Prevalence and correlates of roll-your-own cigarette smoking among South African adults during 2010–2011 and 2017–2018

Lungile Nkosi¹, Israel T. Agaku¹,², Olalekan Ayo-Yusuf¹,³

ABSTRACT

INTRODUCTION The increasing use of roll-your-own (RYO) cigarettes has been documented globally, but there are no recent data from South Africa, particularly among youths and low-income groups. We assessed changes in prevalence and correlates of RYO smoking among South African adults during 2010–2011 and 2017–2018, and explored expenditure differences between daily smokers of RYO and manufactured cigarettes.

METHODS Nationally representative data of South Africans aged ≥16 years used in this study were from the South African Social Attitudes Survey (SASAS) for 2010–2011 (n=6116), and 2017–2018 (n=5799). Current RYO cigarette use included daily and non-daily use. Annual expenditures were estimated based on typical usage patterns for daily users. Descriptive and multivariable analyses were performed using Stata Version 15 with the level of statistical significance set at p<0.05.

RESULTS The prevalence of ever RYO cigarette use increased from 6.5% (95% CI: 5.6–7.5) during 2010–2011, to 8.5% (95% CI: 7.0–10.0) during 2017–2018 (p=0.026). Current RYO cigarette use prevalence however remained largely unchanged when we compared 2010–2011 to 2017–2018 (5.2% vs 6.3%, p=0.544). During 2017–2018, current RYO cigarette use prevalence was highest among men (11.6%), those who self-identified as Coloreds (11.1%), people aged 25–34 years (7.8%), those with no schooling (7.5%), and those unemployed (9.8%). Annual expenditures associated with typical patterns of daily RYO cigarette smoking were substantially less than for smoking of manufactured cigarettes.

CONCLUSIONS The prevalence of ever RYO cigarette use increased between 2010–2011 and 2017–2018. Current RYO cigarette use during 2017–2018 was more prevalent among Coloreds, Black Africans, youths, those with lower education, and the unemployed. This study’s findings highlight the need to harmonize taxation of cigarettes and RYO cigarettes, and to intensify implementation of evidence-based tobacco control and prevention interventions in South Africa.
cancerogens that have been shown to cause damage to every organ in the body\textsuperscript{7}.

RYO smoking may worsen socioeconomic disparities in tobacco-related morbidity and mortality because of its higher prevalence among groups with lower socioeconomic status, including Black African males from rural areas and individuals with lower education. The most common, and strongest contributing factor to RYO cigarette smoking across several studies was its relatively lower costs compared to manufactured cigarettes\textsuperscript{1-4,6,8,9}. Other factors associated with RYO smoking include perceived taste/satisfaction, and perceptions of lower health risks\textsuperscript{10}. The increasing availability of flavored RYO tobacco in recent years has potential to increase the prevalence of RYO use among youths because of the increased ease of use and product appeal\textsuperscript{6,10-12}.

No nationally representative study has been published in the past 10 years on the sociodemographic profile of RYO cigarette users within the South African context. In the light of the evolving regulatory landscape, there is a need for up-to-date data on current use patterns, as well as examination of whether shifts have occurred in the key user segments. Furthermore, while it is well acknowledged anecdotally that RYO cigarettes are cheaper than cigarettes in South Africa, the potential for smoker population down-trading from cigarettes to RYO cigarette smoking has not been evaluated empirically within the South African context, especially in the context of increasing availability of cheaper and/or illicitly traded cigarettes\textsuperscript{13} and increasing unemployment in South Africa that could make cigarettes generally unaffordable\textsuperscript{14,15}. This study therefore sought to answer three key questions: 1) ‘How did the percentage and composition of South African adults reporting ever and current use of RYO cigarettes change between the periods 2010–2011 compared to 2017–2018, and what factors were associated with current RYO cigarette use in the more recent period?’; 2) ‘How did the demographic profile of those smoking RYO cigarettes exclusively compare to those smoking manufactured cigarettes exclusively, as well as those smoking both products?’; and 3) ‘What were expenditure differences between daily smokers of RYO cigarettes vs manufactured cigarettes in South Africa during 2018?’.

METHODS

Data sources

Data were from four waves of the South African Social Attitudes Survey (SASAS): 2010 (n=3112), 2011 (n=3004), 2017 (n=3063), and 2018 (n=2736). To increase sample size for subgroup analysis, we combined data for the 2010 and 2011 waves (henceforth, 2010–2011 cycle, pooled n=6116), as well as the 2017 and 2018 waves (henceforth, 2017–2018 cycle, pooled n=5799). SASAS is a nationally representative cross-sectional, face-to-face, household survey of the South African civilian adult population aged ≥16 years, which is conducted by the Human Sciences Research Council. People living in mental institutions, prisons, nursing homes, military barracks, and dormitories are excluded. The survey employs a multi-stage probability sampling method\textsuperscript{16}. Each SASAS round of interviewing consists of a sub-sample of 500 enumeration areas (i.e. primary sampling unit). To ensure the sample was diverse and representative, stratification of enumeration areas was done by province, residence (rural vs urban) and race.

Inputs used to estimate annual expenditures associated with cigarette smoking came from SASAS (average cigarettes smoked per day) and other sources described below. Based on previous reports indicating a quite simple, price-minimizing process of RYO cigarette smoking among most users in South Africa where ‘pipe tobacco is wrapped in newspaper and used as roll-your-own cigarette’\textsuperscript{16,17}, we estimated only the associated costs of pipe or RYO tobacco (and not the additional costs of the rolling paper). We included prices for not only products labelled as actual RYO tobacco, but also pipe tobacco being marketed for use as hand-rolled cigarettes. Including both types of products ensured we adequately captured the diversity of products of different costs, sources, and user profiles. To derive cost estimates for pipe or RYO tobacco, we accessed South Africa Yellow Pages listing of tobacco shops in South Africa\textsuperscript{18}. From those selling pipe or RYO tobacco, we extracted information on name of vendor, name of pipe/RYO product, description, size of packet, and the price. The most recurring pouch size was 50 g of pipe or RYO tobacco, the median price of which was ZAR 96.8 (1000 South African Rand about US$55, currently).
SASAS Measures

Sociodemographic variables
Sociodemographic variables included age (16–24; 25–34; 35–44; 45–64; and ≥65 years), gender (male or female), race (self-identifying as Black African, Colored, White, or Asian/Indian), education level (no schooling/less than primary school, completed primary school, some high school, completed high school, tertiary education or equivalent), and employment status (employed, unemployed, not in the workforce).

Tobacco product use behavior
Ever and current use of the following products was assessed: manufactured cigarettes, RYO cigarettes, hubbly-bubbly/hookah/waterpipe, and e-cigarettes. Ever users were defined as persons who indicated they used the particular tobacco product ‘currently every day’, ‘currently some days’, ‘stopped completely, less than 6 months’, ‘stopped completely, more than 6 months’. Current users were those who answered ‘currently every day’ or ‘currently some days’.

Number of cigarettes smoked per day (CPD) was assessed with the question ‘On the days that you smoke, on average, how many manufactured cigarettes, (excluding hand rolled cigarettes) do you smoke per day?’. Participants could type in a numeric response. We used this question to estimate the median number of cigarettes smoked per day among users of manufactured cigarettes as well as among users of RYO cigarettes (77.9% of RYO smokers also smoked manufactured cigarettes in 2018; we assumed their smoking intensity when using hand-rolled cigarettes was similar to when using manufactured cigarettes).

Associated costs from the last cigarette purchase made was assessed in SASAS with the questions: 1) ‘How much did you pay for your last cigarette purchase, per stick/individual cigarette?’ (For those who bought single sticks); and 2) ‘How much did you pay for your last cigarette purchase, per pack?’ (For those who bought cigarettes in a pack).

Data analysis
All statistical analyses were performed using Stata Version 15 (Stata Corp, College Station, TX, USA). Data were weighted to yield nationally representative estimates. Descriptive analyses were performed to explore whether the percentage of South African adults reporting ever and current use of RYO cigarettes changed between 2010–2011 and 2017–2018; whether the composition of current RYO cigarette smokers changed between the two specified periods; and how the demographic profile of those smoking RYO cigarettes exclusively compared with those smoking manufactured cigarettes exclusively, and those smoking both RYO and manufactured cigarettes. Group differences were tested using chi-squared statistic at the 5% alpha level. List-wise deletion was performed for missing records. For the study aim comparing the demographic characteristics of exclusive RYO cigarette smokers, exclusive manufactured cigarette smokers, and dual users of both products, we combined data across all four waves (2010, 2011, 2017, and 2018) to ensure adequate sample size for the exclusive RYO cigarette smoker category. For the demographic profile of exclusive RYO cigarette smokers, the denominator was survey participants who reported that they currently smoked RYO but not manufactured cigarettes; exclusive smokers of manufactured cigarettes were those who reported they currently smoked manufactured cigarettes but not RYO, while dual smokers of RYO and manufactured cigarettes comprised survey participants who reported they currently smoked both RYO and manufactured cigarettes.

Adjusted prevalence ratios (APRs) were calculated in a multivariable Poisson regression model to explore factors associated with current RYO cigarette use using the 2017–2018 pooled data; independent variables assessed were province, age, gender, employment status, residence, race, as well as use of other tobacco products such as manufactured cigarettes, hookah, cigars, e-cigarettes, and snuff. Statistical significance was set at p<0.05 for the final model. Unless otherwise specified in the context of exclusive use between RYO and manufactured cigarettes, all mentions of RYO cigarette use (ever or current) are mutually inclusive of manufactured cigarettes/other tobacco products (i.e. they describe RYO use, regardless of whether the individuals used manufactured cigarettes or any other tobacco product).

Expenditure difference between daily smokers of RYO versus manufactured cigarettes
For daily cigarette smokers who bought manufactured cigarettes in sticks, the daily cost of smoking cigarettes...
was the cost of a single stick multiplied by the number of cigarettes smoked per day. For those who bought in packs, it was cost of a single pack multiplied by (number of cigarettes smoked per day/20). Monthly expenditures were extrapolated by multiplying daily costs by 30, annual expenditures by multiplying monthly expenditures by 12.

RYO cigarette smoking is more subject to variability in the amount of tobacco consumed and the overall expenditure, depending on the size of the paper, how it is rolled (fairly tight vs loose/under filled), as well as whether the smoker used other accessories such as rolling machines, rolling paper, filter tips, filter tubes, lighters, holders for papers or tobacco, aroma cards, or other related accessories. To estimate the annual expenditure associated with daily RYO cigarette smoking, we first determined the expected number of cigarettes to be smoked in a year by multiplying the median CPD determined among RYO smokers (6 sticks, from 2018 SASAS) by 365, yielding 2190 cigarettes. We then calculated the number of 50 g bags of RYO tobacco (i.e. the most recurring size) that would need to be bought in a year to meet demand by dividing 2190 by the minimum number of RYO cigarettes that could be rolled from a 50 g tobacco pouch. Multiplying the number of RYO bags smoked in a year by the cost of 1 bag yielded the total estimated annual expenditure associated with daily smoking of RYO cigarettes.

To account for the potential variability in the minimum number of cigarettes that could be rolled from a 50 g tobacco pouch, we applied varying paper sizes as specified in the British Standard International Organization of Standardization statistics\(^\text{19}\), an internationally recognized benchmark. These were: 1) a 70 mm cigarette paper which consumes 0.75 g of tobacco per cigarette stick, equivalent to a yield of 66 rolled cigarettes per 50 g pouch or 33 sets of 50 g pouches in a year (i.e. 2190/66); 2) a 79 mm cigarette paper which consumes 0.88 g of tobacco per cigarette stick, equivalent to a yield of 56 rolled cigarettes per 50 g pouch, or 39 sets of 50 g pouches in a year; and 3) a 100 mm cigarette paper which consumes 1.18 g of tobacco per cigarette stick, equivalent to a yield of 42 rolled cigarettes per 50 g pouch, or 52 sets of 50 g pouches in a year.

### RESULTS

**Sociodemographic characteristics of the study population**

In the 2017–2018 cycle of SASAS, the population comprised mostly Black Africans (78.6%), whereas the smallest racial group was Indian/Asian (2.9%) (Table 1). By age, 50.6% of the population was aged 16–35 years. Gender composition was similar between males (50.0%) and females (50.0%). Over a third of the population (37%) had completed high school, and only 3.7% of participants reported no formal schooling. The significant difference between the two pooled periods of surveys was that more people had completed high school, and more were unemployed in 2017–2018 compared to 2010–2011.

**Prevalence and correlates of RYO cigarette smoking between 2010–2011 and 2017–2018**

Ever RYO cigarette smoking in the overall population increased from 6.5% during 2010–2011, to 8.5% during 2017–2018 (p=0.026) (Table 2). During 2017–2018, the prevalence of ever RYO cigarette use was highest among those who self-identified as Coloreds at 13.1%, followed by Black Africans at 8.4%, and lowest among Indians/Asians (5.6%) and Whites (5.8%). By age, ever use prevalence of RYO cigarette smoking was just over 9% in the age groups 16–24 (9.2%), 25–34 (9.4%), and 55–64 years (9.5%), and lowest among those aged ≥65 years (7.0%). Ever use of RYO cigarettes was over five-fold higher among men (14.4%) than women (2.7%). Participants with primary school education had the highest prevalence (12.1%) of ever use of RYO cigarette smoking, whereas those with tertiary education had the lowest prevalence (4%). Unemployed participants had the highest prevalence (12.5%) of ever smoking RYO cigarettes, compared to employed participants at 8.1%.

The prevalence of current RYO cigarette use during 2010–2011 was 5.2% and did not change significantly compared to 2017–2018 (6.3%, p=0.544). During 2017–2018, the prevalence of current RYO cigarette use was also highest among Coloreds at 11.1%, followed by Black Africans at 6.6% but lowest among Indians/Asians at 2.0%. The prevalence of RYO cigarette current use was highest (7.8%) in the age group 25–34 years, followed by the 16–24 years age...
group (7.0%), but lowest among the oldest age group ≥65 years (3.2%). Current use of RYO cigarettes was over seven-fold higher among men (11.6%) than women (1.6%). Participants with primary school education had the highest prevalence (8.4%) of current use of RYO cigarette smoking, followed by participants with no schooling (7.5%); those with tertiary education had the least prevalence (3.7%). Unemployed participants had the highest prevalence (9.8%) of current RYO cigarette smoking, compared to employed participants at 6.8%.

Within segmentation analyses of RYO cigarette smokers during 2010–2011 versus 2017–2018, results showed shifts in the composition of current RYO cigarette smokers by employment and education, but not by race, gender, and age. Specifically, of current RYO cigarette smokers, the percentage of unemployed individuals doubled between 2010–2011 (24.8%) and 2017–2018 (41.5%); correspondingly, the percentage of employed individuals decreased, as shown in Table 3. Similarly, by education, an increase was seen in the composition of current RYO cigarette smokers who reported having completed high school, increasing from 24.1% in 2010–2011, to 39.6% in 2017–2018.

Table 1. Characteristics of study participants in SASAS between 2010–2011 and 2017–2018

| Characteristics | 2010–2011 | 2017–2018 | p* |
|-----------------|-----------|-----------|----|
|                 | n | %   | n | %   |
| **Total**       | 6116 | 100 | 5799 | 100 |
| **Race**        |   |     |     |     |
| Black African   | 3664 | 76.7 | 3596 | 78.6 | 0.542 |
| Colored         | 1037 | 9.4 | 904 | 9.1 |
| Indian/Asian    | 624 | 2.9 | 685 | 2.9 |
| White           | 788 | 11.0 | 611 | 9.5 |
| **Age (years)** |   |     |     |     |
| 16–24           | 1184 | 27.2 | 931 | 24.1 | 0.128 |
| 25–34           | 1406 | 25.6 | 1202 | 26.6 |
| 35–44           | 1224 | 18.2 | 1126 | 19.2 |
| 45–54           | 1039 | 13.7 | 861 | 13.3 |
| 55–64           | 659 | 8.3 | 823 | 9.2 |
| ≥65             | 599 | 7.1 | 856 | 7.8 |
| **Gender**      |   |     |     |     |
| Male            | 2508 | 47.6 | 2321 | 50.0 | 0.098 |
| Female          | 3607 | 52.4 | 3478 | 50.0 |
| **Education level** |   |     |     |     |
| No school       | 260 | 3.8 | 261 | 3.7 | <0.001 |
| Primary         | 931 | 14.2 | 857 | 11.8 |
| Some high school | 2161 | 37.2 | 1985 | 36.8 |
| High school completed | 1751 | 31.6 | 1900 | 37.0 |
| Tertiary        | 892 | 13.2 | 640 | 10.0 |
| Other/don’t know | 0 | 0.0 | 34 | 0.7 |
| **Employment status** |   |     |     |     |
| Employed        | 2090 | 31.7 | 1549 | 26.4 | <0.001 |
| Unemployed      | 1616 | 22.8 | 1718 | 27.8 |
| Not in the workforce | 2234 | 45.5 | 2138 | 45.8 |

All percentages (%) are weighted, and all raw counts (n) are unweighted. *The p-values are from chi-squared tests of independence and are testing whether the sociodemographic composition differed between the two time periods (i.e. 2010–2011 vs 2017–2018). All tests were two-tailed and deemed significant at p<0.05.
Distinct characteristics associated with RYO versus manufactured cigarette smoking

Striking differences were seen among those who smoked RYO cigarettes and how they smoked it, contrasted to manufactured cigarettes. Within 2018 SASAS, daily use was more common for manufactured cigarettes than RYO cigarettes. Of those reporting ever use of manufactured cigarettes during 2018, 65.3% reported they smoked daily, 21.2% smoked some days, 3.1% had quit within the past 6 months, and 10.4% had quit >6 months ago. For RYO cigarettes, however, the corresponding percentages were 46.9% for daily smoking, 38.9% for smoking on some days, 4.2% for quitting within the past 6 months, and 9.9% for quitting >6 months ago.

Significant differences were seen in the racial composition of exclusive smokers of RYO cigarettes, exclusive manufactured cigarettes, and dual users of RYO and manufactured cigarettes. Within pooled analysis across all four survey waves, exclusive RYO cigarette smokers had a higher composition of Black Africans (88.7%) versus exclusive smokers of manufactured cigarettes (65.3%).

| Table 2. Percentage of South African adults aged ≥16 years who reported ever a and current b use of roll-your-own cigarettes between 2010–2011 and 2017–2018 |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Characteristics                | Ever use        | Current use     | Ever use        | Current use     |
|                                | 2010–2011       | 2017–2018       | 2010–2011       | 2017–2018       |
|                                | % (95% CI)      | % (95% CI)      | % (95% CI)      | % (95% CI)      |
| Total                          | 6.6 (5.6–7.5)   | 8.5 (7.0–10.0)  | 0.026           | 5.2 (4.3–6.0)   | 6.3 (5.3–7.9)   | 0.544           |
| Race                           |                |                |                |                |                |
| Black African                  | 7.0 (5.9–8.2)   | 8.4 (6.7–10.2)  | 0.178           | 5.5 (4.5–6.6)   | 6.6 (5.1–8.1)   | 0.243           |
| Colored                        | 9.9 (7.4–12.5)  | 13.1 (8.7–17.5) | 0.209           | 8.3 (5.8–10.8)  | 11.1 (7.0–15.2) | 0.242           |
| Indian/Asian                   | 2.7 (0.1–5.4)   | 5.6 (2.2–9.0)   | 0.210           | 2.3 (–0.3–5.0)  | 2.0 (0.9–3.1)   | 0.828           |
| White                          | 1.5 (0.4–2.6)   | 5.8 (2.6–9.0)   | 0.001           | 0.5 (0.1–1.0)   | 4.2 (1.3–7.1)   | 0.000           |
| Age (years)                    |                |                |                |                |
| 16–24                          | 6.6 (4.5–8.7)   | 9.2 (5.9–12.5)  | 0.175           | 5.8 (3.8–7.7)   | 7.0 (4.5–9.4)   | 0.438           |
| 25–34                          | 6.1 (4.3–7.8)   | 9.4 (6.1–12.7)  | 0.054           | 4.2 (2.9–5.5)   | 7.8 (4.7–11.0)  | 0.015           |
| 35–44                          | 6.7 (4.8–8.7)   | 7.2 (4.9–9.5)   | 0.764           | 5.3 (3.5–7.1)   | 5.9 (3.6–8.1)   | 0.685           |
| 45–54                          | 6.5 (4.4–8.5)   | 7.7 (4.7–10.6)  | 0.499           | 5.4 (3.4–7.3)   | 6.8 (4.0–9.7)   | 0.394           |
| 55–64                          | 9.6 (6.2–13.1)  | 9.5 (6.5–12.6)  | 0.956           | 7.4 (4.4–10.4)  | 6.5 (3.9–9.1)   | 0.660           |
| ≥65                            | 4.6 (2.2–6.9)   | 7.0 (4.0–10.0)  | 0.195           | 2.9 (1.3–4.6)   | 3.2 (1.1–5.2)   | 0.859           |
| Sex                            |                |                |                |                |
| Male                           | 11.3 (9.6–13.1) | 14.4 (11.6–17.2)| 0.062           | 9.0 (7.4–10.6)  | 11.6 (9.2–14.1) | 0.071           |
| Female                         | 2.3 (1.6–2.9)   | 2.7 (1.9–3.4)   | 0.408           | 1.6 (1.1–2.2)   | 1.6 (1.1–2.2)   | 0.977           |
| Education level                |                |                |                |                |
| No school                      | 10.0 (5.4–14.6) | 9.7 (3.3–16.2)  | 0.942           | 7.6 (3.7–11.5)  | 7.5 (1.5–13.5)  | 0.966           |
| Primary                        | 11.8 (9.0–14.7) | 12.1 (8.8–15.3)| 0.908           | 9.9 (7.2–12.7)  | 8.4 (5.7–11.1)  | 0.429           |
| Some high school               | 5.5 (4.2–6.8)   | 7.8 (6.0–9.5)   | 0.039           | 4.8 (3.6–6.1)   | 6.3 (4.7–7.9)   | 0.156           |
| High school completed          | 5.8 (4.1–7.6)   | 9.3 (6.3–12.3)  | 0.037           | 4.0 (2.5–5.4)   | 7.1 (4.4–9.8)   | 0.025           |
| Tertiary                       | 4.6 (2.6–6.6)   | 4.0 (1.5–6.5)   | 0.720           | 3.2 (1.5–4.9)   | 3.7 (1.2–6.2)   | 0.755           |
| Employment status              |                |                |                |                |
| Employed                       | 7.5 (5.8–9.2)   | 8.1 (5.5–10.7)  | 0.682           | 5.7 (4.2–7.2)   | 6.8 (4.2–9.4)   | 0.454           |
| Unemployed                     | 8.1 (6.1–10.0)  | 12.5 (9.2–15.9) | 0.015           | 5.7 (4.2–7.2)   | 9.8 (6.6–13.0)  | 0.011           |
| Not in the workforce           | 5.4 (4.0–6.9)   | 6.0 (3.7–8.2)   | 0.682           | 4.7 (3.3–6.0)   | 4.5 (3.0–6.1)   | 0.901           |

All percentages (%) are weighted, and all raw counts (n) are unweighted. a Ever use was defined as persons who indicated they used the particular tobacco product ‘currently every day’, ‘currently some days’, ‘stopped completely, less than 6 months’, ‘stopped completely, more than 6 months’. b Current was defined as persons who indicated they used the particular tobacco product ‘currently every day’, or ‘currently some days’. c The p-values are testing for differences within each row when comparing 2017–2018 vs 2010–2011 for ever or current use of roll-your-own cigarettes, as appropriate. A p<0.05 was deemed statistically significant.
of manufactured cigarettes (55.3%). Exclusive RYO cigarette smokers also had a higher composition of smokers aged 16–24 years (28.6%) than exclusive smokers of manufactured cigarettes (18.6%). Males comprised most users for both RYO and manufactured cigarettes but made up a higher proportion for RYO cigarette (81.7%) than manufactured cigarette (70.9%) smoking. Individuals with no schooling or with only primary school education made up over a third of current RYO cigarette smokers (38.0%).

Table 3. Composition of current smokers of roll-your-own cigarettes by selected demographic characteristics between 2010–2011 and 2017–2018

| Characteristics          | 2010–2011 (n=318) | 2017–2018 (n=327) | p a |
|--------------------------|-------------------|-------------------|-----|
| Race                     |                   |                   |     |
| Black African            | 82.3 (%)          | 78.0 (%)          | 0.0593 |
| Colored                  | 15.2 (%)          | 15.2 (%)          |     |
| Indian/Asian             | 1.3 (%)           | 0.9 (%)           |     |
| White                    | 1.2 (%)           | 6.0 (%)           |     |
| Age (years)              |                   |                   |     |
| 16–24                    | 30.3 (%)          | 25.4 (%)          | 0.4436 |
| 25–34                    | 20.8 (%)          | 31.2 (%)          |     |
| 35–44                    | 18.6 (%)          | 16.9 (%)          |     |
| 45–54                    | 14.2 (%)          | 13.7 (%)          |     |
| 55–64                    | 11.9 (%)          | 9.1 (%)           |     |
| ≥65                      | 4.1 (%)           | 3.7 (%)           |     |
| Gender                   |                   |                   |     |
| Male                     | 83.2 (%)          | 87.7 (%)          | 0.174 |
| Female                   | 16.8 (%)          | 12.3 (%)          |     |
| Education level          |                   |                   |     |
| No school                | 5.6 (%)           | 4.2 (%)           | 0.0183 |
| Primary                  | 27.2 (%)          | 14.9 (%)          |     |
| Some high school         | 34.9 (%)          | 34.9 (%)          |     |
| High school completed    | 24.1 (%)          | 39.6 (%)          |     |
| Tertiary                 | 8.2 (%)           | 5.5 (%)           |     |
| Other/don’t know         | 0.0 (%)           | 1.0 (%)           |     |
| Employment status        |                   |                   |     |
| Employed                 | 34.5 (%)          | 27.2 (%)          | 0.038 |
| Unemployed               | 24.8 (%)          | 41.5 (%)          |     |
| Not in the workforceb    | 40.7 (%)          | 31.4 (%)          |     |

Multivariable analysis of factors associated with current RYO cigarette smoking during 2017–2018

Within adjusted analyses, the strongest correlates of current RYO cigarette smoking were being a current (APR=22.65; 95% CI: 11.89–43.15) or a former (APR=15.89; 95% CI: 5.97–42.31) smoker of manufactured cigarettes. Current use of hookah (APR=2.40; 95% CI: 1.57–3.68) was also significantly associated with current RYO cigarette smoking; however, no significant associations were seen between current RYO cigarette use and use of cigars, e-cigarettes, or snuff (Table 5). Those unemployed were more likely to report current use of RYO cigarettes than those employed (APR=1.70; 95% CI: 1.18–2.43). Conversely, the likelihood of reporting current RYO cigarette use was lower among females compared to males (APR=0.36; 95% CI: 0.24–0.55), urban than rural residence (APR=0.67; 95% CI: 0.46–0.97), Indians/Asians compared to Blacks (APR=0.22; 95% CI: 0.12–0.40), and among those living in Free state compared to Gauteng (APR=0.53; 95% CI: 0.30–0.96).

Annual expenditures associated with daily smoking of RYO versus manufactured cigarettes

Overall, within 2018 SASAS, 15.4% (n=456) were daily smokers of manufactured cigarettes. Within weighted analyses, the median cigarettes smoked per month was 210 sticks, and the median monthly expenditure was ZAR 405. Extrapolated median annual expenditures were ZAR 4860 based on daily smoking of manufactured cigarettes.
For RYO cigarettes, estimated expenditures varied by assumed amount of tobacco consumed per rolled cigarette. Based on median cigarette consumption of 2190 cigarettes per year, the estimated annual expenditures were as follows by varying paper sizes: for a 70 mm cigarette paper consuming 0.75 g of tobacco per cigarette roll, expected annual expenditure was ZAR 3194.4. For a 79 mm cigarette paper consuming 0.88 g of tobacco per roll, expected annual expenditure was ZAR 3775.2. For a 100 mm cigarette paper consuming 1.18 g of tobacco per roll, expected annual expenditure was ZAR 5420.8.
DISCUSSION

The results of the study show that the prevalence of ever RYO cigarette use increased significantly among the South African adult population between 2010–2011 and 2017–2018, from 6.5% to 8.5%; current RYO cigarette use however remained unchanged. Current use prevalence during 2017–2018 was highest among those who self-identified as Coloreds (11.1%) and Black Africans (6.6%), aged 16–24 (7.0%) and 25–34 years (7.8%), males (11.6%), those with only primary school education (8.4%), and the unemployed (9.8%). A common link across these groups is that they are mostly price-sensitive populations who might be using RYO cigarettes as a price minimizing strategy. Indeed, our results suggest that while the annual expenditure associated with daily RYO cigarette smoking may be highly variable depending on the amount of tobacco consumed per roll, annual expenditures associated with the most commonly smoked cigarette size (i.e. King-sized cigarettes, 79–88 mm), were ZAR 3775.2, substantially less than annual expenditures for daily smoking of manufactured cigarettes, ZAR 4860. These findings are in line with previous reports from South Africa and abroad. Nonetheless, our findings also raise the possibility that heavy RYO cigarette smoking may be associated with higher expenditures than the average smoker of manufactured cigarettes, thus limiting cash flow for household necessities among groups that are already at an economic disadvantage.

Existing disparities in the South African tobacco excise taxation system may encourage and perpetuate the use of RYO as a substitute product for cigarettes. During the 2020–2021 tax year, the excise tax on a pack of 20 cigarettes was ZAR 16.66, compared to ZAR 5.39 for a 25 g bag of pipe tobacco which is also used as RYO tobacco. Harmonizing tax between these products would mean raising the tax on the 25 g bag from ZAR 5.39 to given that a 25 g pouch of tobacco contained in RYO cigarettes is approximately the same amount of tobacco as 1.35 packs of manufactured cigarettes. Harmonizing tax between substitute products that have similar harm profiles such as manufactured cigarettes and RYO cigarettes. This is especially important given our finding that former smokers of manufactured cigarettes had a highly elevated likelihood of reporting current use.

Table 5. Adjusted prevalence ratio (APR) for factors associated with current use of RYO cigarettes among South African adults aged ≥16 years, 2017–2018

| Characteristics | Categories | APR (95% CI) | p   |
|-----------------|------------|--------------|-----|
| Province        | Gauteng (Ref.) | 1            |     |
|                 | Western Cape | 0.57 (0.31–1.05) | 0.07 |
|                 | Eastern Cape | 0.79 (0.45–1.41) | 0.43 |
|                 | Northern Cape | 0.90 (0.46–1.74) | 0.745 |
|                 | Free State | 0.53 (0.30–0.96) | 0.035 |
|                 | KwaZulu-Natal | 1.14 (0.73–1.78) | 0.575 |
|                 | North West | 0.63 (0.38–1.06) | 0.08 |
|                 | Mpumalanga | 0.81 (0.48–1.36) | 0.425 |
|                 | Limpopo | 0.69 (0.34–1.39) | 0.295 |
| Age (years)     | 16–24 (Ref.) | 1            |     |
|                 | 25–35 | 0.88 (0.59–1.33) | 0.546 |
|                 | 35–44 | 0.94 (0.60–1.47) | 0.783 |
|                 | 45–54 | 0.91 (0.56–1.48) | 0.713 |
|                 | 55–64 | 0.79 (0.47–1.32) | 0.369 |
|                 | ≥65 | 0.48 (0.21–1.11) | 0.085 |
| Gender          | Male (Ref.) | 1            |     |
|                 | Female | 0.36 (0.24–0.55) | <0.001 |
| Employment status | Employed (Ref.) | 1 |     |
|                 | Unemployed | 1.70 (1.18–2.43) | 0.004 |
|                 | Not in the workforce | 1.19 (0.77–1.83) | 0.446 |
| Residence       | Rural (Ref.) | 1            |     |
|                 | Urban | 0.67 (0.46–0.97) | 0.033 |
| Race            | Black (Ref.) | 1            |     |
|                 | Colored | 1.20 (0.78–1.86) | 0.403 |
|                 | Indian/Asian | 0.22 (0.12–0.40) | <0.001 |
|                 | White | 0.49 (0.24–1.00) | 0.051 |
| Smoking of manufactured cigarettes | Non-smoker (Ref.) | 1 |     |
|                 | Current smoker | 22.65 (11.89–43.15) | <0.001 |
|                 | Former smoker | 15.89 (5.97–42.31) | <0.001 |
| Hookah smoking | Non-smoker (Ref.) | 1 |     |
|                 | Current smoker | 2.40 (1.57–3.68) | <0.001 |
| Cigar smoking   | Non-smoker (Ref.) | 1 |     |
|                 | Current smoker | 1.45 (0.73–2.90) | 0.288 |
| E-cigarette use | Non-user (Ref.) | 1 |     |
|                 | Current user | 1.05 (0.55–2.03) | 0.879 |
| Snuff use       | Non-user (Ref.) | 1 |     |
|                 | Current user | 1.71 (0.93–3.13) | 0.082 |

Adjusted analysis controlled for all factors listed in table. Includes those retired, homemakers, or very disabled and unable to work, or attending school. RYO: roll-your-own.
of RYO cigarettes, possibly because of reduced harm perception, easier access, and greater affordability.

In our study, exclusive RYO cigarette smokers differed from exclusive smokers of manufactured cigarettes in having a higher proportion of Black African respondents, youth, with less education, and those unemployed. Those who reported dual use of RYO and manufactured cigarettes, had some sociodemographic characteristics that fell between those of exclusive RYO and exclusive manufactured cigarettes. These might be individuals who would smoke manufactured cigarettes if they can, but RYO if they must (i.e. as a substitute product). Non-daily smoking was more prevalent for RYO than manufactured cigarettes. This may be attributable to less disposable income on the part of RYO cigarette smokers to sustain daily use, especially when considering the demographic profiles of users.

Although other studies found that quitting rates were lower among exclusive RYO cigarette smokers than exclusive smokers of manufactured cigarettes due to the low cost of RYO cigarettes and perceptions of less harm; our study results suggest that quitting rates were higher among exclusive RYO cigarette smokers than exclusive smokers of manufactured cigarettes. This may be attributed to factors such as non-daily use (possibly lower dependence), negative health effects and inconvenience associated with hand rolling. There is a need for tailored smoking cessation efforts for RYO and manufactured cigarette smokers. Also, the adoption of plain packaging laws and restriction on flavors could further increase quit attempts among exclusive RYO cigarette smokers. Some groups with relatively low prevalence during 2017–2018, saw very large increases in the prevalence of current RYO cigarette smoking between 2010–2011 and 2017–2018. For example, prevalence of current use increased from 0.5% to 4.2% among those who self-identified as White, a 669% relative percent change (RPC). Relatively large increases were also seen for those with matriculation or equivalent (4.0% to 7.1%, relative percentage change of 80%). Surveillance efforts should therefore focus, not only on groups with large prevalence, but also those with large increases over time even if their current prevalence is not dramatic. It is also important to monitor demographic shifts in the overall population over time, as those underlying shifts might influence prevalence. Knowing which groups are driving prevalence (e.g. shifts in the percentage of those unemployed) is important to develop targeted interventions to help reduce demand and use of tobacco products.

Strengths and limitations

The strengths of this study include use of a nationally representative sample of South African adults to examine changes in prevalence of RYO cigarette smoking within the past decade. The standardized methodology of SASAS over time allows for direct comparisons of results. Nonetheless, limitations exist. First, this was a cross-sectional study; therefore, we cannot make any causal inferences. Second, a face-to-face interviewer-administered questionnaire was used to collect data, which together with self-reported risk behavior, might increase the likelihood of participants offering socially desirable responses and potentially misclassifying their smoking status. Third, there is a potential for recall bias on past smoking behavior. It is, however, unlikely that the use of self-reporting will significantly influence our measure of smoking status, as self-report has been shown to be a valid means of assessing smoking status in population surveys. Fourth, annual RYO expenditures did not include costs associated with acquiring rolling machines, rolling paper, filter tips, filter tubes, lighters, holders for papers or tobacco (i.e. RYO tin), aroma cards, or other related accessories. Finally, while we attempted to capture a cross-section of RYO prices from online vendors, some vendors had removed most prices from their websites to comply with restrictions on sales of tobacco products through the postal services, the internet or any other electronic media. The captured prices may therefore not be fully representative of all RYO products sold in stores and over the internet within South Africa. Furthermore, the reported associated costs for RYO cigarettes may be overestimated as the online listed vendors may be more expensive and may not represent all sources of tobacco purchases for RYO cigarettes, especially by low socioeconomic status RYO cigarette smokers who are also more likely to use cheaper pipe tobacco than RYO tobacco.

CONCLUSIONS

The use of RYO cigarettes was more common among Coloreds, and Black Africans. It was also common
among youths, males, those with less education (primary school) and those who were unemployed. Based on typical usage, the annual expenditures associated with daily RYO cigarette smoking based on typical usage patterns were substantially less than that of smoking manufactured cigarettes. Efforts to harmonize taxation of cigarettes and RYO products may discourage use among price-sensitive populations. At the same time, intensified implementation of evidence-based tobacco prevention and control measures is needed to shift risk for the entire population as a whole and reduce aggregate tobacco consumption.

REFERENCES

1. Jackson SE, Shahab L, West R, Brown J. Roll-your-own cigarette use and smoking cessation behaviour: a cross-sectional population study in England. BMJ Open. 2018;8(12):e025370. doi:10.1136/bmjopen-2018-025370

2. Gilmore AB, Tavakoly B, Hiscock R, Taylor G. Smoking patterns in Great Britain: the rise of cheap cigarette brands and roll your own (RYO) tobacco. J Public Health (Oxf). 2015;37(1):78-88. doi:10.1093/pubmed/fdu048

3. Cornelsen L, Normand C. Is roll-your-own tobacco substitute for manufactured cigarettes: evidence from Ireland? J Public Health (Oxf). 2014;36(1):65-71. doi:10.1093/pubmed/fdt030

4. Bayly M, Scollo MM, Wakefield MA. Who uses rollies? Trends in product offerings, price and use of roll-your-own tobacco in Australia. Tob Control. 2019;28(3):317-324. doi:10.1136/tobaccocontrol-2018-054334

5. Partos TR, Gilmore AB, Hitchman SC, Hiscock R, Branston JR, McNeil A. Availability and Use of Cheap Tobacco in the United Kingdom 2002-2014: Findings From the International Tobacco Control Project. Nicotine Tob Res. 2018;20(6):714-724. doi:10.1093/ntr/ntx108

6. Ayo-Yusuf OA, Olutola BG. “Roll-your-own” cigarette smoking in South Africa between 2007 and 2010. BMC Public Health. 2013;13:597. doi:10.1186/1471-2458-13-597

7. U.S. Food and Drug Administration. Roll-Your-Own Tobacco. Published 2019. Accessed November 20, 2020. https://www.fda.gov/tobacco-products/products-ingredients-components/roll-your-own-tobacco

8. Minardi V, Ferrante G, D’Argenio P, et al. Roll-your-own cigarette use in Italy: sales and consumer profile-data from PASSI surveillance, 2015-2016. Int J Public Health. 2019;64(3):423-430. doi:10.1007/s00038-019-1204-5

9. Gallus S, Lugo A, Ghislandi S, La Vecchia C, Gilmore AB. Roll-your-own cigarettes in Europe: use, weight and implications for fiscal policies. Eur J Cancer Prev. 2014;23(3):186-192. doi:10.1097/CEJ.0000000000000010

10. Breslin E, Hanafin J, Clancy L. It’s not all about price: factors associated with roll-your-own tobacco use among young people - a qualitative study. BMC Public Health. 2018;18(1):991. doi:10.1186/s12889-018-5921-8

11. Villanti AC, Johnson AL, Ambrose BK, et al. Flavored Tobacco Product Use in Youth and Adults: Findings From the First Wave of the PATH Study (2013-2014). Am J Prev Med. 2017;53(2):139-151. doi:10.1016/j.amepre.2017.01.026

12. Agaku IT, Odani S, Armour B, et al. Differences in price of flavoured and non-flavoured tobacco products sold in the USA, 2011-2016. Tob Control. 2020;29(5):537-547. doi:10.1136/tobaccocontrol-2019-055111

13. Vellios N, van Walbeek C, Ross H. Illicit cigarette trade in South Africa: 2002-2017. Tob Control. 2020;29(Suppl 4):s234-s242. doi:10.1136/tobaccocontrol-2018-054798

14. Republic of South Africa - Department of Statistics. The South African economy sheds more than half a million jobs in the 3rd quarter of 2021. November 30, 2021. Accessed January 2, 2022. https://www.statssa.gov.za/?p=14922&:text=Between%20the%202nd%20and,%20households%20with%20%265%20000%20each

15. Republic of South Africa - Department of Statistics. Quarterly Labour Force Survey. Quarter 2: 2021. Accessed January 11, 2021. https://www.statssa.gov.za/publications/P0211/P0211ndQuarter2021.pdf

16. Human Sciences Research Council. South African Social Attitudes Survey. Accessed January 20, 2020. http://www.hsrc.ac.za/en/departments/sasas

17. Ayo-Yusuf OA. Re-emergence of traditional tobacco products usage in South Africa: an unintended consequence of existing tobacco control policy. African Journal of Drug and Alcohol Studies. 2005;4(1-2):32-43.

18. Yellow pages. Tobacconists in South Africa. Accessed October 24, 2022. https://www.yellowpages.co.za/search?what=tobacconists

19. International Organization for Standardization. ISO 15592:2008(en). Accessed January 12, 2021. https://www.iso.org/obp/ui/#iso:std:iso:15592:-3:ed-2:v1:en

20. Agaku IT, Vardavas CI, Connolly GN. Cigarette rod length and its impact on serum cotinine and urinary total NNAL levels, NHANES 2007-2010. Nicotine Tob Res. 2014;16(1):100-107. doi:10.1093/ntr/ntt140

21. South African Revenue Service. Annual Report: South African Revenue Service 2019/20. Accessed February 8, 2022. https://www.gov.za/sites/default/files/gcis_document/202104/sars-annual-report-2019-20.pdf

22. Agaku IT, Alpert HR. Trends in annual sales and current use of cigarettes, cigars, roll-your-own tobacco, pipes, and smokeless tobacco among US adults, 2002-2012. Tob Control. 2016;25(4):451-457. doi:10.1136/tobaccocontrol-2014-052125

23. Young D, Borland R, Hammond D, et al. Prevalence and attributes of roll-your-own smokers in the International Tobacco Control (ITC) Four Country Survey. Tob Control. 2006;15 Suppl 3(Suppl 3):iii76-iii82. doi:10.1136/tc.2005.013268
24. Patrick DL, Cheadle A, Thompson DC, Diehr P, Koepsell T, Kinne S. The validity of self-reported smoking: a review and meta-analysis. Am J Public Health. 1994;84(7):1086-1093. doi:10.2105/ajph.84.7.1086