixed with both positive and null findings [13,16]. Results from two small-scale smoking cessation programmes suggests that low neuroticism and low openness to experience may be associated with higher odds of smoking cessation [17,18], and that higher conscientiousness might predict abstinence from smoking [17].

In sum, the majority of studies on smoking and personality have been cross-sectional and have focused only on some of the personality traits of the five-factor model, instead of examining them all together. Even fewer longitudinal studies have assessed all the major dimensions of personality in relation to different smoking behaviours, including smoking initiation, relapse and cessation. These studies have been carried out with relatively small samples. Thus, large-scale studies are needed to establish robustness of the associations between personality and smoking behaviours. Furthermore, it remains unclear whether socio-demographic factors might modify the association between personality and smoking behaviour. For example, while some studies suggest that the association between personality and smoking is stronger among women than men [16], other studies report no gender differences [13,14]. The association between conscientiousness and smoking has been reported to be weaker among older compared with younger age groups [11], but this finding has not been replicated. Education has been linked to smoking behaviours [19], and it has been suggested that there is an interaction between education and personality on smoking [20]. In addition, the association of psychological distress (a concept closely related to high neuroticism) with smoking has been suggested to differ between ethnic groups [21]. However, further research is needed to clarify whether these socio-demographic characteristics are of importance in the relation between personality and smoking. Most previous studies have also not examined subgroup differences with regard to other smoking behaviours besides current smoking.

The aim of the present study was to examine associations between personality traits of the five-factor model (extraversion, neuroticism, agreeableness, conscientiousness and openness to experience) and smoking behaviour in cross-sectional and longitudinal settings. More specifically, we examined whether personality traits predict smoking initiation, smoking relapse and smoking cessation, and whether socio-demographic factors modify these associations. To achieve all this, we pooled data from nine large cohort studies for an individual-participant meta-analysis of 79 757 participants. Individual-participant meta-analysis is seen as the gold standard approach to evidence synthesis and it is an effective way to reduce the potential problem of publication bias [22], from which the previous meta-analyses based on published studies might suffer. Based on previous research we hypothesized that higher extraversion and neuroticism, and lower agreeableness and conscientiousness, would be related to higher probability of smoking and smoking initiation, smoking relapse and with lower probability of smoking cessation.

METHODS AND MATERIALS

Data were selected by searching the data collections of the Inter-University Consortium for Political and Social Research (ICPSR; <http://www.icpsr.umich.edu/icpsrweb/ICPSR/>) and the Economic and Social Data Service (<http://ukdataservice.ac.uk/>) to identify eligible large-scale cohort studies that have measurements of personality and smoking. To be eligible for inclusion, studies needed to be open-access data sets, have a sufficiently large sample size ($n > 1000$), had to include information on the participant's smoking status and personality assessed with at least the brief 15-item questionnaire or with more comprehensive questionnaires based on the five-factor model of personality.

The following cohort studies met the inclusion criteria: the National Longitudinal Study of Adolescent Health (Add Health), the British Household Panel Survey (BHPS), the German Socio-Economic Panel Study (GSOEP), the Household, Income and Labour Dynamics in Australia (HILDA) Survey, the Health and Retirement Study (HRS), the Midlife in the United States (MIDUS), the National Child Development Study (NCDS) the Wisconsin Longitudinal Study graduate (WLSG) sample and the Wisconsin Longitudinal Study Sibling (WLSS) sample. All these studies are well-characterized longitudinal cohort studies with large sample sizes. However, Add Health and NCDS did not have follow-up data on smoking after the assessment of personality, and thus these cohort studies were included only in cross-sectional analyses. All the cohort studies were approved by the relevant local ethics committees. Full details of the cohort studies and used measures are provided in the online Supporting information.

Measures

The five-factor model personality traits were assessed with standardized questionnaire instruments. These instruments measure the following five higher-order personality traits that sum up individual variation in several, more precise, personality dispositions: extraversion (e.g. sociability and sensitivity to positive emotions), neuroticism (e.g. low emotional stability and proneness to anxiety), agreeableness (e.g. cooperativeness and trust towards other people), conscientiousness (e.g. self-control and allegiance to social norms) and openness to experience (e.g. curiosity and open-mindedness) [23].

Current smoking at baseline was measured with different questions across cohort studies that were categorized as follows: 0 = never-smoker; 1 = ex-smoker; and 2 = current smoker. At the follow-up, the same procedure was followed, except that current smoking was categorized as follows: 0 = non-smoker; and 1 = current smoker. Socio-demographics were harmonized across cohort studies as follows: marital status (0 = single, 1 = married/cohabiting), race/ethnicity (0 = white, non-Hispanic; 1 = other) and educational level (0 = primary education, 1 = secondary education, 2 = tertiary education).

Statistical analysis

Cross-sectional associations between personality traits and current smoking in the total sample and within different subgroups were examined using multinomial logistic regression (0 = never-smoker; 1 = ex-smoker; 2 = current smoker), where never-smokers were used as a comparison group. Odds ratios (ORs) were calculated for personality Z-scores [standard deviation (SD) = 1]. Longitudinal associations between personality traits and smoking were analysed in three separate analyses. First, the association between personality traits and smoking initiation among never-smokers was examined. Secondly, the association between personality traits and smoking relapse among ex-smokers was investigated. Thirdly, the association between personality traits and smoking cessation among baseline smokers was examined. All models were adjusted for sex, age at baseline and ethnicity/nationality. Longitudinal analyses were further adjusted for follow-up period in months.

To examine whether the association between personality traits and smoking behaviours differed between socio-demographic groups, we carried out stratified analyses by sex (men versus women), age groups (under 40 years, 40–65 years or > 65 years), marital status (single versus married/cohabiting), race/ethnicity (white versus other) and educational level (primary, secondary or tertiary education). The study-specific results were then pooled together by subgroup using meta-analysis and then

heterogeneity across subgroups was examined using the I^2 statistic. In addition to these subgroup analyses, longitudinal analyses were conducted separately according to the length of follow-up [i.e. short (4 years or less on average) versus long (4 years or more on average)] to examine whether the follow-up time would moderate the association between personality and smoking behaviours.

Meta-analysis was performed using the two-step approach; all models were first fitted separately within each cohort study and the results from the individual cohort studies were then pooled together by using random-effects meta-analysis. Heterogeneity in the effect sizes was examined using the I^2 estimates. Additional sensitivity analyses were performed to examine whether covariates and their interactions with personality traits explained heterogeneity. Sensitivity analyses were performed by first pooling all data together, and then using one-step individual-participant meta-analysis (i.e. logistic multi-level mixed-effects regression analysis). Meta-analysis was performed with the *metan* package of Stata version 13.1 software (StataCorp LP, College Station, TX, USA) and the sensitivity analyses were performed using the R package *lme4* [24].

RESULTS

The total sample included 79 757 participants (age range 15–104, mean age 50.8 years) and 52 684 participants were included in the longitudinal analysis (follow-up mean: 5.2 years; follow-up range: from 15 months to 157 months). Characteristics of the samples are presented in Table 1.

Current smoking status

Cross-sectional analyses, where the association between personality and current smoking status was examined, are presented in Fig. 1. Higher extraversion [pooled OR = 1.16; 95% confidence interval (CI) = 1.08–1.24] and higher neuroticism (OR = 1.19; 95% CI = 1.13–1.26) were associated with an increased risk of smoking. These associations, however, were not consistent across studies ($I^2 = 90%$ for extraversion; $I^2 = 87%$ for neuroticism), suggesting high heterogeneity between studies (Supporting information, Fig. S1). In addition, lower conscientiousness was associated with lower likelihood of smoking (pooled OR = 0.88; 95% CI = 0.83–0.94), which was also not consistent across individual studies ($I^2 = 90%$).

Similar results were found when ex-smokers were compared with never-smokers; higher extraversion (pooled OR = 1.13; 95% CI = 1.08–1.17), higher neuroticism (OR = 1.13; 95% CI = 1.07–1.19) and lower conscientiousness (pooled OR = 0.93; 95% CI = 0.90–0.97) were associated with an increased likelihood of being an ex-smoker. In addition, lower agreeableness (pooled

Table 1 Descriptive characteristics of the nine cohort studies.

	Add Health	BHPS	GSOEP	HILDA	HRS	MIDUS	NCDS	WLSG	WLSS
Participants									
Cross-sectional	5010	10 456	14 075	10 980	13 822	6259	8674	6566	3905
Longitudinal	–	8979	10 052	8379	12 590	4634	–	5230	2820
Follow-up time (months)	–	36.1 (1.2)	48.1 (1.6)	48.0 (1.3)	35.3 (16.0)	107.5 (6.3)	–	134.0 (4.2)	135.8 (6.7)
Age	29.0 (1.8)	47.3 (17.7)	50.4 (16.1)	43.7 (17.9)	67.2 (10.4)	46.8 (12.9)	50.3 (0.5)	54.1 (0.5)	53.1 (7.3)
Sex									
Men	45.9 (2299)	45.8 (5695)	47.1 (6628)	46.8 (5135)	40.7 (5635)	47.5 (2971)	48.2 (4181)	46.4 (3044)	46.7 (1824)
Women	54.1 (2711)	54.2 (5666)	52.9 (7447)	53.2 (5845)	59.3 (8197)	52.5 (3288)	51.8 (4493)	53.6 (3522)	53.3 (2081)
Education									
Primary	33.4 (1675)	28.5 (2983)	15.8 (2,190)	34.4 (3,780)	18.5 (2,563)	8.7 (545)	18.3 (1591)	–	5.2 (204)
Secondary	53.6 (2683)	57.1 (5963)	63.9 (8854)	44.4 (4874)	55.2 (7633)	59.3 (3704)	61.6 (5340)	72.0 (4730)	64.1 (2504)
Tertiary	13.0 (652)	14.3 (1505)	20.3 (2808)	21.2 (2326)	26.2 (3622)	32.0 (1997)	20.1 (1743)	28.0 (1836)	30.7 (1197)
Nationality/ethnicity									
Majority	72.0 (3608)	92.7 (9692)	92.9 (13 076)	79.2 (8701)	78.0 (10 791)	88.9 (5567)	98.0 (8498)	100.0 (6566)	100.0 (3905)
Minority	28.0 (1402)	7.3 (764)	7.1 (999)	20.8 (2279)	22.0 (3041)	11.1 (692)	2.0 (176)	–	–
Marital status									
Married/cohabiting	41.5 (2081)	54.5 (5695)	65.5 (9216)	59.3 (6514)	63.9 (8839)	67.7 (4234)	69.9 (6064)	83.2 (5462)	80.9 (3135)
Single	58.5 (2929)	45.5 (4759)	34.5 (4859)	40.7 (4466)	36.1 (4990)	32.3 (2022)	30.1 (2610)	16.8 (1103)	19.1 (738)
Baseline smoking									
Never-smoker	54.6 (2737)	44.6 (4664)	48.1 (6767)	50.4 (5529)	43.2 (5972)	48.7 (3051)	47.0 (4079)	45.5 (2990)	44.3 (1729)
Ex-smoker	12.3 (615)	22.9 (2397)	25.0 (3512)	28.7 (3152)	43.6 (6034)	29.5 (1844)	31.2 (2708)	36.7 (2412)	38.6 (1506)
Smoker	33.1 (1658)	32.5 (3395)	27.0 (3796)	20.9 (2299)	13.2 (1826)	21.8 (1364)	21.8 (1887)	17.7 (1164)	17.2 (670)
Follow-up smoking									
Non-smoker	–	74.2 (6661)	75.2 (7559)	50.9 (4268)	43.5 (5478)	51.2 (2374)	–	74.9 (3917)	74.4 (2099)
Ex-smoker	–	–	–	31.9 (2675)	45.3 (5707)	33.6 (1556)	–	18.5 (968)	18.3 (517)
Smoker	–	25.8 (2318)	24.8 (2493)	17.1 (1436)	11.2 (1405)	15.2 (704)	–	6.6 (345)	7.2 (204)

Because of missing data in covariates, numbers of covariate frequencies may not add up to the total number of participants with personality and baseline smoking data. Add Health = National Longitudinal Study of Adolescent Health; BHPS = British Household Panel Survey; GSOEP = German Socio-Economic Panel Study; HILDA = Household, Income and Labour Dynamics in Australia; HRS = Health and Retirement Study; MIDUS = Midlife in the United States; NCDS = National Child Development Study; WLSG = Wisconsin Longitudinal Study Graduate Sample; WLSS = Wisconsin Longitudinal Study Sibling Sample

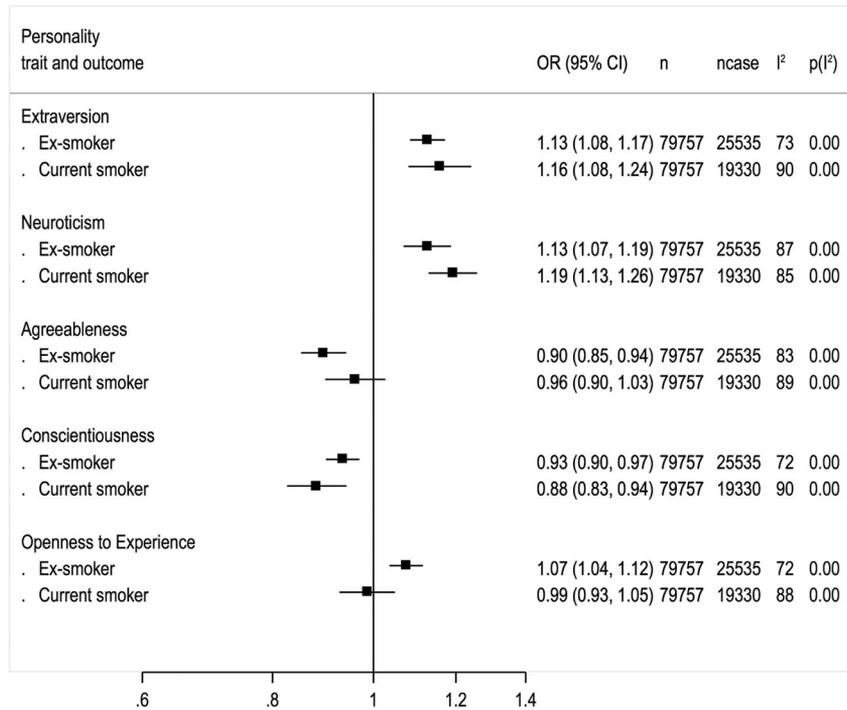


Figure 1 Cross-sectional associations between personality traits and current smoking status at the baseline. Values are odds ratios per 1 standard deviation increment in personality trait. Personality traits are adjusted for each other in addition to sex, age and race/ethnicity

OR = 0.90; 95% CI = 0.85–0.94) and higher openness to experience (OR = 1.07; 95% CI = 1.04–1.12) were also associated with an increased likelihood of being an ex-smoker. However, I^2 values suggested that there was high heterogeneity in the associations across studies (I^2 values between 72 and 90%; for study-specific associations see Supporting information, Fig. S2). Although individual studies suggested some statistically significant cross-sectional associations for agreeableness and openness to experience, the meta-analysis suggested no pooled associations for these two traits.

Smoking initiation, relapse and cessation

Figure 2 presents the associations of the personality traits with (1) smoking initiation among baseline non-smokers, (2) smoking relapse among baseline ex-smokers and (3) smoking cessation among baseline smokers. Higher extraversion (pooled OR = 1.22; 95% CI = 1.04–1.43) and lower conscientiousness (pooled OR = 0.80; 95% CI = 0.68–0.93) were associated consistently with higher odds of smoking initiation (Supporting information, Fig. S3). Higher neuroticism (pooled OR = 1.16; 95% CI = 1.04–1.30) was associated with higher odds of smoking relapse among ex-smokers (Supporting information, Fig. S4). Higher neuroticism was associated consistently with lower odds of smoking cessation among those who smoked at baseline (pooled OR = 0.91; 95% CI = 0.87–0.96) (Supporting information, Fig. S5).

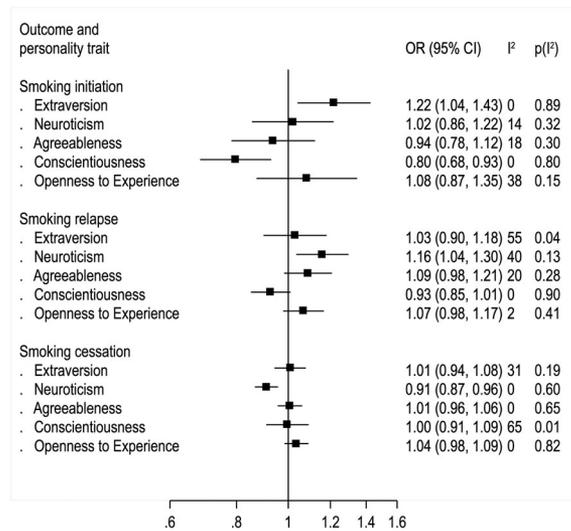


Figure 2 Longitudinal associations between personality traits and smoking initiation, smoking relapse among non-smokers at the baseline and smoking cessation among smokers at the baseline. Values are odds ratios per 1 standard deviation increment in personality trait. Personality traits are adjusted for each other in addition to sex, age, race/ethnicity and follow-up time

Subgroup and sensitivity analyses

Cross-sectional subgroup analyses between personality traits and current smoking status are presented in Supporting information, Tables S1 and S2. No significant sources of heterogeneity, which would explain the large heterogeneity found in the main analysis, were found in

subgroup analyses. However, the associations between extraversion and neuroticism with smoking at baseline did not remain statistically significant among participants aged more than 65 years (OR = 1.02; 95% CI = 0.87–1.17; OR = 1.07; 95% CI = 0.93–1.21, respectively).

Longitudinal subgroup analyses between personality traits and smoking initiation, smoking relapse and smoking cessation are presented in Supporting information, Tables S3–5, respectively. The earlier subgroup findings between personality traits and smoking at baseline were not replicated in the longitudinal subgroup analyses. However, high extraversion predicted smoking relapse only among studies with long follow-up (OR = 1.20; 95% CI = 1.01–1.42), whereas high agreeableness predicted smoking relapse among studies with short-follow-up (OR = 1.17; 95% CI = 1.05–1.31).

Additional sensitivity analyses suggested that results from the two- and one-step individual participant meta-analysis were similar (Supporting information, Table S6). Observed heterogeneity between studies in the association between neuroticism and relapse was reduced 94% when moderators and interactions between personality traits and moderators were included in the one-step multi-level logistic regression model.

DISCUSSION

In an individual-participant meta-analysis of nine cohort studies, higher neuroticism, higher extraversion and lower conscientiousness were associated with increased probability of smoking. However, whereas higher extraversion and lower conscientiousness were associated with smoking initiation, only high neuroticism was associated with smoking relapse, indicating that personality is associated differently with smoking initiation and relapse. Among those smoking at baseline, smoking cessation was predicted by lower neuroticism, but not by extraversion or conscientiousness.

Many of the present results are in agreement with previously published data. In a meta-analysis of 25 published cross-sectional studies (total $n > 47\,000$) investigating extraversion and neuroticism, smoking was associated with higher neuroticism and higher extraversion [10]. The effect size for extraversion was larger in the previously published meta-analysis (OR = 1.41; 95% CI = 1.29–1.57; transformed from Cohen's $d = 0.19$; 95% CI = 0.14–0.25) compared with our current study (pooled OR = 1.16; 95% CI = 1.08–1.24). Similarly, the effect size for neuroticism was slightly larger (OR = 1.24; 95% CI = 1.08–1.44; transformed from Cohen's $d = 0.12$; 95% CI = 0.04–0.20) than that observed in our present study (pooled OR = 1.19; 95% CI = 1.13–1.26). In another meta-analysis of published studies examining health correlates of conscientiousness, ($n = 47\,000$), higher conscientiousness was

associated with lower likelihood of smoking [11]. Again, the effect size was considerably larger in this meta-analysis (OR = 0.60; 95% CI = 0.58–0.62; transformed from a correlation based effect size $r = -0.14$; 95% CI = -0.13 to -0.15) compared with our current study (pooled OR = 0.88; 95% CI = 0.83–0.94). However, whereas a previous meta-analysis with 4730 participants found an association between low agreeableness and current smoking, this association was not found in the current study [12]. In addition, contrary to prior longitudinal evidence [13–16], neuroticism and openness to experience were not associated with smoking initiation.

The effect sizes tended to be lower in our analyses than in the two previous meta-analyses [10,11]. For example, the effect estimate for the association between conscientiousness and smoking was 32% lower in our study compared with the earlier meta-analysis based on published studies [11]. Several reasons might explain why our results differed in terms of magnitude from those in previous meta-analyses [10,11]. First, meta-analyses based on published data can be affected by publication bias, which is caused by selective publishing of positive findings, and can artificially inflate effect estimates [25]. In the current study, data were obtained from two public databases and the analyses were preplanned, thus the final results were not influenced by the results from individual cohort studies. This procedure is likely to reduce the problem of selectively publishing significant findings only. Indeed, similar differences between published and unpublished studies have been also found in previous independent data analysis (IPD) meta-analyses of psychosocial factors and health [26], including the association between personality and all-cause mortality [27].

Our analyses indicated that there was heterogeneity in the results between the cohort studies. Some heterogeneity can be naturally expected, as included cohort studies were from different countries and used different sampling methods. However, our sensitivity analyses suggested that observed between-study heterogeneity in the neuroticism–smoking relapse association was reduced substantially when moderators and interactions between personality traits and moderators were included in the sensitivity analyses. Thus, it is likely that the subgroup differences are of importance in individual cohort studies, but they are not so consistent that they would be seen at the meta-analytical level. However, it is also likely there are, for example, some socio-cultural and biological factors, which we were not able to measure, that could explain the observed heterogeneity across studies. Further research is needed to identify these factors.

Different psychological processes may underlie smoking initiation, smoking relapse and smoking cessation [28–30]. Our findings show that personality is also associated differentially with some of these smoking behaviours; higher extraversion and lower conscientiousness were associated with smoking initiation, whereas lower neuroticism was

associated with smoking cessation and higher neuroticism was associated with smoking relapse. These findings are plausible. High extraversion is related to sensation-seeking and sociability, and as smoking is often a social activity, individuals with higher extraversion might start smoking and smoke more just because they are more social. High neuroticism, in turn, reflects low emotional stability and high proneness to anxiety and stress. Given that smoking may represent a strategy to relieve stress [31], the stress-proneness and higher levels of negative emotions among neurotic individuals may explain their higher odds of smoking relapse. We also found that high neuroticism was associated with a lower likelihood of smoking cessation. This may also be related to their stress-proneness. Furthermore, smoking cessation introduces withdrawal symptoms, and these symptoms may be experienced more strongly by individuals with high neuroticism.

Previous individual-participant meta-analyses have identified conscientiousness as the central health-related personality trait. Low conscientiousness has been found to predict obesity [32], diabetes [33], cardiovascular disease and stroke [34] and all-cause mortality [27], and many unfavourable health behaviours [11,35]. Cancer appears to be one of the few health outcomes that is not predicted by low conscientiousness—or by any other personality trait [36]. High conscientiousness reflects good self-control and capacity for long-term planning, so the lower smoking behaviour associated with conscientiousness is likely to reflect the greater adherence to a healthy life-style and public health recommendations.

There have been repeated calls to include personality information in health behaviour interventions [37,38]. Our results suggest that although the magnitude of the personality–smoking relationship might be smaller than reported previously, personality is associated clearly with smoking behaviour. In particular, increased attention and support to individuals high on the personality dimension neuroticism could improve the outcome of smoking cessation interventions. A recent study suggests that interventions targeted to adolescents who display high anxiety sensitivity and hopelessness (i.e. high neuroticism) may be effective in preventing and reducing problematic drinking [39]. Our findings imply that this could also be the case in interventions promoting smoking cessation. In addition, as neuroticism is related to depressive symptoms [40,41] and depression is highly comorbid with smoking [42], personality-informed interventions to reduce smoking could also support those with depressive symptoms. Further research should also investigate whether the success in current smoking cessations programmes vary depending on individuals' personality dispositions.

Some methodological limitations need to be acknowledged. Smoking status was self-reported, which might lead to the underestimation of smoking prevalence [43].

It is possible, for example, that individuals classified as ex-smokers were smokers a relatively long time ago, or that current smokers respond as being ex-smokers due to social desirability. The study cohort included mainly middle-aged Caucasian participants, and thus the results might not be generalizable to other ethnic groups. The current study also contained relatively few initiators, which might bias the results. Although the five-factor model is one of the most-used conceptualizations of personality structure and has considerable empirical support [7], it has also been criticized; its structure and usefulness at the individual level has been questioned [44] and it has also been seen to be too broad to capture all the possible variation in personality traits [45]. Personality was measured with different instruments of the five-factor traits in different cohort studies, which could have introduced heterogeneity in the associations. However, different instruments of the five-factor traits have been shown to correlate strongly with each other, suggesting that this may not have been a major source of heterogeneity in the current meta-analysis [7,46].

In conclusion, this individual-participant meta-analysis showed that high extraversion, high neuroticism and low conscientiousness are associated with smoking behaviour, although the effect sizes were lower than those reported in previous meta-analyses, which were based on published data. Smoking cessation was predicted only by low neuroticism, suggesting that behavioural, emotional and cognitive dispositions related to this personality dimension may be particularly relevant for interventions.

Declaration of interests

None.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher’s web-site:

Table S1 Subgroup analyses of cross-sectional associations between personality traits and smoking at the baseline.

Table S2 Subgroup analyses of cross-sectional associations between personality traits and being an ex-smoker at the baseline.

Table S3 Subgroup analyses of longitudinal associations between personality traits and smoking initiation.

Table S4 Subgroup analyses of longitudinal associations between personality traits and smoking relapse.

Table S5 Subgroup analyses of longitudinal associations between personality traits and smoking cessation.

Table S6 Comparison of the two-step and one-step individual participants meta-analysis results.

Figure S1 Cross-sectional associations between the five-factor model personality traits and smoking at the baseline. Values are odds ratios per 1 standard deviation increment in personality trait.

Figure S2 Cross-sectional associations between the five-factor model personality traits and being an ex-smoker at the baseline.

Figure S3 Longitudinal associations between the Five-Factor Model personality traits and smoking initiation among non-smokers at the baseline.

Figure S4 Longitudinal associations between the five-factor model personality traits and smoking relapse among never-smokers at the baseline.

Figure S5 Longitudinal associations between the five-factor model personality traits and smoking cessation among smokers at the baseline.