A decomposition analysis of sociodemographic factors and non-cigarette tobacco use as contributors to the change in smoking rates in South Africa between 2017/18 and 2021

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Background. Trends data up to 2018 suggest that tobacco smoking was increasing in South Africa (SA), but only limited information is available on the impact of the COVID-19 pandemic on the current pattern of use of tobacco and nicotine products (TNPs).
Objectives. To assess trends in sociodemographic patterns in the use of TNPs and the extent to which sociodemographic factors and non-cigarette tobacco use may explain possible changes in rates of TNP use between 2017/18 and 2021.
Methods. Data from three waves (2017, 2018 and 2021) of the South African Social Attitudes Survey (total *N*=8 140) were analysed. The sociodemographic correlates of current daily and non-daily use of factory-manufactured cigarettes (FMCs), roll-your-own (RYO) cigarettes, waterpipe/hubbly, electronic cigarettes (ECigs), snuff (a smokeless tobacco) and any combination of FMCs, RYO cigarettes and waterpipe/hubbly ('current smoking') in 2017/18 (pre-pandemic) were compared with those for 2021 (during the pandemic). Chi-square analyses and generalised linear models were used to compare the prevalence of TNP use between the two periods. A Blinda-Oaxaca decomposition analysis was also used to explore the roles of various sociodemographic factors, including any differences in the use of TNPs, that may explain any observed differences in smoking rates between 2017/18 and 2021.
Results. Current smoking increased significantly from 22.4% (95% confidence interval (CI) 20.4 - 24.5) in 2017/18 to 27.6% (95% CI 24.3 - 31.1) in 2021 (*p*=0.009). Smoking of FMCs did not change significantly overall between these two periods (20.1% v. 22.1%; *p*=0.240), except for a significant increase among those who self-identified as black African and a decrease among those who self-identified as coloured and those currently employed. However, the use of waterpipe/hubbly, ECigs, RYO cigarettes and snuff increased significantly. Women, individuals aged <35 years and black Africans had the largest increase in waterpipe/hubbly and ECig use. A decomposition analysis showed that increased waterpipe/hubbly and RYO use explained 52% and 15%, respectively, of the increase in smoking rates, while lower employment during 2021 compared with 2017/18 explained 15% of the increase in smoking rates during 2021.
Conclusion. The use of all TNPs continued to increase in SA, particularly among women and unemployed people. These findings have policy and practice implications for addressing socioeconomic disparities in tobacco-related diseases.

Tobacco use remains a serious threat to public health, as it is responsible for ~8 million deaths globally every year[1] and ~31 000 deaths per year in South Africa (SA).[2] Combustible cigarettes and non-cigarette products, such as waterpipe/hubbly smoking, still pose the greatest and most recognised harm, but the introduction of new non-combustible tobacco and nicotine products (TNPs) such as heated tobacco products and electronic cigarettes (ECigs) has increased access to a variety of products with varying health risk profiles.[3] Although the global incidence of adult cigarette smoking has dropped since 1980, the increased diversity of and growing market for TNPs promoted as less harmful alternatives to conventional factory-manufactured cigarettes (FMCs) have resulted in recent increases in the prevalence of concurrent use of various TNPs (i.e. dual and polytobacco use).[4]

An increasing number of countries periodically report estimates of their tobacco consumption patterns in line with the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) guidelines for monitoring tobacco use, as represented by 'M' in the acronym 'MPOWER'.[5] Recent trends data from SA covering the period from 2007 to 2018 suggest that, while the use of FMCs has not increased, there has been a significant increasing trend in the use of other combustible tobacco products (predominantly waterpipe/hubbly and roll-your-own (RYO) cigarettes) and non-combustible tobacco and nicotine products (predominantly snuff (a smokeless tobacco) and ECigs).[4] SA has one of the highest rates of tobacco consumption in Africa.[6] By 2018, the prevalence of use of combustible tobacco products, especially non-cigarette tobacco use such as waterpipe/hubbly smoking, had increased significantly compared with the data from 2010.[4]

While the country was grappling with the burden of increasing tobacco use, the COVID-19 pandemic began, with associated high morbidity and mortality worldwide.[7] SA was reported to be one of the most severely affected countries in Africa.[8] Systematic reviews suggested that people with a history of smoking faced an increased risk of severe COVID-19 that might result in death.[9] In an effort to prevent the spread of the coronavirus in the country and therefore reduce the burden of the COVID-19 pandemic, the SA government implemented measures including an almost 5-month temporary ban (27 March - 17 August 2020) on the sale of TNPs, which were classified as non-essential goods in terms of the Disaster

Management Act No. 57 of 2002 and the modified regulations in section 27(2).[10]

However, reports suggest that many South Africans had continued access to FMCs through illicit cigarette markets, albeit at >200% of the pre-ban cost.[11] It has also been suggested that South Africans may have had online access to the promotion of ECigs and heated tobacco products during the COVID-19 restrictions.[12] A few studies have examined the impact of COVID-19 on smoking. A systematic review reported a decline in smoking prevalence during the peak periods of the COVID-19 pandemic, suggesting that some people who smoked may have stopped out of fear of contracting the virus and experiencing serious disease.[13] However, findings from an Australian study found a significant increase in nicotine use across the country during the COVID-19 pandemic,[14] while a UK study found consistent variations in smoking prevalence across age groups, with an increase among 18 - 24-year-olds and a decrease among 45 - 65-year-olds, who were at increased risk for hospitalisation and death from COVID-19 .[15]

There has been no consensus on the proportion of SA smokers who quit during the TNP ban under the COVID-19 lockdown,[11,16] but a brief report on smoking prevalence from the 2021 Global Adult Tobacco Survey in SA[17] suggests that there had been an increase in smoking prevalence. However, the brief report provided no stratified analysis of trends for different tobacco and nicotine products, and it did not provide any empirical explanation for the increase. Such detailed analysis will help provide insight on baseline tobacco use status across various sociodemographic strata as we move towards the tobacco reduction target articulated in objective 2.4 in SA's 2022 - 2027 National Strategic Plan for the Prevention and Control of Non-Communicable Diseases (NCDs).[18] Furthermore, such an analysis will contribute to the monitoring of progress towards the achievement of the WHO's Sustainable Development Goal target 3.4 (Prevention and control of non-communicable diseases) and the implementation of target 3a (Full implementation of the WHO FCTC),[18] and inform priority interventions, including which population subgroups need to be prioritised in interventions. Therefore, building on findings from a previous trend study that covered the period before the COVID-19 pandemic and the adoption of the National Strategic Plan for the Prevention and Control of NCDs,[4] the present study sought to assess patterns in the use of TNPs from 2010 to 2021 and how the pattern of use of various tobacco products and sociodemographic characteristics of users may explain any possible differences in smoking rates between the period 2017/18 and 2021.

Methods
Study design
This was a cross-sectional study using secondary data sources from five waves of the South African Social Attitudes Survey (SASAS), namely the surveys conducted in 2010 (*N*=2 887), 2011 (*N*=2 760), 2017 (*N*=2 777), 2018 (*N*=2 580) and 2021 (*N*=2 783). The trends for product use were determined using all five waves. The determination of change in smoking rates and contributors to the change between 2017/18 and 2021 was restricted to pooled data for 2017/18 (*N*=5 357), representing the pre-pandemic period, and the data collected from September to December 2021 (during the fourth wave of the pandemic), representing the pandemic period.

The South African Social Attitudes Survey
The annual SASAS conducted by the Human Sciences Research Council (HSRC) since 2003 uses multi-stage probability sampling to obtain a nationally representative sample of all non-institutionalised

South Africans aged ≥16 years. Details of the sampling have been published previously.[4] Briefly, the survey samples were drawn from the HSRC master sample, consisting of 1 000 census enumeration areas (EAs). Each SASAS interview round included a sub-sample of 500 EAs stratified by province, geographical subtype (rural v. urban) and race, to ensure that the sample was diverse and representative. The sample target was 3 500. In each EA, seven household visiting spots were chosen at random to be visited by trained fieldworkers/ interviewers. For each household, interviewers randomly selected a respondent from a list of eligible household members (aged ≥16 years) using a Krish grid. Pre-validated questionnaires, as previously used in other published reports,[4,19] were administered in participants' households by these trained fieldworkers. The SASAS surveys were ethically cleared by the HSRC Ethics Committee (ref. no. 5/17/08/11, 12 February 2020), and the present study was approved by the Faculty of Health Sciences Research Ethics Committee at the University of Pretoria (ref. no. 329/2023).

Measures
Tobacco and nicotine products use
TNP use was determined from participants' response to the question featured in all five SASAS waves that requests participants to indicate whether they use, or have used, any of a list of TNPs. Consistent with the literature and previous publications,[4,19] all those who indicated that they used a product 'every day' or 'some days' were categorised as current users of the respective TNPs. The products listed and included in this study were FMCs, RYO cigarettes, waterpipe/hubbly, snuff and ECigs. Any respondent who indicated current use of FMCs or RYO cigarettes or waterpipe/hubbly (combustible tobacco products), singly or in combination, was classified as a current tobacco smoker.

Sociodemographic variables
Sociodemographic variables included sex (male or female), age (16 - 24, 25 - 34, 35 - 44, 45 - 54 or ≥55 years), race (self-identifying as black African, coloured, Asian/Indian or white), location (rural or urban), education (less than high school, high school or more than high school) and employment (never employed, previously employed or currently employed).

Data analysis
Stata version 17 (StataCorp, USA) was used for statistical analysis using the 'svyset' mode, which takes account of the multi-stage sampling approach used in the SASAS. Sampling weights were also applied, taking into account response patterns to ensure that the estimates derived remained nationally representative. Descriptive prevalence trends data were represented in graphs. Descriptive statistics, including weighted estimates with 95% confidence intervals (CIs), were presented for subgroups in a bivariate analysis. Chi-square statistics were used to test group differences, including differences in the prevalence of use of the various TNPs during the pre-pandemic and pandemic periods and among different sociodemographic groups during those periods.

A generalised linear model (Poisson family) with log link function was used to explore factors independently associated with current tobacco smoking (using any combustible tobacco) during the periods 2017/18 and 2021. Adjusted prevalence-rate ratios (aPRRs) were presented for group differences in the final model. All sociodemographic variables significant at *p*<0.10 in bivariate analysis were initially included in the model to explore potential confounding variables, but only those significant at *p*<0.05 were retained in the final model.

Blinda-Oaxaca decomposition analysis

The decomposition of the difference between smoking prevalence prior to the pandemic (2017/18) and that during the pandemic (2021) was assessed using an adapted Blinda-Oaxaca decomposition analysis.[20] This counterfactual analysis is based on two regression models fitted separately for the two periods. The analysis divides the difference into three components, namely the explained or endowment component, the unexplained or coefficient component, and an interaction between the endowment and coefficient components. The explained component arises because of differences between the characteristics of the two periods, such as differences in employment or any other sociodemographic variables. The unexplained component is attributed to different influences of these characteristics in each of the two time periods, all other factors remaining constant. As a first step, the decomposition analysis included only sociodemographic factors. The second step included the different tobacco and nicotine products in the model as potential contributors to the pre-pandemic to pandemic period changes in tobacco smoking. Statistical significance for all tests was set at $p<0.05$.
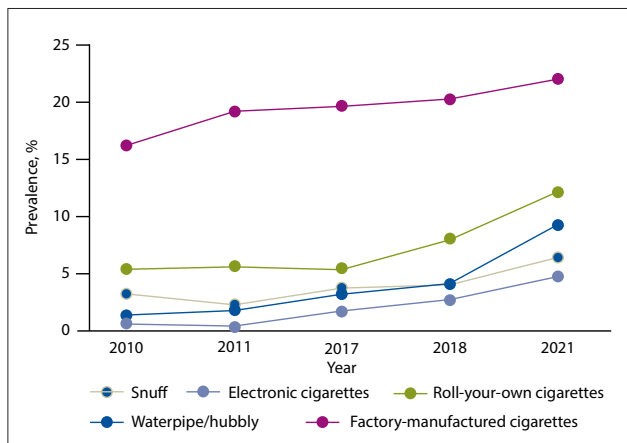

Fig. 1. Trends in the use of various tobacco and nicotine products from 2010 to 2021.

Results

Prevalence of use of tobacco and nicotine products from 2010 to 2021

Tobacco smoking (use of all combustible tobacco products) among SA adults increased significantly from 18.0% (95% CI 16.0 - 20.37) in 2010 to 27.6% (95% CI 24.3 - 31.1) in 2021. The prevalence of the use of snuff (a non-combustible tobacco product) doubled between 2010 (3.1%; 95% CI 2.3 - 4.1) and 2021 (6.4%; 95% CI 4.9 - 8.5) (Fig. 1). The prevalence of the use of ECigs (a non-combustible nicotine product) increased almost tenfold, from as low as 0.5% (95% CI 0.2 - 0.9) in 2010 to 4.7% (95% CI 3.3 - 6.5) in 2021.

Tobacco smoking in general was consistently higher among men than among women of all ages (Fig. 2). In 2010, the prevalence of smoking among men peaked in the 45 - 54 years age group, whereas among women it peaked in the 35 - 44 years age group. However, in 2021, the prevalence of smoking among both men and women peaked in the 24 - 35 years age group (Fig. 2B and D). In contrast to FMC smoking, for which there was no difference in prevalence between 2010 and 2021 among 16 - 24-year-old women (Fig. 2C), the prevalence of all forms of tobacco smoking was higher in 2021 than in 2010 for women in this age group (Fig. 2D).

All forms of tobacco smoking increased significantly from a prevalence of 22.4% (95% CI 20.4 - 24.5) in the 2017/18 period (before the COVID-19 pandemic) to 27.6% in 2021 (during the pandemic). In particular, Mpumalanga and Gauteng provinces experienced significant increases in smoking prevalence after 2017/18 (Fig. 3).

Although smoking decreased in Eastern Cape Province, this change (as with other provinces in which there was a decrease) was not statistically significant (i.e. the change was small enough to be within the margins of statistical error). Over the years, the smoking of RYO cigarettes and waterpipe/hubbly use increased steadily, being the largest increase observed between the periods 2017/18 and 2021 (Table 1). However, the prevalence of FMC smoking did not change significantly after 2017/18.

Pattern of tobacco and nicotine use by sociodemographic characteristics, 2017/18 v. 2021 (Table 1)

The prevalence of snuff use increased significantly for all sociodemographic groups, except among those residing in rural areas
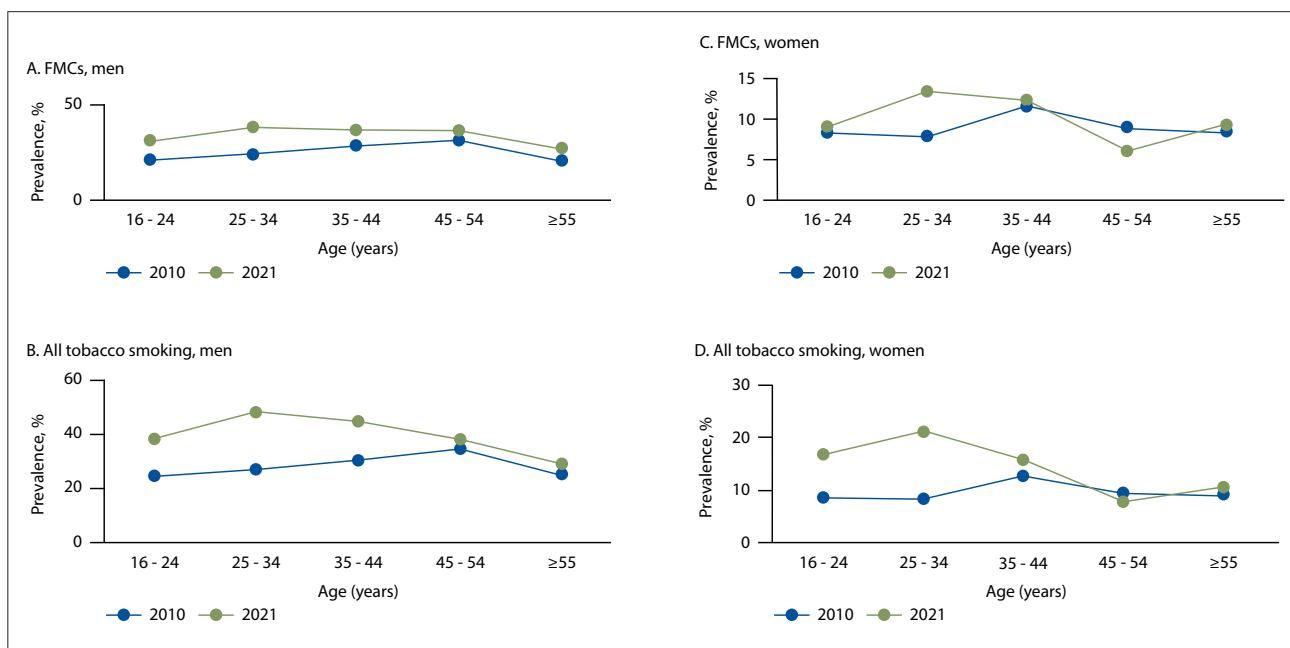

Fig. 2. Age-specific prevalence of FMC smoking and all forms of tobacco smoking among men and women in 2010 v. 2021. (FMC = factory-manufactured cigarette.)
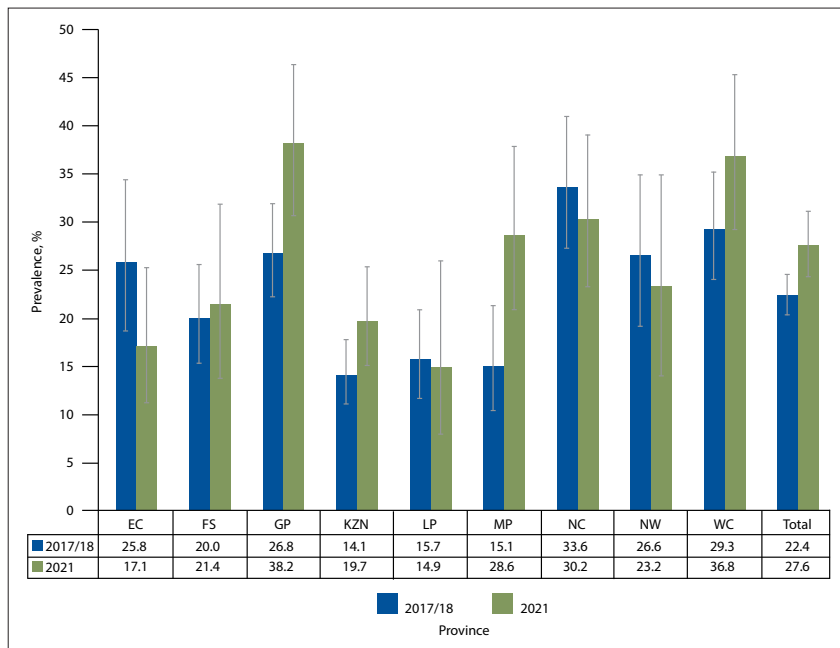
Fig. 3. Prevalence of all forms of tobacco smoking by province in 2017/18 compared with 2021. (EC = Eastern Cape; FS = Free State; GP = Gauteng; KZN = KwaZulu-Natal; LP = Limpopo; MP = Mpumalanga; NC = Northern Cape; NW = North West; WC = Western Cape.)

and those aged 16 - 24 years, 45 - 54 years and ≥55 years, among whom it remained unchanged. Snuff use was highest among those with less than high school education (8.7%), among women (8.6%), among those who had lost their job (8.3%), in the age group 35 - 44 years (8.0%), and among those who self-identified as black Africans (7.1%). The proportion of snuff users who also smoked FMCs increased from 23.2% in 2017/18 to 34.5% in 2021, but this increase was not statistically significant.

The prevalence of ECig use doubled from 2017/18 to 2021. The largest increase was observed among women (0.8% v. 4.0%). In 2017/18, ECig use was far more common among those who self-identified as white (6.4%) than among other racial groups, but by 2021, it had become most common among those who self-identified as coloured (8.0%). Otherwise, ECig use remained most common among those who had more than high school education and among those aged <35 years. The proportion of ECig users who were also smoking FMCs in 2017/18 did not differ significantly from the proportion doing so in 2021 (66.8% v. 61.0%).

By 2021, RYO cigarette smoking had increased for all sociodemographic groups, except among those who self-identified as Indian/Asian, those aged ≥55 years, those who had lost their job and those who were rural residents, among whom the prevalence remained unchanged. Those aged <35 years had the largest increase in RYO smoking. Otherwise, RYO smoking was highest among men (19.8%) and those who self-identified as black African or coloured. In 2017/18, 81.5% of RYO smokers were also smoking FMCs, and this had not changed significantly by 2021 (86.5%).

A different pattern emerged for FMC smoking after the 2017/18 period. FMC smoking remained unchanged overall and for most sociodemographic groups, except for men, urban residents, those with more than high school education, those who were unemployed, and those who self-identified as black Africans, among whom FMC smoking increased significantly. In contrast, a significant decrease in FMC smoking was observed among those in the 45 - 54 years age group, those who were employed and those who self-identified as coloured. Strikingly, in 2017/18, FMC smoking was lowest among those who were unemployed, but in 2021, it was lowest among those who were employed and highest among those were unemployed. Of all current combustible tobacco smokers, 19.7% were not smoking FMCs in 2021, compared with just 10.5% in 2017/18.

By 2021, waterpipe/hubbly smoking had increased for all sociodemographic groups, except for those in the 45 - 54 years age group, those with more than high school education and those who self-identified as Indian/Asian or white, among all of whom waterpipe/hubbly smoking remained unchanged. The largest increase was experienced among women and those in the 35 - 44 years age group (approximately four-fold). Waterpipe/hubbly smoking remained

most common among those with more than high school education (17.4%), those aged <35 years (14.0%), men (12.3%) and those who self-identified as coloured (11.2%). In 2017/18, 66.8% of waterpipe/hubbly smokers concurrently smoked FMCs, and this was not statistically significantly different from the 55.3% who were concurrently smoking FMCs in 2021.

In the final generalised linear model (Table 2), tobacco smoking prevalence in general was 25% higher in 2021 than in the 2017/18 period (aPRR 1.25; 95% CI 1.08 - 1.44). Smoking prevalence remained higher among those who had previously been in paid employment than among those who had never been in paid employment or were currently working. However, smoking was significantly lower among those aged ≥55 years (aPRR 0.79; 95% CI 0.64 - 0.97) compared with those aged 16 - 24 years. Other factors associated with tobacco smoking are shown in Table 2.

The difference between 2017/18 and 2021 in the predicted probability of being a tobacco smoker was 5.2% (Table 3). The results show that only the explained effects were significant and could explain 4.1% of the total 5.2% difference in tobacco smoking prevalence between these two periods. Of these, increases in waterpipe/hubbly smoking and RYO cigarette smoking in 2021 compared with the 2017/18 period explained 52.0% and 15.4%, respectively, of the overall increase, but the lower proportion of employed people during 2021 than in 2017/18 increased the difference by 14.8%.

Discussion

This cross-sectional study provided estimates of the prevalence of the use of combustible and non-combustible TNPs across different sociodemographic groups from 2010 to 2021, focusing on the period before the COVID-19 pandemic (2017/18) and during the pandemic (2021). The finding of increasing trends in the use of TNPs from 2010 to 2021 is consistent with findings from a study that documented the prevalence up to 2018.[4] In particular, the estimates from the current study suggest that there has still been no significant change in the prevalence of the use of FMCs, but that the use of all other TNPs, including waterpipe/hubbly and RYO cigarettes, has increased significantly, particularly among women, black Africans and younger adults (<35 years). The difference in relation to the distribution of employment status in 2017/18 compared with 2021 contributed a relatively small but significant difference to the total

Table 1. Current use of TNPs by sociodemographic characteristic in 2017/18 compared with 2021[†]

| | Non-combustible | | | | | |
| | Snuff, % (n) | | | ECigs, % (n) | | |
	2017/18	2021	p-value (row)	2017/18	2021	p-value (row)
Overall	3.9 (218)	6.4 (140)	0.004*	2.2 (91)	4.7 (117)	0.002*
Sex						
Male	2.1 (34)	4.1 (43)	<0.001*	3.6 (61)	5.4 (70)	0.018*
Female	5.6 (184)	8.6 (97)	0.002*	0.8 (30)	4.0 (47)	<0.001*
Age (years)						
16 - 24	1.3 (14)	3.1 (9)	0.063	3.5 (29)	5.8 (19)	0.058
25 - 34	3.8 (38)	6.9 (30)	0.002*	3.1 (26)	6.9 (41)	0.006*
35 - 44	2.4 (27)	8.0 (47)	<0.001*	1.6 (12)	3.3 (22)	0.072
45 - 54	5.6 (33)	5.2 (17)	0.483	0.7 (10)	2.5 (15)	0.008*
≥55	7.6 (106)	7.8 (37)	0.818	0.7 (14)	3.5 (20)	0.001*
Race						
Black African	4.6 (197)	7.1 (113)	<0.001*	1.5 (36)	4.2 (59)	<0.001*
Coloured	1.1 (9)	3.8 (16)	<0.001*	3.5 (20)	8.0 (34)	<0.001*
Indian/Asian	0.8 (4)	2.0 (2)	0.498	2.9 (12)	3.2 (6)	0.655
White	1.1 (8)	4.1 (2)	0.001*	6.6 (23)	6.4 (18)	0.148
Location of residence						
Rural	4.4 (83)	4.8 (34)	0.199	1.2 (13)	2.0 (14)	0.627
Urban	3.6 (135)	6.9 (106)	<0.001*	2.6 (78)	5.6 (103)	<0.001*
Education						
Less than high school	5.7 (174)	8.7 (77)	0.005*	1.7 (35)	4.4 (41)	<0.001*
High school	1.9 (37)	5.6 (45)	<0.001*	2.4 (35)	4.2 (42)	0.012*
More than high school	1.6 (7)	2.7 (18)	0.010*	4.4 (21)	6.4 (34)	0.659
Employment						
Never employed	3.5 (90)	4.0 (42)	<0.001*	1.6 (27)	6.2 (60)	<0.001*
Previously employed	4.7 (82)	8.3 (32)	0.003*	1.9 (24)	4.2 (24)	0.038*
Currently employed	3.6 (35)	7.2 (66)	0.010*	3.6 (32)	3.7 (33)	0.817

*Significant difference for column comparison (p<0.05).
[†]Some column totals may not add up to the overall figure because of missing/incomplete data for that variable.

Table 2. Final generalised linear model of factors significantly associated with current tobacco smoking during 2017/18 and 2021

Explanatory variables	aPRR (95% CI)
Race	
Black African	1
Coloured	1.68 (1.45 - 1.97)
Indian/Asian	1.13 (0.92 - 1.39)
White	1.35 (1.13 - 1.62)
Sex	
Male	1
Female	0.34 (0.29 - 0.39)
Age group (years)	
16 - 24	1
25 - 34	1.24 (1.01 - 1.51)
35 - 44	1.05 (0.85 - 1.31)
45 - 54	1.10 (0.88 - 1.38)
≥55	0.79 (0.64 - 0.97)
Location of residence	
Rural	1
Urban	1.43 (1.17 - 1.74)
Employment status	
Never employed	1
Previously employed	1.39 (1.19 - 1.63)
Currently employed	0.99 (0.83 - 1.17)
Survey year	
2017/18 (pre-COVID)	1
2021 (during COVID pandemic)	1.25 (1.08 - 1.44)

aPRR = adjusted prevalence-rate ratio; CI = confidence interval.

change in smoking prevalence, but the majority of the change could be explained by the increase in the prevalence of waterpipe/hubbly use (a non-cigarette tobacco) and, to a lesser extent, by increased RYO cigarette smoking.

It was striking that the prevalence of FMC smoking did not change significantly from that observed in 2017/18, despite reported increased illicit cigarette consumption in 2021.[21] It is conceivable that the same number of FMC smokers were just consuming more (illicit) cigarettes per day in 2021 than in 2018. This assumption can be made on the basis of the findings of a previous study on the impact of the COVID-19 lockdown on smoking among Italian adults, which showed that although smoking prevalence decreased overall, cigarette consumption increased among those who continued to smoke, and displayed an association with mental distress.[22] Alternatively, the increase in cigarette consumption from 30% to 35% in 2017 to an estimated 54% (illicit) in 2021 may be an overestimation of the extent of illicit cigarette consumption, as this estimation approach was based on the assumption that all smokers were smoking FMCs, which should have attracted excise taxes.[21] However, the present study shows that the number of smokers who did not smoke FMCs doubled by 2021, increasing significantly from just 11% in 2017/18 to ~20% in 2021. The implications, if any, of this change in the pattern of combustible tobacco use in estimating illicit cigarette consumption based on the FMC excise tax gap analysis requires further research.

Despite the fact that there was no significant change in FMC smoking, overall combustible and non-combustible means of nicotine use increased significantly during the period under study, given the increased prevalence of waterpipe/hubbly and RYO cigarette smoking and the increased use of snuff and ECigs. The observed increase in

| Combustible | | | | | | | | |
| RYO cigarettes, % (*n*) | | | FMCs, % (*n*) | | | Waterpipe/hubbly, % (*n*) | | |
2017/18	2021	*p*-value (row)	2017/18	2021	*p*-value (row)	2017/18	2021	*p*-value (row)
6.7 (307)	12.2 (262)	<0.001*	20.1 (1 111)	22.1 (664)	0.240	3.6 (147)	9.3 (226)	<0.001*
11.7 (235)	19.8 (194)	<0.001*	30.3 (721)	34.7 (467)	0.028*	5.6 (100)	12.3 (135)	<0.001*
1.7 (72)	5.1 (68)	<0.001*	9.7 (77)	10.4 (197)	0.357	1.7 (47)	6.5 (91)	<0.001*
7.1 (48)	16.9 (51)	0.005*	16.4 (145)	20.7 (77)	0.058	6.2 (55)	14.0 (52)	0.009*
7.9 (73)	14.8 (73)	0.004*	20.8 (247)	26.4 (169)	0.257	5.2 (46)	14.1 (81)	<0.001*
6.2 (52)	12.4 (60)	<0.001*	20.0 (218)	24.5 (160)	0.024*	1.7 (18)	8.1 (53)	<0001*
7.0 (56)	6.7 (40)	0.058	25.9 (207)	19.4 (122)	0.031*	2.4 (16)	3.1 (19)	0509
4.9 (78)	7.4 (38)	0.351	19.8 (294)	17.2 (136)	0.276	0.8 (12)	3.5 (21)	0.001*
6.7 (198)	12.8 (167)	<0.001*	15.9 (485)	20.2 (324)	0.041*	3.4 (71)	9.8 (143)	<0.001*
11.2 (73)	13.3 (66)	0.009*	41.3 (310)	26.7 (163)	0.001*	6.4 (40)	11.2 (55)	<0.001*
2.2 (18)	2.9 (12)	0.117	26.6 (141)	25.2 (82)	0.831	4.2 (23)	2.9 (14)	0.069
4.3 (18)	8.7 (17)	0.001*	32.1 (175)	33.2 (95)	0.445	3.3 (13)	5.4 (14)	0.069
6.6 (95)	7.8 (41)	0.582	15.5 (190)	11.1 (89)	0.407	1.0 (16)	4.3 (33)	0.001*
6.8 (212)	13.7 (221)	<0.001*	22.2 (921)	25.7 (575)	0.003*	4.8 (131)	11.0 (193)	<0.001*
6.9 (206)	12.2 (127)	0.001*	20.7 (620)	21.3 (296)	0.461	2.9 (58)	7.2 (70)	0.001*
7.3 (87)	11.4 (92)	0.034*	20.7 (384)	21.7 (253)	0.208	3.6 (65)	7.7 (84)	0.001*
3.8 (13)	13.9 (43)	<0.001*	15.1 (104)	24.9 (115)	0.011*	7.6 (23)	17.4 (72)	0.068
4.4 (81)	13.0 (101)	<0.001*	13.0 (257)	26.7 (294)	<0.001*	3.5 (52)	11.0 (108)	<0.001*
10.1 (114)	13.7 (69)	0.178	26.9 (431)	25.4 (180)	0.628	3.1 (38)	9.0 (42)	<0.001*
7.0 (91)	10.8 (92)	0.046*	25.3 (374)	16.8 (190)	0.007*	4.7 (50)	8.1 (76)	0.072

ECig use, together with the increase in smoking prevalence over the last 12 years, is consistent with a population study in SA which suggested that ECig use is not associated with long-term smoking cessation outcomes and that most ECig users continued concurrently to smoke cigarettes.[23]

Considering that an increase in the use of these alternative forms of obtaining nicotine was observed even before the onset of the COVID-19 pandemic, the increasing use of these products may be related to the lower affordability of FMCs and/or the perceived lower relative risk of using these alternative products compared with FMCs. These two factors may be of increased relevance, because the 5-month temporary ban of TNPs from April to August 2020 was reportedly associated with an increase of >200% in FMC prices,[11] and there were awareness campaigns that emphasised the increased risk of COVID-19 infection among older adults who smoked cigarettes.[24] It was therefore no surprise that in the present study, smokers were less likely to be ≥55 years of age as opposed to <35 years of age.

The fact that Gauteng was one of only two regions that recorded a significantly increased smoking prevalence during 2021 compared with 2017/18 may be related to increased use of waterpipe/hubbly use, perceived especially among young adults as a way of coping with the economic and mental stress that many experienced after the onset of the pandemic in 2020.[15] Waterpipe/hubbly use as a coping mechanism may be particularly relevant to young people who were socially restrained by lockdowns at the peaks of the epidemic in this most densely populated and urbanised economic hub of the country, where a large proportion of South Africans aged 18 - 34 years reside,[25] and which had also recorded the highest cumulative number of COVID cases in the country by the time of

the 2021 survey.[26] The significant increase in smoking prevalence in Mpumalanga requires further investigation. This increase may be related to the increasing use of much cheaper RYO cigarettes as a price minimisation strategy for those who could not access or afford FMCs during the temporary ban, especially in this relatively rural province. Nevertheless, it is worth noting that the observed increased access to cheaper RYO cigarettes and waterpipe/hubbly by all population groups did not cancel out the significant decrease in FMC smoking observed among those who self-identified as coloured – a group that has historically had the highest smoking rates in SA.[4] The significant reduction in the prevalence of all tobacco smoking in the coloured population is a welcome development. This reduction may be associated with the fact that, compared with black Africans, this population group experienced disproportionately high tobacco-related mortality rates,[2] so it is possible that greater realisation of the health risk in these communities may have prompted people to quit tobacco smoking after the onset of the COVID-19 pandemic. However, further research is needed on the factors contributing to the observed decrease in smoking prevalence in the coloured population and in certain provinces.

The suggestion that the increase in smoking prevalence observed in 2021 may be related to economic and mental stress is supported by the fact that the present study also showed that in the controlled model, people who had lost their jobs (i.e. indicated that they had been in paid jobs in the past) had a higher smoking prevalence than those who were currently in paid jobs, and that the prevalence in this group was even higher than among those who had never been employed. Indeed, our decomposition analysis suggests that if as many people had been in paid jobs in 2021 as there were in 2017/18,

Table 3. Blinder-Oaxaca decomposition of the contributors to the difference in tobacco smoking prevalence during 2021 (during COVID pandemic) compared with 2017/18 (pre-COVID)

	Rate, %	*p*-value	% of total difference explained
2021	27.6	<0.001	
2017/18	22.4	<0.001	
Difference	5.2	0.010	
Explained/endowment	4.1	0.025*	
Unexplained/coefficient	0.5	0.616	
Interaction	0.6	0.354	
Explained			
Employment	−0.8	0.002*	14.8
Waterpipe/hubbly	2.7	<0.001*	52.0
RYO cigarettes	0.8	0.017*	15.4
FMCs	1.6	0.255	n/a
Snuff	−0.2	0.073	n/a

RYO = roll-your-own; FMCs = factory-manufactured cigarettes; n/a = not applicable.
*Statistically significant contribution to the difference (p<0.05).

the prevalence of smoking would have been 15% lower in 2021. It is also conceivable that apart from the associated psychosocial stress, those who lost their jobs may have had more opportunities to continue smoking, particularly in the absence of the usual workplace restrictions that could trigger consideration of quitting.

The fact that young adults, especially women, were increasingly smoking ECigs and waterpipe/hubbly may also be related to mental stress, as reported cases of gender-based violence against women increased during the COVID-19 movement restrictions, which may have forced women to spend unusually long periods at home with their partners.[27] Studies have suggested that women who experience violence may find relief in smoking, which could be especially relevant to the social nature of waterpipe/hubbly smoking. Alternatively, the increase in the use of these emerging TNPs by young women could be related to exposure to advertisements and targeted promotion of these products to young females on social media, resulting in changes in network smoking norms.[28] A recent study of adolescents from 20 countries in Africa indeed suggested that an increased level of reported exposure to tobacco advertisements was positively associated with waterpipe smoking among girls.[29] The fact that these young adult women are of childbearing age and likely to spend time with children, as caregivers and therefore as role models, suggests potential serious public health problems in the future if culturally appropriate health promotion interventions are not targeted at this population group to reduce all forms of use of nicotine and tobacco products.

Study limitations and strengths

In interpreting the study findings, it is necessary to consider the study's limitations and strengths. The limitations of this study include the fact that it did not report on the number of cigarettes smoked per day, as the data were not consistently available in all datasets. Furthermore, smoking status was self-reported and may be subject to reporting bias, as some respondents may have felt that it was not socially desirable to identify as a smoker during a pandemic – especially women, as female smoking may be perceived as a social taboo. Moreover, there were time lags between the survey in 2018 and the onset of the pandemic in 2020, and between the onset of the pandemic and the last survey in 2021. Our findings may therefore not have captured changes after the onset of COVID-19 and before the last quarter of 2021, when the survey was conducted. For the same reason, our findings may also not be comparable to those of studies that measured changes in smoking patterns over a more regular period (e.g. monthly) before and during the pandemic. The cross-sectional design also does not lend itself to causal inferences.

Despite these limitations, the study has a number of strengths. First, the study sample was nationally representative, including all sociodemographic groups and provinces of SA and therefore making the study findings generalisable. The study is also the first (that we are aware of) to attempt to quantify contributors to the changes in smoking prevalence and the use of both combustible and non-combustible TNPs after the COVID-19 lockdowns in SA. The study has therefore provided the baseline for monitoring future changes in the pattern of use of TNPs as the government works towards achieving the objectives set in the National Strategic Plan for the Prevention and Control of NCDs.[15]

Conclusions

The study finding of an increase in smoking prevalence with an associated increase in waterpipe/hubbly use during 2021 compared with 2017/18, especially among young adults and women, highlights the need to strengthen tobacco control legislation that would prevent the uptake of emerging TNPs by young SA adults without any benefit at a population level in terms of helping large numbers of adult smokers stop smoking. The findings therefore support the passing into law of the proposed Tobacco Products and Electronic Delivery Systems Control Bill[30] that will, among other things, restrict the marketing of these products, introduce pictorial health warning labels and restrict public smoking, which tends to drive the social acceptance of tobacco consumption, including waterpipe/hubbly use. Furthermore, the findings highlight the need to pay attention to health promotion campaigns that encourage a healthy lifestyle, including providing smoking cessation support as part of planning for future pandemic response. Priority may be given to vulnerable populations such as the unemployed, young adults and women, who may be particularly vulnerable to economic and mental stress as unintended consequences of responses to a pandemic. Further investigation into the underlying mechanisms contributing to the observed trends in tobacco consumption and its consequences for public health strategies may be necessary.

1. World Health Organization. WHO report on the global tobacco epidemic, 2023: Protect people from tobacco smoke. Geneva: WHO, 2023. https://escholarship.org/uc/item/7x18m7f9 (accessed 7 August 2023).
2. Groenewald P, Pacella R, Sitas F, et al. Estimating the changing disease burden attributable to smoking in South Africa for 2000, 2006 and 2012. S Afr Med J 2022;112(8b):649-661. https://doi.org/10.7196/SAMJ.2022.v112i8b.16492
3. Dunbar MS, Tucker JS. Introduction to the special issue 'Emerging trends in combustible tobacco and vaping product use'. Int J Environ Res Public Health 2022;19(9):4992. https://doi.org/10.3390/ijerph19094992
4. Egbe CO, Gwambe S, Londani M, Erinoso O, Ayo-Yusuf OA. Trends in the use and dual use of factory-made combustible cigarettes, other tobacco products and electronic cigarettes: Results from South African Social Attitudes Surveys during 2007 to 2018. Tob Induc Dis 2023;21(July):94. https://doi.org/10.18332/tid/168121
5. World Health Organization. WHO global report on trends in prevalence of tobacco use 2000-2025. 4th ed. Geneva: WHO, 2021. https://www.who.int/initiatives/mpower (accessed 24 August 2023).
6. Reitsma MB, Kendrick PJ, Ababneh E, et al. Spatial, temporal, and demographic patterns in prevalence of smoking tobacco use and attributable disease burden in 204 countries and territories, 1990-2019: A systematic analysis from the Global Burden of Disease Study 2019. Lancet 2021;397(10292):2337-2360. https://doi.org/10.1016/S0140-6736(21)01169-7
7. Mapanga W, Craig A, Mtintsilana A, et al. The effects of COVID-19 pandemic lockdowns on alcohol consumption and tobacco smoking behaviour in South Africa: A national survey. Eur Addict Res 2023;29(2):127-140. https://doi.org/10.1159/000528484
8. Johns Hopkins Coronavirus Resource Center. COVID-19 map. Baltimore, Md.: Johns Hopkins Coronavirus Resource Center. https://coronavirus.jhu.edu/map.html (accessed 25 August 2023).
9. Reddy RK, Charles WN, Sklavounos A, Dutt A, Seed PT, Khajuria A. The effect of smoking on COVID-19 severity: A systematic review and meta-analysis. J Med Virol 2021;93(2):1045-1056. https://doi.org/10.1002/jmv.26389
10. Republic of South Africa. Disaster Management Act 57 of 2002. https://www.gov.za/documents/disaster-management-act (accessed 27 August 2023).
11. Filby S, van der Zee K, van Walbeek C. The temporary ban on tobacco sales in South Africa: Lessons for endgame strategies. Tob Control 2022;31(6):694-700. https://doi.org/10.1136/tobaccocontrol-2020-056209
12. Agaku I, Egbe CO, Ayo-Yusuf OA. Circumvention of COVID-19-related restrictions on tobacco sales by the e-cigarette industry in South Africa and comparative analyses of heated tobacco product vs combustible cigarette volume sales during 2018-2020. Prev Med 2021;148:106526. https://doi.org/10.1016/j.ypmed.2021.106526
13. Almeda N, Gómez-Gómez I. The impact of the COVID-19 pandemic on smoking consumption: A systematic review of longitudinal studies. Front Psychiatry 2022;13:941575. https://doi.org/10.3389/fpsyt.2022.941575
14. Thai PK, Tscharke BJ, O'Brien J, et al. Increased nicotine consumption in Australia during the first months of the COVID-19 pandemic. Nicotine Tob Res 2023;25(6):1194-1197. https://doi.org/10.1093/ntr/ntac275
15. Jackson SE, Beard E, Angus C, Field M, Brown J. Moderators of changes in smoking, drinking and quitting behaviour associated with the first COVID-19 lockdown in England. Addiction 2022;117(3):772-783. https://doi.org/10.1111/add.15656
16. Saloojee Y, Mathee A. COVID-19 and a temporary ban on tobacco sales in South Africa: Impact on smoking cessation. Tob Control 2022;31(e2):e207-e210. https://doi.org/10.1136/tobaccocontrol-2020-056293
17. World Health Organization. 2021 GATS Fact Sheet South Africa. Geneva: WHO, 2021. https://www.who.int/publications/m/item/2021-gats-fact-sheet-south-africa (accessed 7 August 2023).
18. National Department of Health, South Africa. National Strategic Plan for the Prevention and Control of Non-Communicable Diseases, 2022-2027. Pretoria: NDoH, 2022. https://www.sancda.org.za/wp-content/uploads/2022/05/NCDs-NSP-SA-2022-2027.pdf (accessed 19 May 2024).
19. Ngobese SP, Egbe CO, Londani M, Ayo-Yusuf OA. Non-smoker's exposure to second-hand smoke in South Africa during 2017. Int J Environ Res Public Health 2020;17(21):8112. https://doi.org/10.3390/ijerph17218112
20. Li J, Shi L, Xu L, Qin W, Wang H. Urban-rural disparities in hypertension prevalence, detection, and medication use among Chinese adults from 1993 to 2011. Int J Equity Health 2017;16(1):50. http://doi.org/10.1186/s12939-017-0545-7
21. Vellios N. How big is the illicit cigarette market in South Africa? Econ3×3, 7 September 2022. https://www.econ3x3.org/article/how-big-illicit-cigarette-market-south-africa (accessed 1 September 2023).
22. Carreras G, Lugo A, Stival C, et al. Impact of COVID-19 lockdown on smoking consumption in a large representative sample of Italian adults. Tob Control 2022;31(5):615-622. https://doi.org/10.1136/tobaccocontrol-2020-056440
23. Agaku I, Egbe CO, Ayo-Yusuf OA. Associations between electronic cigarette use and quitting behaviours among South African adult smokers. Tob Control 2022;31(3):464-472. https://doi.org/10.1136/tobaccocontrol-2020-056102
24. Dave JA, Tamuhla T, Tiffin N, et al. Risk factors for COVID-19 hospitalisation and death in people living with diabetes: A virtual cohort study from the Western Cape Province, South Africa. Diabetes Res Clin Pract 2021;177:108925. https://doi.org/10.1016/j.diabres.2021.108925
25. Statistics South Africa. SA population reaches 58.8 million. 29 July 2019. https://www.statssa.gov.za/?p=12362 (accessed 16 April 2024).
26. Statista. Confirmed coronavirus (COVID-19) cases in South Africa as of March 06, 2022, by region. 20 June 2023. https://www.statista.com/statistics/1108127/coronavirus-cases-in-south-africa-by-region/ (accessed 20 May 2024).
27. Mahlangu P, Gibbs A, Shai N, Machisa M, Nunze N, Sikweyiya Y. Impact of COVID-19 lockdown and link to women and children's experiences of violence in the home in South Africa. BMC Public Health 2022;22(1):1029. https://doi.org/10.1186/s12889-022-13422-3
28. Williams CT, Grier SA, Marks AS. 'Coming to town': The impact of urbanicity, cigarette advertising, and network norms on the smoking attitudes of black women in Cape Town, South Africa. J Urban Health 2008;85:472-485. https://doi.org/10.1007/s11524-008-9286-7
29. Agaku IT, Sulentic R, Dragicevic A, et al. Gender differences in use of cigarette and non-cigarette tobacco products among adolescents aged 13-15 years in 20 African countries. Tob Induc Dis 2024;22:10.18332/tid/169753. https://doi.org/10.18332/tid/169753
30. Republic of South Africa. Tobacco Products and Electronic Delivery Systems Control Bill (B33-2022). 2022. https://www.parliament.gov.za/bill/2307574 (accessed 7 September 2023).