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Assessing dual nicotine use in Spain: Transition to cessation or sustained consumption?

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ABSTRACT

Background: Spain's aging population, coupled with the persistent prevalence of smoking, places increasing pressure on the country's healthcare system. Novel nicotine products, such as e-cigarettes and heated tobacco products (HTPs), may serve as an adequate, less harmful alternative and cessation tool for smokers. However, critics are concerned about the risk of uptake among never-smokers and high rates of dual use of both conventional cigarettes and alternatives. Therefore, it is crucial to determine whether dual use presents a transitional phase toward cessation or if alternatives are a complementary nicotine source for smokers. The outcome of this assessment should guide whether regulations should harmonize or differentiate nicotine products based on the relative harm of each product.

Methods: We conducted a cross-sectional study among 1329 Spanish nicotine users on their history of consumption. This large dataset allowed us to track each respondent's consumer journey from initiation to switching behavior to cessation. We also applied a linear regression model to determine the predictors of exclusive smoking behavior or dual use.

Results: The vast majority of consumers start their nicotine journey with conventional cigarettes. When smokers take up non-combustible alternatives (NCAs) and become dual users, they gradually replace cigarettes with NCAs in terms of frequency and intensity of use. Observing a sample of consumers using nicotine products consistently for the past 5 years shows that dual users not only replace harmful cigarettes with NCAs but also that their total nicotine consumption declines. Among current and former HTP users, 44 % reported using HTPs to quit or reduce their smoking, while 16 % of e-cigarette users expressed the same motivation. In addition, 43 % of all users of nicotine products stated that they would consider quitting smoking if the regulatory or tax framework for tobacco products were to change.

Conclusions: The findings suggest that governments should implement policies that incentivize smokers to switch to less harmful alternatives, even if they initially become dual users. By recognizing dual use as part of the cessation journey, policymakers can develop strategies to better support smokers in reducing harm, particularly the most vulnerable smokers. Policymakers can better support smokers in transitioning away from traditional cigarettes and reduce the overall public health burden of smoking by integrating fiscal, regulatory, and awareness-raising measures.

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1. Introduction

Smoking remains a pervasive public health issue in Spain, as a significant portion of the population continues to smoke regularly, causing a considerable number of disease cases. Although smoking rates have declined from 35 % in 2009 to 24 % in 2023, the effects of smoking continue to reverberate throughout the country, particularly within the healthcare system and the economy (European Commission, 2024).

The burden of smoking-related diseases is particularly acute due to Spain's aging population. Older adults not only face greater challenges in quitting smoking but also have a substantially higher likelihood of developing smoking-related diseases, including lung cancer, chronic obstructive pulmonary disease, and other respiratory conditions (Gellert et al., 2012). Between 2000 and 2021, the number of deaths attributable to smoking in the generation born between 1952 and 1971 more than quadrupled, from 3300 to 14,800 (Global Burden of Disease Collaborative Network, 2024). The demographic shift with an increasing proportion of elderly individuals thereby exacerbates the public health challenge, as older smokers place greater demands on the healthcare system. The ability of seniors to quit smoking is often hindered by decades of nicotine addiction and a reduced capacity for physical recovery, making them more vulnerable to the long-term health effects of tobacco use.

The growing toll of smoking also puts pressure on Spain's healthcare infrastructure, which is already grappling with a skilled labor shortage in the healthcare sector (Guven et al., 2023). The increasing demand for medical care related to smoking exacerbates existing strains on the system, reducing its capacity to respond to urgent healthcare needs. The burden of smoking is not limited to the direct expenses associated with treating smoking-related illnesses but also includes the broader economic consequences of smoking. For instance, when younger family members are called upon to care for their elderly relatives suffering from smoking-related conditions, their ability to participate fully in the workforce diminishes, reducing overall labor force participation and consumer spending. This reduction in productivity and spending power hampers economic growth, compounding the negative effects of smoking on Spanish society. Smoking-attributable economic costs are estimated at 18.5 billion Euro annually in Spain, a financial burden that further stretches governmental health expenditures (Vital Strategies, 2024).

Given the far-reaching impacts of smoking, both in terms of public health and economic sustainability, reducing smoking rates remains a critical priority for Spanish society. In recent years, the introduction of novel nicotine products, such as e-cigarettes and heated tobacco products (HTPs), has added a dimension to the tobacco control landscape. These products, which may provide an alternative to traditional combustible cigarettes, have gained popularity among smokers seeking less harmful options. By 2023, e-cigarettes and HTPs accounted for 8 % of the total tobacco market in Spain, reflecting a shift in consumer preferences (Tobacco Journal International, 2023; Gómez, 2024). Nevertheless, the prevalence of both products only stood at 2 % in 2023 (European Commission, 2024).

Novel nicotine products differ fundamentally from traditional cigarettes in that they do not rely on combustion to deliver nicotine. Instead, they heat or vaporize their ingredients, which reduces the release of harmful toxicants typically associated with the combustion of tobacco. Research suggests that reduced exposure to toxic chemicals associated with novel nicotine products may lower the risk of developing smoking-related diseases, such as lung cancer and respiratory illnesses, although the long-term health effects are still being studied (Znyk et al., 2021; German Federal Institute for Risk Assessment (BfR), 2018; Committee on Toxicity).

Among novel nicotine products, HTPs is defined as having the closest resemblance to traditional cigarettes in terms of sensory experience, including familiar flavors and physical handling, which may appeal to smokers seeking a close alternative to cigarettes. In contrast, e-cigarettes do not contain tobacco and are available in a wide range of flavors, offering a different experience that may appeal to different types of users. Both HTPs and e-cigarettes have been found to be less addictive than conventional cigarettes, which has led to their promotion as tools for reducing smoking-related harm (Etter and Eissenberg, 2015; Vukas et al., 2023). However, the extent to which they can help smokers quit entirely remains a key question in the public health community.

Despite these potential health benefits compared to traditional smoking, the introduction of novel nicotine products has sparked debate among public health experts and policymakers. On one side of the debate, advocates argue that these products represent an important harm reduction tool for current smokers, offering an alternative to nicotine consumption and potentially facilitating smoking cessation. On the other side, critics warn that novel nicotine products may serve as an entry to traditional cigarette use, particularly among young people, or may be used in conjunction with conventional cigarettes, thus limiting their effectiveness in reducing overall nicotine dependence.

The ongoing debate surrounding the role of novel nicotine products in tobacco control is of great interest to policymakers. If these products are effective in helping smokers quit or significantly reduce their nicotine consumption, they could serve as tools in reducing the overall public health burden of smoking. However, several critical questions remain unresolved: How do consumers initiate their nicotine use with these products? Are dual users (those who use both cigarettes and novel nicotine products) increasing or reducing their overall nicotine intake? And ultimately, do novel nicotine products effectively aid in smoking cessation, or do they simply serve as complementary goods that maintain nicotine addiction?

In response to the market uptake of novel nicotine products, the Spanish government introduced the *"Plan Nacional de Prevención y Control del Tabaquismo 2024–2027"*, aiming to harmonize the regulation of novel nicotine products with that of traditional tobacco products (Ministerio de Sanidad, 2024). This regulatory approach treats all nicotine products the same, effectively assuming that novel nicotine products do not provide any additional benefits in terms of harm reduction or smoking cessation.

To assess whether the concerns of the Spanish government are justified and to answer the questions about novel nicotine products, we conducted the Risk Reduction Survey in 2024, surveying 1329 Spanish nicotine consumers on their consumption patterns. The survey aimed to determine whether novel nicotine products are used as complementary goods to harmful tobacco products or whether they serve as a viable alternative for reducing cigarette consumption or even helping smokers quit. This paper presents the findings of

this survey. Key areas of focus include the types of products smokers initially used, the average age of nicotine initiation, and the motivations behind switching to novel nicotine alternatives, such as perceived harm reduction and health concerns. The study also examined whether dual users are modifying their overall nicotine consumption and whether novel nicotine products are serving as effective tools for smoking cessation. It seeks to contribute to the discussion on the regulation of novel nicotine products and the role that novel nicotine products may play in improving public health outcomes in Spain.

In Chapter 2, we review the existing literature on the topic, identifying gaps in the consumption patterns of novel nicotine products in Spain. Chapter 3 details the methodology used in the study, including the design of the survey and the empirical techniques applied. Chapter 4 presents the descriptive and empirical results of the survey, while chapter 5 discusses the limitations of the study and proposes avenues for future research in this area. Chapter 6 concludes, and chapter 7 provides policy recommendations.

2. Literature review

The growing body of research on novel tobacco products suggests that these alternatives offer health benefits for smokers. E-cigarettes and HTPs are designed to deliver nicotine without the harmful byproducts associated with the combustion of tobacco, potentially making them safer options for nicotine delivery. Elias et al. noted that HTPs could expose users to fewer respiratory irritants and carcinogens, potentially lowering health risks associated with smoking (Elias et al., 2018). Additionally, Romaszko-Wojtowicz et al. support the finding that HTPs emit lower levels of toxicants compared to conventional cigarettes (Romaszko-Wojtowicz et al., 2021). These findings are supported by a range of health experts (Forster et al., 2018; Auer et al., 2017; Jaccard et al., 2017; Caruso et al., 2021; Zagoriti et al., 2020; Stephens, 2018). Scientific evidence on the reduced harmful exposure of novel nicotine products has led some health authorities to publish statements on their risk reduction potential, such as the U.S. Food and Drug Administration (FDA) (U.S. Food and Drug Administration, 2020), Japan's National Institute of Public Health (Bekki, 2017) and the Dutch National Institute for Public Health (Slob et al., 2020).

Despite the findings of a large body of research on the health risks of novel nicotine products, there exists a research gap on the transitional use patterns associated with these products among Spaniards. Whether Spanish smokers leverage these products complementary to their tobacco consumption or as a substitution tool – and in which phase of consumption – is of critical interest to policymakers as this is the base for less strict or stricter regulation than conventional cigarettes. So far, only a few international studies focused on the potential transitional phase when smokers pick up less harmful alternatives but are not yet able to quit smoking completely. Borland et al.'s findings indicate that among nicotine users in the U.S., Australia, and Canada, 80 % are exclusive smokers, 9 % are exclusive vapers, 3 % are dual daily users, 1 % concurrent non-daily users, 6 % predominant smokers and 1 % predominant vapers (Borland et al., 2019). Maglia et al. found that dual users consume e-cigarettes for smoking reduction, smoking cessation, and reduction of health risks (Maglia et al., 2018). Regarding young adults in the U.S., Yonek et al. found that users of e-cigarettes as a cessation strategy were significantly more likely to reduce smoking and achieve abstinence than non-users (Yonek et al., 2020). Similarly, examining a U.S. study, Berry et al. reported that e-cigarette users were more likely to attempt quitting and succeed in cessation and found a correlation between increased e-cigarette use and higher rates of smoking cessation in the general population (Berry et al., 2018). Brouwer et al. found that in the U.S., the share of dual users decreased between 2017–2021 as dual users transitioned to exclusive electronic nicotine delivery systems use, indicating a change in consumption patterns, where overall nicotine use persists but consumed in a less harmful way (Brouwer et al., 2024). These findings indicate that novel nicotine products reduce or support the cessation of conventional smoking products. However, the effectiveness of e-cigarettes as a cessation aid is not universally accepted. For example, Sweet et al. emphasized the need for more extensive population-based studies to clarify the relationship between e-cigarette use and smoking behavior in a study based on a U.S. cohort (Sweet et al., 2018).

Our paper aims to address the research gap on the consumption journey of novel nicotine products in Spain by presenting results of the Risk Reduction Survey, providing insights into the patterns of non-combustible alternative (NCA) use among current and former nicotine users. It is unique thanks to the detailed microdata it presents on the Spanish population and its detailed analysis of nicotine use history at an individual level.

3. Methodology

3.1. Data

The Risk Reduction Survey conducted in Spain aimed to understand patterns of tobacco consumption, focusing on traditional products including manufactured and roll-your-own cigarettes, as well as alternative nicotine products including e-cigarettes and HTPs. This survey targeted 1329 current tobacco users aged 15 and older, ensuring that the sample was representative of the country's population in terms of age and gender. The cross-sectional study utilized online, face-to-face, and telephone interviews, aiming to provide a comprehensive overview of tobacco use across the country.

One of the primary goals of the survey was to analyze the initiation age for different nicotine products. By tracking when individuals started using these products, potential intervention points for reducing nicotine uptake can be identified. Alongside this, the survey explored each participant's history and determinants of tobacco use, thereby providing important context for understanding consumption habits. Additionally, the survey examined use frequency and intensity, asking participants to report how often and how much they consumed various nicotine products.

The survey also collected detailed socio-demographic indicators including income, education, and employment status (see Table 1). This allowed assessing whether these variables influenced nicotine consumption patterns. Additionally, information was gathered on

participants' tobacco expenditures, the prevalence of chronic diseases, and the social context of nicotine use, such as smoking with friends or family.

Despite being a cross-sectional survey, the design enabled a longitudinal analysis by tracking initiation age, cessation age, and current age of participants. Thus, each individual's history of nicotine consumption could be mapped over time. This approach was also applied to analyze the intensity and frequency of dual use. Finally, the survey addressed participants' views on potential regulatory changes to the legal treatment of e-cigarettes and HTPs, and how such changes might impact their consumption behaviors. The findings from this survey provide valuable insights into the evolving landscape of tobacco use in Spain and offer critical data to inform future public health policies related to nicotine products.

3.2. Approach

Our analysis aims to track the nicotine consumption history of every participant based on their responses to the survey questions. The microdata generated from survey responses allowed us to construct "consumer journeys" according to the participant's use history. These consumer journeys are differentiated according to present and historic statuses with respect to nicotine consumption, initiation, smoking of combustible cigarettes, use of NCAs, dual use of cigarettes and NCAs, and cessation of nicotine consumption. We categorized these consumer journeys into nicotine use types to distinguish between main consumer behavior patterns. Although the survey includes 1329 respondents we ultimately considered 1307 respondents as 22 respondents did not report an initiation age. Thus, we dismissed those respondents as we could not track their history of consumption.

Table 1
Characteristics of the study population.

Variable	Participants		Variable	Participants	
	($N = 1329$)	[n (%)]		($N = 1329$)	[n (%)]
Gender			**Occupational activity**		
Male	663	49.9 %	Unemployed	66	5.0 %
Female	666	50.1 %	Householder	75	5.6 %
Age			Student	214	16.1 %
18 years and below	61	4.6 %	Retired	198	14.9 %
Between 18 and 25 years old	292	22.0 %	Public sector	160	12.0 %
Between 25 and 40 years old	338	25.4 %	Private sector	488	36.7 %
Between 40 and 65 years old	339	25.5 %	Self-employed	128	9.6 %
65 years and older	299	22.5 %	**Income**		
Education			<10,000 Euro	386	29.0 %
No education	40	3.0 %	10,000 Euro - 30,000 Euro	571	43.0 %
Primary Education	138	10.4 %	30,000 Euro - 50,000 Euro	119	9.0 %
Secondary Education	239	18.0 %	>50,000 Euro	18	1.4 %
Vocational training of intermediate level	148	11.1 %	No answer	235	17.7 %
High School Diploma	213	16.0 %	**Unhealthy drinking habits (rated from 1 not at all to 5 completely)**		
Higher Vocational Education	183	13.8 %	1	612	46.0 %
University education	368	27.7 %	2	370	27.8 %
Marital status			3	171	12.9 %
Single	647	48.7 %	4	50	3.8 %
Separated	33	2.5 %	5	32	2.4 %
Widowed	88	6.6 %	No answer	94	7.1 %
Divorced	97	7.3 %	**Unhealthy eating habits (rated from 1 not at all to 5 completely)**		
Married or Registered Partner	464	34.9 %	1	666	50.1 %
Place of Residence			2	326	24.5 %
Andalucía	120	9.0 %	3	171	12.9 %
Aragon	1	0.1 %	4	56	4.2 %
Autonomous Community of Navarra	120	9.0 %	5	11	0.8 %
Basque Country	3	0.2 %	No answer	99	7.4 %
Canary Islands	1	0.1 %	**Overweight or obese (rated from 1 not at all to 5 completely)**		
Cantabria	1	0.1 %	1	827	62.2 %
Castilla y León	340	25.6 %	2	248	18.7 %
Castilla-La Mancha	127	9.6 %	3	96	7.2 %
Catalonia	175	13.2 %	4	46	3.5 %
Community of Madrid	154	11.6 %	5	18	1.4 %
Extremadura	124	9.3 %	No answer	94	7.1 %
Galicia	3	0.2 %	**Diabetes (rated from 1 not at all to 5 completely)**		
Illes Balears	1	0.1 %	1	1018	76.6 %
Principality of Asturias	1	0.1 %	2	125	9.4 %
Region of Murcia	2	0.2 %	3	41	3.1 %
Valencian Community	156	11.7 %	4	19	1.4 %
Chronic disease			5	21	1.6 %
Yes	326	24.5 %	No answer	105	7.9 %
No	949	71.4 %			
No answer	54	4.1 %			

In a simple linear regression model following Pinto and Delgado, a set of subgroup-specific determinants X_i is used as independent variables to explore the factors driving each nicotine type (Pinto Hernández and Delgado-Rodríguez, 2023).

$$logit(p_T) = X_i + \varepsilon$$

The dependent variable of the logit regression design expresses the probability of belonging to a given type. The independent variable is a matrix that includes several variables. Using this design, two different regressions were carried out.

The first regression focuses on the probability of being an exclusive cigarette smoker without having ever used NCAs. With this indicator as the dependent variable $p_{ExclCCnoNCA}$, the matrix X_i of independent variables consists of the following factors: Whether any household member used cigarettes inside the home during the respondent's childhood; whether any household member used cigarettes outside the home during the same period; the age at which the respondent initiated nicotine use; whether the respondent usually smokes cigarettes in the company of others; the respondent's gender; the current age of the respondent; the presence of chronic disease; the respondent's net annual salary; the highest level of education attained; the current employment status; the current marital status; the community of residence; along with the health indicators of alcohol consumption, overweight status, diabetes status, and dietary habits.

The second regression focuses on the probability of being a dual user. With this indicator as the dependent variable $p_{Dualuse}$, the matrix X_i of independent variables contains all the factors from the first regression as well as the two additional variables of whether the individual uses e-cigarettes in the company of other people and whether the individual uses HTPs in the company of other people.

4. Results

4.1. Descriptive analysis

4.1.1. Nicotine consumption patterns

At the time of the survey, 4 % of our sample population were dual users, however, this figure cannot be translated to the entire Spanish population as the survey is not representative of overall nicotine use patterns, meaning it does not include non-nicotine users in the sample. Instead of estimating population-level prevalence rates, the survey rather aimed to determine the behavior behind using different products. Fig. 1 illustrates all potential consumer journeys of respondents from the survey, tracking their progression through three stages of nicotine consumption. By analyzing the initiation age and patterns of current and past consumption, it is possible to determine whether respondents have passed through multiple phases of the nicotine consumption journey. For instance, some individuals may remain in the initial phase, where they exclusively smoke cigarettes. Others, however, may transition to using

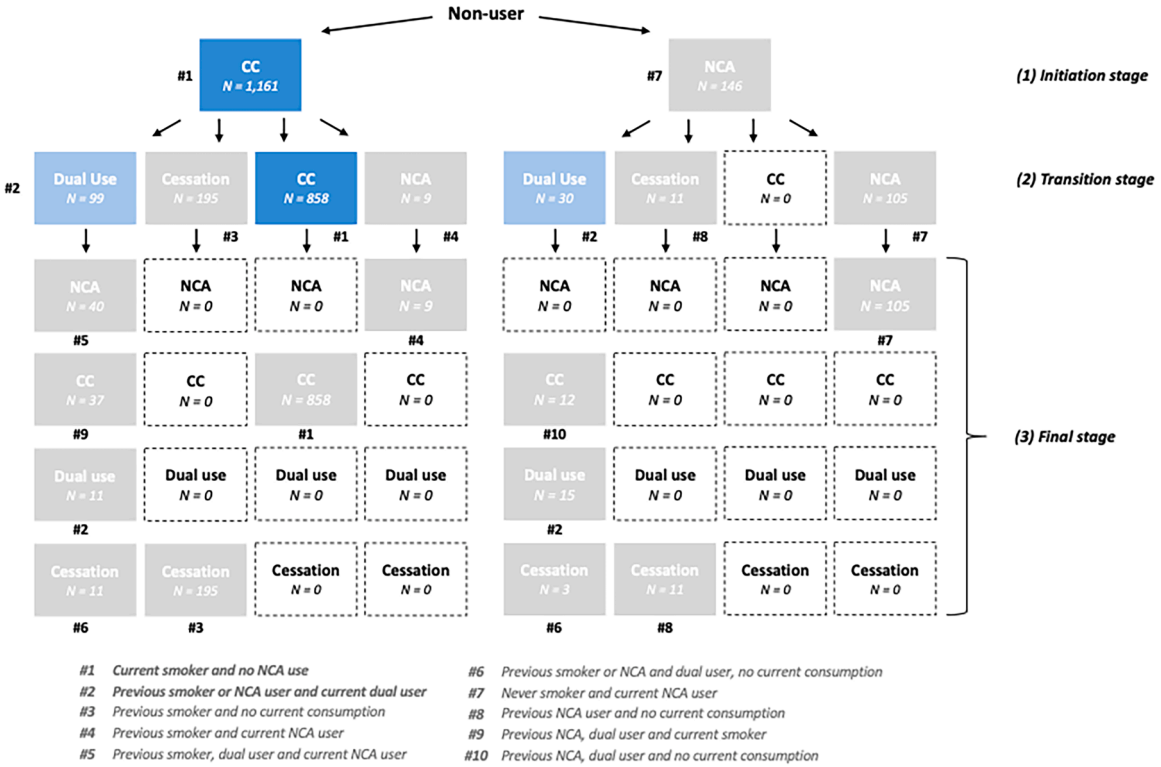

Fig. 1. Respondents' nicotine consumption patterns.

alternative nicotine products additionally, indicating that they have moved through two phases. In cases where individuals have progressed from exclusive smoking to dual-use to complete cessation of nicotine use, they have passed through three phases. This multi-phase process explains why the number of lifetime nicotine users exceeds the number of current users at the time of the survey, as former users are included as well.

Among 1161 respondents who initiated with cigarette smoking:

- 9 respondents transitioned directly from cigarette smoking to NCAs in the transition phase;
- 195 respondents ceased smoking altogether;
- And 99 individuals adopted e-cigarettes or HTPs, thus classified as dual users. Of these, 40 respondents transitioned from dual use to exclusive NCA consumption in the final stage, 37 switched back to exclusive smoking, and 11 quit nicotine use entirely.

Given the small proportion of respondents who initiated nicotine use with NCAs, numbers on the right-hand side of Fig. 1, which represents these individuals, remain marginal. 146 respondents initiated with NCAs and of those, 11 respondents stopped nicotine use entirely and 30 picked up smoking in the transition phase. Of those 30 dual users, 12 switched to exclusive smoking in the final stage and 3 stopped nicotine use entirely.

Due to the relatively small sample sizes for certain consumer types, the analysis in the following sections will focus on a comparison between exclusive smokers having never used NCAs, and dual users. This comparison aims to explore whether smokers tend to complement or substitute their cigarette consumption when adopting both combustible and non-combustible products.

4.2. Initiation

The survey data reveals that 89 % of respondents began their nicotine consumption with conventional cigarettes, whereas only 11 % initiated their journey using e-cigarettes or HTPs. This underscores the dominant role that traditional cigarettes have played as the primary entry point for nicotine use among the surveyed population.

Regarding the age of initiation, all current or former smokers reported starting their nicotine journey with cigarettes between the ages of 16 and 18. In contrast, those who began with NCAs as primary or secondary products typically started using these products at a later stage. Specifically, dual users reported an average age of 27 for initiating or switching to NCA use. This suggests a delayed uptake of alternative nicotine products compared to the earlier adoption of conventional cigarettes.

4.3. Average consumption

The data indicate distinct differences in consumption patterns between exclusive smokers and dual users, providing insights into how the introduction of NCAs may impact nicotine use behavior. Exclusive smokers, on average, consume cigarettes five days per week, while dual users smoke only three days per week. Although dual users also use NCAs three days per week, the likely overlap between these days of cigarette and NCA consumption suggests that dual users may maintain a similar frequency of overall nicotine use compared to exclusive smokers.

Moreover, the introduction of NCAs appears to reduce the intensity of harmful cigarette use. Exclusive smokers report consuming 136 packs of cigarettes per year, whereas dual users smoke significantly less, averaging only 90 packs annually – a 34 %-reduction in cigarette consumption. This shift away from cigarettes reflected in the intensity of use serves as a more meaningful indicator of potential health effects than the frequency of use.

In addition to their cigarette consumption, dual users also consume an average of 118 pack-equivalents of NCAs annually. To estimate NCA consumption, respondents were asked to report their use of HTP sticks, disposable e-cigarettes, and pre-filled cartridges, as well as the number of times they refilled their e-cigarette cartridges in the past week. Given the variability in e-cigarette cartridge sizes and nicotine levels, comparisons between NCA units and cigarette sticks are challenging. For simplicity, we assume that one cigarette is equivalent to one HTP stick or one disposable e-cigarette, while 20 cigarettes equal one refillable or pre-filled e-cigarette cartridge. This assumption helps standardize the comparison, though further exploration of these limitations is discussed in the limitations section of the study.

In summary, the data suggest that dual users are gradually replacing cigarettes with NCAs, potentially reducing the harmful impact of cigarette smoking by substituting some of their consumption with less harmful alternatives.

4.4. Lifetime consumption

We also investigated a sample of nicotine users who have consistently used nicotine over the past five years. The five-year period was chosen to capture trends that reflect the introduction and market establishment of HTPs, which were launched in 2016 (Golpe et al., 2022). It provides a relevant timeframe for observing shifts in consumption patterns.

For exclusive smokers, the total consumption over this period amounted to 864 cigarette packs on average. In contrast, dual users, both those who smoked and used NCAs before or within the past five years, demonstrated a significant reduction in cigarette consumption. Dual users reduced their smoking by 42 %, consuming only 504 cigarette packs during this time.

In addition to cigarette consumption, dual users consumed the equivalent of 345 packs of NCAs over the five years. Although comparing NCAs to cigarette packs remains complex, as outlined in the previous section, the data suggest that total nicotine consumption declines with dual use. Specifically, the combined consumption of cigarettes and NCAs among dual users totaled 849 pack

equivalents, compared to the 864 packs consumed exclusively by smokers. This indicates a modest reduction in overall nicotine use when individuals transition from solely smoking cigarettes to incorporating NCAs into their consumption habits.

These findings suggest that the uptake of NCAs may contribute to a reduction in harmful cigarette consumption and, a slight overall decline in nicotine use over time, illustrated in Fig. 2.

4.5. Cessation with NCAs

Among all dual users in the survey sample, nearly 19 % have successfully stopped nicotine consumption entirely. Additionally, among those who initiated nicotine use with NCAs, 8 % have already quit using nicotine altogether. While these percentages seem modest, it is important to consider that the relatively recent market introduction of NCAs limits the time for long-term cessation outcomes to manifest. In other words, the transition period may take a few years from initiation with cigarettes to dual-use to cessation, particularly for long-term smokers. These early cessation rates may serve as an indicator that NCAs can play a role in facilitating the quitting process for smokers.

4.6. Motivation for using NCAs

The survey data reveals notable differences in the motivations for using HTPs versus e-cigarettes. Among current and former HTP users, 44 % reported that they consume HTPs to quit or reduce their smoking, while 48 % indicated that they use HTPs because they perceive them to be less harmful or less addictive than traditional cigarettes. In contrast, 16 % of current and former e-cigarette users reported using e-cigarettes to quit or reduce smoking, and 34 % stated that they use e-cigarettes because they are perceived to be less harmful or less addictive. These findings suggest that HTP users may consider HTPs as a more effective substitute for cigarettes. This perception may contribute to the preference for HTPs as a tool for reducing or quitting smoking.

Additionally, 43 % of all respondents indicated that they would consider quitting smoking (that is, they would stop consuming combustible products) if legislative circumstances were to change. Among these individuals, 48 % responded that they would quit smoking if cigarette prices increased, 5 % stated they would quit cigarettes if NCAs became more affordable, and 7 % said they would quit cigarettes if NCAs were less strictly regulated than cigarettes – for instance, if they were permitted in smoke-free environments. These findings highlight the importance of external factors, such as pricing and regulatory environments, in influencing smokers' decisions to quit and their potential shift toward NCAs.

4.7. Expenditure

The high prices of tobacco products place a significant financial burden on households, reducing the disposable income available for essential needs. Exclusive smokers spend an average of 26 Euros per week on cigarettes, amounting to an annual expenditure of 1400 Euros. Dual users spend more, with an average of 34 Euros per week, resulting in annual costs of 1800 Euros.

This difference in spending may be due to the more costly components and production costs of NCAs resulting in higher before-tax

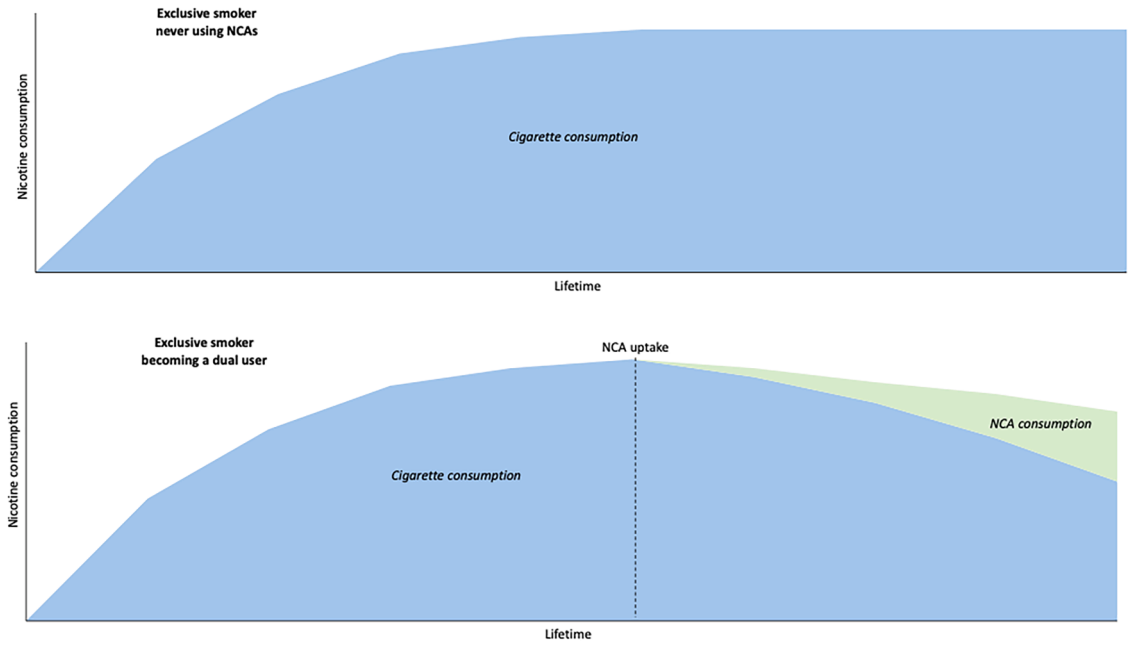

Fig. 2. Illustration of the declining cigarette and total nicotine levels when smokers pick up NCAs.

prices than cigarettes. As a result, dual users face a greater financial outlay for their nicotine consumption, despite consuming less harmful products.

This raises questions about the application of "sin taxes" by the Spanish government, which are typically justified on the basis of discouraging harmful consumption. Since dual users are reducing their intake of more harmful cigarettes by incorporating NCAs into their nicotine use, the higher cost they face would be inconsistent with the public health rationale behind such taxes.

4.8. Empirical analysis

4.8.1. Exclusive smoker without experiencing NCAs

The linear regression analysis provides insights into the factors that influence whether an individual maintains exclusive smoking behavior or transitions to dual use (see Table 2). Several variables were found to significantly increase the likelihood of remaining an exclusive smoker without ever using NCAs. One of the significant predictors was exposure to family members smoking cigarettes outside the home during childhood, suggesting that early social environments play a key role in shaping smoking habits. Individuals who started smoking at a relatively older age were more likely to remain exclusive smokers. Social contexts of smoking, such as smoking cigarettes in the company of other people, and a higher current income also reinforced exclusive smoking behavior. Health conditions like chronic illness, being overweight, and having diabetes were all associated with a higher likelihood of exclusive smoking.

In addition, certain factors were found to decrease the likelihood of being an exclusive smoker and never picking up NCAs. Women were less likely to be exclusive smokers and a higher age at the time of the survey also reduced the likelihood of exclusive smoking. Education played a significant role, with those having higher levels of education less likely to be exclusive smokers. Finally, unhealthy eating habits were associated with a lower likelihood of being an exclusive smoker. The contradictory influence of unhealthy eating habits and lower likelihood of smoking as well as obesity and higher likelihood of smoking suggests that at least one of these indicators could be affected by self-selection bias. As respondents self-assess their health status, they might overestimate their health status and select healthy eating habits while being overweight, or vice versa. These predictors should therefore be treated with caution.

4.8.2. Dual user

Several variables significantly increase the likelihood of an individual becoming a dual user (see Table 3). Again, it includes having a family member who smoked cigarettes outside the home during childhood. Additionally, dual users are more likely to have social smoking behaviors, such as regularly smoking cigarettes, using HTPs, or using e-cigarettes in the company of others. Age at the time of

Table 2
Regression table for predictors of being an exclusive smoker without ever having experienced NCAs.

Variable	Coefficient	Standard Error	P-value	Confidence Interval Lower Bound	Confidence Interval Upper Bound
Intercept: Being an exclusive smoker without having experienced NCAs	2.23	0.14	0.00***	1.96	2.50
Member(s) of the household used cigarettes inside the home during childhood	0.00	0.05	0.99	−0.10	0.11
Member(s) of the household used cigarettes outside the home during childhood	0.39	0.06	0.00***	0.28	0.50
Initiation age	0.01	0.00	0.00***	0.01	0.02
Usually smoke cigarettes in the company of other people	3.40	0.06	0.00***	3.28	3.51
Gender (male = 0)	−0.09	0.04	0.03**	−0.17	−0.01
Age	−0.07	0.00	0.00***	−0.07	−0.06
Suffer from a chronic disease	0.59	0.05	0.00***	0.49	0.69
Net annual salary	0.09	0.02	0.00***	0.06	0.12
Education level (no education = 0)	−0.13	0.01	0.00***	−0.15	−0.10
Occupation status (unemployed = 0)	−0.02	0.01	0.12	−0.05	0.01
Marital status (single = 0)	0.28	0.01	0.00***	0.25	0.30
Residence (Andalucía = 0)	−0.08	0.01	0.00***	−0.09	−0.07
Unhealthy drinking habits	−0.18	0.03	0.00***	−0.23	-0.13
Being overweight or obese	0.16	0.02	0.00***	0.11	0.21
Having diabetes	0.18	0.02	0.00***	0.13	0.22
Unhealthy eating habits	−0.13	0.03	0.00***	-0.18	−0.08
Model fit					
Pseudo R-squared (McFadden)	0.34				
AIC	16,669.98				
BIC	16,812.09				
Log-Likelihood	−8317.99				
No. Observations	31,546.00				
Df Residuals	31,529.00				
Df Model	16.00				

*$p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

the survey also plays a role, with older individuals being more likely to adopt dual-use habits, most likely because NCA initiation occurs at an older age. Higher levels of education and alcohol consumption, as well as an unhealthy diet, were also linked to a greater likelihood of becoming a dual user.

Conversely, certain factors significantly decrease the likelihood of dual use. Individuals who started smoking at an older age are less likely to incorporate NCAs into their smoking behavior. Those with higher incomes and individuals who are overweight also showed a reduced likelihood of becoming dual users. Again, self-assessed health conditions should be treated with caution due to self-selection biases.

The analysis highlights the importance of socioeconomic factors in shaping nicotine consumption patterns. Notably, individuals with lower levels of education are less likely to substitute smoking with less harmful alternatives, underscoring the role of education in shaping health-related behaviors. Additionally, individuals with chronic illnesses and obesity, who are at higher risk of health complications, are less likely to engage in dual use, which suggests that these groups may be less inclined or able to adopt alternatives to smoking. These findings point to the need for targeted public health interventions that address both educational disparities and the needs of individuals with additional health risk factors.

5. Discussion

In this study, respondents were asked about their use of four product types: manufactured cigarettes, hand-rolled cigarettes, HTPs, and e-cigarettes. These products are the most popular in Spain, however, the increasing uptake of other novel nicotine products, such as nicotine pouches, highlights the need for future studies to include a broader range of products as they evolve in the market.

Respondents were asked to complete the questionnaire themselves, which may have introduced self-selection bias, potentially leading to over- or underestimation of their nicotine use or health status. However, this is a common limitation in survey-based research and is difficult to completely eliminate. Efforts to mitigate this bias, such as clear instructions and anonymity, were made, but some degree of bias remains inherent in self-reported data.

Respondents were asked to report the number of weekly consumed manufactured cigarettes, hand-rolled cigarettes, HTP sticks, disposable e-cigarettes, pre-filled e-cigarette cartridges, and the number of times they refilled their e-cigarette cartridges. However, determining an exact equivalence between these different forms of nicotine delivery remains a challenge, particularly as the sizes and nicotine levels of e-cigarette cartridges vary widely. To simplify the analysis, the study assumed that one cigarette is equivalent to one HTP stick or one disposable e-cigarette, and that 20 cigarettes equal one refillable or pre-filled e-cigarette cartridge (Marsh, 2023; Ichor

Table 3
Regression table for predictors of being a dual user.

Variable	Coefficient	Standard Error	P-value	Confidence Interval Lower Bound	Confidence Interval Upper Bound
Intercept: Being a dual user	−7.22	0.51	0.00***	−8.22	−6.21
Member(s) of the household used cigarettes inside the home during childhood	−0.09	0.16	0.56	−0.40	0.21
Member(s) of the household used cigarettes outside the home during childhood	0.48	0.17	0.01***	0.14	0.82
Initiation age	−0.07	0.02	0.00***	−0.11	−0.03
Usually smoke cigarettes in the company of other people	1.67	0.15	0.00***	1.37	1.97
Usually use HTPs in the company of other people	4.48	0.22	0.00***	4.05	4.90
Usually use e-cigarettes in the company of other people	4.27	0.17	0.00***	3.93	4.60
Gender (male = 0)	0.16	0.13	0.24	−0.11	0.42
Age	0.03	0.01	0.00***	0.02	0.05
Suffer from a chronic disease	−0.13	0.17	0.45	−0.45	0.20
Net annual salary	−0.20	0.06	0.00***	−0.33	−0.08
Education level (no education = 0)	0.12	0.04	0.00***	0.04	0.20
Occupation status (unemployed = 0)	−0.02	0.04	0.72	−0.10	0.07
Marital status (single = 0)	−0.22	0.04	0.00***	−0.30	−0.13
Residence (Andalucía = 0)	0.01	0.02	0.71	−0.03	0.04
Unhealthy drinking habits	0.17	0.07	0.01**	0.03	0.31
Being overweight or obese	−0.22	0.10	0.03**	−0.42	−0.02
Having diabetes	−0.17	0.13	0.20	−0.43	0.09
Unhealthy eating habits	0.28	0.08	0.00***	0.13	0.44
Model fit					
Pseudo R-squared (McFadden)	0.34				
AIC	2399.70				
BIC	2558.53				
Log-Likelihood	−1180.85				
No. Observations	31,546.00				
Df Residuals	31,527.00				
Df Model	18.00				

*$p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Liquid, 2024; Ecigator, 2023). While this assumption simplifies the comparison between cigarettes and NCAs, it inevitably overlooks the complexity of product differences. One potential improvement would be to ask questions about the specific types of products respondents use, and to estimate their nicotine levels, translating that into cigarette-equivalent units. However, this approach is complicated by the fact that many consumers may not be aware of the exact nicotine content or specific product types they are consuming.

A limitation of the study is the broad estimation of current age, as respondents provided age ranges rather than specific figures. A more precise reporting of age would allow for a clearer understanding of participants' nicotine consumption histories, which is particularly important for analyzing the progression of nicotine use over time. The study design also restricts the ability to capture more complex switching behaviors. For instance, if someone quit smoking, then stopped and later resumed, or switched among several nicotine products over time, these transitions are not fully captured by the questionnaire. Capturing more detailed histories would require an expanded and more complex set of questions, potentially increasing the burden on respondents.

To gain deeper insights into nicotine consumption patterns and the adoption of new products, future studies would benefit from longitudinal designs. Tracking the same respondents over several years would allow for a more comprehensive understanding of how nicotine use evolves, how product switching occurs over time, and the impact of novel nicotine products on smoking behavior. Longitudinal studies would thus be crucial for capturing the dynamic nature of nicotine consumption and providing more robust data to inform public health strategies.

6. Conclusion

At the time of the survey, 4 % of our sample population were dual users. This figure cannot be directly translated to the entire Spanish population as the survey is not representative of overall nicotine use patterns, meaning it does not include non-nicotine users in the sample. Instead of estimating population-level prevalence rates, the survey aimed to determine the behavior behind using different products. Our survey shows that most nicotine users start with conventional cigarettes, but when smokers pick up NCAs and become dual users they gradually replace cigarettes with NCAs. Over a five-year period, dual users not only reduced cigarette consumption but also experienced a slight decline in total nicotine use. Moreover, 44 % of HTP users and 16 % of e-cigarette users reported using these products to quit or reduce smoking. Additionally, 43 % of respondents indicated they would consider quitting smoking if external factors, such as prices or regulations, changed. Despite their reduced harm, dual users spend more on nicotine products due to the higher costs associated with NCAs, raising questions about the justification of high taxes on these less harmful alternatives.

7. Policy implications

The findings indicate that dual use is often a transition phase in the smoking cessation process, indicating that smokers gradually move from cigarettes to dual-use before quitting altogether. This suggests that governments should implement policies that incentivize smokers to switch to less harmful alternatives, even if they initially become dual users. By recognizing dual use as part of the cessation journey, policymakers can better support smokers in reducing harm, particularly for the most vulnerable smokers. In fact, the survey revealed that 43 % of smokers would reduce their cigarette consumption under different regulatory conditions. Thus, instead of applying the same policy approach to NCAs and cigarettes, as the Spanish government currently intends to do, legislators should differentiate among the different products.

Future regulatory decisions should consider several key factors. First, protecting young people is crucial, as most smokers start with conventional cigarettes at an early age. Measures that limit adolescent access to cigarettes and restrict the availability of appealing disposable and flavored e-cigarettes are important steps. Second, fiscal policies should encourage smokers to switch to less harmful alternatives by making e-cigarettes and HTPs more affordable. This could be achieved by adjusting tax rates to favor these products over traditional cigarettes, as research shows that pricing and taxation are effective in influencing consumer behavior. For instance, studies like those by Pinto & Delgado (2023) have demonstrated that tobacco taxes can guide consumers toward less harmful products by making them more attractive from an economic point of view.

Third, in addition to fiscal measures, differentiated regulatory frameworks are needed to encourage the adoption of alternatives as cessation tools. For example, allowing the use of HTPs in smoke-free environments would make these alternatives more appealing, promoting a transition away from conventional cigarettes. By creating a regulatory environment that is less stringent for safer alternatives, governments can complement price incentives and further motivate smokers to switch. Such measures are supported by a share of NCA users who stated in the survey they would reduce or quit smoking if HTPs or e-cigarettes were preferred in regulatory and fiscal treatment.

Finally, awareness-raising efforts are essential to target high-risk groups, particularly older and chronically ill smokers. Health campaigns and counseling services that promote e-cigarettes and HTPs as viable alternatives can help these individuals reduce their cigarette consumption. Spain could learn from successful initiatives in the UK, such as "Stoptober" and "No Smoking Day," which have effectively used peer support and community engagement to encourage smoking cessation (Today is the Day, 2024; Public Health England, 2018; Jamie and Martin, 2022). These education efforts can be adapted to emphasize the benefits of novel nicotine products, leveraging social dynamics to motivate smokers to transition to less harmful alternatives.

In conclusion, by integrating fiscal, regulatory, and awareness-raising measures, policymakers can better support smokers in transitioning away from traditional cigarettes and reduce the overall public health burden of smoking.

CRediT authorship contribution statement

Alfredo Cabezas-Ares: Methodology, Investigation, Data curation. **Fernando Pinto-Hernández:** Formal analysis, Data curation, Conceptualization. **María Jesús Delgado-Rodríguez:** Methodology, Investigation, Conceptualization.

Declaration of interests

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.

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