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Abstract

Smoking continues to be one of the leading causes of death and disability around the world. Recent health studies, however, have reported that these diseases are more likely to be due to the smoke from burning rather than the actual nicotine content. This study uses a cost of illness approach in estimating the cost of smoking-related illness in the Philippines and calculating the potential reduction in costs if a significant portion of the adult smoking population switches to the exclusive use of non-combusted alternatives (NCAs), which drastically reduces the risk of contracting smoking-related diseases. This study finds that cost reductions in the Philippines could amount to approximately USD3.4 billion or 0.87% of GDP, assuming 50% of the adult smoking population switch to NCAs and that they experience a 70% lower likelihood of contracting smoking-related illnesses. In consideration of segments of the adult smoking population who are unable to cease smoking activity, NCAs may potentially serve as a less harmful option.

Keywords: Cost of illness approach, smoking-related diseases, heated tobacco products

I. Introduction

It is widely known that cigarette smoking comes with a myriad of adverse effects. It is one of the leading (however preventable) causes of ischaemic heart disease (IHD); chronic obstructive pulmonary diseases (COPD); tracheal, bronchus, and lung cancer; and increases the risk of stroke (Forster et al., 2018). This comes with death and disability, which further translates to economic impacts in the form of productivity losses. Although smoking prevalence is decreasing worldwide, in 2019 alone, deaths from tobacco-attributable diseases numbered 7.4 million globally (Tobacco Atlas, 2022). However, advances in the health sciences have shed light on the nature of smoking-related diseases and have revealed that these diseases are more likely to be linked to toxicants present in inhaled smoke rather than nicotine, which implies that what causes these diseases is the process of combustion (and the resulting smoke), rather than the nicotine content (Forster et al., 2018; Farsalinos & Le Houezec, 2015; Benowitz, 2010).

This may suggest the potential of non-combusted alternatives (NCAs), such as heated tobacco products (HTPs), nicotine pouches, Snus, and e-cigarettes, to serve as tobacco alternatives for adult smokers who cannot curb their smoking habits. Although risks are still present in using NCAs (because they still deliver nicotine), it has been noted that harmful chemicals in the aerosol of HTPs and e-cigarettes are significantly lower than those in combusted tobacco products. For example, studies have confirmed that HTPs lead to a reduction of harmful constituents and major carcinogens such as aldehydes and volatile organic compounds by about 97% (Forster et al., 2018; Mallock et al., 2018), which may translate to a 70% reduction of health risks based on the statistical distributions of traditional smokers and smokers of HTPs.

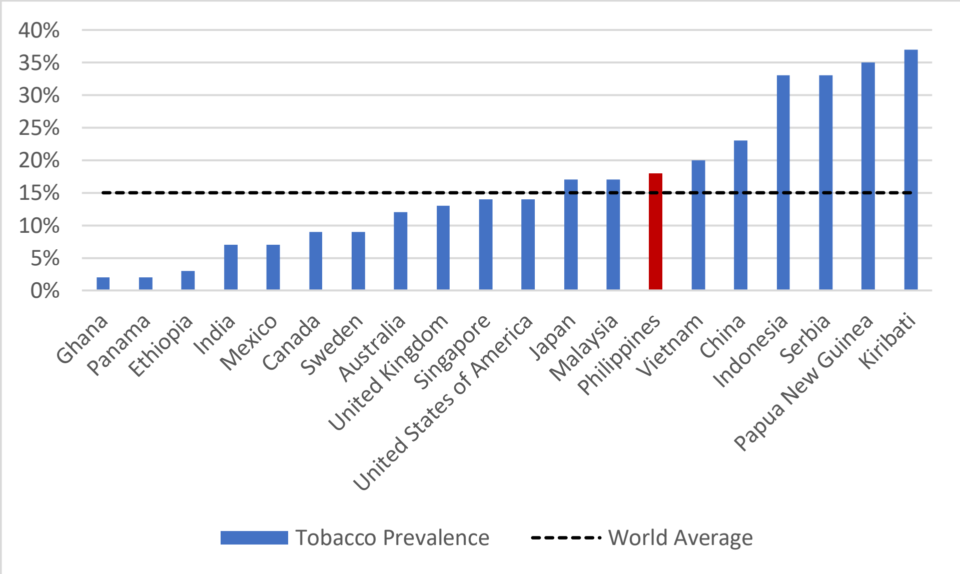
From an economic perspective, the reduced risk of death and disease that comes with the use of NCAs would potentially translate to reductions in the costs associated with tobacco-related illnesses. This may possibly decrease spending on medical procedures and treatments and productivity losses due to smoking-related morbidity and mortality. Hence, this warrants an investigation estimating the potential reduction in the costs of smoking attributable to the adoption of NCAs.

This study estimates the impact of the adoption of NCAs on the economic costs of smoking-related diseases using an annual cost of illness approach. To my knowledge, this study is one of the few that extends the typical cost of illness model to include the switching from combusted to NCAs to estimate the possible savings for a country when a significant portion of the adult smoking population switches to NCAs. This study also applies the findings of recent health studies regarding the percentage reductions in harmful constituents and health risks.

This study focuses on the cost of tobacco-related illnesses in the Philippines—one of the countries with the highest smoking prevalence. Figure 1 presents a comparative picture of smoking prevalence around the world. Developed countries tend to have lower prevalence although countries such as the United States and Japan have one of the highest incidence of smokers (Tobacco Atlas, 2019). Whereas India, for example, may have registered a low prevalence, but it has one of the highest number of smokers in the world. The Philippines on the other, not only has above average smoking prevalence, it is also one of the countries with the largest adult smoking populations in the world (Tobacco Atlas, 2019). Much like the global trend, smoking prevalence in the Philippines has decreased over time—with the overall prevalence decreasing from 29.7% of the adult-aged population in 2009 to 23.8% in 2015, according to the 2015 Global Adult Tobacco Survey (Department of Health [DOH], 2015), decreasing further to 18.5 % in 2021 (DOH, 2023). This sums up to about 14.4 million adult smokers, where majority are male. It was estimated in 2015 that around 87,600 Filipinos die due to tobacco-related illnesses every year, and the cost of illness and death was approximately PHP188 billion annually (DOH, 2015). The Philippines is also one of the world's leading tobacco-leaf producing countries, producing around 51,061 tonnes in 2019, and is one of the countries with the lowest percentage of adults who use smokeless tobacco (only about 1.7%; Southeast Asia Tobacco Control Alliance, 2021).

Figure 1

Smoking Prevalence (% of Population Aged 15+) in Select Countries Around the World, 2019



Source: Tobacco Atlas, 2019.

A few limitations need to be noted. First, studies on the cost of illness of tobacco employ diverse methods and data sources, and are heavily reliant on whatever data is available for a particular context. Hence, assumptions, calculations, and parameters used in the model are liable to change, and results are therefore not readily comparable across studies (Makate et al., 2020). This study is different from a cost-benefit approach in that costs of taking up NCAs are not considered due to data limitations, so only potential benefits (cost of illness reductions) are estimated. Second, cost of illness studies can be conducted using (a) lifetime approach (compares costs of tobacco users vs. never-users over an entire lifespan), which demands the use of longitudinal data of healthcare costs and imposes assumptions of how life expectancy changes over time, or (b) annual approach (the cross-sectional approach which estimates costs for a given year), which cannot adjust for life expectancy or changes in healthcare costs over time (Tobacconomics, 2019). Often, the decision on which approach to use depends on the time horizon of the analysis and the availability of data. This study uses the classic annual method to estimate the costs of illness in the absence of longitudinal data on healthcare costs and life expectancy. Regardless, the annual approach still provides a valid form of analysis, given that we are looking at the shorter-term effects of switching to NCAs. In terms of methodology, due to data limitations for transition probabilities, the model employed assumes a fixed adult smoking population, that no additional individuals start smoking, and that switchers from combusted products to NCAs do not switch back, and that they switch to exclusive use of NCAs (no mixing). It is also assumed that risk reduction is equally applied to all switchers to NCAs. The model is unable to capture the timeframe of when the risk reduction due to switching to NCAs will take place, so we do not attempt to comment on the timing of the risk reduction. Lastly, when calculating losses to productivity due to disability and mortality, this study only takes into account IHD, COPD, tracheal, lung, and bronchial cancers, and stroke for diseases attributable to smoking to provide a conservative estimate, and given how these diseases are those most strongly linked to smoking (Forster et al, 2018).

II. Model

The strategy in estimating the cost of illness in this study adopts the model developed by Goodchild et al. (2018) and expands it to introduce a switching parameter to capture the effect of switching from combusted to NCAs.

a. Cost of Illness Model

The total economic cost (TEC) of tobacco is comprised of the direct cost of healthcare expenditures attributable to tobacco, and the indirect costs that cover productivity losses due to morbidity and mortality associated with tobacco, measured using the human capital method. TEC is given by:

$$TEC = SAHE + VLPD + PVLM \tag{1}$$

Where:

$SAHE$ = Smoking-attributable health expenditure (direct cost)

$$SAHE = SAF \times THE$$

Such that:

$SAF =$ Smoking attributable fraction (%) generated through Goodchild et al.'s (2018) global regression equation of share of health resources allocated to treating smoking-attributable disease and disease burden:

$$\widehat{SAF} = 0.024643 \times SAD$$

Where:
$\widehat{SAF}$ = predicted smoking-attributable fraction
SAD = smoking-attributable deaths

$THE =$ Total health expenditure (in monetary terms, USD or PHP)

$VLPD$ = Value of lost productivity to disability (indirect cost)

$$VLPD = LYLD \times PROD$$

Such that:
$PROD$ = productivity: GDP per adult member (monetary terms, USD or PHP)
$LYLD =$ Labor years (number of years) lost to disability computed as

$$LYLD = \sum_j SYLD_j \times EMP_j$$

Where:
∀ gender j
EMP_j = employment to population ratio
$SYLD_j$ = smoking-attributable years lost to disability (number of years), such that

$$SYLD_k = PROP_k \times YLD_k$$

Where:
$PROP_k =$ smoking-attributable proportion of years lost to disability (%)
$YLD_k =$ years lost to disability (# of years)

$PVLM$ = Present value of lost productivity due to mortality (indirect cost), aggregated for all ages in the working age group 15–64, for both sexes.

$$PVLM = \sum_a \sum_j PVLM_{ja}$$

$$PVLM_{ja} = (LYLM_{ja} \times PROD) \times \left(\frac{(1+gr)}{(1+d)}\right)^{YRS_a}$$

Where:
$gr =$ growth rate of $PROD$; $d =$ discount rate (exogenous parameter)
$LYLM_{ja} =$ labor years lost due to mortality (# of years) for each age group per sex, such that

$$LYLM_{ja} = SAD \times YRS_a \times EMP_{ja}$$

Where:
$YRS_a =$ years to retirement (# of years) per age group

b. Change in the incidence of illnesses due to the switch to NCA

At this point, I depart from the model of Goodchild et al. (2018) and expand it to capture the potential impact of switching to NCAs. Savings from the reduction in the incidence of each illness may be computed as the change in the total cost of the smoking-related illness, and this is driven by the change (reduction) in the number of people that have the disease, because of the improvement in health outcomes associated with switching to NCAs.

$$\Delta TEC = \Delta P \times AEC \qquad (2)$$

Where ΔP is the change in the number of smokers that contract a tobacco-related disease, and AEC is the average cost per person. Predicting ΔP is therefore paramount in predicting how much could be saved by switching to NCAs. This is influenced by both the proportion of the smoking population that switches from combusted to NCAs, γ, and the reduction of the risk of contracting tobacco-related illnesses by adopting NCAs, which is presented as the difference in the risks faced by switchers and non-switchers, $\alpha_2 - \alpha_1$. Figure 1 presents a decision tree that helps model the reduction in the number of people with a tobacco-related illness.

The population of smokers N can be divided into a proportion γ that completely switched to NCAs, and a proportion $1-\gamma$ that maintains the use of traditional combusted alternatives. Non-switchers (NS) are faced with an α_1 probability of contracting a tobacco-related disease, so if nobody switches to NCAs, the incidence of people with the disease would be

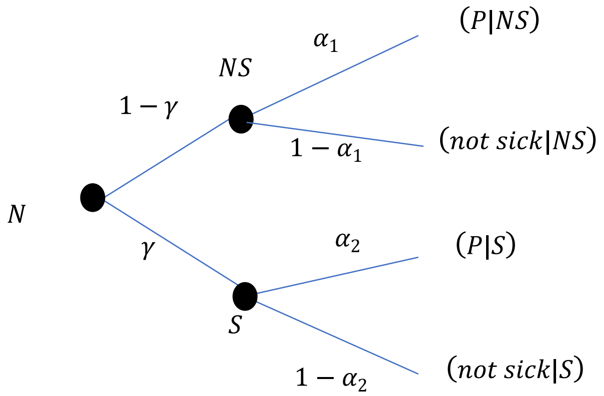
$$P_{\gamma=0} = \alpha_1 N \qquad (3)$$

Whereas in a scenario where a γ proportion switches, the incidence of NS that contract a tobacco-related disease will be given by

$$P_{\gamma>0}^{NS} = (1-\gamma)\alpha_1 N \qquad (4)$$

Figure 1

Decision Tree of Smoking-Related Disease Incidence



Because of the less harmful nature of NCAs, switchers (S) are faced with a probability of contracting disease α_2, such that $\alpha_1 > \alpha_2$. The incidence of S that contract a tobacco-related disease is given by

$$P^S{}_{\gamma>0} = \gamma\alpha_2 N \tag{5}$$

It is implied that under the with-switching scenario, the total number of people that contract a tobacco-related disease is given by

$$\begin{gathered} P_{\gamma>0} = P^{NS} + P^S = (1-\gamma)\alpha_1 N - \gamma\alpha_2 N \\ P_{\gamma>0} = \alpha_1 N - \gamma\alpha_1 N + \gamma\alpha_2 N \end{gathered} \tag{6}$$

ΔP is therefore predicted by taking the difference between the with-switching and without-switching scenarios. This may be seen as

$$\begin{gathered} \Delta P = P_{\gamma>0} - P_{\gamma=0} \\ \Delta P = \alpha_1 N - \gamma\alpha_1 N + \gamma\alpha_2 N - (\alpha_1 N) \\ \Delta P = (\alpha_2 - \alpha_1)\gamma N \end{gathered} \tag{7}$$

Equation (7) is negative by nature, given $\alpha_1 > \alpha_2$, and therefore reduces the number of people that have contracted a tobacco-related disease. This decline is expected to be greater as the proportion of switchers γ increases, and the larger the gap between α_1 and α_2.

Note that the key parameter of interest here would be γ as this would facilitate how much savings may be generated based on the number of smokers that switch to NCA.

It is straightforward to see from Equation (2) that this will result in the monotonic (and homogenous across subcomponents) reduction of SAD, $LYLD$, and $LYLM$, and hence TEC. An example for SAD would be:

$$\Delta SAD = (\alpha_2 - \alpha_1)\gamma \times SAD$$

Given that $(\alpha_2 - \alpha_1) < 0$ and $\gamma > 0$, we can expect $\Delta SAD < 0$, that is, a reduction in the cost associated with smoking-attributable death. Total savings, therefore, would be given by

$$|\Delta TEC| = |\Delta SAHE + \Delta VLPD + \Delta PVLM|$$

which is derived from the reductions in direct and indirect costs $\Delta SAHE < 0, \Delta VLPD < 0$, $\Delta PVLM < 0$, thanks to the reduced risk of contracting tobacco-related diseases realized in the use of NCAs.

III. Data Sources

The main data sources used to compute the cost savings of switching to NCAs are the Tobacco Atlas (2022), the World Bank (2022) database, and the October 2019 quarterly round of the Philippine Labour Force Survey published by the Philippine Statistics Authority. Table 1 summarizes the key variables, parameter values, and data sources.

Table 1

Variables, Descriptions, Key Parameter Values, and Data Sources

Panel A. Smoking and health-related variables		
Variable	Description/Value	Data Source
Smoking-attributable death (SAD)	Percentage of deaths that are attributable to smoking-related disease, disaggregated by gender. Male: 23.2% Female: 9.9% Average: 16.55%	Tobacco Atlas (2022)
Smoking-attributable proportion of years lost to disability ($PROP$)	Percentage of years lost to disability that is attributable to smoking-related diseases Average: 11.28%	Tobacco Atlas (2022)
Years lost to disability (YLD)	Number of years lost to disability due to smoking-attributable diseases (includes trachea, bronchus, and lung cancers, ischaemic heart disease, stroke, and chronic obstructive pulmonary disease only) Total, Philippines: 548.3	Global Health Estimates 2019 (WHO, 2020)
Years to retirement (YRS)	Average number of years to retirement, by age.	2019 Labour Force Survey
Panel B. Economic Variables		
Variable	Description/Value	Data Source
Total Health Expenditure (THE)	Magnitude is derived from applying current health expenditures as a percentage of GDP of 2019. In USD.	World Bank (2022)
GDP per adult member ($PROD$)	Calculated by dividing GDP (constant 2015 USD) by population aged 15–64.	World Bank (2022)
Employment to population ratio	Calculated by dividing the total number of employed persons by the total population.	2019 Labour Force Survey; World Bank (2022)

Panel C. Parameter Values		
Variable	Description/Value	Data Source
Switching Parameter (γ)	Proportion of adult smoking population that shifts to NCAs. Tested for the range 0.05 to 0.5.	Model specification.
Risk reduction ($\alpha_2 - \alpha_1$)	Reduction in risk of contracting smoking-related diseases.	
	Based on statistical distribution of people contracting smoking-related illnesses: 70%	PMI MRTP Application
	Based on reduction of harmful constituents: 97%	Forster et al. (2018)
	Based on biomarker changes: Average [95% C.I.] = 28.81% [26.66%, 31.24%]	Ludicke et al. (2019)
Growth rate of GDP per adult member (gr)	Calculated as the average growth in GDP per adult member from 2016 to 2021. Average: 1.91%	World Bank (2022)
Discount rate (d)	= 9%	Asian Development Bank (2017)

In the following analysis, cost savings are computed for select intervals of $\gamma \in [0.05, 0.5]$ to look at the marginal effects as well. This range is suggested to be a reasonable estimate for the proportion of the population that shifts to NCAs.

The selection of the risk reduction parameter reflects varying approaches as well. First, the main specification of this parameter is based on the PMI MRTP Application, which the U.S. Food & Drug Administration confirms to have an average lower toxicity of 70%. This is based on the comparison of the statistical distribution of NCA users to those using combusted products. This reflects the likelihood that users of NCAs will contract smoking-related diseases on average. The study of Forster et al. (2018), on the other hand, documents a reduction of harmful constituents (e.g., carcinogens) by 97% in NCAs compared to combusted products. This means that there are 97% fewer harmful substances in NCAs, but this may not necessarily translate to 97% fewer NCA users that contract smoking-related diseases. The biomarker reduction among NCA users in the study of Ludicke et al. (2019) suggests that "harmful" biomarkers in NCA users are 28.81% lower than those using combusted products, but this may not necessarily translate to a 28.81% lower likelihood of contracting a smoking-related disease.

Hence, in this study, the 70% risk reduction is primarily used to guide the discussion. The 97% and 28.81% risk reduction parameters, on the other hand, are still estimated but only presented as alternative scenarios.

IV. Results

Table 2 presents the main results of the study, including the robustness checks based on alternative risk reduction parameters. The baseline cost of smoking-related illness in the Philippines in 2019 and the corresponding potential cost reduction that may be realized by switching to NCAs based on the 70% risk reduction based on the statistical distribution is reported in Panel A. It may be seen that the total cost of tobacco-related illness is estimated at USD9.8 billion, or 2.48% of Philippine GDP in 2019. This is primarily driven by the costs associated with premature mortality (which is estimated at nearly USD9.7 billion), which is to be expected because the Philippines' smoking-attributable death for men is 23.2%, which is 6.3 percentage points higher than the world average and for women is 9.9% which is 2.5 percentage points higher than the world average (Tobacco Atlas, 2022). This is coupled with an average employment rate of about 60.7% of the working-age population, which implies that losses due to premature death would expectedly be large. This is followed by the direct costs of treating smoking-related illness which is USD125.3 million, whereas costs relating to smoking-attributable disability are estimated to be at only USD144,000. This latter finding may be expected as well, given that years lost to disability per capita in the Philippines is quite low relative to the rest of the world.

If those who switch to NCAs are 70% less likely to contract smoking-related diseases, costs of smoking-related illnesses can be expected to decrease by USD343 million—about 0.09% of the Philippine GDP in 2019 or a cost reduction of 3.5%—which is realizable if 5% of the adult smoking population switch to NCAs. This can go up to USD3.4 billion or 0.87% of the Philippine GDP in 2019 or a 35% reduction if 50% of the adult smoking population switch to NCAs. In terms of marginal effects, this implies that for every 10 percentage points increase in the proportion of the adult smoking population switching to NCAs, costs relating to smoking-related illness may decrease by USD687.25 million.

Panels B and C report the potential cost reduction of switching to NCAs if risk reduction is based on the 97% reduction in harmful constituents and 28.81% biomarker reduction, respectively. These results provide a test for sensitivity, or at least alternative scenarios that may give insight into the range by which costs may be reduced. Expectedly, the distribution between direct and indirect costs is preserved, and cost reductions monotonically increase with the assumed risk reduction parameter.

Under the 97% reduction scenario, cost reduction can range from USD476 million (0.12% of GDP if 5% of the adult smoking population switch to NCAs) to USD4.8 billion (1.2% of GDP if there is a 50% switch. This entails a USD940 million for every 10 percentage points increase in the population of adult smokers that switch to NCAs. Cost reduction estimates under this assumption are around 40% higher than those in the 70% cost reduction assumption.

Under the 28.81% reduction scenario, cost reduction ranges from USD141 million (0.03% of GDP) given a 5% switch to NCAs, to USD1.4 billion (0.35% of GDP) if up to 50% switch. The marginal effect is about USD282.83 million per 10 percentage points increase in the adult smoking population switching to NCAs. In this scenario, cost reduction estimates are about 42% lower than those in the 70% cost reduction assumption.

Table 2

Cost of Illness of Smoking-Related Diseases and Potential Cost Reduction of Switching to NCAs for 2019, in Million USD

Panel A. Based on 70% risk reduction based on statistical distribution

	Cost of illness (without switching)	Cost reduction of switching to NCAs						
		γ	0.05	0.1	0.2	0.3	0.4	0.5
Total Cost	9,817.875		343.626	687.251	1,374.502	2,061.754	2,749.005	3,436.256
Direct Cost	125.307		4.386	8.771	17.543	26.314	35.086	43.857
Indirect Cost, Total	9,692.568		339.240	678.480	1,356.960	2,035.439	2,713.919	3,392.399
Indirect Cost, Disability	0.144		0.005	0.010	0.020	0.030	0.040	0.050
Indirect Cost, Death	9,692.424		339.235	678.470	1,356.939	2,035.409	2,713.879	3,392.348

Panel B. Based on 97% risk reduction based on reduction of harmful constituents

		Cost reduction of switching to NCAs						
		γ	0.05	0.1	0.2	0.3	0.4	0.5
Total Cost			476.167	952.334	1,904.668	2,857.002	3,809.335	4,761.669
Direct Cost			6.077	12.155	24.310	36.464	48.619	60.774
Indirect Cost, Total			470.090	940.179	1,880.358	2,820.537	3,760.716	4,700.895
Indirect Cost, Disability			0.007	0.014	0.028	0.042	0.056	0.070
Indirect Cost, Death			470.083	940.165	1,880.330	2,820.495	3,760.661	4,700.826

Panel C. Based on 28.81% risk reduction based on biomarker reduction

		Cost reduction of switching to NCAs						
		γ	0.05	0.1	0.2	0.3	0.4	0.5
Total Cost			141.415	282.830	565.660	848.490	1,131.321	1,414.151
Direct Cost			1.805	3.610	7.220	10.829	14.439	18.049
Indirect Cost, Total			139.610	279.220	558.441	837.661	1,116.881	1,396.102
Indirect Cost, Disability			0.002	0.004	0.008	0.012	0.017	0.021
Indirect Cost, Death			139.608	279.216	558.432	837.649	1,116.865	1,396.081

Source: Author's computation.

V. Conclusion

Although smoking prevalence around the world, particularly in the Philippines, has declined in recent decades, actual magnitudes and the corresponding incidences of death and disability associated with smoking-attributable diseases remain high. However, some consolation may be found in the discoveries of recent studies that have shown that tobacco-related illnesses are more likely to be caused by burning rather than the nicotine content. Medical studies have shown that NCAs, which forego any burning, contain significantly fewer harmful constituents, leading to reductions in harmful biomarkers and a lower likelihood of contracting smoking-related diseases. This study estimates the potential reduction in the costs of smoking-related illnesses associated with the high adoption of NCAs by the adult smoking population. This study is one of the few to extend the classical cost of illness model to include switching from combusted smoking products to NCAs. This study finds that the cost of smoking-related illness in the Philippines in 2019 is estimated at USD9.8 billion, or 2.48% of GDP. However, this can potentially be reduced by 35% or USD3.4 billion (0.87% of GDP) if around 50% of the adult smoking population switches to NCAs. As a reminder of the limitations of the methodology, these figures are under the assumptions that switchers to NCAs never switch back to traditional tobacco products or switch to NCAs exclusively (no mixed use), that the assumed risk reduction is the same for all switchers, and that the timeframe for the risk-reducing effect is not something that can be factored into the methodology at the moment.

Although it may seem from the results of this study that NCAs provide an avenue to ultimately diminish the costs of smoking-related illness, it should be emphasized that the best way would still be to promote cessation among the adult population. Alternatively, never-smokers should be prevented from even starting. However, in consideration for segments of the adult population who are unable to stop despite clinical, therapeutic, or rehabilitative interventions, NCAs may be viewed as a less harmful option, and so this segment of the population should be encouraged to consider switching to NCAs.

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