

Estimation of the global number of vapers: 82 million worldwide in 2021

Tomasz Jerzyński and Gerry V. Stimson

Abstract

Purpose – Nicotine is consumed by one in five of the global adult population, mostly by smoking tobacco cigarettes. Modern electronic cigarettes came onto the market from around 2007 and have considerable potential to improve population health by displacing tobacco smoking. The purpose of this study is to map the use of e-cigarettes, but this is difficult due to absence of data sources for many countries.

Design/methodology/approach – The global number of vapers was estimated to be 68 million in 2020. New data in 2021 offered an opportunity to update that estimate. The method of assumed similarity was used for countries with missing data. The average prevalence of vaping was calculated for each World Health Organization region, World Bank income classification group and the legal status of e-cigarettes in each country. The number of vapers was calculated for the adult population. The estimate was refined by adjusting for changes in market value size and the actual year of surveys.

Findings – Population prevalence data on e-cigarette used were available for 48 countries. We estimate that there were 82 million vapers worldwide in 2021: 9.2 million in the Eastern Mediterranean region; 5.6 million in the African region; 20.1 million in the European region; 16.8 million in the Americas; 16.0 million in the Western Pacific region; and 14.3 million in South-East Asia.

Originality/value – Global, regional and national estimates of the numbers of vapers are important indicators of trends in nicotine use, and monitoring the uptake of vaping is important to inform international and national policy.

Keywords E-cigarettes, Nicotine, Vaping, Tobacco harm reduction, Prevalence, Estimation

Paper type Research paper

Purpose

Nicotine is one of the most popular drugs in the world, along with alcohol and caffeine and is used by around 22% of the global adult population (WHO, 2022). Nicotine is consumed in a wide variety of ways including by smoking in cigarettes, pipes, cigars, bidis and water pipes, orally by sucking or chewing tobacco, nasally as snuff and more recently by a range of newer non-combustible delivery systems such as vapes, heated-tobacco-products and non-nicotine pouches. Most people consume nicotine by smoking cigarettes, which accounted for about 93% of the global nicotine market by retail sales value in 2020 (Global Trends in Nicotine, 2021).

The World Health Organisation (WHO) estimates that there are almost a billion (984 million) smokers worldwide or about one-fifth of the adult population (WHO, 2021a). This figure has not changed significantly since 2000. Declines in smoking prevalence in some countries and population groups have been offset by increases in other countries, as well as by population growth. About 80% of smokers live in low- and middle-income countries, and 46% live in three countries – China, India and Indonesia (World Population Prospects, (2019); WHO, 2021a).

The combustion of tobacco releases harmful toxins: around 4,000 chemicals are released by burning including carbon monoxide and many known carcinogens. The health consequences of smoking are estimated to be 8 million premature deaths from smoking-related diseases

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each year (Murray *et al.*, 2020), which is three times more than the number who die from malaria, HIV and tuberculosis combined and 14 times higher than the estimated numbers of deaths each year from illicit drugs (500,000, of which 70% are related to the use of opioids) (World Health Organization, 2021). Smoking is therefore a major avoidable cause of non-communicable diseases.

A wide range of measures has been proposed and introduced to prevent and reduce smoking. The international treaty on tobacco – the Framework Convention on Tobacco Control – acknowledges the role of demand reduction, supply reduction and harm reduction in tobacco control, but the major emphasis on international and national strategy has been to focus on reducing consumption by demand and supply measures – such as taxation, education and information and cessation treatment. The package of measures is known by the WHO acronym MPOWER – Monitoring tobacco use and prevention policies, Protecting people from tobacco smoke, Offering help to quit tobacco use, Warning about the dangers of tobacco, Enforcing bans on tobacco advertising, promotion and sponsorship and Raising taxes on tobacco. There has, globally, been inadequate implementation of many MPOWER measures with for example only around 30% of the global population having access to cessation services to help quit tobacco use, mainly in richer countries (WHO, 2021b). Strengthening the implementation of the framework convention on tobacco control (FCTC) is one of the UN Sustainable Development Goals, as measured by the age-standardized prevalence of current tobacco use among persons 15 years of age and older (UN, 2020).

Harm reduction options for smokers to consume nicotine without combustion changed significantly with the invention of the modern electronic cigarette (Shapiro, 2022). E-cigarettes containing nicotine came onto the market in Europe and North America from around 2007 onwards. They do not burn tobacco and emit no toxic smoke, producing substantially safer vapour instead. Before this, the only harm reduction options for smokers were nicotine replacement therapy products (such as nicotine gums and patches) and – in some countries – Swedish style snus or other lower risk oral tobaccos (GSTHR, 2022a).

The term “e-cigarette” is commonly used in the sources cited in this article. E-cigarettes are also known as “vaping devices”, “vaping products” or “vapes” and the people who use them “vapers”. This nomenclature is to differentiate them both from combustible cigarettes and other electronic non-combustible nicotine delivery systems (such as heated tobacco products). “Nicotine-Vaping Product” (NVP) is a term used to distinguish use of vaping devices containing nicotine from devices used for consuming other substances such as cannabis products. We use the term “Safer Nicotine Products” (SNP) to refer to a generic class of non-combustible nicotine products, including nicotine vapes, Swedish style snus, non-tobacco nicotine pouches (Patwardhan and Fagerström, 2022) and heated tobacco products (Tattan-Birch *et al.*, 2022).

The rise in vaping has been associated with public, political and scientific debates about their relative toxicity compared with cigarettes (Chun *et al.*, 2017; Münzel *et al.*, 2020), their short medium- and long-term impacts on the health (DeVito and Krishnan-Sarin, 2018; Sobczak *et al.*, 2020), the role of flavours (Patten and De Biasi, 2020) and the potential for uptake by young people and never smokers (Soneji *et al.*, 2017; Bernat *et al.*, 2018). However, there is growing consensus that NVP are significantly safer than smoking. The largest independent report, commissioned by the UK Office for Health Improvement and Disparities found that vaping poses only a small fraction of the health risks of smoking: levels of exposure to cancer causing and other toxicants are drastically lower in people who vape compared with those who smoke (McNeill *et al.*, 2022).

NVP and other SNP have considerable potential to improve population health by displacing tobacco smoking. The use of SNP is a core element of tobacco harm reduction, where smoking or the use of toxic oral tobaccos can be substituted by safer, non-combustible products (GSTHR, 2022c).

A key question then is whether SNP are replacing tobacco cigarettes or whether they are supplementary to smoking (sometimes referred to as “dual use”). This requires information on the dynamics of smoking and NVP use within countries. There is no single method for assessing this and we are unaware of studies that have specifically addressed the issue. Multiple methods of within country assessment might include repeat population tracking studies and panel studies measuring transitions between products.

Given the lack of information about the dynamics of nicotine use, inferences must be made from trends in smoking and NVP use. But, there are data deficiencies both for smoking and more so for NVP use. The main sources of information for estimating changes in NVP use are market data and prevalence studies. Market data – in terms of items of products sold or market value – are generally unavailable publicly on a country level. They are also difficult to interpret epidemiologically, as they relate to units and value, not numbers of consumers, hence cannot readily be converted to population prevalence data. Ideally, global estimations of vaping should be based on robust country level surveys. Mapping the population prevalence of the use of e-cigarettes is therefore important, but it is difficult for many countries due to the cost and logistics of population surveys. Less than half of the global adult population is covered by surveys of e-cigarette use (Jerzyński *et al.*, 2021). Coverage is highest in high- and upper middle-income countries. This paper attempts to address the issue of data deficiency on NVP use, at a global level.

Estimating the country and global prevalence of health data has been driven by increasing interest in monitoring global health progress, including monitoring of Sustainable Development Goals (AbouZahr *et al.*, 2017). Given the paucity of health data in many countries, this has led to the development of various methods for estimating missing data. Data for health indicators suffer many shortcomings, including the absence of appropriate methodologically sound surveys and variations in definition and measurement. Nearly all global indicators and many country level indicators encounter partial or missing data. Global health estimates usually produce information for all countries even where national data are missing. This is done by generating statistical models using information from countries with data, including other country level variables, and then estimating for countries with missing data based on assumed similarity (e.g. geography, GDP, World Bank [WB] classification) (AbouZahr *et al.*, 2017).

Method used to estimate of the global number of vapers in 2020

The global state of tobacco harm reduction (GSTHR) project (<https://gsthr.org/>) collects information on the prevalence of NVP use and use of other SNP. The project provides global, regional and national reporting on the availability and use of SNPs and related regulations. The project collects information from research publications and government, and NGO reports and information is also gathered through a network of national and regional correspondents in 201 countries (262 including territories and significant regions within a country). The GSTHR database compiles country-based information over time and product categories (GSTHR, 2022b).

The GSTHR project published the first global estimate of the number of NVP users, which stood at 68 million in 2020 (Jerzyński *et al.*, 2021). The 2020 figure was derived in two stages, firstly, an estimation of the global population of e-cigarette users using 2018 data and then a projection to 2020 using adjustment for market value data.

Data on e-cigarette use were available from 49 countries up to 2018. The way in which e-cigarette use is assessed varied across studies. For example, Eurobarometer asks respondents to choose from one of a range of responses (“you currently use it”, “you used to use it but you have stopped”, “you have tried only once or twice” or “you have never used it”) and for those who currently use it asks a supplementary question on frequency of use

(“every day”, “every week”, “every month”, “less than monthly” or “you have tried only once or twice”). Another wording, but also based on the term “current use”, was used in Global Adult Tobacco Surveys. It asked “do you currently use electronic cigarettes or any other vaping device on a daily basis, less than daily, or not at all?” and respondents could check “daily”, “less than daily” or “not at all”. In most cases, the statistics reported in this field concerned current use. Hence, in our study, we also extracted data referring to current use.

To estimate global numbers, we used the method of assumed similarity which is commonly used in global health estimates where there is an absence of data at country level (Fuller, 1974; Mandell, 1974; Little and Smith, 1987; Rubin, 1987; AbouZahr *et al.*, 2017). This assumes that countries that share characteristics will have similar health metrics. This allows imputation of unknown trait values from the aggregate values in countries where they are known. This method has been used to estimate the prevalence of drug injecting (Aceijas *et al.*, 2004), mortality associated with pandemic influenza in 2009 (Verity *et al.*, 2020) and the severity of coronavirus disease (Verity *et al.*, 2020). The method is used by WHO and other UN agencies and donors to generate global and national estimates from a variety of sources on a wide range of characteristics, in particular the level and dynamics of demographic and social indicators such as population, fertility and mortality (Boerma and Mathers, 2015).

For our analysis, we used the WHO region, the WB income classification and the legal status of NVP.

Regarding legal status, there are numerous ways in which e-cigarettes are controlled or regulated (and more often not). The top-level categorisation of legal status used in our GSTHR database is: “Allowed” which means that there is some specific law or regulation that permits the marketing, sale, purchase and use of the product (and which might include for example product registration and quality control, product specification, age of purchase, place of purchase and use in public places) – globally 75 countries; “Banned” which means that there is some specific or legacy law which prohibits marketing or use of the product – globally 36 countries; and “Not regulated” which means that there is no specific law or regulation regarding the product – globally 85 countries (Shapiro, 2020, p. 113).

Using the information available from the surveys, we calculated the average prevalence of vaping for each WHO region, the WB income classification group and the legal status of e-cigarettes from our own database (Table 1). The intersection of these factors allowed us to separate 72 subgroups (four income groups, six regions and three types of legal regulation). The average prevalence of vaping was calculated for each group. The calculated values were used as proxies for prevalence data in countries where this information was unknown. Each of the 72 calculated values was assigned to a country using known values of the grouping factors. We calculated the number of vapers by taking the total adult population (over 15 years of age) obtained from the UN database for 2018 (World Population Prospects, 2019). There were 40.3 million vapers in the 49 countries with available survey data. The estimation procedure indicated 17.8 million vapers living in 152 countries where information on NVP prevalence was unavailable. This gave an estimated total of 58.1 million vapers worldwide in 2018.

In the second stage, estimates were projected to 2020. Most of the survey data allowed for the calculation of an estimate for 2018 (32 studies were from 2017 or 2018, 14 earlier and 3 later). Therefore, the data were adjusted to arrive at estimates for 2020. This was done by reference to data on market growth of NVP. Based on data on e-cigarette market value reported by Statista (Statista, 2020), we tracked changes in global revenues in the e-cigarette market and adjusted the 2018 figure using annual market data to arrive at an estimate for 2020 of 68 million vapers globally (Jerzyński *et al.*, 2021).

Method used to estimate the global number of vapers in 2021

As in our previous estimate, we used information on the prevalence of vaping in known countries to impute the prevalence of vaping in countries where this information was

Table 1 Mean per cent prevalence of e-cigarette use by legal status, WHO region and WB income group

Factor	Mean	N	Country
<i>Legal sales status</i>			
Allowed	2.4	40	Austria, Belgium, Bulgaria, Canada, China, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malaysia, Malta, The Netherlands, New Zealand, Philippines, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Taiwan, United Arab Emirates, United Kingdom, United States
Banned	1.0	5	Australia, Brazil, Colombia, Japan, Mexico
Not regulated	1.8	3	Bangladesh, Kazakhstan, Russian Federation
<i>WHO regions</i>			
African	–	0	
Americas	2.0	6	Brazil, Canada, Colombia, Costa Rica, Mexico, United States
Eastern Mediterranean	5.0	1	United Arab Emirates
European	2.3	32	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, United Kingdom
South-East Asia	0.2	1	Bangladesh
Western Pacific	1.8	8	Australia, China, Hong Kong, Japan, Malaysia, New Zealand, Philippines, Taiwan
<i>WB income groups</i>			
High-Income	2.7	33	Australia, Austria, Belgium, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, New Zealand, Poland, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Sweden, United Arab Emirates, United Kingdom, United States
Upper Middle Income	1.0	13	Brazil, Bulgaria, China, Colombia, Costa Rica, Hong Kong, Hungary, Kazakhstan, Malaysia, Mexico, Romania, Serbia, Taiwan
Lower Middle Income	0.8	1	Philippines
Low Income	0.2	1	Bangladesh

Source: Table by authors

missing. Some new data has been released following our previous estimate. The largest was the *Special Eurobarometer 506* (27 EU Member States), published in February 2021 ([European Commission, 2021](#)). Additional new datapoints also include the UK, New Zealand, Taiwan and the USA. This created a new source data set of 51 countries

with general population surveys reporting prevalence of daily or current use of e-cigarettes (references to the data sources are in the supplementary document titled “Surveys on vaping.docx”).

There were three questionable data points in the new data set: Tonga, Uganda and Jordan. The information from these countries did not have a trusted source and indicated an implausible high level of use. Due to the poor availability of other data for their regions and income groups, their impact on all countries sharing their characteristics was very high. We therefore omitted these countries from the analysis when calculating average prevalence levels for each subgroup. Thus, 48 countries remained in our data set. Most of the new information on prevalence of vaping came from surveys conducted in 2020–2021 (66.7%).

The estimation for 2021 was based on the same assumptions and methods and has the same limitations as described in our previous work. The main problems are the under-representation of surveys from the African, South-East Asian and Eastern Mediterranean regions and the under-representation of lower-income countries. Results for these countries may be distorted and inaccurate.

We calculated the average prevalence of vaping for each WHO region, WB income classification group and the legal status of the sale of e-cigarettes and then imputed this for countries where information on the prevalence of vaping was unknown. We also tested the matching procedure by adding further country characteristics – the Human Development Index and GDP.

Analysis

The surveys covered 48 countries: Australia, Austria, Bangladesh, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Ireland, Italy, Japan, Kazakhstan, Latvia, Lithuania, Luxembourg, Malaysia, Malta, Mexico, The Netherlands, New Zealand, Philippines, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Taiwan, Uganda, United Arab Emirates, the UK and the USA. [Table 1](#) shows the mean percent prevalence for these surveys by legal status, WHO region and WB income group.

The first matching, in which all three factors (legal status, WHO region and WB income group) were brought together, added 30 countries with unknown data – increasing coverage to 78 countries. Two-factor matching by WB group and legal sales status, increased coverage to 103 countries. WHO region and legal sales status together increased coverage to 111 countries. WB and WHO groups together increased coverage to 121 countries. At the end of the matching chain, legal sales status covered the remaining countries with unknown data.

Given that more information on country characteristics might improve estimation, we also tested matching using additionally the Human Development Index and GDP. At this level of precision, all of the additional variance that could be generated by them was covered by the WB income groups. Using HDI and GDP did not improve the matching process and so was dropped from further analysis.

We derived estimates of the number of adults vaping for 2021 by applying the prevalence estimate to the adult population, using UN population estimates for each country. In the data sets, we considered, the adult data were derived from ages 15 and 16 and less frequently 18 and over. Therefore, we used UN population figures for people 15 years and older.

We then adjusted by survey date and regional market growth rate. We obtained data for US dollar market value of e-cigarette sales by region for 2015–2021 ([Euromonitor International, 2021](#)) and developed projections based on the actual year of data adjusted by regional market growth rate.

The largest market was North America, mainly accounted for by the USA, whose market size in 2021 was estimated at \$10.3bn, whereas Canada's market size was \$1.4bn. This was followed by Western Europe at \$6.6bn, Asia Pacific at \$4.4bn and Eastern Europe at \$1.6bn. The smallest market was the Middle East and Africa at \$490mn, Latin America at \$122mn and Australasia at \$118mn.

Each region had different market growth rates over time. To maintain the natural variation, the growth proportions have been calculated by region with the actual value. Figure 1 shows the trend lines for regional market size as a ratio to the starting point, set at 2015. The growth rates from 2015 to 2021 were: Australasia 1.010, Latin America 1.012, Middle East and Africa 1.028, Eastern Europe 1.106, Asia Pacific 1.272, Western Europe 1.480 and North America 1.976.

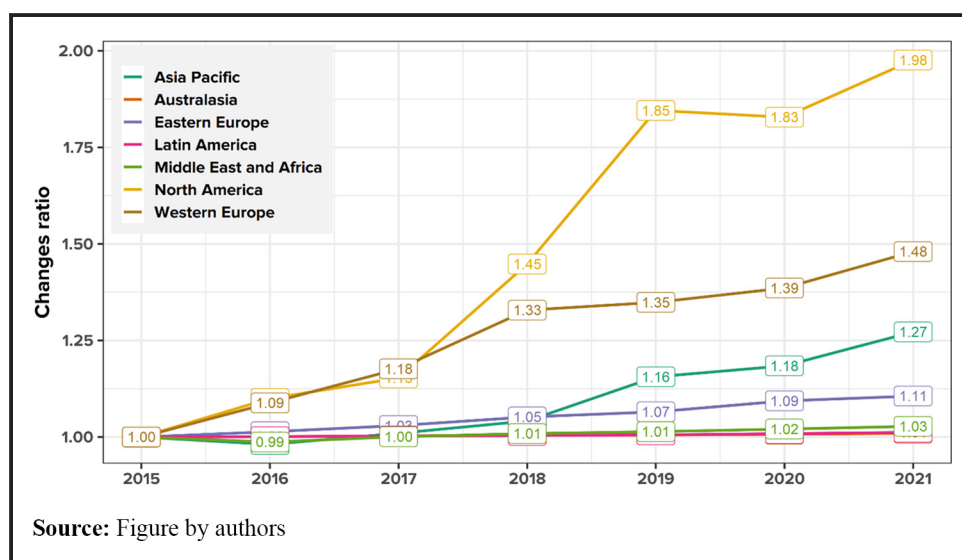
Each country's estimated number of e-cigarette users was calculated by taking into account the date of the latest prevalence survey and regional market growth rate since the survey.

For example, in China, the latest prevalence survey was conducted in 2015. To estimate the prevalence of e-cigarette use in 2021, we adjusted by market growth in the Asia Pacific region between 2015 and 2021. For the Asia Pacific region, the market grew 1.27 times (127%) between 2015 and 2021. By applying this regional growth rate for the period 2015–2021 to the 2015 prevalence data, we estimated the increase in the number of e cigarette users in China between 2015 and 2021. In Taiwan, the latest prevalence survey was conducted in 2020. Taiwan is also in the Asia Pacific region, but for the one-year period between 2020 and 2021, the market grew only 1.03 times (103%). Application of this growth rate data to the 2020 prevalence data enabled us to estimate the increase in the number of e cigarette users in Taiwan between 2020 and 2021.

This market rate modification was performed for datasets older than 2021. The study year was capped from the bottom to 2015. We treated all older studies as if their implementation took place in 2015. Forecasts with longer periods become too uncertain.

There is some uncertainty regarding the relationship between market value and prevalence of e-cigarette use because we do not have a measure of the number and type of units sold nor of consumption patterns. For example, an increase in unit price, other things being

Figure 1 Changes in nicotine-vaping products market size by regions as a ratio to the initial state set to 2015



equal, would be reflected in an increase in market value but not consumption. Therefore, as a final adjustment the output values are reduced by a market feedback coefficient. This coefficient is a measure of the relationship between market size the prevalence of NVP use over time. In two countries, we had information on the correlation between annual market value and prevalence (the UK and New Zealand) which was 0.87. Conservatively, we therefore adjusted country estimates by 0.87.

Findings

Estimate of the global number of vapers in 2021

The global number of vapers in 2021 is estimated at 81.9 million. [Figure 2](#) shows our previous estimates for 2018 (58.1 m) and our previously published projection from 2018 to 2020 (68 m); the last point shows the new estimate for 2021 (81.9 m). The dashed line shows the theoretical increase from an assumed starting point of e-cigarette consumption around 2007 when most markets first started to develop.

Compared to previous estimates, the 2021 one shows a significant but expected growth. Vaping prevalence was highest in Europe and the Eastern Mediterranean and lowest in Southeast Asia. The largest number of vapers was estimated for Europe and lowest for Africa ([Table 2](#)).

Some regions and income groups have very few survey data points which potentially distorts country and regional estimates. In this case, it is necessary to be very careful and to be aware of how much support in existing data a given estimate has (how much information it is based on). Nevertheless, bearing in mind all limitations, it is possible to draw an indicative map, showing the global prevalence of vaping as shown in [Figure 3](#).

Validation of previous estimate

We were able to test the robustness of our previous estimate by comparing data for our 2020 projection against actual survey data for 2021 for a subset of 35 countries for which data were available. This created an opportunity to check our previous estimations and projections. The results obtained confirmed the reasonably good accuracy of the previously

Figure 2 Estimated global number of vapers

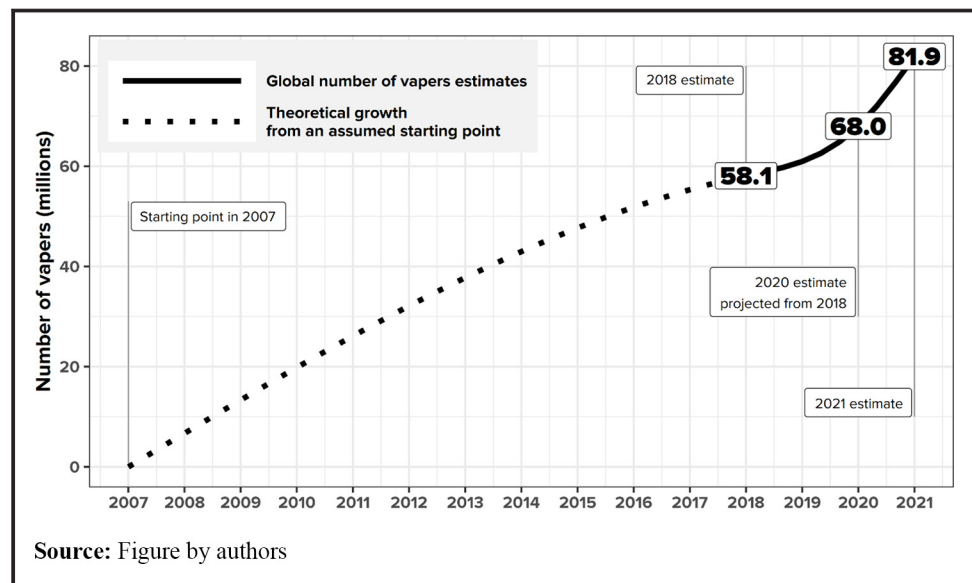
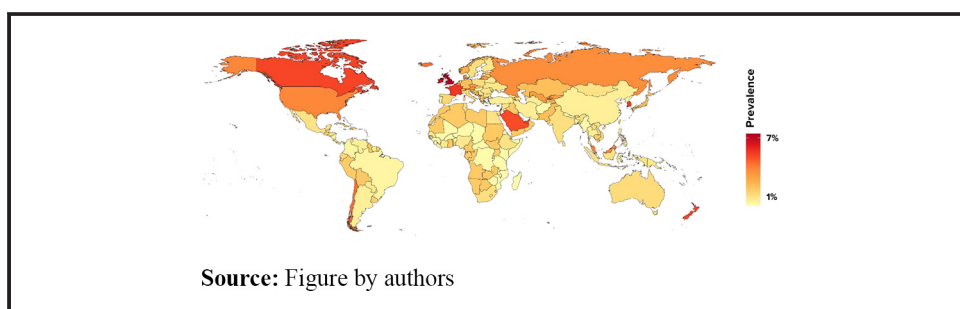


Table 2 Estimated prevalence of vaping and number of vapers by WHO region, 2021

WHO region	Mean % prevalence	No. of vapers in millions
African	1.0	5.6
Americas	1.8	16.8
Eastern Mediterranean	2.3	9.2
European	2.3	20.1
South-East Asia	0.7	14.3
Western Pacific	1.8	16.0

Source: Table by authors

Figure 3 Estimated prevalence of vaping by country

used method. The 2020 projected number of e-cigarette users in this selected group of countries for 2020 was 23.5 million. The number from actual data for these countries in 2021 was 25.1 million (Supplementary Table).

Summary and conclusions

Global, regional and national estimates of the numbers of vapers are important indicators of trends in nicotine use. Since the introduction of NVD into many global markets from 2007 onwards, there has been a steady upward rise in the estimated numbers of vapers. Our new estimate of 82 million in 2021 shows a continued increase over our previous estimate of 58 million in 2018 and projection of 68 million in 2020. The increase is mainly accounted for by growth in North American and Western European markets.

All global measures of health indicators are estimates ([Boerma and Mathers, 2015](#)). There is uncertainty in all estimates, and the fewer the data points the greater the uncertainty of the estimate. Our estimates are more robust for high- and upper middle-income countries, for which there are more datasets and measures over time. The estimates were not improved by adding GDP and the Human Development Index. All modelling-based imputation depends on the availability of input data and the modelling assumptions. More sophisticated modelling including parametric and regression models require better quality data than is currently available. In the case of our estimation, the palette is strictly limited. But this is an open area for future approaches when more data points from around the world become available. The strength of our method is indicated by analysis of a subset of 35 countries: the values predicted from our previous work were very close to actual survey data for 2021.

Despite the continued growth in the number of vapers, which we estimate at almost 30% from 2018 to 2021, their global number – 82 million – is still small compared to the global number of smokers estimated by the WHO at 1 billion. Given the limitations of data sets on both smoking and vaping, it is difficult at this point to assess – at a global level – the extent

to which vaping is displacing smoking. The biggest future impact on the global number of smokers will be by displacement in low- and middle-income countries (where 80% of smokers live) and in particular in China, India and Indonesia (where 46% of smokers live).

In recent years, there has been an expansion of e-cigarette use, particularly in some countries in Europe and in North America. Data for some countries (for example the UK) indicate a substitution effect whereby the increase in e-cigarette use is associated with a decline in smoking. In the UK, the proportion of the adult population using vaping products rose from 1.7% in 2012 to 8.3% in 2022 (ASH, 2022). The rise in vaping has been associated with a drop in smoking, which is now at 12.3% (ONS, 2021). Vaping products are now the main tool that smokers use when they want to quit cigarettes. Public Health England reported in its 2021 annual report that “[...] Using a vaping product is the most popular aid used by people trying to quit smoking. [...]” (McNeill *et al.*, 2021). Vaping products are also more successful than other methods. (Hartmann-Boyce *et al.*, 2021). There is also evidence for substitution effects of other SNP: the uptake of heated tobacco products has been associated with a rapid decline in cigarette sales in Japan and the rise in the use of snus has been associated with a decrease in smoking in Sweden and Norway (Cummings *et al.*, 2020; Shapiro, 2020, p. 51; Statistics Norway, 2022; Statistics Sweden, 2022).

Assessing the potential public health impact of vaping requires estimates of both the prevalence of vaping and the prevalence of smoking over time. But, information on vaping is scarce. Despite global tobacco control and regulatory interest in NVP, there is a dearth of national population data. Only a few countries, mainly in North America, Australasia and Europe have invested significantly in monitoring the use of NVP over time. National and international debate about smoking and alternatives will be enhanced by better information.

The number of countries with usable prevalence data on vaping remains low, at 48 (49 for our previous estimate). Less than 50% of the global population is covered by adult population surveys (Jerzyński *et al.*, 2021). Most surveys are conducted in high-income countries (33/48), and the European region has the highest coverage, mainly accounted for by the EU Special Barometer study. 85% of the global population is covered by surveys in high-income countries, 78% in upper middle-income, but only 9% and 6%, respectively, in lower middle-income countries (Jerzyński *et al.*, 2021). There are other data uncertainties and deficiencies, including variations in questions used to record NVP use and frequency, and the difficulty of extracting information from the surveys of concomitant use of NVP and combustibles.

Given the policy, public and academic interest in NVP, there is a remarkable dearth of data and analysis to track use of NVP and the impact on smoking. In addition to the lack of population surveys, even fewer countries have data which tracks NVP use and smoking over time. The observed association between increasing NVP use and a decline in smoking that has been observed in some countries (above) needs to be supplemented by studies which map transitions between products in population cohorts or repeat cross-sectional studies. Given the paucity of data, it is premature to estimate the impact of different regulatory regimes on the prevalence of NVP use.

The past two decades has seen increasing global interest in health indicators, and WHO and other health agencies and funders make extensive use of health indicators to set goals, allocate resources, encourage policy change and to track progress over time (Boerma and Mathers, 2015). This has been spurred on by the UN Sustainable Development Goals, which now comprises 17 SDGs, 169 targets and 231 health indicators (UN, 2020). While there has been considerable international and national commitment to monitoring tobacco use, this has not been extended to e-cigarettes. No organisation is systematically supporting the collection of data on e-cigarette use at a country population level. The WHO has promoted the importance of collecting up-to-date information on the use of tobacco and related products, and the first element of its MPOWER tobacco control strategy is Monitoring. WHO estimates (WHO, 2021a) of smoking trends are available for 165 countries

but do not include information on e-cigarettes. The WHO FCTC country reporting system includes questions on smoking and use of smokeless tobacco products but does not ask countries to report on the prevalence of the use of NVP or other SNP (WHO FCTC, 2020). Other international data systems are similarly deficient. The Global Adult Tobacco Survey (WHO, 2017) last conducted in 2018 (in China, Romania and Tanzania) has been conducted in 32 countries but only has data on e-cigarette use for six countries. The WHO STEPS (WHO, 2020) data collection system which is used for NCD risk factor surveillance now includes optional questions for e-cigarettes implemented in six countries (WHO, 2021a). The US Centers for Disease Control Global Tobacco Surveillance System (CDC's Office on Smoking and Health, 2016) aim to enhance country capacity to design, implement and evaluate tobacco control interventions, but none of the surveys it promotes measures adult NVP use.

There are clearly data deficiencies. Despite international and national policy interest in the uptake of NVP, global availability of good data remains scarce. International and national policy discussions on NVP are being conducted in the absence of robust data about the use of these products.

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Supplementary material

The supplementary material for this article can be found online.

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