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Use of tobacco cessation aids and likelihood of smoking cessation: A French population-based study

Mathilde Fekom^{a,*}, Tarik El Aarbaoui^c, Romain Guignard^b, Raphaël Andler^b,
Guillemette Quatremère^b, Simon Ducarroz^a, Viêt Nguyen-Thanh^b, Maria Melchior^a

^a INSERM, Sorbonne University, Team of Social Epidemiology (ERES), Pierre Louis Institute of Epidemiology and Public Health (IPLESP), Paris, France

^b Santé publique France, The National Public Health Agency, Saint Maurice, France

^c EpiDermE, Université Paris Est Créteil, F-94010 Créteil, France

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ABSTRACT

Although smoking prevalence has been decreasing worldwide, sustained tobacco cessation remains a challenging goal for many smokers. Several types of tobacco cessation aids are available such as nicotine replacement therapy (NRT) and electronic cigarette, the effectiveness of the latter is still a matter of debate. This study aims to test differences in successful smoking cessation according to the type of aid used, considering selection and confounding factors.

We used data from the 2017 French Health Barometer, a cross-sectional survey conducted by France's Public Health Agency. We studied the relationship between e-cigarette and NRT use and three distinct outcomes collected retrospectively: smoking status 6, 12 and 24 months after the cessation attempt (yes vs no). All results were weighted to be nationally-representative and controlled for propensity scores included via overlap weighting (OW).

The use of an e-cigarette was significantly associated with tobacco cessation at 6 months (OWeighted OR = 1.38, 95 % CI: 1.03–1.99) as well as at 12 months (OWeighted OR = 1.61, 95 % CI: 1.13–2.27) and 24 months (OWeighted OR = 1.61, 95 % CI: 1.01–2.57). The use of NRT was negatively associated with tobacco cessation at 12 months (OWeighted OR = 0.62, 95 % CI: 0.43–0.89) and 24 months (OWeighted OR = 0.57, 95 % CI: 0.35–0.92). While the use of an e-cigarette alone or combined with NRT is associated with an increase in the likelihood of smoking cessation, the effects of the use of NRT alone on long-term smoking abstinence are probably limited.

1. Introduction

While tobacco smoking prevalence has significantly diminished in industrialized countries over past decades, long-term cessation remains an issue for many smokers (Halpern et al., 2018). Sustained tobacco cessation is associated with psychological, social and environmental factors and thereby represents a challenging goal to achieve. As a result, comprehensive tobacco control strategies are actively promoted, such as the MPOWER strategy launched in 2007 by the World Health Organization, which includes extensive tobacco cessation support for smokers (World Health Organization WHO, 2008). In practice, in many countries, anti-smoking policies have been implemented. Those policies include smoking and tobacco advertisement bans, communication on the dangers of smoking and the benefits of quitting, increases in

taxation, as well as support for smokers who wish to quit (World Health Organization WHO, 2019).

The question of the long-term effectiveness of different types of smoking cessation aids in real-life settings is still under debate in the public health community, in particular regarding electronic cigarettes (e-cigarettes), which are mainly nicotine-based devices that are disseminated since 2010 (Fairchild et al., 2019). Although research suggests that e-cigarettes are safer than traditional cigarettes (McNeill et al., 2015), the level of risk reduction is still being discussed (Balfour, 2021; Haute Autorité de Santé, 2016). On the one hand, one may argue that smokers are primarily addicted to the nicotine itself, and that e-cigarettes represent a suitable substitute for traditional cigarettes to avoid nicotine withdrawal symptoms (Hartmann-Boyce et al., 2021). On the other hand, some studies suggest that e-cigarette use might enhance

* Corresponding author.

E-mail address: mathilde.fekom@iplesp.upmc.fr (M. Fekom).

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nicotine dependence (Chen, 2020) and therefore reduce the odds of successful smoking cessation in the long term. Other studies have shown that children exposed to e-cigarette adverts might reduce the perceived harm of regular tobacco smoking (Vasiljevic et al., 2018). Moreover, the European Respiratory Society which gathered publications on e-cigarette use, highlighted the lack of evidence regarding the safety of e-cigarettes in the long term, due to the potentially toxic chemicals they contain (Bals et al., 2019). An additional issue is that many e-cigarette users keep on smoking traditional cigarettes in parallel to vaping, increasing the risk of deleterious effects on their health. Yet, data from a cohort study of dual users of both e-cigarettes and traditional cigarettes indicate that compared to traditional cigarette users only, dual users were more likely to be abstinent at 6 months, but this was no longer the case at 12 or 18 months (Sweet, 2018). A randomized controlled trial conducted in the United States showed that sustainable tobacco cessation at 6 months is not facilitated by the use of e-cigarettes when combined with usual care (Halpern et al., 2018).

A meta-analysis gathering 136 studies on nicotine replacement therapy (NRT) concluded that licensed forms of NRT can significantly increase smoking cessation rates (Hartmann-Boyce et al., 2019). However, the effectiveness of NRT in terms of long-term abstinence appears to be limited: a randomized trial failed to demonstrate additional efficacy beyond 24 consecutive weeks of use (Schnoll et al., 2015) and results from a meta-analysis further showed that focusing on durations of 6 to 12 months after the cessation might overestimate the lifetime benefit of NRT by 30 % (Etter and Stapleton, 2006). E-cigarettes and NRT have also been compared in randomized trials, and the former appears to be more effective than the latter for successful tobacco cessation (Hartmann-Boyce et al., 2019; Schnoll et al., 2015). Finally, real-life use and effectiveness are probably different from what has been observed in clinical trials and there is need for updated information on this topic.

In addition to studying successful smoking cessation (Halpern et al., 2018; Balfour, 2021; Schnoll et al., 2015) additional information can be conveyed by the duration of abstinence (Marti, 2010). This distinction matters as the intervention necessary to address the two goals might differ. In France, since January the 1st 2019, up to 65 % of the cost of NRT is covered by the national health insurance scheme when prescribed by a health professional. In addition, the French National Authority for Health (HAS) emphasizes the importance of support and guidance by a medical professional for sustainable tobacco cessation through motivational interviews, therapy, etc. (Haute Autorité de Santé, 2014). More recently, the HAS proposed a specific tool to be used by health professionals for early identification and brief intervention on patients' tobacco consumption (Haute Autorité de Santé, 2021).

Using data from the French Health Barometer survey, we aimed to contribute to the ongoing discussion about effective ways of initiating and maintaining tobacco cessation in a real-life rather than an experimental setting. In particular, we studied the relationship between use of NRT and/or an electronic cigarette use with regard to smoking cessation 6, 12 and 24 months after the smoking cessation attempt among smokers drawn from the general population.

2. Methods

2.1. Source

Data for this study come from the French Health Barometer, a representative general population telephone survey which aims to assess population levels of knowledge, behaviors and beliefs regarding health. These surveys have been carried out since 1992 by the National Institute for Prevention and Health Education (Inpes) and now by the French National Public Health Agency (Santé publique France). Telephone numbers (landlines and mobile phones) are generated randomly (Richard et al., 2016). For landlines, only one individual per household is randomly selected to participate (Kish, 1949).

The survey includes a section dedicated to the assessment of tobacco

consumption. In particular, the 2017 wave of the French Health Barometer survey (response rate: 48.5 %) included questions regarding smoking and tobacco cessation patterns, use of smoking cessation aids, as well as a number of relevant socio-demographic and health-related questions.

2.2. Populations

France's 2017 National Health Barometer survey was carried out from January 5th to July 8th and included 25,319 individuals aged 18 to 75 years. Interviews lasted 31 min on average. We excluded from the statistical analyses never-smokers and participants who smoked or used to smoke only occasionally yielding a sample of 12,101 daily smokers and former daily smokers. Individuals were classified as former smokers if they had smoked for at least 6 months and reported quitting for at least one week prior to the survey. To keep exposure groups comparable, the study sample was limited to individuals who tried to stop smoking at least once and for at least one week (successfully or not), that is 87.2 % of ever-daily smokers ($n = 10,556$). In this subgroup, 41.9 % ($n = 4,423$) were current daily smokers while 58.1 % ($n = 6,133$) were former daily smokers. Since we aimed to assess the association between e-cigarette use and smoking cessation, we limited the study to the 4,022 individuals who attempted to quit smoking in the 4 years prior to the study, which roughly corresponds to the period when e-cigarettes were marketed in France. In addition, to compare smokers and former smokers only participants whose last smoking cessation attempt was at least 6 months before the survey were included, yielding a sample of $n = 2,783$ participants.

3. Variables

3.1. Exposure – Type of smoking cessation aid

Participants who reported attempting to quit smoking were asked 'Which smoking cessation aid did you use to quit smoking?'. It was a question with 9 non-exclusive pre-coded response choices. Similarly to previous work (Guignard, 2021), we distinguished 5 groups: use of 1) an e-cigarette and no NRT (called e-cigarette), 2) NRT and no e-cigarette (called NRT), 3) both an e-cigarette and NRT (called e-cigarette and NRT), 4) another type of help and 5) nothing. The last option was used as the reference category.

4. Study outcomes

We considered three different study outcomes corresponding to participants' smoking status 6, 12 and 24 months after the smoking cessation attempt reported. 6 months is a standard period to consider smoking abstinence as sustainable (Lee and Kahende, 2007). Participants who quit smoking for at least 6/12/24 months at the time of survey were considered as former smokers. The 3 outcomes yielded samples of respectively $N = 2,783$, $N = 1,947$ and $N = 1,079$ participants. More specifically, a participant who answered "yes" to "Do you smoke?", "yes" to "Do you smoke every day?" and "More than 6/12/24 months" to "When was the last time you tried to stop smoking?" was classified as a smoker and a participant who answered "no" to "Do you smoke?", "yes" to "Had you smoked daily for more than 6 months?" and "More than 6/12/24 months ago" to "When did you stop smoking?" was classified as a former smoker.

4.1. Covariates

The socio-demographic variables controlled for in these analyses include participants' sex (woman vs man), age (in years), number of persons in the household (headcount), work status (employed (reference), student, out-of the labour force, retired), occupational grade (worker (reference), supervisor/office employee or equivalent,

executive, other, not working), highest level of education (<high school (reference), high school graduate, college or > college), income per consumption unit (split into terciles), relationship status (in a relationship vs single) and having children (yes vs no).

Behavioral and health-related characteristics studied were: negative life events (>=1 among: serious money issues, loss of family member or unwanted sexual relationship), frequency of physical activity (never (reference), monthly/annually, weekly), chronic disease (based on the question: 'Do you have a chronic disease or health issue?' yes vs no), life satisfaction (based on the question 'On a scale from 0 to 10, how would you rate your life currently?'), psychotropic medication (based on the question: 'Have you ever taken any medication for nerves or sleep problems, such as a tranquilizer, sleeping pills, antidepressants, etc.?' yes vs no) and social support (based on the question 'How many people

are close enough to you so that you can count on them in case of a serious personal problem?', below 3 (reference), 3–5, 6 and above).

Additionally, we considered participants' age of regular smoking initiation, number of quit attempts prior to the survey and cessation type (radical vs progressive).

5. Statistical analyses

5.1. Weights

All results were weighted to consider the probability of being included in the survey, which depended on the respondent's phone lines number and of the number of eligible persons in the household. Weights were calculated using the 2016 employment survey from National

Table 1

Characteristics of ever smokers who attempted to quit at least 6 months and at most 4 years before the survey stratified by tobacco cessation help type.

	Overall	None	E-cigarette	NRT**	E-cig. & NRT	Other	p
<i>N</i>	2783	1716	430	334	95	209	
<i>Socio-demographics</i>							
Sex = Woman (%)	1262 (45)	774 (45)	195 (45)	143 (43)	48 (51)	102 (49)	0.681
Age (mean (SD))	40.62 (13.93)	39.06 (14.19)	40.54 (12.33)	46.78 (13.24)	45.16 (12.80)	41.69 (13.24)	<0.001
Nb. persons household (mean (SD))	2.83 (1.36)	2.90 (1.37)	2.79 (1.35)	2.79 (1.41)	2.40 (1.21)	2.69 (1.25)	0.006
<i>Work Status (%)</i>							
Employed	1751 (63)	1051 (61)	298 (69)	196 (59)	68 (72)	138 (66)	
Student	171 (6)	121 (7)	23 (5)	8 (3)	1 (1)	17 (8)	
Out-of the labour force	601 (22)	395 (23)	81 (19)	71 (21)	21 (22)	33 (16)	
Retired	260 (9)	148 (9)	27 (6)	59 (18)	4 (5)	22 (10)	
<i>Occupational grade (%)</i>							
Worker	662 (24)	421 (25)	84 (20)	84 (25)	30 (31)	43 (21)	0.136
Supervisor/office employee	1349 (48)	828 (48)	226 (53)	146 (44)	44 (46)	105 (50)	
Executive	311 (11)	166 (10)	57 (13)	54 (16)	7 (7)	27 (13)	
Other	41 (1)	27 (2)	7 (2)	1 (0)	0 (0)	4 (2)	
Not working	421 (15)	274 (16)	55 (13)	48 (15)	14 (15)	29 (14)	
<i>Level of education (%)</i>							
<high school	1490 (54)	928 (54)	208 (48)	199 (60)	52 (54)	104 (50)	0.293
High school graduate	517 (19)	322 (19)	88 (20)	50 (15)	16 (17)	41 (19)	
College or > college	775 (28)	465 (27)	134 (31)	85 (25)	27 (29)	64 (31)	
<i>Income per consumption unit** (%)</i>							
1st tertile	1177 (42)	801 (47)	147 (34)	123 (37)	37 (39)	69 (33)	<0.001
2nd tertile	935 (34)	545 (32)	161 (37)	121 (36)	33 (35)	75 (36)	
3rd tertile	671 (24)	370 (22)	122 (28)	90 (27)	24 (26)	65 (31)	
Relationship status = Single (%)	1687 (61)	1085 (63)	246 (57)	175 (52)	55 (58)	126 (60)	0.017
Children = yes (%)	1352 (49)	841 (49)	210 (49)	163 (49)	43 (45)	94 (45)	0.889
<i>Behavioral & health</i>							
Negative life event = yes (%)	1243 (45)	729 (42)	198 (46)	172 (52)	52 (55)	92 (44)	0.040
<i>Physical activity* (%)</i>							
Never	844 (30)	507 (30)	126 (29)	130 (39)	26 (27)	54 (26)	0.046
Monthly/annually	369 (13)	218 (13)	52 (12)	48 (14)	19 (20)	33 (16)	
Weekly	1571 (56)	990 (58)	252 (59)	156 (47)	50 (53)	122 (58)	
Chronic disease* = yes (%)	985 (35)	547 (32)	163 (38)	151 (45)	52 (55)	72 (34)	<0.001
<i>Life Satisfaction* (%)</i>							
Unsatisfied	168 (6)	89 (5)	29 (7)	31 (9)	6 (7)	13 (6)	0.321
Satisfied	1325 (48)	838 (49)	200 (47)	158 (47)	41 (43)	87 (42)	
Very satisfied	1290 (46)	789 (46)	200 (46)	145 (43)	48 (50)	109 (52)	
Psychotropic medication = yes (%)	1117 (40)	613 (36)	180 (42)	178 (53)	47 (49)	99 (47)	<0.001
<i>Social support* (%)</i>							
Below 3	639 (23)	419 (24)	73 (17)	77 (23)	30 (32)	40 (19)	0.020
3 to 5 people	1180 (42)	686 (40)	199 (46)	149 (45)	38 (40)	108 (52)	
6 and above	964 (35)	610 (36)	158 (37)	109 (33)	27 (28)	61 (29)	
<i>Tobacco-related</i>							
Age regular smoking initiation*(mean (SD))	19.15 (4.53)	19.36 (4.67)	18.56 (4.26)	19.25 (4.73)	18.81 (3.59)	18.67 (3.78)	0.020
Nb quit attempts* (mean (SD))	3.70 (7.69)	3.60 (8.19)	3.81 (7.04)	3.75 (7.81)	5.12 (5.75)	3.55 (4.68)	0.151
Cessation type* = Progressive (%)	696 (25)	398 (23)	137 (32)	90 (27)	31 (33)	41 (20)	0.005
Smoking status =Former smoker (%)	987 (35)	573 (33)	188 (44)	100 (30)	44 (47)	82 (39)	0.001

Data come from the 2017 French Health Barometer phone survey from Santé publique France. All headcounts and percentages were weighted by margin calibration. p-values from Pearson chi-square tests for categorical variables and from

one-way ANOVA tests for continuous variables were reported.

*Imputed using Multiple Imputation by Chained Equations (mice package in R).

** NRT = Nicotine Replacement Therapy.

° Consumption units (CU) are calculated the following way: 1 CU for the first adult in the household, 0.5 CU for the other persons aged 14 years or older, 0.3 CU for the children under 14 years.

Institute of Statistics and Economic Studies, to render the sample representative in terms of sex crossed with age, urbanicity, region of residence, level of education and the number of persons living in the household of the French general population.

5.2. Descriptive analyses

Variables potentially associated with the use of smoking cessation aids were described in the first study sample (Table 1, see Appendix for the other samples). Statistical significance was evaluated using Pearson chi-square tests for categorical variables and one-way analysis of variance (ANOVA) for continuous variables.

5.3. Outcome

We performed both bivariate weighted logistic regressions using the survey package in R, and weighted logistic regression models controlled for propensity scores (Li et al., 2018) computed with the Gradient Boosting Machine (GBM) algorithm (Friedman, 2001). This non-parametric method allows for complex and non-linear relationship between input variables. Since the overlap between the distributions of propensity scores corresponding to different exposure categories was relatively small, we used the overlap weighting (OW) technique (Zhou et al., 2020). Conceptually, the OW method focuses on observations with the most overlap between the exposed and reference group covariates by assigning them a larger weight. This analysis was tested with the SumStat function of the PSweight package in R (Zhou et al., 2020). All potential selection and confounding factors that were significantly associated with the study outcome at a statistical level of $p < 0.2$ given the exposure were considered in the statistical analyses.

The software used for the statistical analyses was R 4.0.4 (Team, 2021).

6. Results

6.1. Descriptive analyses

6.1.1. Factors associated with the use and types of smoking cessation aid

In our first sample (N = 2783), 1716 individuals reported no aids during their last tobacco cessation attempt, representing 61.7 % of the overall sample, while 15.5 % used an e-cigarette without NRT (n = 430), 12.0 % NRT without an e-cigarette (n = 334) and 3.4 % both (n = 95), see Table 1. Participants who reported no smoking cessation aid as well as those who used an e-cigarette were younger (respectively 39.06 and 40.54 years) than those who used NRT (46.78 years-old). While neither sex, level of education, having children nor life satisfaction were significantly associated with the type of smoking cessation aid used, other characteristics were, namely the number of persons in the household, work status, occupational grade, relationship status, income, no physical activity, experience of negative life events, presence of a chronic disease and use of psychotropic medication.

Finally, individuals who used an e-cigarette without NRT were more likely to report satisfactory social support, initiated regular smoking earlier (average of 18.56 years-old), quit smoking progressively and the proportion of former smokers was higher there than in the NRT group or in the group with no aids.

6.1.2. Regression analyses

Table 2 displays the results of both bivariate and propensity-score controlled logistic regression analyses. In bivariate analyses, only the use of an e-cigarette alone (6 months: OR = 1.54, 95 % CI: 1.19–2.00, 12 months: 1.65 (1.21–2.26), 24 months: 1.76 (1.15–2.71)) was significantly associated with smoking cessation at 6, 12 and 24 months.

After controlling for potential selection and confounding factors, all odds ratios were attenuated but similar to those observed in bivariate analyses. There was a positive gradient in the association between e-

Table 2

Bivariate and propensity score-controlled analyses examining the relationship between smoking cessation aids and smoking cessation.

Bivariate analysis		Analysis controlled for PS*	
Tobacco cessation aid	OR (CI)	Tobacco cessation aid	OR (CI)
<i>6 months after cessation attempt (N = 2783)</i>			
none (ref.)	1.00	none (ref.)	1.00
e-cigarette	1.54 (1.19–2.00)	e-cigarette	1.38 (1.03–1.99)
NRT	0.85 (0.63–1.15)	NRT	0.73 (0.53–1.00)
e-cigarette and NRT	1.73 (1.06–2.84)	e-cigarette and NRT	1.49 (0.91–2.44)
other	1.29 (0.91–1.82)	other	1.17 (0.81–1.70)
<i>12 months after cessation attempt (N = 1947)</i>			
none (ref.)	1.00	none (ref.)	1.00
e-cigarette	1.65 (1.21–2.26)	e-cigarette	1.61 (1.13–2.27)
NRT	0.65 (0.46–0.90)	NRT	0.62 (0.43–0.89)
e-cigarette and NRT	2.25 (1.26–4.02)	e-cigarette and NRT	2.15 (1.21–3.84)
other	1.05 (0.70–1.57)	other	0.93 (0.60–1.43)
<i>24 months after cessation attempt (N = 1079)</i>			
none (ref.)	1.00	none (ref.)	1.00
e-cigarette	1.76 (1.15–2.71)	e-cigarette	1.61 (1.01–2.57)
NRT	0.58 (0.37–0.90)	NRT	0.57 (0.35–0.92)
e-cigarette and NRT	1.53 (0.78–3.00)	e-cigarette and NRT	1.74 (0.80–3.77)
other	0.89 (0.51–1.57)	other	0.64 (0.33–1.21)

OR: odds ratio; CI: confidence interval; PS = Propensity scores.

Data come from the 2017 French Health Barometer phone survey from Santé publique France. Results are shown for former smokers (vs smokers). All regressions (logistic on the left and logistic controlled for PS on the right) were weighted by margin calibration.

* Variables included were: age, work status, occupational grade, level of education, income, relationship status, life satisfaction, negative life event, having children, nb. quit attempts, age of initiation to regular smoking and cessation type.

cigarette use and smoking cessation for at least 6 months (OWeighted OR = 1.38, 95 % CI: 1.03–1.99), 12 months (OWeighted OR = 1.61, 95 % CI: 1.13–2.27), and 24 months (OWeighted OR = 1.61, 95 % CI: 1.01–2.57).

In contrast, there was a negative gradient between NRT use and smoking cessation for at least 6 months (OWeighted OR = 0.73, 95 % CI: 0.53–1.00), 12 months (OWeighted OR = 0.62, 95 % CI: 0.43–0.89) and 24 months (OWeighted OR = 0.57, 95 % CI: 0.35–0.92). For those who used both an e-cigarette and NRT, the odds ratio of smoking cessation was the highest 12 months after the quit attempt (OWeighted OR = 2.15, 95 % CI: 1.21–3.84) and then decreased and became statistically non-significant at 24 months (OWeighted OR = 1.74, 95 % CI: 0.80–3.77).

7. Discussion

7.1. Main findings

Our study, based on nationally-representative data collected among smokers and former smokers, suggests that while e-cigarette use is associated with both short and medium-term transition from being a smoker to being a former smoker, its protective effect on a longer-term remains uncertain. In addition, NRT use does not appear to help sustainable abstinence in the long term. Thus, limiting the study of tobacco cessation to a short-term binary outcome can lead to wrong conclusions about the real-life effectiveness of e-cigarette and NRT use with regard to long-term smoking abstinence. Standard tobacco cessation aids should therefore be considered as short-term support, which may need to be complemented by other forms of support to lead to lasting results.

7.1.1. Strengths and limitations

Our study presents several limitations. First, ours is a retrospective assessment which might induce recall bias, especially regarding the accuracy of respondents' answers. In particular, users of e-cigarette who were still using it at the time of the survey might recall better their cessation aids than those who used NRT to stop smoking and who stopped since then. However, limiting the period of investigation to the 4 years preceding the survey probably limited the extent of information bias. Second, our study was conducted in 2017 and smoking patterns may have somewhat changed since. While there is evidence that smoking rates in France decreased since this study was conducted (Pasquereau et al., 2021), there is no reason that associations between the use of smoking cessation aids and smoking cessation have changed over time. Third, due to the survey design, we could not control for the level of tobacco consumption, nor for the level of tobacco dependence since former smokers were not asked about their smoking level or addiction prior to cessation. Because heavy smokers – for instance dual users who are trying to reduce their tobacco consumption – might choose their tobacco cessation aid differently from light smokers, our results may suffer from residual confounding. In fact, prior studies have highlighted the fact that heavy smokers are more likely to use an e-cigarette than light smokers (Hajek et al., 2019). Fourth, our assessment of smoking cessation aids was broad, and we had no information about the amount of nicotine taken in each smoking cessation aid studied, nor the form (gum, patch, etc.) or duration of use. Fifth, we assumed that all variables included in the statistical analyses were stable from the time of the tobacco cessation attempt to the time of the survey. If this assumption is inexact, it may induce incomplete control for confounding factors. Moreover, tobacco cessation being self-reported, it may not be entirely accurate as people generally have less incentive to report a relapse.

However, our study has also several strengths. First, we studied a nationally representative sample of the French population. Contrary to clinical trials that are conducted with volunteers, our study was conducted in real life conditions, and is thereby easier to generalize. Second, the results of Guignard et al. (Guignard, 2021) were extended and improved using a recent method that takes into account potential confounders by propensity scores overlap weighting. This technique enabled us not only to consider potential interactions between the variables involved, but also to tackle the positivity assumption, in the sense that it emphasizes observations that have the highest probability of belonging to any exposure group. By doing so, we can lean towards a study design in which exposure is more randomized.

Future work should be conducted in larger samples of smokers in order to increase statistical power and investigate more thoroughly differences in the effectiveness between e-cigarette and NRT products use.

8. Findings' interpretation

Our study shows that the use of an e-cigarette - alone or in combination with NRT - appears to be associated with tobacco cessation, while this does not appear to be the case for exclusive NRT use in our sample. One explanation may lie in the possibility that vaping resembles smoking and might therefore reduce the need to smoke tobacco while maintaining a somewhat familiar gesture. Moreover, smokers tend to under-report their tobacco consumption leading to under-dosed NRT prescription, while vapers are able to adjust their nicotine intake more easily, therefore possibly tailoring their use to their level of addiction. One study suggests that e-cigarette use can help tobacco cessation among smokers who never planned to quit (Kasza, et al., 2021). To the contrary, some NRT products such as patches, are more 'passive' and might not fill the psychological or social needs associated with smoking (Hajek et al., 2019). Another explanation might be that NRT users are heavier smokers than e-cigarette users, and therefore not controlling for heaviness of smoking might lead to stronger residual confounding for

NRT users.

We also observed that, although results did not reach statistical significance, dual users of an e-cigarette and NRT appear more similar to exclusive e-cigarette users than to exclusive NRT users. There are several explanations for this phenomenon. First, it could be that socio-demographic features associated with e-cigarette use (regardless of any other aids used) are associated with long-term abstinence. This may be the case for socioeconomic position, or the level of smoking prior to cessation, which predicts e-cigarette use (Aljandaleh et al., 2020). Second, as reported by an extensive randomized controlled trial comparing these two smoking cessation aids, compliance with NRT prescription is not always guaranteed among individuals who were dispensed NRT products (Hajek et al., 2019). NRT products may not always be convenient to use and individuals who report using NRT products to stop smoking may not do so consistently, which could lead to non-homogenous nicotine use or dosage issues, which favor relapse. In fact, a population-based study carried out in England showed that NRT is only effective when prescribed by a health professional (Jackson et al., 2019).

One possible explanation behind the potential lack of long-term efficacy of these tobacco cessation aids, despite the short-term efficacy of an e-cigarette use, lies in the ongoing nicotine dependence they perpetuate (Etter and Stapleton, 2006; Sweet, 2018) although it is possible to try to reduce it by decreasing the dosage. Other effective ways to help smokers quit tobacco include behavioral counselling and financial incentives (Hartmann-Boyce et al., 2022; Berlin et al., 2021). One way to increase the likelihood of long-term smoking abstinence may be to combine counselling with self-help approaches (Hajek et al., 2019). Tobacco dependence is a chronic and relapsing disorder which requires repeated treatments or prolonged follow-up similarly to other chronic disease (Etter and Stapleton, 2006), and long-term follow-up of former smokers should be put in place whenever possible.

9. Conclusion

Our results suggest that in real life circumstances, e-cigarette use is associated with short, mid and potentially long-term smoking cessation, while NRT use is almost not associated with sustainable smoking abstinence. Successful smoking cessation probably requires medical follow-up and strong support, which should be offered to all smokers attempting to quit tobacco.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2022.102044>.

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