

ATI Working Paper

Confronting health inequality through risk-based taxation in South Africa

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ABSTRACT

South Africa suffers from high levels of health inequality and an underperforming public health care system, with non-communicable diseases being more prevalent among those relying on public health care. An excise regime that is risk-based presents an opportunity to reduce the prevalence of non-communicable diseases and thereby lessen health inequality. This paper considers the extent to which the South Africa excise rates on alcohol, tobacco and nicotine, and sugar are risk-based. It provides suggestions on how these excise rates can be adjusted to better reflect the relative harm of excisable goods.

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1 Introduction

South Africa suffers from social inequality.² The country rates highest in the world in both income and wealth inequality (World Inequality Database 2023).³ It has high inequality of opportunity, unequal access to basic services, and wide and entrenched spatial disparities in welfare (Sulla 2022).⁴ Although reducing social inequality is a government objective, as seen in the National Development Plan 2012 and many existing policies, social inequality persists (South African Government 2012). In fact, it has risen over the last 20 years (Statistics South Africa 2019a).

Social inequalities in South Africa are shaped by the history of apartheid, a system of institutionalized racial segregation that had existed in the country since 1948. Although the country has made significant progress towards political and legal equality since the end of apartheid in 1994, South Africa continues to face significant challenges in addressing social inequality, with ongoing racial and economic segregation that persist throughout the country. (World Bank 2022). The impact of historical racially discriminatory policies, underperforming public sector, and weak government policies explain over 40 percent of inequality.⁵ Race influences education, labor markets, and location pathways to better outcomes. These effects are apparent in the mean monthly income across racial groups; white South Africans earn nearly four times what black South Africans earn (Statistics South Africa 2019a).⁶

The race-based income, power and wealth discrepancies result in health inequality. The South African health system comprises an under-performing public sector that struggles to meet demand, and an expensive private sector that provides high-quality services, but requires private medical insurance. Access to such insurance is not equal. In 2019, only 10.8 percent of black South Africans and 20.8 percent of colored South Africans had private insurance, while 64.4 percent of Indian and 72.4 percent of white South Africans had private health insurance (Statistics South Africa 2019b). South Africa's public health system is chronically understaffed, especially in rural and remote areas, which leads to long waiting times and rushed appointments. Around 70 percent of doctors work only in the private sector, leaving only 30 percent of doctors available for the public sector (De Villiers 2021). Public health care in addition is often characterized by other problems, such as outdated facilities, poor disease control and prevention practices, and poor quality of care (Omotoso and Koch. 2018). This

² Inequality is the difference in social status, income, wealth, or opportunity between individuals or groups.

³ Income inequality refers to how unequally income is distributed within a population. It is often accompanied by wealth inequality, i.e. the unequal distribution of assets such as property and savings.

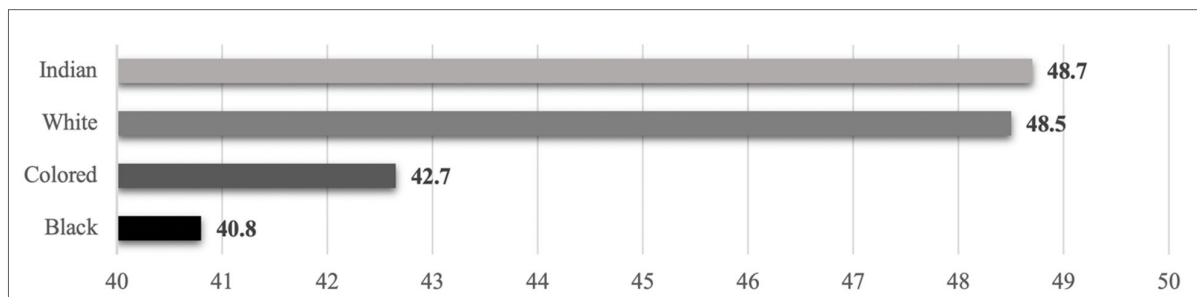
⁴ South Africa ranks 126th in gender inequality.

⁵ Education is the other large determinant of inequality in South Africa, explaining 30 percent of the variance in inequality in 2018.

⁶ White South Africans earned an average of R24,600 per month between 2011 and 2015, while blacks earned R6,900, coloreds R9,300, and Indians R14,200.

unequal access to quality health care may be one explanation for differences in life expectancy, as shown in Figure 1.

Figure 1. Weighted life expectancy from age 20 by race



Source: Lam, A. et al. (2022)

These inequalities in health care is especially concerning when considering the prevalence of non-communicable diseases (NCDs) in South Africa, such as cardiovascular disease, cancer, and diabetes. Over half of South African deaths are attributable to these diseases (World Bank 2020). Alarmingly, the percentage of death because of NCDs is rising.⁷ Making matters worse, there is a significant difference in the prevalence of NCDs among racial groups, with black and colored South Africans - who can least afford private insurance - being significantly more likely to live with a NCD than white and Indian South Africans (Tenkorang 2018).

Reducing the prevalence of NCDs in South Africa will reduce health inequality. Besides reducing the burden on disadvantaged groups, it will ease demand on the public health care system, which can improve its quality of care or reduce the funding requirement of this system. It deserves to be a foremost government priority.

To reduce the prevalence of NCDs, the risk factors of NCDs should be lessened, such as the use of combustible tobacco, excessive alcohol consumption, and consumption of sugar-sweetened beverages (SSBs). In 2016, 25,708 South Africans between the ages of 35 and 74 died because of smoking (Boachie et al. 2020). In 2015, 62,300 predominantly poor⁸ South Africans died from alcohol-attributable causes and in 2021, 96,000 died from diabetes (International Diabetes Federation 2021). About half of the adult South African population is overweight (23.6 percent) or obese (26.2 percent) and the rate of obesity is projected to increase to 37 percent by 2030 (National Department of Health 2016 and World Obesity Federation 2022). The costs associated with these statistics are large, with

⁷ Deaths because of NCDs have increased from 39 percent in 2000 to 51 percent in 2019.

⁸ For alcohol, 60 percent of deaths occurred among people with low socioeconomic status, compared to only 15 percent of deaths among people of high socioeconomic status.

the economic cost of smoking, alcohol and obesity being R42 billion (2016), R38 billion (2009), and R33 billion (2020), respectively (Boachie et al. 2020).

Excise taxes discourage the consumption of harmful goods.⁹ Lowering the consumption of tobacco, alcohol, and SSBs should reduce the prevalence of NCDs and, thereby, favorably impact social inequality and the demands on the public health system. However, the design of an excise regime determines its effectiveness in reducing the prevalence of NCDs. One design option to meet this objective is risk-based taxation.

2 Risk-based excise taxation

The traditional role of excise taxes is to improve the allocation of resources in an economy as a result of improved information, as provided by market prices. For certain goods, the private costs a good is not equal to the (net) social costs, or the private costs are not valued correctly by consumers. Where the social costs exceed private costs,¹⁰ there exists negative externalities and where private costs are undervalued by consumers, there exists negative internalities. The role of the excise is to tax these externalities and internalities and, thereby, raise prices so the market price reflects social costs, rather than potentially undervalued private costs.

Where market prices do not reflect social costs, they reduce efficiency and guide consumers to make uninformed or harmful decisions, such as buying more combustible tobacco, alcohol or SSBs than they would with better information. If the excise corrects this situation, the allocation of resources should improve and consumers should make less harmful purchasing decisions. For combustible tobacco, alcohol, and SSB, reduced purchases would lessen the risks of NCDs. Further, the government collects tax revenues that can fund public health care, which now faces less pressure because of the lower prevalence of NCDs.

However, within categories of excisable goods (e.g. alcohol, tobacco and nicotine, and sugar), the social costs of goods is not the same. For instance, the social cost of beer is much lower than spirits. This is not only because beer is less expensive to produce than spirits. The social cost is influenced by alcohol levels and spirits contain a higher percentage of alcohol per volume than beer.

⁹ The presence of illicit trade can undermine the effectiveness of tax increases as both a public health and fiscal measure by introducing cheaper alternatives to legal, full-price products. Although illicit cigarette trade is a serious problem in South Africa, its existence should not undermine tobacco control policies. Rather, part of these policies should be increased efforts to strengthen borders and reduce the prevalence of illicit products through preventative, detective, and corrective administrative controls. Since such a response to illicit trade is beyond the scope of this paper, this paper focuses on legal trade.

¹⁰ In theory, this is marginal social cost and marginal private cost. However, in practice costs are generally pooled and excise rates not based on marginal costs.

Alcohol consumption gives rise to costs that increase with the amount of alcohol consumed, such as health costs, road accidents, and domestic violence; costs that are not reflected in private costs. Since these costs increase with alcohol consumption, spirits have larger social costs than beer. To have the social costs of spirits and beer both equal their respective private costs, the excise rate needs to be higher on spirits than on beer for the same volume of liquid.

The idea of risk-based excise taxes is to set specific tax rates in accordance with the relative risk or harm within a category of excisable goods. A risk-based rate cannot be ad-valorem since relative risk is generally not linearly related to price and in many markets there are low cost, high harm excisable goods.

A risk base rate on alcohol will raise the price of beer by a much smaller amount than the price of spirits, reflecting the difference in risk associated with these products. While consumers may have preferred spirits to beer before introducing the excise, many will substitute beer for spirits — a decision that reduces harm.¹¹¹²

This substitution effect induced by risk-based excise taxes is essential to reduce the prevalence of NCDs. Where excise rates are not based on relative risk, more consumers will prefer higher risk-and-harm excisable goods to lower risk-and-harm goods. The excise regime will be less effective to reduce the prevalence of NCDs. This explains why the International Agency for Research on Cancer recommends risk-based excise rates:

“...as less harmful products have become more prevalent, and a continuum of risk or harm is present, it is appropriate to differentiate taxes according to relative risks. The overriding focus remains the reduction of demand for the most harmful products” (International Agency for Research on Cancer (2019).

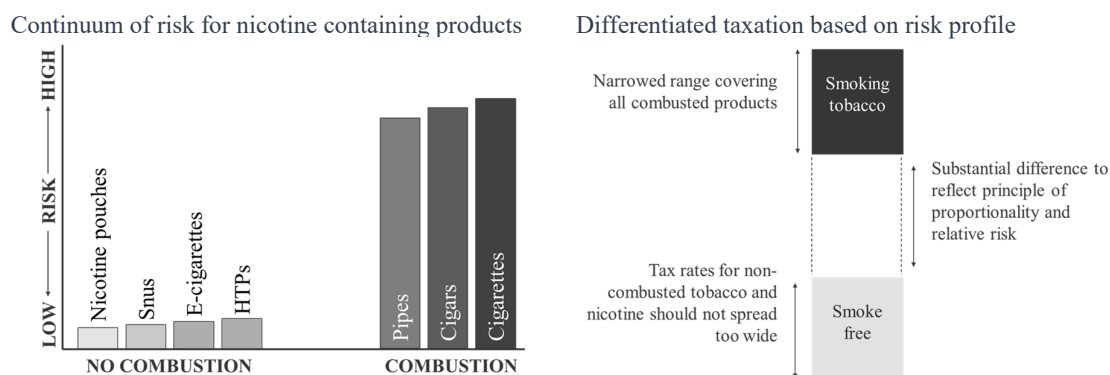
The continuum of risk or harm referred to by the International Agency for Research on Cancer applies to tobacco and nicotine products. Within this category of excisable goods, the evidence, of which there is a lack of longitudinal studies, suggests that combustible tobacco, as contained in cigarettes or loose tobacco, is more harmful and carcinogenic than non-combustible products, such as e-cigarettes

¹¹ The overall consumption of both spirits and beer will also reduce since both are more expensive than before introducing the excise.

¹² One example of a successful risk-based alcohol taxation is the Minimum Unit Pricing (MUP) policy implemented in Scotland in 2018. This policy sets a minimum price per unit of alcohol (50 pence per unit), with the aim of reducing alcohol consumption and related harms. The price per unit is based on the alcohol content of the beverage, meaning that products with higher alcohol content are subject to a higher minimum price (Scottish Government 2018). Studies show that the MUP led to a 13.4 percent reduction of deaths attributable to alcohol consumption and hospitalizations attributable to alcohol consumption decreased by 4.1 percent (Wyper et al. 2023).

and heated tobacco products (HTPs).^{13,14} Chaloupka (2015) provides a visual representation of such a risk-based approach, as reproduced in Figure 2.

Figure 2. Risk-based taxation of tobacco and nicotine



Source: Chaloupka (2015)

Applying risk-based excise taxation to tobacco and nicotine should result in substitution of lower harm and risk alternatives for higher harm products, thereby reducing the prevalence of NCDs. If not risk-based, market prices will undermine this substitution and social costs will not equal private costs. This may lead consumers to persist with behavior that is more costly to themselves, others, and the government.¹⁵

For the same reasons, SSBs should be taxed based on risk. For these beverages, the risks of consumption relate to the high sugar content of a beverage, which is associated with higher rates of obesity, diabetes, and other diseases (Cabrera Escobar et al. 2013). A risk-based approach would therefore reflect the sugar content of a beverage and social costs of SSB consumption, increasing the price of high-sugar beverages more than low-sugar beverages to motivate substitution towards low-sugar beverages.

¹³ HTPs produce an aerosol instead of smoke solely by heating instead of burning the tobacco. E-cigarettes heat a liquid that creates an aerosol that normally contains nicotine.

¹⁴ A summary of the literature is provided in section 3.2. For other summaries of the literature see House of Commons Science and Technology Committee (2018) and Public Health England (2018).

¹⁵ Two successful examples of risk-based excise taxation of tobacco are the United Kingdom and New Zealand. The United Kingdom and New Zealand have set targets to achieve a smoke-free population by 2030 and 2025 respectively (Parliament UK 2019 and Ministry of Health New Zealand 2018). To reach this goal, both countries have increased their combusted tobacco excise taxes significantly in the past years. While smoking prevalence has decreased considerably, it is clear, particularly in the case of New Zealand, that excise taxes cannot be increased further without causing financial harm to vulnerable groups (Ministry of Health New Zealand 2021). To address this issue, both use a risk-based excise taxation approach that differentiates tobacco and nicotine taxes based on their relative risk profiles. They promote less risky alternatives through lower excise taxation, which encourages smokers to switch to less dangerous forms of nicotine consumption (United Nations 2022).

3 Risk-based taxation in South Africa

3.1 Alcohol

Alcohol is extensively consumed in South Africa. Per capita alcohol consumption was 11.5 liters of pure alcohol in 2015 (WHO 2016). When only considering drinkers, this statistic increases to 28.9 liters of pure alcohol; among the highest in the world (WHO 2018).

The extensive consumption of alcohol often results in alcohol abuse. Alcohol is abused by over ten percent of the population (Pengpid et al. 2021).¹⁶ Particularly worrying is that abuse is more prevalent in socioeconomically disadvantaged groups that are less able to afford private medical insurance (Lawana and Booysen 2018).¹⁷ There is inequality in alcohol use, and inequality in the treatment of resulting NCDs.

Risk-based taxation can improve these inequalities. For beer, spirits, and other alcohol beverages, a risk-based excise rate would be one rate (e.g. R200) per liter of pure alcohol, reflecting the social cost per liter of pure alcohol. This rate will be the same, irrespective of the type of beverage, its place of production, or the inputs used to produce it. These factors do not influence the risks of alcohol consumption.¹⁸

South Africa only partially apply risk-based taxation to alcohol (Figure 3). Although South Africa relies on specific rates and the rate of spirits is the highest,—R257.20 per liter of pure alcohol— it is over 130 times greater than the rate on traditional beer. The rate on wine is less than beer, motivating the consumption of a beverage with greater harm. Only malt beer and ciders are taxed at an equivalent rate.

Objectives other than reducing the prevalence on NCDs are determining alcohol excise rates. For traditional beer, the objective may be to reduce home brewing. However, providing a cheap alcohol beverage to poor individuals, who may not afford private medical insurance and are likely of weaker health, may work against health and social objectives. The low rate on wine may support domestic production, but potentially lessen production efficiency, require higher tax rates on more distortive taxes, and increase social inequality.¹⁹ These trade-offs underlines the challenges when designing an excise regime with multiple objectives.

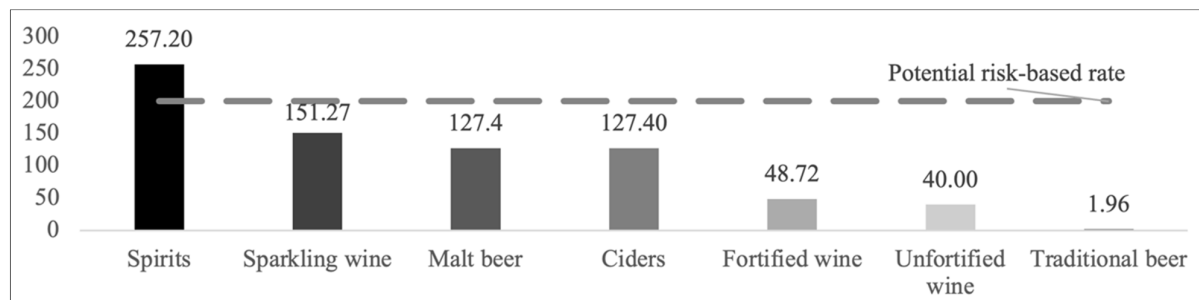
¹⁶ This excludes children younger than 15 years old.

¹⁷ The prevalence of alcohol abuse varies significantly among different ethnic groups, with higher rates of alcohol abuse observed among colored (13.5 percent) and black South Africans (10.4 percent) compared to white South Africans (7.4 percent).

¹⁸ The costs of alcohol consumption not reflected in price tend to rise linearly with alcohol content. The rate that different beverages are consumed is a factor that affects these costs. However, since drinks are often mixed with other liquids, individuals' rates of consumption are different, and to avoid a complex excise regime, economists generally rely only on pure alcohol content.

¹⁹ Domestic production can be supported through other tax instruments, such as the capital allowances under the income tax.

Figure 3. Excise rate per liter of pure alcohol



Note: The calculation is based on an average alcohol content of 13 percent for unfortified wine, 18 percent for fortified wine, 11 percent for sparkling wine and 4 percent for traditional beer. The potential risk-based rate is for illustrative purposes. The rate that will result in alcohol prices reflecting their true costs may differ from this rate in South Africa.

Source: Own calculation based on National Treasury (2023)

3.2 Tobacco and nicotine

The prevalence of cigarette smoking in South Africa is high and increasing. In 2017, about 20 percent of the adult population smoked (Health department South Africa 2022). By 2021, this increased to one of the highest rates in sub-Saharan Africa: 24 percent (Gitonga et al. 2021 and WHO 2022).

These statistics are especially unsettling when looking at the demographics of smokers. Most smokers have low incomes and education levels; that is, individuals who cannot afford private medical insurance and may not fully understand the risks of smoking (WHO 2022).²⁰ It is therefore essential that tobacco and nicotine prices communicate the relative risks of tobacco and nicotine products; that excise taxes are risk-based.

To apply risk-based taxation to combustible tobacco, a specific rate per cigarette should be set and used to determine a specific rate for loose tobacco (Branston et al. 2018).²¹ This involves relying on the average grams of tobacco in a cigarette and applying this rate to loose tobacco. If done correctly, a gram of tobacco should be taxed at the same rate whether in a cigarette or roll-your-own stick. If not, the price of either product will not reflect social costs since the risks and harm from combustible tobacco, whether loose tobacco or in a cigarette, are similar. As a result, consumers will substitute towards the less expensive form of tobacco, increasing the risks of NCDs.

South Africa taxes loose tobacco at R0.468 per gram or R0.35 per rolled stick.²² However, cigarettes are taxed at more than double this amount: R1.04 per stick, which equates to about R1.30 per gram.²³

²⁰ There are also racial differences in smoking prevalence. The smoking prevalence among colored individuals is 40.1 percent, while among Indians it is 22.1 percent. In contrast, white and black individuals had smoking prevalence rates of 15.3 percent and 15.1 percent (Reddy et al. 2015).

²¹ Ad valorem rates, which tax a percentage of the value, cannot allow for risk-based taxation since tobacco prices differences do not reflect differences in harm.

²² Commonly used rolling paper takes 0.75 grams of tobacco.

²³ A typical cigarette contains about 0.8 grams of tobacco.

When considering existing estimates of the true costs of smoking,²⁴ the tax on cigarettes is in line with these costs. However, loose tobacco is undertaxed. Its price does not reflect social costs. It motivates consumers to prefer loose tobacco to other forms. It provides misinformation to consumers and increases the probability of NCDs in South Africa.²⁵

To determine risk-based rates for non-combustible tobacco and nicotine requires evidence of the relative risk or harm of these products compared to cigarettes. Since these products are relatively new to the market, there is no long-term evidence on harm of non-combustible tobacco and nicotine products, outside of probable long-term harm estimates. Further, since the harm of these products is a subject of considerable debate, it is worthwhile provide an overview of the literature here (see Table 1 in Annex).

The available literature can be grouped under five categories: 1) toxicological risk assessment, which studies the toxins present in different products, 2) exposure, which studies the effect of different products on biomarkers of clinical relevance, 3) usage, which studies the behavioural impact of different products, 4) net effect of consumption, which studies the medium to long-term consequences of different products, and 5) initiation, which studies whether products are complementary or substitutional.

When considering the literature in Table 1 (see Annex), together with the in-depth, independent literature reviews by Glasser et.al (2017), Public Health England (2018), and Simonavicius et al. (2019), the consensus seems to indicate that HTPs are about 80 percent less harmful than cigarettes. For e-cigarettes, the consensus seems to indicate that this product is 95 percent less harmful than cigarettes, per stick equivalent, noting that a milliliter of nicotine liquid provides about the equivalent number of puffs of 10 cigarettes. Relying on this evidence, risk-based tax rates for HTPs would be 20 percent of the stick equivalent rate for cigarettes. For e-cigarettes it would be five percent of the stick equivalent rate for cigarettes, or about half the rate of cigarettes per milliliter of nicotine liquid. Based on the current rate applied to cigarettes and relying on the existing evidence, risk-based rates for HTPs are about R0.69 per gram or R0.208 per stick and the risk-based rates for e-cigarettes are R0.52 per milliliter or R0.052 per stick equivalent liquid (Table 2).^{26,27}

As with combustible tobacco, South Africa's taxes on HTP and e-cigarettes are not fully risk-based. Although relying on specific rates, the existing rates of R0.975 per gram or R0.78 per stick of HTP,

²⁴ These estimates change by context and country but generally exceed USD 1 per packet of 20 cigarettes.

²⁵ The use of loose tobacco is more prevalent in lower socio-economic groups in South Africa, which may raise demands on the public healthcare system (Ayo-Yusuf and Olutola 2013).

²⁶ A milliliter of ENDS liquid is about equivalent to 10 cigarettes in terms of nicotine content. The harm is about 5 percent of a cigarette.

²⁷ Because of the low risk and harm from e-cigarettes, some countries such as the United Kingdom does not levy an excise on these products (HM Revenue & Customs 2023).

and R2.90 per milliliter or R0.29 per stick equivalent of e-cigarette liquid appears to exceed a risk-based rate. If this is the case, the prices of these products suggest to consumers that these products are more harmful than the scientific evidence shows. This undermines the substitution effect of these products for combustible tobacco, increasing the probability of NCDs.

Table 1. Current and risk-based rates for tobacco and nicotine products

Product	Current rate		Risk-based rate	
	Legislated	Stick equivalent	Recommended	Stick equivalent
Cigarettes	R1.04 per stick	R1.04	R1.04 per stick	R1.04
Loose cigarette tobacco	R0.468 per gram	R0.351	R1.30 per gram	R0.975
HTPs (in stick-format)	R0.78 per stick	R0.78	R0.208 per stick	R0.208
HTPs (in loose-format)	R0.975 per gram	R0.293	R0.69 per gram	R0.208
E-cigarette liquid	R2.90 per milliliter	R0.29	R0.52/ml of liquid	R0.052

Note: It is assumed that a hand-rolled stick contains 0.75g of loose cigarette tobacco and that 0.1ml of e-cigarette liquid is equivalent to one consumption unit. It is assumed that HTPs contain on average 0.3g of tobacco.

Source: National Treasury (2023) and own calculations.

3.3 Sugar-sweetened beverages

South Africans' dietary habits are concerning. Increasingly, South Africans are consuming processed and ultra-processed foods, including SSBs (Stacey et al. 2012). The amount of sugar consumed is double that recommended by the World Health Organization (University of the Witwatersrand 2016 and WHO 2015). Such excessive sugar consumption has a direct effect on the rate of obesity, diabetes, fatty liver syndrome and other NCDs (Seidelmann et al. 2018). And these diseases are more prevalent under lower socioeconomic groups in South Africa (Saxena et al. 2019; Tugendhaft et al. 2015 and Goetjes et al. 2021).

The sugar tax likely reduced diet-related NCDs. Prior to its introduction in 2018, the annual consumption of SSBs doubled to six billion liters between 2002 and 2016. However, since its introduction, many South African consumers have substituted untaxed for taxed beverages (Hofmann et al. 2021). Notably, in a low-income township, the intake of taxed beverages decreased by over 30 percent (Essman et al. 2021). Because of improved information as reflected in market prices, residents reduced their expenditures on SSBs and substituted low-harm liquids such as water; a decision that may be beneficial towards their health and reduce health inequality.

The success of the sugar tax can partly be explained by its design: it approximates a risk-based tax. The specific rate of R0.0231 per gram of sugar applies to all beverages with added sugar.²⁸ Unlike

²⁸ Pure fruit juices are exempt. A justification for the exemption may be that pure fruit juice contains nutrients that provide a health benefit, which lowers the true cost of pure fruit juice.

alcohol, the tax does not differentiate based on type of beverage. It provides information to consumers that the harm from sugar consumption decreases with the amount of sugar consumed — information that motivate consumers to reduce their risks of NCDs.²⁹

4 Conclusion

South Africa's health inequality requires urgent intervention. Besides a chronic lack of access to quality health care, consumption decisions exacerbate the burden on the health care sector. These decisions are, in part, driven by prices that misinform consumers of the relative risks of excisable goods. The information provided by market prices can be improved through risk-based taxation and, thereby, play a role in reducing the prevalence of NCDs and lessen social inequality.

South Africa only partially applies risk-based taxation to alcohol and tobacco and nicotine. Although only specific rates are appropriately relied on, the rate on traditional beer and wine motivates consumers to prefer these beverages to malt beer, ciders, and other alcoholic beverages. Since the rate differs by beverage type, it suggests to consumers that alcohol in certain beverages is less harmful, which is not the case. For risk-based taxation, a single rate per liter of pure alcohol is required. It should not differentiate by product type.³⁰ Without such a rate, the excise regime will be less successful in lowering the prevalence of alcohol-related NCDs.

The specific rates on tobacco and nicotine may also benefit from refinement. The rate of loose tobacco is too low and needs to increase to about the rate of cigarettes. The excise rates of HTPs and e-cigarettes may need to be lowered to reflect the most recent scientific evidence on the risk and harm of these products and motivate harm-reducing substitution.

The excise on sugar serves as a valuable example of risk-based taxation. Since its introduction, consumers have substituted SSBs for untaxed beverages, lowering their risk of NCDs. It is estimated that this regime will prevent 8,000 premature deaths because of diabetes and save the government R2 billion in health care costs over 20 years (Saxena et al. 2019). It will significantly reduce the demands on the public healthcare system.

In its “*Our future - make it work*” National Development Plan, the South African government set objectives to increase life expectancies, reduce NCDs, and improve health inequality. An improved risk-based approach to excise taxes presents an opportunity to serve these commitments.

²⁹ Whether the rate per gram of sugar reflects social costs is an important consideration and beyond the scope of this paper.

³⁰ This approach also has a benefit for tax administrators since they do not need to classify alcohol by beverage type.

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6 Annex

Table 1. An overview on global evidence on e-cigarettes and heat-not-burn tobacco products

Toxicological risk assessment						
Author	Publication	Year	Findings	Government body	Independent research	Industry research
Superior Health Council of Belgium	Advisory report of the superior health council no. 9538 New Tobacco Products: Heated Tobacco Products.	2020	Despite the methodological limitations of the tests, the in vitro studies generally show a decrease in the induction potency of cytotoxicity and mutagenicity due to exposure to a heated tobacco product, compared to conventional cigarettes. Sub-chronic in vivo exposure to the aerosols of IQOS produces little or less severe histopathological changes than sub-chronic exposure to conventional cigarettes. However, the correlation between these effects and clinical changes in humans is not known.	☒	☐	☐
Slob, W., Soeteman-Hernández, L. G., Bil, W., Staal, Y. C. et al. (Dutch National Institute for Public Health and the Environment)	A method for Comparing the Impact on Carcinogenicity of Tobacco Products: A Case Study on Heated Tobacco Versus Cigarettes.	2020	Development of a method that focusses on the change in cumulative exposure (CCE) of the compounds emitted. The CCE was estimated to be 10- to 25-fold lower when using HTPs instead of cigarettes. Such a change indicates a substantially smaller reduction in expected life span, based on available dose-response information in smokers. However, this is a preliminary conclusion, as only eight carcinogens were considered so far. Furthermore, an unfavorable health impact related to HTPs remains as compared to complete abstinence.	☒	☐	☐
U.S. Food and Drug Administration (FDA)	FDA briefing document: Meeting of the Tobacco Products Scientific Advisory Committee January 24–25.	2018	Harmful and Potentially Harmful Constituents (HPHCs) were present at lower levels in aerosol from the HeatSticks compared to mainstream cigarette smoke. HPHCs are 54-99.9% lower in the IQOS system when compared per unit (HeatStick vs. cigarette) and 25-99.8% lower when the compared to normalized nicotine levels. The independent testing performed by FDA's Southeast Tobacco Laboratory confirmed the lower levels of selected HPHCs in the aerosol from the HeatSticks compared to mainstream cigarette smoke.	☒	☐	☐
Mallock, N., Böss, L., Burk, R., Danziger, M. et al. (German Federal Institute for Risk Assessment)	Levels of selected analytes in the emissions of "heat not burn" tobacco products that are relevant to assess human health risks.	2018	Study confirms that levels of major carcinogens are markedly reduced in the emissions of the analyzed HNB product in relation to the conventional tobacco cigarettes and that monitoring these emissions using standardized machine smoking procedures generates reliable and reproducible data which provide a useful basis to assess exposure and human health risks.	☒	☐	☐
UK Committee on Toxicity	Statement on the toxicological evaluation of novel heat-not-burn tobacco products.	2017	Investigations on heat-not-burn products showed a decrease in the harmful and potentially harmful compounds (HPHCs) in the aerosol generated by the device to which the user would be exposed, compared to the HPHCs in the mainstream smoke from a conventional cigarette. For tested heat-not-burn products, there were some HPHCs, where the reduction was approximately 50%, but the reduction in a number of other HPHCs was greater than 90%, with many of the compounds being below the limits of detection or quantification for the assays used.	☒	☐	☐
Schaller, J. P., Keller, D., Poget, L., Pratte, P. et al.	Evaluation of the Tobacco Heating System 2.2. Part 2: Chemical composition, genotoxicity, cytotoxicity, and physical properties of the aerosol.	2016	The low operating temperature of THS2.2 results in significantly lower concentrations of HPHCs in the mainstream aerosol compared with the mainstream smoke of the 3R4F reference cigarette when expressed on either a per-Tobacco Stick/cigarette or a per-mg nicotine basis, while the MMAD of both aerosols remains similar. The reductions in the concentrations of most HPHCs in the THS2.2 aerosol were greater than 90% when compared with 3R4F and were not affected by machine-smoking of THS2.2 under extreme climatic conditions. No	☐	☐	☒

			evidence of tobacco combustion was found when using the THS2.2 device with puffing regimens that were significantly more intense than the HCl conditions. The mutagenic and cytotoxic potencies of the mainstream aerosol fractions from THS2.2, when evaluated by the Ames, mouse lymphoma, and NRU assays were reduced by at least 85%–95% compared with the mainstream smoke aerosol of 3R4F.			
Exposure						
Author	Publication	Year	Findings	Government body	Independent research	Industry research
Travis N, Knoll M, Cook S, Oh H et al.	Chemical Profiles and Toxicity of Electronic Cigarettes: An Umbrella Review and Methodological Considerations.	2023	While most reviews concluded that electronic cigarettes were likely less harmful than cigarettes, there was hesitancy to draw clear conclusions due to variable analytical procedures and inconsistent findings among the included studies. Future systematic reviews with improved methodology and reporting are needed to adequately inform tobacco regulatory actions.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Begić, E., Aziri, B., Omeragić, E., Medjedović, E. et al.	Heat-not-burn tobacco products and cardiovascular risk reduction: A systematic review of randomized controlled trials.	2023	The search of three databases identified 167 records, and after selection process, 25 randomized controlled trials were eligible for our study's criteria. Twenty studies investigated the effects of heat-not-burn products on biomarkers of clinical relevance. Five studies evaluated other functional heart parameters rather than biomarkers. With heat-not-burn tobacco products, significant reductions were found in biomarkers of exposure and biological effect related to pathways involved in cardiovascular disease, including inflammation, oxidative stress, lipid metabolism, platelet function, and endothelial dysfunction.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
McNeill, A., Simonavičius, E., Brose, L., Taylor, E. et al.	Nicotine vaping in England: an evidence update including health risks and perceptions.	2022	The reviewed studies show that compared to smoking, using vaping products leads to a substantial reduction in biomarkers of toxicant exposure associated with cigarette smoking. However, the degree of any residual risk remains unclear, mainly because of the lack of comparisons between long-term former smokers who do and do not vape or comparisons with those who have never smoked or vaped.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tattan-Birch, H., Hartmann-Boyce, J., Kock, L., Simonavicius, E. et al.	Heated tobacco products for smoking cessation and reducing smoking prevalence.	2022	No studies reported on cigarette smoking cessation, so the effectiveness of heated tobacco for this purpose remains uncertain. There was insufficient evidence for differences in risk of adverse or serious adverse events between people randomized to switch to heated tobacco, smoke cigarettes, or attempt tobacco abstinence in the short-term. There was moderate-certainty evidence that heated tobacco users have lower exposure to toxicants/carcinogens than cigarette smokers and very low- to moderate-certainty evidence of higher exposure than those attempting abstinence from all tobacco. Independently funded research on the effectiveness and safety of HTPs is needed.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Znyk, M., Jurewicz, J., Kaleta, D.	Exposure to Heated Tobacco Products and Adverse Health Effects, a Systematic Review.	2021	The review suggests that heat-not-burn products may be products with a reduced risk of chronic diseases, including respiratory and cardiovascular diseases and cancer compared to traditional smoking, although in the case of non-smokers so far, they may pose a risk of their occurrence. Research seems to be necessary to assess the frequency of heat-not-burn tobacco products use and its potential negative health effects.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Akiyama, Y., Sherwood, N.	Systematic review of biomarker findings from clinical studies of electronic cigarettes and heated tobacco products.	2021	A comparison of levels of biomarkers of tobacco-related exposure collected in clinical studies revealed that the use of e-cigarettes and heat-not-burn products could lead to a significant reduction in exposure to harmful substances compared to combusted cigarettes. In tandem, the health status of e-cigarettes and heat-not-burn users, indexed by levels of biomarkers of biological effect showed potential for improvement compared to smoking. However, larger and longer-term population-based studies are needed to further clarify these findings.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Peruzzi, M., Biondi-Zoccai, G., Carnevale, R., Cavarretta, E. et al.	Vaping Cardiovascular Health Risks: an Updated Umbrella Review.	2020	The umbrella review suggests that electronic vaping cigarettes, and likely heat-not-burn cigarettes, despite clearly causing an increase in overall cardiovascular risk, may represent a temporary lesser evil than traditional combustion cigarettes in a risk-reduction or risk-modification strategy, aiming for eventual abstinence from all tobacco or nicotine products.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Usage						
Author	Publication	Year	Findings	Government body	Independent research	Industry research
Hartmann-Boyce, J., Butler, A. R., Theodoulou, A., Onakpoya, I. J. et al.	Biomarkers of potential harm in people switching from smoking tobacco to exclusive e-cigarette use, dual use or abstinence: secondary analysis of Cochrane systematic review of trials of e-cigarettes for smoking cessation.	2023	Comparing electronic cigarettes with combustible cigarettes, 12 of 13 biomarkers were significantly lower in electronic cigarettes users, with no difference for the 13th. Comparing electronic cigarettes with dual users, 12 of the 25 biomarkers were lower for electronic cigarettes, and five were lower for dual use. For the remaining eight measures, single studies did not detect statistically significant differences, or the multiple studies contributing to the outcome had inconsistent results. Only one study provided data comparing dual use with combustible cigarettes; of the 13 biomarkers measured, 12 were significantly lower in the dual use group, with no statistically significant difference detected for the 13th. Only one study provided data on abstainers.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Butler, A. R., Lindson, N., Fanshawe, T. R., Theodoulou, A. et al.	Longer-term use of electronic cigarettes when provided as a stop smoking aid: Systematic review with meta-analyses.	2022	In the studies included in the review just over half of people given nicotine e-cigarettes at study start were found to be still using e-cigarettes at six or more months follow up. Of successful quitters, 70% were found to still be using e-cigarettes at six months or more. Future studies need to collect and report data on continued e-cigarette and study product use, including longer-term data beyond six months to assess whether the use of e-cigarettes and other study products is transitional or persistent.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Hartmann-Boyce, J., Lindson, N., Butler, A. R., McRobbie, H. et al.	Electronic cigarettes for smoking cessation.	2022	There is moderate-certainty evidence that electronic cigarettes with nicotine increase quit rates compared to electronic cigarettes without nicotine and compared to nicotine replacement therapy. Evidence comparing nicotine electronic cigarette with usual care/no treatment also suggests benefit, but is less certain. More studies are needed to confirm the size of effect, particularly when using modern electronic cigarette products.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Beard, E., Brown, J., Shahab, L.	Association of quarterly prevalence of e-cigarette use with ever regular smoking among young adults in England: a time-series analysis between 2007 and 2018.	2022	Prevalence of e-cigarette use among the youth population in England does not appear to be associated with substantial increases or decreases in the prevalence of smoking uptake. Small associations cannot be ruled out.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Pisinger, C., Rasmussen, S. K. B.	The Health Effects of Real-World Dual Use of Electronic and Conventional Cigarettes versus the Health Effects of Exclusive Smoking of Conventional Cigarettes: A Systematic Review.	2022	Most prospective studies found dual use to be at least as harmful as exclusive smoking of conventional cigarettes. The longest follow-up was six years. Most of the best available cross-sectional studies found dual use associated with the same and, in several studies, significantly higher risk of self-reported symptoms/disease than in exclusive smoking of conventional cigarettes. The intensity of cigarette smoking seems associated with worse health.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vanderkam, P., Bonneau, A., Kinouani, S., Dzeraviashka, P. et al.	Duration of the effectiveness of nicotine electronic cigarettes on smoking cessation and reduction: Systematic review and meta-analysis.	2022	Abstinence at the end of the intervention and follow-up periods was significantly higher in the nicotine electronic cigarette group, compared to nicotine replacement therapy and to the non-nicotine electronic cigarette condition. With regard to smoking reduction, the electronic cigarette with nicotine is significantly more effective than nicotine replacement therapy at the end of the intervention and follow-up periods and non-nicotine electronic cigarette in the long term.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Adermark, L., Galanti, M. R., Ryk, C., Gilljam, H. et al.	Prospective association between use of electronic cigarettes and use of conventional cigarettes: a systematic review and meta-analysis.	2021	The review and meta-analysis suggests that e-cigarette use may predict the initiation or recurrence of cigarette smoking. E-cigarette users had an increased probability of future cigarette smoking even after adjusting for potential confounders, suggesting that e-cigarette use by itself could be considered a predictor of subsequent conventional smoking.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Chan, G. C. K., Stjepanović, D., Lim, C., Sun, T. et al.	A systematic review of randomized controlled trials and network meta-analysis of e-cigarettes for smoking cessation.	2021	Smokers assigned to use nicotine e-cigarettes were more likely to remain abstinent from smoking than those assigned to use licensed nicotine replacement therapies, and both were more effective than usual care or placebo conditions. More high-quality studies are required to ascertain the effect of e-cigarette on smoking cessation due to risk of bias in the included studies.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Net effect of consumption						
Author	Publication	Year	Findings	Government body	Independent research	Industry research
Levy, D., Cadham, C. J., Yuan, Z., Yameng, L. et al.	Comparison of smoking prevalence in Canada before and after nicotine vaping product access using the SimSmoke model.	2023	Comparing 2012-2020 survey data of post-nicotine vaping products to SimSmoke projected smoking prevalence trends, one survey indicated a nicotine vaping products-related relative reduction of 15% (15%) for males (females) age 15+, but 32% (52%) for those ages 15-24. The other survey indicated a 14% (19%) nicotine vaping products-related smoking reduction for ages 18+, but 42% (53%) for persons ages 18-24. Much of the gain occurred since Canada relaxed nicotine vaping products restrictions. nicotine vaping products-related 2012-2020 smoking reductions yielded 100,000 smoking-attributable deaths averted from 2012 to 2060.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Banks, E., Yazidjoglou, A., Brown, S., Nguyen, M., Martin, M. et al.	Electronic cigarettes and health outcomes: umbrella and systematic review of the global evidence.	2023	E-cigarettes can be harmful to health, particularly for non-smokers and children, adolescents, and young adults. Their effects on many important health outcomes are uncertain. E-cigarettes may be beneficial for smokers who use them to completely and promptly quit smoking, but they are not currently approved smoking cessation aids. Better quality evidence is needed regarding the health impact of e-cigarette use, their safety and efficacy for smoking cessation, and effective regulation.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vu, G. T., Stjepanović, D., Sun, T., Leung, J., Chung, J., Connor, J. et al.	Predicting the long-term effects of electronic cigarette use on population health: a systematic review of modelling studies.	2023	A population increase in e-cigarette use may result in lower smoking prevalence and reduced burden of disease in the long run, especially if their use can be restricted to assisting smoking cessation. Given the assumption-dependent nature of modelling outcomes, future modelling studies should consider incorporating different policy options in their projection exercises, using shorter time horizons and expanding their modelling to low-income and middle-income countries where smoking rates remain relatively high.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Lee, P. N., Fry, J. S., Gilliland, S., Campbell, P. et al.	Estimating the reduction in US mortality if cigarettes were largely replaced by e-cigarettes.	2022	Substantial reductions in deaths and life-years lost were observed even under pessimistic assumptions. These findings supplement literature indicating e-cigarettes can importantly impact health challenges from smoking.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Wang, R. J., Bhadriraju, S., Glantz, S. A.	E-Cigarette Use and Adult Cigarette Smoking Cessation: A Meta-Analysis.	2021	As consumer products, in observational studies, e-cigarettes were not associated with increased smoking cessation in the adult population. In randomized clinical trials, provision of free e-cigarettes as a therapeutic intervention was associated with increased smoking cessation.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Goniewicz, M. L., Miller, C. R., Sutanto, E., Li, D.	How effective are electronic cigarettes for reducing respiratory and cardiovascular risk in smokers? A systematic review.	2020	The review included a small number of studies. it provided consistent results. Former smokers who transitioned to e-cigarettes showed ~40% lower odds of respiratory outcomes compared to current exclusive smokers. Switching from smoking to e-cigarette does not appear to significantly lower odds of cardiovascular outcomes. Since the utility of cross-sectional studies for causal inference remains limited, both randomized controlled trials and prospective cohort studies are needed to better evaluate contributions of e-cigarettes as harm reduction tools for smokers.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Warner, K. E., Mendez, D.	E-cigarettes: Comparing the Possible Risks of Increasing Smoking Initiation with the Potential Benefits of Increasing Smoking Cessation.	2019	Potential life-years gained as a result of vaping-induced smoking cessation are projected to exceed potential life-years lost due to vaping-induced smoking initiation. These results hold over a wide range of plausible parameters.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Initiation						
Author	Publication	Year	Findings	Government body	Independent research	Industry research
Han, G., Son, H.	A systematic review of socio-ecological factors influencing current e-cigarette use among adolescents and young adults.	2022	Findings indicate that multi-dimensional factors influence e-cigarette use among adolescents and young adults. Therefore, an approach that considers these factors is required to develop effective interventions for the prevention of e-cigarette use.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Pierce, J. P., Chen, R., Leas, E. C., White, M. M. et al.	Use of E-cigarettes and Other Tobacco Products and Progression to Daily Cigarette Smoking.	2021	Trying e-cigarettes and multiple other tobacco products before age 18 years is strongly associated with later daily cigarette smoking. The recent large increase in e-cigarette use will likely reverse the decline in cigarette smoking among US young adults.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
O'Brien, D., Long, J., Quigley, J., Lee, C. et al.	Association between electronic cigarette use and tobacco cigarette smoking initiation in adolescents: a systematic review and meta-analysis.	2021	The systematic review found that e-cigarette use was associated with commencement of tobacco cigarette smoking among teenagers in Europe and North America, identifying an important health-related harm. Given the availability and usage of e-cigarettes, this study provides added support for urgent response by policymakers to stop their use by teenagers to decrease direct harms in this susceptible population group, as well as to conserve achievements in diminishing tobacco cigarette initiation.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Levy, D. T., Warner, K. E., Cummings, K. M., Hammond, D., Kuo, C., Fong, G. T. et al.	Examining the relationship of vaping to smoking initiation among US youth and young adults: a reality check.	2019	The inverse relationship between vaping and smoking was robust across different data sets for both youth and young adults and for current and more established smoking. While trying electronic cigarettes may causally increase smoking among some youth, the aggregate effect at the population level appears to be negligible given the reduction in smoking initiation during the period of vaping's ascendance.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Source: Own analysis