

BMJ Open Motivation to stop smoking in the German population between 2016 - 2021 and associated factors: results from a repeated cross-sectional representative population survey (German Study on Tobacco Use, DEBRA study)

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ABSTRACT

Objectives We aimed to describe population trends in motivation to stop smoking between 2016 and 2021 in Germany. Furthermore, the aim was to estimate to what extent higher ratings on the validated German version of the Motivation To Stop Scale (MTSS) are associated with sociodemographics, nicotine dependence, past quit attempts, and use of e-cigarettes and tobacco product alternatives.

Methods We used data from the German Study on Tobacco Use: an ongoing repeated cross-sectional face-to-face household survey collecting representative data of the German population every other month since 2016. We analysed data from 18 969 adult current smokers with multivariable ordinal regression and described MTSS scores between 2016 and 2021 (scores 1–7=lowest to highest level of motivation).

Results The mean MTSS score was 2.04 (SD=1.37) and showed a slight downward trend over time. Younger age, higher level of education, fewer cigarettes per day, more time spent with urges to smoke, a recent quit attempt, no previous waterpipe use and current or past e-cigarette use were associated with higher MTSS scores. The largest effect estimates were observed for at least one quit attempt 0–6 months ago versus no attempt in the past year (OR=7.54; 95% CI 6.78 to 8.40), at least one quit attempt 7–12 months ago versus no attempt in the past year (OR=4.00; 95% CI 3.59 to 4.45) and for current versus never use of e-cigarettes (OR=1.71; 95% CI 1.48 to 1.99).

Conclusions Recent quit attempts and current use of e-cigarettes were associated with higher motivation to stop smoking in the German population. Actions to boost the general motivation to stop smoking are required.

INTRODUCTION

Smoking prevalence in Germany has remained high with presently more than 30% of persons aged 14 and older reporting that they currently smoke tobacco.¹ Initiating

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Our study sample was large and consisted of representative data collected over repeated survey waves.
- ⇒ The outcome measure—motivation to stop smoking—was measured on a validated scale, which covers motivation fully.
- ⇒ A study and analysis plan was preregistered before conducting the data analysis.
- ⇒ This is a cross-sectional study which cannot assess causality or temporality of the identified associations.

smoking cessation requires at least some degree of motivation according to the COM-B (Capability-Opportunity-Motivation-Behaviour) model of behaviour, as per which behaviour is induced by the interaction of capability, opportunity and motivation.^{2–3} Smokers with higher motivation to stop are more likely to attempt quitting within the near future.⁴ Assessing smokers' motivation to stop could have several benefits. For instance, smokers who are the least motivated to stop could be addressed with targeted interventions to enhance motivation to stop smoking.

Motivation can be conceptualised with the PRIME (Plans-Responses-Impulses-Motives-Evaluations) theory and plays a major part for behaviour to occur. This theory combines different aspects of motivation into one theoretical concept.³ Among individual factors associated with a higher motivation to stop are low or light smoking,⁵ lower nicotine dependence and a higher number of past quit attempts.⁶ Some studies also indicated

that motivation to stop might be higher in women^{7,8} and younger smokers.^{6,8,9} Motivation to stop possibly differs according to socioeconomic status as well, as in some studies, a higher social grade⁸ and better education⁹ were positively associated with an enhanced motivation. Due to the rising prevalence of electronic cigarette (e-cigarette) utilisation¹⁰ and their frequent usage as a quitting aid,¹¹ the question has elicited interest as to whether or not e-cigarette consumers might be more motivated to stop tobacco smoking. Results, so far, have not been consistent.^{8,12} Data concerning motivation to stop tobacco smoking among consumers of tobacco product alternatives like heated tobacco products (HTP) and waterpipe are sparse.

Measuring motivation to stop smoking on a population level is useful to monitor the effectiveness of tobacco control implementations. Trajectories of overall motivation to stop in a population have been analysed for European countries like Switzerland and Greece, showing an increase over time, but these studies only included two and three measurement points to cover a time span of 10 (1996–2006) and 5 (2006–2011) years, respectively.^{13,14} To our knowledge, recent trends in the average motivation to stop among smokers in the German population are unknown.

Representative data regarding associations of motivation to stop with sociodemographics and smoking behaviour in the population of Germany are also lacking. In addition, most international studies on correlations with motivation to stop focused solely on intentions to stop, which does not represent the concept of motivation comprehensively.³ When motivation to stop was investigated, it is still difficult to compare research results since most studies used different measures to assess motivation.^{4,6,15,16} The Motivation To Stop Scale (MTSS) is a single-item measure for motivation to stop based on the PRIME theory, which maps motivation fully combining its different aspects (intention, belief, desire).^{3,17,18} The MTSS has been shown to be valid in predicting quit attempts in the UK,¹⁷ in the Netherlands¹⁹ and in Germany.¹⁸ A higher level of motivation was associated with a higher probability of at least one quit attempt in the following 12 (UK) or 6 months (Netherlands and Germany).

The aim of our study was twofold. First, we aimed to describe population trends in motivation to stop in Germany between 2016 and 2021. Second, we aimed to estimate to what extent current smokers' motivation to stop smoking is associated with sociodemographics, nicotine dependence, past quit attempts and use of e-cigarettes and tobacco product alternatives in a representative sample of the adult population in Germany.

METHODS

Study population

We used data from the German Study on Tobacco Use (DEBRA), an ongoing repeated cross-sectional household survey on use of tobacco and alternative nicotine

delivery products in Germany. Since June 2016, we have been collecting representative population data every other month using computer-assisted face-to-face household interviews of people (2000 per wave) aged 14 and older. Details of the study and sampling strategy were published in the study protocol.²⁰ Multistage, multistratified random probability sampling was applied to select respondents from wave 1 (June/July 2016) to wave 21 (October/November 2019). Starting with wave 22 (January 2020), respondents have been selected by using a dual frame design: a composition of random stratified sampling (50% of the sample) and quota sampling (50% of the sample). This switch of the sampling design has been described in detail elsewhere (<https://osf.io/s2wxc/>). The study questionnaire is available online (<https://osf.io/jq935/>).

All current tobacco smokers of the DEBRA study database aged 18 and older from wave 1 up to wave 33 (November 2021) were selected (n=19 257, 29.5%) from 65 317 adults interviewed in total, 407 (0.6%) did not report on smoking status. Tobacco smoking included smoking of cigarettes, cigars, pipe but not e-cigarettes and HTP. Among those, respondents to the MTSS were eligible for analysis (n=18 969, hereafter referred to as the full sample). Although the MTSS has been externally validated for adolescents aged 14–17 (inclusive) in Germany,¹⁸ attempts to stop smoking and smoking cessation are presumably far less prevalent in this age group. Therefore, we focused on adult tobacco smokers, but repeated all analyses for respondents aged 14–17 (inclusive). The adapted methodology and results of this subgroup analysis are outlined in online supplemental materials only.

The DEBRA study is registered in the German Clinical Trial Register (registration numbers DRKS00011322, DRKS00017157 and DRKS00028054).

Measures

Dependent variable

The dependent variable for our analyses was motivation to stop smoking, measured by the validated German version of the MTSS (see box 1).¹⁸ In the MTSS, motivation is rated on a 7-level scale, each presenting a different level of motivation, from the absence of motivation (level 1) to a strong desire and short-term intention to quit (level 7), to form an ordinal scale.¹⁷

Independent variables

Variables evaluated were age as a continuous variable for the regression analysis and as a categorical variable (18–24, 25–44, 45–64 and 65+) for the description of trends. Furthermore, we used gender as a categorical variable (male or female) and level of education as a categorical variable (low (9 years of education or no graduation), middle (10–11 years of education) or high (≥ 12 years of education)) for both analyses. Another variable included was income as a continuous variable of net household income (adjusted for household size

Box 1 The Motivation To Stop Scale (MTSS)

We asked all tobacco smokers: 'Which of the following describes you?' The response categories were (interpretation in parenthesis):

1. I don't want to stop smoking (absence of any belief, desire or intention).
2. I think I should stop smoking but don't really want to (belief only).
3. I want to stop smoking but haven't thought about when (moderate desire but no intention).
4. I REALLY want to stop smoking but I don't know when I will (strong desire but no intention).
5. I want to stop smoking and hope soon (moderate desire and intention).
6. I REALLY want to stop smoking and intend to in the next 3 months (strong desire and medium-term intention).
7. I REALLY want to stop smoking and intend to in the next month (strong desire and short-term intention).

and composition rounded to the nearest 1000 Euros and coded as 0 to 7=highest income) for the regression analysis and as a categorical variable for the description of trends. Income was adapted using an equalisation technique (OECD-modified equivalence scale) of the Organisation for Economic Co-operation and Development (OECD) to take different household sizes and compositions into account and calculate net household income per capita. Details of the adjustment process are found elsewhere (<https://osf.io/387fg>). Regarding income as a categorical variable, we constructed groups to roughly achieve a 20%–60%–20% distribution using the following categories: low (0 € and <1000 €), middle (≥1000 € and <2000 €) and high (≥2000 €).

Independent variables solely included in the regression analysis were number of cigarettes smoked per day as a continuous variable, recent quit attempts as a categorical variable (no attempt in the past 12 months, at least one attempt 7–12 months ago or at least one attempt 0–6 months ago), time spent with urges to smoke as a continuous variable (1 (not at all) to 6 (all the time)), strength of urges to smoke as a continuous variable (0 (no urges) to 5 (extremely strong urges))²¹ and use of e-cigarettes as a categorical variable (never, ex-experimental, ex-regular or current use).

An exception was an additional subsample analysis of the secondary aim (using data from wave 13 up to wave 33, n=12 353, hereafter referred to as the subsample), which included HTP and waterpipe use. For these two variables, the relevant questions were added to the DEBRA study database from wave 13 onwards. Use of HTP (never, ex-experimental, ex-regular or current use) and use of waterpipe (never, ex-experimental, ex-regular or current use) were included as categorical variables.

Statistical analysis

Prior to all statistical analyses, we preregistered a study and analysis protocol on the Open Science Framework (<https://osf.io/qn6ts/>) with a detailed outline of the applied methods. Data used for our first research aim

(description of trends) were weighted accounting for personal and household characteristics, in order to achieve representativeness of the population of Germany. The weighting process has been described in detail elsewhere.²⁰ For our regression analysis, unweighted data were used.

For the description of trends, we calculated and presented the mean MTSS score for each survey wave including 95% CIs. These were compared descriptively for all tobacco smokers and stratified by gender, age, income and education. We calculated linear trend lines additionally.

Associations between independent variables and the MTSS were tested using multivariable ordinal regression analyses for the full sample and subsample in two separate regression models, one for each sample with all independent variables added to the model simultaneously. Year of the survey as a categorical variable was added as a design factor to control for potential confounding. Ordinal regression analyses were chosen instead of linear regression, since the likelihood to predict a future quit attempt did not show a clear linear but still an ordinal trend as a function of the MTSS. Prior examination of the proportional odds assumption revealed a violation in the full study sample ($p<0.001$) but not in the subsample ($p=0.091$). Due to the relatively large sample size, minor violations may have possibly lead to a statistically significant result. Hence, as intended and outlined in our analysis protocol, we descriptively compared the ORs obtained by dichotomising the MTSS at increasingly higher levels (ie, 1: level 1 vs levels 2–7; 2: 1–2 vs 3–7; etc) and performing six separate logistic regression analyses. ORs for each explanatory variable were similar. We, therefore decided to stick with the ordinal regression model.

To check for the effect of missing data, we ran a sensitivity analysis by imputing missing values of the MTSS and all independent variables. Overall, the amount of missing values was low, exceeding 5% only in the variable numbers of cigarettes smoked per day. Using multiple imputation, we created 25 imputed datasets in IBM SPSS Statistics V.27.0 with all independent variables and the dependent variable serving as predictors. Rubin's rule was used to combine the results of regression analyses across the imputed datasets.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Sample characteristics

Baseline characteristics of the total sample of adult tobacco smokers are depicted in [table 1](#). The sample had a mean age of 47.0 years (SD=16.5) and 13.7 cigarettes were smoked on average per day (SD 8.1). The majority had not tried to quit smoking in the past 12 months

Table 1 Sample characteristics in total and by level of motivation to stop smoking (all adult tobacco smokers*, unweighted data)

	All smokers (n=19 257†)	MTSS level 1 (n=9255)	MTSS level 2 (n=5190)	MTSS level 3 (n=1994)	MTSS level 4 (n=595)	MTSS level 5 (n=1554)	MTSS level 6 (n=208)	MTSS level 7 (n=173)
Age in years, mean (SD)	47.0 (16.5)	47.9 (16.8)	47.7 (16.2)	43.5 (15.7)	44.3 (15.5)	45.7 (15.5)	45.5 (15.7)	43.8 (16.5)
Gender								
Men	53.6 (10,317)	55.0 (5,085)	52.4 (2,719)	51.8 (1,032)	53.3 (317)	51.5 (800)	49.5 (103)	52.6 (91)
Women	46.4 (8,937)	45.0 (4,168)	47.6 (2,471)	48.2 (961)	46.7 (278)	48.5 (754)	50.5 (105)	47.4 (82)
Level of education								
Low	33.7 (6,406)	36.5 (3,340)	33.1 (1,696)	28.1 (551)	26.3 (154)	31.1 (477)	32.2 (67)	22.7 (39)
Middle	40.9 (7,775)	41.1 (3,760)	41.6 (2,128)	40.6 (796)	44.0 (258)	39.0 (597)	35.1 (73)	39.5 (68)
High	25.4 (4,820)	22.4 (2,049)	25.3 (1,295)	31.2 (612)	29.7 (174)	29.9 (458)	32.7 (68)	37.8 (65)
Income‡, mean (SD)	1.5 (0.8)	1.5 (0.8)	1.5 (0.8)	1.5 (0.8)	1.5 (0.9)	1.4 (0.8)	1.6 (0.9)	1.5 (0.9)
Number of cigarettes per day, mean (SD)	13.7 (8.1)	14.4 (8.3)	14.0 (7.8)	11.9 (7.5)	13.3 (8.1)	12.5 (8.0)	10.9 (7.9)	11.0 (8.6)
Recent quit attempts								
No attempt in the past 12 months	85.7 (15,933)	94.4 (8,470)	86.5 (4,382)	79.4 (1,523)	61.5 (350)	59.4 (904)	38.4 (78)	37.3 (60)
At least one attempt 7–12 months ago	6.9 (1,280)	3.4 (302)	7.0 (353)	10.6 (203)	17.4 (99)	16.5 (251)	14.8 (30)	18.0 (29)
At least one attempt 0–6 months ago	7.5 (1,389)	2.3 (203)	6.5 (328)	10.0 (192)	21.1 (120)	24.1 (367)	46.8 (95)	44.7 (72)
Time spent with urges to smoke, mean (SD)	3.3 (1.1)	3.3 (1.1)	3.4 (1.0)	3.2 (1.0)	3.3 (1.0)	3.2 (1.0)	3.2 (1.1)	3.3 (1.2)
Strength of urges to smoke, mean (SD)	2.1 (1.0)	2.1 (1.0)	2.1 (0.9)	1.9 (0.9)	2.1 (1.0)	2.0 (0.9)	1.9 (0.9)	2.0 (1.1)
Use of e-cigarettes								
Never	74.8 (14,393)	79.7 (7,369)	73.0 (3,786)	70.3 (1,402)	63.4 (377)	64.5 (1,003)	63.5 (132)	64.2 (111)
Ex-experimental	18.4 (3,542)	15.1 (1,395)	20.7 (1,074)	21.5 (428)	25.7 (153)	23.7 (368)	22.1 (46)	23.7 (41)
Ex-regular	2.7 (520)	2.1 (194)	2.9 (152)	3.7 (74)	4.0 (24)	3.3 (52)	3.8 (8)	5.2 (9)
Current	4.0 (776)	3.1 (283)	3.4 (176)	4.5 (90)	6.9 (41)	8.4 (131)	10.6 (22)	6.9 (12)
Use of HTP§								
Never	91.0 (11,345)	91.5 (5,592)	91.3 (3,183)	87.8 (1,137)	87.7 (250)	92.2 (862)	89.4 (110)	87.0 (80)
Ex-experimental	7.6 (948)	7.3 (448)	7.2 (252)	10.4 (135)	10.2 (29)	5.9 (55)	8.1 (10)	9.8 (9)
Ex-regular	0.7 (83)	0.5 (30)	0.8 (29)	0.7 (9)	1.1 (3)	0.4 (4)	1.6 (2)	2.2 (2)
Current	0.8 (96)	0.6 (39)	0.6 (22)	1.1 (14)	1.1 (3)	1.5 (14)	0.8 (1)	1.1 (1)
Use of waterpipe§								
Never	70.8 (8,840)	73.4 (4,490)	70.2 (2,453)	65.4 (848)	61.6 (175)	67.2 (630)	65.9 (81)	66.3 (61)
Ex-experimental	21.1 (2,635)	18.6 (1,141)	22.3 (778)	24.8 (322)	25.7 (73)	24.9 (233)	25.2 (31)	27.2 (25)
Ex-regular	3.5 (440)	3.2 (198)	3.5 (122)	4.5 (58)	6.3 (18)	3.2 (30)	5.7 (7)	3.3 (3)
Current	4.6 (578)	4.7 (290)	4.0 (139)	5.2 (68)	6.3 (18)	4.7 (44)	3.3 (4)	3.3 (3)

Numbers present percentage (number), unless otherwise stated.

*Data from DEBRA waves 1–33, except for use of HTP and waterpipe, for which only data from waves 13–33 were used.

†1.5% (n=288) had missing data for the MTSS.

‡Range from 0 (0 Euro income) to 7 (7,000 or more Euro income).

§12,509 adult tobacco smokers included from waves 13 to 33 of whom 1.2% (n=156) had missing data for the MTSS, column sums differ accordingly. DEBRA, German Study on Tobacco Use; HTP, heated tobacco products; MTSS, Motivation To Stop Scale.

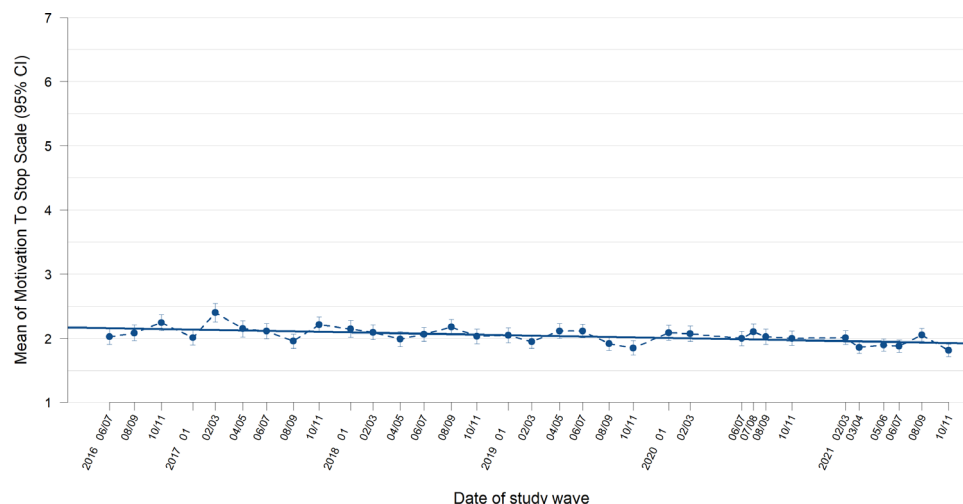


Figure 1 Trend of motivation to stop smoking among adult tobacco smokers in Germany (weighted data, n=18 303). The markers on the x-axis present the accurate mean date of each study wave. Trend line (linear regression) presented as solid line. Due to lockdowns caused by the COVID-19 pandemic, no survey waves could take place in April/May 2020 and January 2021.

(85.7%, n=19 933), and had never used e-cigarettes (74.8%, n=14 393).

Trend analysis

The overall trend of motivation to stop smoking among adult tobacco smokers during the period between June/July 2016 and November 2021 showed a slight downward trend and an overall low level of motivation with a mean of 2.04 (SD=1.37) (figure 1). The seven levels of motivation were distributed as follow: category 1 (absence of motivation), 47.6%, category 2, 27.8%, category 3, 10.8%, category 4, 3.3%, category 5, 8.4%, category 6, 1.2% and category 7 (strong desire and short-term intention to quit), 0.9%. We were only able to detect an increase in motivation to stop smoking in the age group of 18–24 years. The downward trend was also less distinct in smokers in the high income and high education group (online supplemental figures 1A–1D).

Associations with motivation to stop smoking

Full sample analysis

As outlined in table 2, multivariable ordinal regression analysis revealed that younger age ($OR_{adj}=0.97$; 95% CI 0.96 to 0.99 per 10 years), smoking fewer cigarettes per day ($OR_{adj}=0.82$; 95% CI 0.79 to 0.86 per 10 cigarettes per day), more time spent with urges to smoke ($OR_{adj}=1.05$; 95% CI 1.01 to 1.10) and high ($OR_{adj}=1.40$; 95% CI 1.29 to 1.51) and middle ($OR_{adj}=1.10$; 95% CI 1.03 to 1.19) compared with a low level of education were associated with a higher motivation to stop smoking.

Furthermore, having attempted to quit at least once during the past 12 months was associated with an increased motivation. Among current smokers with a recent quit attempt, an attempt within the past 6 months was associated most strongly with a higher motivation to stop smoking ($OR_{adj}=7.54$; 95% CI 6.78 to 8.40). Ever use of e-cigarettes, in particular, current ($OR_{adj}=1.71$; 95% CI

1.48 to 1.99), ex-regular ($OR_{adj}=1.30$; 95% CI 1.10 to 1.55) and ex-experimental ($OR_{adj}=1.42$; 95% CI 1.32 to 1.53) use compared with never use, was associated with a higher motivation to stop.

Association with use of HTP and waterpipe (subsample analysis)

Current HTP use was not associated with motivation to stop, but ex-experimental versus never use of HTP was associated with a lower motivation to stop smoking ($OR_{adj}=0.81$; 95% CI 0.70 to 0.93). With regard to waterpipe use, current use was associated with a lower motivation to stop smoking compared with never use ($OR_{adj}=0.65$; 95% CI 0.53 to 0.79) (see table 2). The remaining associations were broadly similar to the results of the full sample analysis.

Sensitivity analysis

Our sensitivity analysis using imputed data showed a statistically significant association with gender, indicating that women tended to be more motivated to stop smoking ($OR_{adj}=1.07$; 95% CI 1.01 to 1.13). All other results remained stable regarding reaching statistical significance and directions of effects.

Analysis of adolescent smokers

Sample characteristics (online supplemental table 1), associations with motivation to stop smoking (online supplemental table 2) and the trend analysis (online supplemental figures 2,3) for adolescent smokers are presented in online supplemental material.

DISCUSSION

Our representative study of the German population showed that a higher motivation to stop smoking is associated with several person characteristics of current adult tobacco smokers. Large effect estimates were observed

Table 2 Multivariable ordinal regression model of associations with level of motivation to stop smoking among current adult tobacco smokers in Germany (unweighted data)

	Higher rating on the MTSS (1-7)	
	Full sample analysis* (wave 1–33, n=17 243)†	Subsample analysis* (wave 13–33, n=11 458)‡
	OR _{adj} (95% CI)§	OR _{adj} (95% CI)§
Age (per 10 years)	0.97 (0.96 to 0.99)	0.95 (0.93 to 0.98)
Gender		
Men (ref)	1.00	1.00
Women	1.03 (0.98 to 1.10)	1.00 (0.93 to 1.07)
Level of education		
Low (ref)	1.00	1.00
Middle	1.10 (1.03 to 1.18)	1.07 (0.98 to 1.16)
High	1.40 (1.29 to 1.51)	1.42 (1.28 to 1.57)
Income¶	0.99 (0.96 to 1.03)	1.00 (0.96 to 1.05)
Number of cigarettes per day (per 10 cigarettes per day)	0.82 (0.79 to 0.86)	0.80 (0.75 to 0.84)
Recent quit attempts		
No attempt in the past 12 months (ref)	1.00	1.00
At least one attempt 7–12 months ago	4.00 (3.59 to 4.45)	4.96 (4.26 to 5.76)
At least one attempt 0–6 months ago	7.54 (6.78 to 8.40)	8.37 (7.25 to 9.67)
Time spent with urges to smoke	1.05 (1.01 to 1.10)	1.07 (1.01 to 1.12)
Strength of urges to smoke	0.97 (0.93 to 1.01)	1.00 (0.95 to 1.06)
Use of e-cigarettes		
Never (ref)	1.00	1.00
Ex-experimental	1.42 (1.32 to 1.53)	1.45 (1.31 to 1.60)
Ex-regular	1.30 (1.10 to 1.55)	1.44 (1.16 to 1.79)
Current	1.71 (1.48 to 1.99)	1.68 (1.38 to 2.04)
Use of HTP		
Never (ref)	–	1.00
Ex-experimental	–	0.81 (0.70 to 0.93)
Ex-regular	–	0.97 (0.62 to 1.53)
Current	–	1.01 (0.65 to 1.55)
Use of waterpipe		
Never (ref)	–	1.00
Ex-experimental	–	1.07 (0.97 to 1.17)
Ex-regular	–	0.95 (0.78 to 1.16)
Current	–	0.65 (0.53 to 0.79)

*Year of the survey added as a design factor.

†10.0% (n=1726) of cases had to be excluded due to missing data in at least one independent variable.

‡7.2% (n=895) of cases had to be excluded due to missing data in at least one independent variable.

§OR of a higher level on the MTSS (1–7) for a one-unit increase in a continuous predictor, unless otherwise stated, or change in level for a categorical predictor.

¶Range from 0 (0 Euro income) to 7 (7,000 or more Euro income).

.HTP, heated tobacco products; MTSS, Motivation To Stop Scale.

among others with the use of e-cigarettes, recent quit attempts and a higher level of education. The overall motivation to stop in Germany is low and has slightly declined between 2016 and 2021, only in younger smokers, aged 18–24 an increase was observable.

Present and past consumers of e-cigarettes reported a higher motivation to stop smoking than those who never tried e-cigarettes; among those current users of e-cigarettes compared with never users showed the highest odds of having a higher level of motivation. The link with

current e-cigarette use had already been suggested but remained debatable to date.^{12 22} Unlike most past studies, we used a validated single-item measure of motivation to stop smoking.¹⁸ To our knowledge, only Jackson *et al* investigated this association with the MTSS in a sample of English smokers and obtained a similar result, but the MTSS was dichotomised in their study.⁸ It is known that use of e-cigarettes among tobacco smokers often indicates preparation for a quit attempt,^{12 23} possibly accompanied with cutting down on tobacco use.²³ While the debate on potential harms of vaping is still ongoing,^{24 25} this piece of evidence nonetheless extends the already existing picture of e-cigarette users in the sense that they present a subset of tobacco smokers who are motivated to stop smoking tobacco. However, causality of this association cannot be assessed with our cross-sectional design. It is possible that smokers more motivated to stop start vaping or that e-cigarette use increases their motivation to do so.²⁶ The first option seems more plausible in our view, since the majority uses them to help with quitting.²² The benefit in cessation rates is underpinned by a recent Cochrane review.²⁷ Whatever the direction in which the controversy on e-cigarettes continues to develop, smoking cessation aids could especially be offered to this subgroup who used e-cigarettes at some point in their life (25.1% of all tobacco smokers in our sample). That past e-cigarette users are also more motivated presents an interesting finding and could have various reasons. They present a heterogeneous group of past dual users (tobacco and e-cigarettes) or past single users of e-cigarettes. The mechanism could be the same as with current users—and motivation stays elevated after stopping to consume e-cigarettes—or different.

One or more recent attempts to quit, and, especially, if these have been made within the past 6 months, were found to be associated with increased motivation to try quitting again. This finding matches results by Marques-Vidal *et al*, who showed that more past quit attempts were positively associated with intention to attempt quitting again.⁶ After a failed quit attempt, which is the most common outcome,²⁸ motivation does not vanish but stays elevated, resulting in subsequent quit attempts.²⁹ In our study, recently failed quitters had four to seven times higher odds of reporting an increased level of motivation to stop smoking than those who did not attempt quitting during the previous year.

A higher level of education was associated with more motivation to stop smoking as well. This result is in line with previous research, which looked at intention to quit only.⁹ Contradictory to past findings, income, as a measure of socioeconomic status, showed no statistically significant association.³⁰ A possibility remains that the relationship with income is not linear and could not be captured in our study.

Younger age, fewer cigarettes per day and more time spent with urges to smoke were associated with a higher motivation to stop smoking. But age and time spent with urges to smoke showed relatively small effect sizes.

Once again, a non-linear relationship with age could be debated. Nicotine dependence had been negatively associated with being more motivated to stop before.⁶ We were not able to confirm this since strength of urges to smoke, a useful proxy measure of nicotine dependence,²¹ did not show an association and time spent with urges to smoke was positively associated with a higher motivation. The result regarding number of cigarettes per day is in line with previous results.⁵

Female smokers were found to be more motivated to stop smoking in other studies, although one study included only university students and looked at intention to quit,⁷ and the other had a different study objective.⁸ We could not confirm this relation although our sensitivity analysis of the full sample showed a statistically significant result. A replication of this investigation is needed here.

Regarding alternative tobacco products, the most interesting finding was that current users of waterpipe were less motivated to stop smoking. Waterpipe is an understudied tobacco product, especially in Western countries. Past research though emphasises that waterpipe use is a social habit.³¹ It is imaginable that the secondary benefit from social gatherings may, therefore, discourage these smokers from quitting.

Representative data of the German population enabled us to show that the overall motivation to stop smoking among adult smokers was low and slightly decreased further in the period between 2016 and 2021. This trend was consistent in most subgroups of gender, age, education and income. Two previously conducted trend analyses from Greece and Switzerland from more than 10 years ago, therefore not directly comparable to Germany and the recent time period, suggested an increase over time.^{13 14} Those increases have been discussed as the result of implemented tobacco control regulations, such as plain packaging,³² tax increases³³ and others like public information campaigns.^{34 35} Results from the MTSS validation studies do not feature the trend of the MTSS but show that the mean MTSS score in the Netherlands (3.63; data from waves between 2012 and 2014) and UK (2.88, data from waves between 2008 and 2011) was higher in those countries than what we found.^{17 19} The time periods analysed are not identical but could indicate that the overall motivation to stop smoking is lower in Germany than in at least some other European countries. Our study presents a new and unique finding for Germany, which tallies with the stable high prevalence of tobacco smoking in Germany.¹ Tobacco control regulations have been correlated with smoking prevalence,³⁶ and Germany is ranked last of all European countries on the current Tobacco Control Ranking Scale from 2019.³⁷ The unchanged, rather declining motivation to stop smoking, could be a consequence of only few new tobacco control policies in Germany since 2010.³⁷ According to the Behaviour Change Wheel, the intervention functions 'education, persuasion, coercion, restriction, environmental restructuring, modelling and enablement' would need to be addressed in Germany to

increase motivation to stop smoking—one out of three components of the wheel's core the COM-B model of behaviour.²

Strengths and limitations

Limitations of our study need to be addressed. We were only able to analyse self-reported data. Missing data were present and potentially could have biased our complete case analyses. Yet, our sensitivity analysis using imputed data confirmed nearly all results, and overall missing data were rare. Data not missing completely at random may have occurred though. Since this is a cross-sectional study design, we were not able to assess causality or temporality of any identified associations. Our analyses are of an exploratory nature, since no precise specifications on relationships between the variables in the models were made a-priori. In addition, they were restricted to variables available from the DEBRA study, other variables that might be associated with the MTSS like, for example, frequency of smoking cessation approaches by health professionals, self-efficacy or smoking in the family environment, could not be evaluated.

The core strengths of this investigation are its representative data, large sample size and repeated survey waves over a period of more than 5 years. Furthermore, in comparison to past studies, we used a validated measure of motivation to stop smoking, which covers motivation fully,^{17 18} and assessed associations with a broad number of smokers' characteristics. A study and analysis plan was preregistered before conducting the data analysis as well.

Implications

Our findings have three main implications. First, the observed decrease in motivation to stop smoking in Germany on a population-level calls for actions to boost those. More stringent tobacco control regulations like further tax increases, more powerful add bans, as well as more restrictive smoking bans in restaurants and bars could be one approach. However, these need to be supported with a reimbursement of the costs of smoking cessation treatments and public awareness campaigns. Second, in the healthcare context, smokers less motivated to stop smoking should be addressed with methods to enhance their motivation. The 5As method—a brief intervention to offer smoking cessation support in primary care—for example, explicitly recommends the provision of the 5 Rs intervention (relevance, risks, rewards, roadblocks and repetition) in case of low motivation to enhance motivation to stop.³⁸ Third, the characteristics most strongly associated with an enhanced motivation to stop smoking could be utilised to select the most motivated smokers. It could be efficient to advise smoking cessation more frequently or intensively to current and/or past e-cigarette users as well as recently failed quitters. Information on smoking cessation could be distributed where e-cigarettes are sold, for example.

Conclusions

In summary, recently failed quitters and current as well as past e-cigarette users are more motivated to stop smoking. Targeting recently failed quitters and e-cigarette smokers with low-threshold support for smoking cessation may be feasible. Furthermore, motivation to stop smoking on a population level remains low and declines in Germany, which calls for actions in order to tackle the high smoking prevalence in Germany.

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