The impact of MPOWER tobacco control policies on tobacco use in African countries

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Research Article

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Abstract

Aim

This study aims to evaluate the impact of MPOWER tobacco control policies on smoking and smokeless tobacco (SLT) use prevalence in Africa, between 2007 and 2018.

Subject and Methods:

This is a longitudinal ecological study using panel data from 40 African countries at 6 time-points between 2007 and 2018. MPOWER scores and tobacco use prevalence data were obtained from the WHO global health repository. Two-way fixed effects regression models were used to assess the impact of the MPOWER policies on smoking and SLT use prevalence among African adults. The analysis was stratified by sex and UN African sub-region.

Results

In the primary analysis of all included countries, only the fiscal tobacco control measure (represented by the price of cigarettes) was significantly associated with a decrease in tobacco use among African adults – each $10 increase in the price of a 20-cigarette pack was associated with a 2.90 (95% CI: 0.30, 5.50) percentage point decrease in smoking prevalence, and a 1.10 (95% CI: 0.02, 2.00) percentage point decrease in SLT use prevalence, among men. In the stratified analysis by UN African sub-regions, the greatest impact was observed in Western and Northern Africa, and MPOWER policies appeared to be more effective in reducing smoking prevalence than SLT use prevalence.

Conclusion

The MPOWER package (especially its fiscal component) has had an impact on tobacco use in African countries. However, more attention needs to be paid to SLT use in Africa, which appears to have been impacted to a much lesser extent than smoking.

Introduction

While tobacco use declines in developed countries, it remains a growing concern in the developing world. Currently, about 80% of the world's approximately 1.1 billion smokers live in low- and middle-income countries (LMICs), which includes most of Africa (WHO 2021). Consequently, tobacco-attributable deaths are projected to double in LMICs between 2002 and 2030. Beyond its dire health implications, tobacco use in developing countries also reinforces the cycle of poverty, as economically deprived tobacco users lose most of their meagre income to the addiction. Within Africa, the rapid population growth and recently improving economic conditions create the ideal opportunity for a rise in tobacco consumption. Eriksen et al. (2012) reported that cigarette consumption increased by 52% in Africa between 1980 and 2016, while decreasing by 33% and 44% in Europe and the Americas respectively. Furthermore, compared to the adult smoking prevalence in Africa which is lower than all other WHO regions of the world, Eriksen et al. (2012) reported that the youth smoking prevalence in Africa exceeded those of South-East Asia, the Eastern Mediterranean, and the Western Pacific regions. This suggests that, in the absence of appropriate interventions, tobacco use may continue to increase in Africa.

In 2003, the WHO (2004) proposed a Framework Convention on Tobacco Control (FCTC), in order to stem the tide of global widespread tobacco use. The FCTC is a global treaty that specifies minimum tobacco control measures which member countries are obligated to implement. The WHO further introduced the MPOWER policy package in 2008 to assist FCTC-party countries in implementing the treaty`s provisions and evaluating its effectiveness (WHO 2008). “MPOWER” represents the six cardinal FCTC tobacco control measures: **M**onitor tobacco use; **P**rotect people from tobacco smoke; **O**ffer help to quit tobacco use; **W**arn about the dangers of tobacco; **E**nforce bans on tobacco advertising and promotion; and **R**aise taxes on tobacco products (WHO 2008). To track FCTC implementation in any country, scores are assigned for each of these six measures and then added up to give that country`s MPOWER composite score. At the 6th session of the FCTC conference of Parties, there was a call for periodic evaluations of the impact of these policies (WHO, 2006). However, no study has evaluated the impact of the MPOWER tobacco control package on tobacco use, with a specific focus on Africa. Also, no past study has assessed its effect on smokeless tobacco (SLT) use.

Multiple studies (Bafunno et al. 2020; Dubray et al. 2015; Flor et al. 2021; Gravely et al. 2017; Heydari 2019; Hoffman et al. 2019; Husain et al. 2020; Levy et al. 2018; Ngo et al. 2017; Wilson et al. 2012) have assessed the impact of MPOWER in a global context, and Winkler et al. (2015) focused solely on West-Africa. Most of these studies reported that MPOWER score was negatively associated with cigarette smoking prevalence in a global context. However, these studies did not perform a specific analysis of the African data, and their aggregate global results may exaggerate the impact of tobacco control policies in Africa, since the region is reported to have generally low tobacco control levels (Heydari 2019). Also, by using *cigarette smoking* prevalence as the only outcome of interest, these studies neglected smokeless tobacco products, which remain quite popular in African countries (Eriksen et al. 2012). Furthermore, most of these studies either neglected or were unable to introduce a substantial lag period between MPOWER policy implementation and tobacco prevalence, limiting their ability to assess policy impact (Husain et al. 2020).

Amongst these global studies, Dubray et al. (2015) found a negative association between composite MPOWER scores and smoking prevalence globally, although the generalizability of this finding is limited by the inclusion of predominantly high-income countries in the analysis. Similarly, Ngo et al. (2017) found that higher implementation of the WHO FCTC was significantly associated with reductions in smoking prevalence and cigarette consumption. However, their studied sample included few African countries due to limited data availability at the time. Winkler et al. (2015) conducted a study of West-African countries and reported that, although tobacco control was generally negatively correlated with smoking, only tobacco cessation programs had a statistically significant effect on smoking prevalence. However, they only used data from two time-points (2008 and 2010), limiting their capacity for any causal inference.

More recently, Husain et al. (2020) took a new approach by classifying the countries of the world based on their initial tobacco control preparedness and initial smoking burden into: High MPOWER - High Prevalence (HM-HP); High MPOWER - Low Prevalence (HM-LP); Low MPOWER - High Prevalence (LM-HP) and Low MPOWER - Low Prevalence (LM-LP) groups. Slightly over half of the countries in the LM-LP group were from Africa, while the HM-HP group was constituted of mostly high income European countries. While MPOWER was significantly negatively associated with cigarette smoking prevalence in the HM-HP and HM-LP groups, an insignificant negative association was found for the LM-HP group, and a significant *positive* association was found for the LM-LP group, suggesting an ineffectiveness of the MPOWER package in Africa. As such, it is important to verify the impact of MPOWER policies specifically in Africa and investigate any heterogeneities by geographical region, tobacco product type, or sex.

Using ecological MPOWER package data, this longitudinal study will evaluate the impact of tobacco control policies on tobacco use in Africa between 2007 and 2018. Unlike previous studies, the outcome variables will include the

prevalence of both tobacco smoking and smokeless tobacco use. Also, in order to observe any regional differences within the continent, the analysis will be further stratified by the five UN sub-regions of Africa. Also, since heterogeneity of tobacco policy impact by sex has been reported in previous studies (Winkler et al. 2015; Ngo et al. 2017), the analysis will be stratified by sex.

Methods

Variables and Data Sources

Data on tobacco use prevalence, MPOWER scores, and cigarette prices were obtained from the WHO Global Health Observatory data repository (Vardell 2020). This repository provided age-standardized estimates of current smoking and current smokeless tobacco use prevalence among men and women in 40 African countries, for the years 2007, 2010, 2012, 2014, 2016 and 2018. Current tobacco use prevalence here is defined as "the percentage of the population aged 15 years and over who currently use any tobacco product (smoked and/or smokeless tobacco) on a daily or non-daily basis… [where] the tobacco products include cigarettes, pipes, cigars, cigarillos, water-pipes (hookah, shisha), bidis, kretek, heated tobacco products, and all forms of smokeless (oral and nasal) tobacco, [and] exclude e-cigarettes (which do not contain tobacco), 'e-cigars', 'e-hookahs', JUUL and 'e-pipes'" (Vardell 2020). The WHO obtained these prevalence data from national surveys conducted in each country, and all estimates were age-standardized to the WHO standard population.

The global repository also provided country MPOWER scores, which represent the strength of each country's tobacco control policy. The WHO collates these scores using data from country-reported surveys and by directly assessing countries' legislative documents. The composite MPOWER score is obtained by summing up each country's individual scores for the M, P, O, W, E and R components. The minimum obtainable score is 6 (1 for each component) and the maximum is 29 (4 for M, and 5 each for P, O, W, E and R). The WHO repository provided MPOWER scores for all African countries for the years 2008, 2010, 2012, 2014, 2016 and 2018. After collating these data, a two-year lag was introduced by pairing MPOWER scores at time *t* with tobacco use prevalence estimates at time *t + 2 years* (beginning with MPOWER 2008 + Prevalence 2010). This lag allowed some time for impact manifestation of introduced MPOWER policies (Husain et al. 2020).

Cigarette price plays an important (potentially mediating) role in the effect of MPOWER policies on tobacco smoking prevalence, as cigarette prices are influenced by tobacco taxation (the fiscal "R" component of MPOWER). This relationship is described in a directed acyclic graph provided in the appendix. Indeed, since cigarette price reflects all taxes imposed on tobacco products, it is arguably a more realistic metric of the implementation of fiscal tobacco control measures than the R score itself, which merely indicates the presence of policy. Some previous studies modelled this relationship between the R score and cigarette price by dropping R from the MPOWER composite score and using a price or tobacco tax variable instead (Flor et al. 2021; Husain et al. 2020). Similarly, the R component will be replaced in this study by cigarette price. The WHO database provided the price of a 20-cigarette pack of the most popular brand in each included African country, for the years 2007, 2010, 2012, 2014, 2016 and 2018 (Vardell 2020). These prices were converted from the reported local currencies into 2021 USD equivalents (adjusted for inflation and purchasing power parity), using the CCEMG–EPPI cost conversion tool (Campbell and Cochrane Economics Methods Group - the Evidence for Policy and Practice Information, https://eppi.ioe.ac.uk/costconversion/default.aspx). Lastly, since income influences tobacco demand, this analysis controlled for income at each time-point. Each country's Gross National Income (GNI) per capita was obtained from the World Bank database for years corresponding to the tobacco use prevalence estimates.

Analysis

Descriptive analysis was conducted by creating colour-coded maps of tobacco use prevalence and MPOWER scores across Africa in 2018. Also, countries' MPOWER scores in 2008 were plotted against the percentage point change in their tobacco use prevalence between 2007 and 2018 for men and women. Next, panel data two-way fixed effects regression models were built with smoking or SLT use prevalence as the dependent variable and composite MPOWE score, cigarette price, and GNI per capita as the independent variables. The MPOWE score represents the collection of non-fiscal tobacco control policies, while cigarette price was taken to represent the essence of fiscal tobacco control policies (R component) in each country. The models also included both year and country fixed effects to eliminate bias from unobservable time-varying and country-varying factors respectively. The analysis was conducted separately for tobacco smoking and smokeless tobacco use, and further stratified by sex. Since the individual MPOWE components are usually highly correlated (Husain et al. 2020), they were not included independently in the models in order to avoid issues with multicollinearity. Lastly, the above analysis was repeated for each of the five UN African sub-regions to observe any heterogeneity by region. Due to the smaller sample sizes at this stage, only year fixed effects were included to eliminate bias from unobserved factors which vary over time but are constant across countries. Since countries within the same geographical sub-region are presumably similar, country fixed effects were forgone in a bid to boost the degrees of freedom available for each regression (Hanck et al. 2019).

Sensitivity Analysis

A series of sensitivity analyses were done to test the robustness of the results. First, a model was specified with cigarette price replaced with the R component of MPOWER. Next, in order to rule out substantial unmeasured confounding, a model was specified with unemployment rate as a negative control outcome. The rationale here is this: if a significant association is found between MPOWER components and unemployment rate, then any observed association between MPOWER and tobacco use may have been a product of significant confounding (Lipsitch et al. 2010). Unemployment rate was chosen as the negative control outcome since it shares a similar set of potential confounders as the study outcome (tobacco use prevalence), except for the exposure of interest (MPOWER policies).

All statistical analysis were performed with R statistical software (version 4.2.2). P-values less than 0.05 were considered statistically significant. The compiled dataset and R code used for this study are available at the GitHub repository here: https://github.com/pharmsteve/MPOWER.git.

Results

There were 200 complete observations from 40 countries in the time-lagged panel dataset, representing five distinct time-points (MPOWER 2008/Prevalence 2010, MPOWER 2010/Prevalence 2012, MPOWER 2012/Prevalence 2014, MPOWER 2014/Prevalence 2016, and MPOWER 2016/Prevalence 2018). At 2018, the average tobacco use prevalence among African adults, men, and women were 14.7%, 25.5%, and 3.8%, respectively. Between 2007 and 2018, tobacco use prevalence decreased by 12.7% and 44.4% among African men and women respectively. The mean composite MPOWER score in 2018 was 18.7, representing a 14.7% increase from 16.3 in 2008. At 2018, the Southern African region had the highest average adult tobacco use prevalence (22.7%), followed by Northern (20.2%), Eastern (15.0%), Central (10.7%) and Western (10.4%) regions. Figure 1 shows colour-coded maps describing the distribution of tobacco use prevalence and MPOWER scores across Africa in 2018.

The first map pictographically shows that the geographical regions with the highest tobacco use prevalence were Southern and Northern Africa, while Western Africa had the lowest tobacco use prevalence. From the second map, it may be observed that Egypt, Seychelles and Senegal had the 3 highest MPOWER scores of 27, 26 and 25 respectively, while Malawi and Sierra Leone had the lowest scores of 11 and 12 respectively. Most other countries had mid-range MPOWER scores between 15 and 20. The effect of MPOWER on tobacco use is unclear from the maps, since many

countries with high MPOWER scores in 2018 also had high tobacco use prevalence. A plot of *initial* MPOWER scores and *change* in tobacco use prevalence may be more insightful.

Figure 2 shows plots of initial MPOWER score (in 2008) against the change in tobacco use prevalence (2018 minus 2007), with linear trend lines and 95% confidence intervals included. For Men, higher MPOWER scores in 2008 appear to be weakly associated with a decrease in tobacco use prevalence between 2007 and 2018 (Pearson correlation coefficient = -0.05). For women however, higher MPOWER scores appear to be weakly associated with an increase in tobacco use prevalence (Pearson correlation coefficient = 0.09). This suggests some sex-based heterogeneity in the effect of tobacco control policies in Africa, which will be further examined using sex-stratified longitudinal regression analyses.

Table 1 shows the output for four panel regression models of tobacco smoking and SLT use prevalence among men and women respectively.

Table 1
Regression results for all included countries

	Tobacco Smoking		Smokeless Tobacco	
	Men	**Women**	**Men**	**Women**
MPOWE	0.01 (-0.14, 0.16)	-0.00 (-0.04, 0.04)	0.00 (-0.04, 0.04)	0.04 (-0.03, 0.12)
Cig Price	-0.29* (-0.55, -0.03)	-0.03 (-0.10, 0.04)	-0.11* (-0.20, -0.02)	-0.05 (-0.21, 0.11)
GNI per capita	0.00 (-0.00, 0.00)	0.00 (-0.00, 0.00)	0.00 (-0.00, 0.00)	0.00 (-0.00, 0.00)

NB: 95% CIs in parentheses. *p < 0.05, **p < 0.01. Regression models include the 40 African countries for which tobacco use data was available. All variables are mutually adjusted and all models include year and country fixed effects.

From the results, the non-fiscal MPOWE score is not significantly associated with tobacco smoking prevalence among African adults. However, the cigarette price variable (representing the fiscal R component of MPOWER) is significantly associated with a reduction in both smoked and smokeless tobacco use prevalence among men. Specifically, each $10 increase in the price of a 20-cigarette pack was associated with a 2.90 (95% CI, 0.30 to 5.50) percentage point decrease in smoking prevalence, and a 1.10 (95% CI, 0.02 to 2.00) percentage point decrease in SLT use prevalence, among men.

Table 2 shows the results from the stratified analysis for each UN African sub-region. For tobacco smoking, the non-fiscal MPOWE policies are negatively associated with tobacco use in Western, Eastern and Northern Africa, while the fiscal policy is negatively associated with tobacco use in all regions except Central Africa. For smokeless tobacco use, the non-fiscal MPOWE policies are negatively associated with tobacco use only in Northern Africa, while the fiscal policy is negatively associated with tobacco use in Northern and Western Africa. In general, the MPOWER package appears to have been effective in reducing tobacco smoking prevalence in most regions, but much less so for smokeless tobacco use.

Table 2
Regression results for UN African sub-regions

	Western (n = 12)		Eastern (n = 15)		Central (n = 4)		Northern (n = 4)		Southern (n = 5)	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Tobacco smoking										
MPOWE	-1.65***	-0.48***	0.86*	-0.23***	0.85*	0.01	0.77	-0.16*	-1.46	0.56*
Cig Price	-0.36	-0.98*	0.56	0.22**	-1.24*	-0.17	-2.86.	-0.26*	-4.10	-1.71*
GNI per capita	-0.01***	-0.002**	0.00	0.00***	0.00	0.00	0.00	0.00	-0.00	0.00**
Smokeless tobacco use										
MPOWE	0.19*	0.26.	0.45**	0.23	0.20	0.09.	-0.45***	-0.05	3.07*	1.18.
Cig Price	-0.67*	0.09	-0.38	-0.23	-0.21	-0.11.	-0.24	-0.13*	-0.34	-1.13
GNI per capita	0.00	-4.30	0.00	-0.00	0.00.	-0.00	0.00***	0.00*	0.02*	0.00***

NB: .p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001. Each column represents two separate models for smoking and SLT use for each sex in a region. All variables are mutually adjusted and all models include year fixed effects.

In the sensitivity analyses where Price was replaced with the R score in the regression models, the results remained largely unchanged. For instance, the model for tobacco smoking among women in Western African produced a coefficient of -0.38 for the non-fiscal *MPOWE* score (95% CI -0.60 to -0.15, p < 0.01) and − 1.12 for the fiscal *R* score (95% CI -2.21 to -0.03, p < 0.05). Furthermore, sensitivity analyses using unemployment rate as a negative control outcome produced no associations between fiscal or non-fiscal MPOWER policies and unemployment rate, suggesting that the observed associations between MPOWER policies and tobacco use are not attributable to unmeasured confounding. The tests of model fit showed no violations of the assumptions underlying linear models.

Discussion

Tobacco use prevalence in Africa decreased during the study period, and this reduction was significantly associated with the fiscal "R" component of MPOWER (represented by cigarette price) among men in the entire dataset of 40 countries. Further subgroup analysis of the five sub-regions of Africa showed heterogeneities in this effect, with the strongest associations observed in Western and Northern Africa. In general, this study suggests that tobacco policies (especially the fiscal policies) have been fairly effective in Africa, although this effect is much less pronounced for smokeless tobacco use than for tobacco smoking. Since this is the first study to evaluate the MPOWER package with a specific focus on the African continent, there is a dearth of evidence against which to compare these results.

In their global study, Husain et al. (2020) analysed a subgroup which was half-constituted of African countries and found a positive association between MPOWER scores and tobacco smoking prevalence. The current study's use of price as a more realistic proxy for the fiscal "R" policy likely explains our contradictory results. Also, unlike the 2-year lag used in this study, Husain et al, applied a lag of 1 year, which may not be sufficient for impact transmission of introduced policies, especially in African countries. Lastly, the current study's stratified analysis by sex and UN African sub-region likely revealed important nuances which Husain et al.'s global study was unable to unearth. Winkler et al. (2015) conducted a study of West-African countries only, and reported a general negative correlation between

MPOWER policies and tobacco smoking. Similarly, the strongest negative associations between MPOWER policies and tobacco use in this study were found in West Africa. Similar to the findings of Ngo et al. (2017), the MPOWER policies were not significantly associated with tobacco use among women in our primary analysis of all countries. However, the stratification by sub-region showed a significant negative MPOWER association with female smoking in all regions except Central Africa, and with female SLT use only in Northern Africa.

A novel and important finding of this study is the apparent low effectiveness of MPOWER policies in reducing smokeless tobacco use in Africa. The regional analysis showed a significant negative association between MPOWER policies and SLT use only in Western and Northern Africa. In the other regions, there was either no significant association (Central Africa) or a positive significant association (Southern and Eastern Africa). This indicates that, in their current state, tobacco control policies are not optimally designed to address SLT use in Africa, where these products remain quite popular (Eriksen et al. 2012). For instance, tobacco taxes may not affect locally sourced tobacco products like dry snuff and chewing tobacco. Also, the levels of public knowledge of the harms of SLT use are lower than that of tobacco smoking, as shown in an Ethiopian study by Peterson et al. (2018). In the same study, over 10% of respondents believed that SLT use was a good way of seeking protection from evil spirits. This exemplifies the traditional and religious footing of SLT use in many African societies, and reflects a need for special policies focused on SLT use, especially education-based initiatives targeted at rural areas.

Considering the reported high prevalence of tobacco use among African adolescents, there is a need for increased tobacco control in order to prevent a future tobacco epidemic in the continent (Eriksen et al. 2012). This will require financial investment in specific tobacco control initiatives recommended in the MPOWER package, including prevalence surveillance and smoking cessation programs. Unfortunately, Heydari (2019) reported that only 2.5% of WHO African countries (viz. Seychelles and Mauritius) scored up to 85% in tobacco control policy strength, compared to 22.8% for the Americas and 18.8% for Europe. Indeed, these two African countries are respectively high-income and upper-middle income countries, suggesting a role of financial status on national tobacco control capability. In the current study, African countries in the upper middle-, lower middle- and low-income groups scored 7, 8 and 10 MPOWER composite points lower than high-income countries respectively, on average. Similarly, the WHO (2015) reported that high-, middle- and low-income countries spent $1.26, $0.03 and $0.0004 per capita respectively on tobacco control in 2013/2014. This financial reality raises serious concerns about the prospects of tobacco control in Africa.

Fortunately, the tobacco problem comes with a convenient and effective remedy in the form of tobacco taxation – a measure that has been touted by the WHO (2010) as the single most effective tobacco control policy. The WHO recommends excise taxes as the ideal form of tobacco taxation, since it raises the price of tobacco products relative to other articles and does not simply aim to account for inflation. Indeed, a plethora of evidence exists about the effectiveness of tobacco taxes, both in terms of reducing tobacco consumption and generating revenue (Chaloupka et al. 2012; Olivera-Chávez et al. 2010). The current study also showed tobacco taxes (as reflected in cigarette prices) to be the most widely effective tobacco control policy in African countries.

However, increasing tobacco taxes often has the undesired effect of creating a conducive environment for tobacco smugglers, who provide tobacco products at significantly lower rates by evading taxes. This is a particular concern for African countries due to porous regulatory mechanisms and an attendant proliferation of black markets (Joossens et al. 2009). Despite this adverse effect of increased smuggling, the World Bank (1999) asserts that raising tobacco taxes would still produce increased revenue and a decrease in tobacco consumption. As such, given the effectiveness of fiscal policies in this study, African governments should actively introduce tobacco taxes and fund more tobacco control and cessation initiatives using the generated revenue. For, in the words of Adam Smith (1776), “Sugar, rum and

tobacco are commodities which are nowhere necessaries of life, which are become objects of almost universal consumption, and which are therefore *extremely proper subjects of taxation*".

Strenghts & Limitations

Important strengths of this study include its use of longitudinal data from 5 distinct time-points, the introduction of a 2-year lag to allow for the manifestation of policy impact, and the assessment of both smoked and smokeless tobacco use prevalence as outcome variables. However, this study also has some important limitations. First, due to the ecological design, the study is subject to the limitations of ecological studies, including the ecologic fallacy. Also, the study's reliance on secondary data results in a susceptibility to the weaknesses of each data source, e.g. variabilities in the design and conduct of the national surveys in different countries may introduce some information bias. Furthermore, the MPOWER scores used in this study measure the presence of tobacco legislation and not its implementation. This limitation inspired the use of cigarette prices as a more practical proxy for the R component. Lastly, the 10-year duration of this study may not be enough time for the observation of tobacco policy impact in some countries, although the WHO expected concrete observable results within 10 years of policy implementation (WHO, 2006).

Declarations

Funding: The current study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interests: The author has no relevant financial or non-financial interests to disclose.

Ethics approval: Since this study used secondary data and did not involve direct interaction with human or animal subjects, ethical clearance was not required.

Consent to participate: Not Applicable

Consent for publication: Not Applicable

Availability of data and material: All data used for this study are directly downloadable from WHO Global Health repository and World Bank database. The compiled dataset used for this study is available as an excel spreadsheet at the GitHub repository here: https://github.com/pharmsteve/MPOWER.git.

Code availability: All R statistical code used for this analysis are provided at the GitHub repository here: https://github.com/pharmsteve/MPOWER.git

Author's contributions: The author was responsible for the conception and design of the study, as well as the statistical analysis, writing and revision of the manuscript.

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References

1. Bafunno D, Catino A, Lamorgese V et al (2020) Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: A systematic review. Journal of Thoracic Disease 12:3844
2. Chaloupka FJ, Yurekli A, Fong GT (2012) Tobacco taxes as a tobacco control strategy Tob Control 21:172-180 https://doi.org/10.1136/tobaccocontrol-2011-050417
3. Dubray J, Schwartz R, Chaiton M et al (2015) The effect of MPOWER on smoking prevalence. Tob Control 24:540-542. https://doi.org/10.1136/tobaccocontrol-2014-051834
4. Eriksen M, Mackay J, Ross H (2012) The tobacco atlas. Atlanta GA: American Cancer Society:32-33
5. Flor LS, Reitsma MB, Gupta V et al (2021) The effects of tobacco control policies on global smoking prevalence Nature Medicine 27:239-243 https://doi.org/10.1038/s41591-020-01210-8
6. Gravely S, Giovino GA, Craig L et al (2017) Implementation of key demand-reduction measures of the WHO Framework Convention on Tobacco Control and change in smoking prevalence in 126 countries: an association study Lancet Public Health 2:e166-e174 https://doi.org/10.1016/s2468-2667(17)30045-2
7. Hanck C, Arnold M, Gerber A et al (2019) Introduction to Econometrics with R University of Duisburg-Essen:1-9
8. Heydari G (2019) Which countries are the best in tobacco control? A quantitative analysis of the MPOWER 2017 Journal of Global Health Reports 3
9. Hoffman SJ, Poirier MJP, Rogers Van Katwyk S et al (2019) Impact of the WHO Framework Convention on Tobacco Control on global cigarette consumption: quasi-experimental evaluations using interrupted time series analysis and in-sample forecast event modelling British Medical Journal 365:l2287 https://doi.org/10.1136/bmj.l2287
10. Husain MJ, Datta BK, Nargis N et al (2020) Revisiting the association between worldwide implementation of the MPOWER package and smoking prevalence, 2008-2017 Tob Control https://doi.org/10.1136/tobaccocontrol-2020-055758
11. Joossens L, Merriman D, Ross H et al (2009) How eliminating the global illicit cigarette trade would increase tax revenue and save lives. International Union Against Tuberculosis and Lung Disease (The Union), Paris Lung Disease, Paris
12. Levy DT, Yuan Z, Luo Y et al (2018) Seven years of progress in tobacco control: an evaluation of the effect of nations meeting the highest level MPOWER measures between 2007 and 2014 Tob Control 27:50-57 https://doi.org/10.1136/tobaccocontrol-2016-053381
13. Lipsitch M, Tchetgen Tchetgen E, Cohen T (2010) Negative Controls: A Tool for Detecting Confounding and Bias in Observational Studies Epidemiology 21
14. Ngo A, Cheng KW, Chaloupka FJ et al (2017) The effect of MPOWER scores on cigarette smoking prevalence and consumption Prev Med 105s:S10-s14 https://doi.org/10.1016/j.ypmed.2017.05.006
15. Olivera-Chávez RI, Cermeño-Bazán R, de Miera-Juárez BS et al (2010) [The effect of tobacco prices on consumption: a time series data analysis for Mexico] Salud Publica Mex 52 Suppl 2:S197-205 https://doi.org/10.1590/s0036-36342010000800015
16. Petersen AB, Thompson LM, Dadi GB, Tolcha A and Cataldo J.K (2018) An exploratory study of knowledge, attitudes, and beliefs related to tobacco use and secondhand smoke among women in Aleta Wondo, Ethiopia. BMC women's health, 18(1), pp.1-10.
17. Smith A (1776) An inquiry into the nature and causes of the wealth of nations: Volume One. London
18. World Health Organization (2004) WHO framework convention on tobacco control (No. SEA-Tobacco-6). WHO Regional Office for South-East Asia.

19. World Health Organization, 2006. Rules of procedure of the conference of the parties to the WHO Framework convention on tobacco control.
20. World Health Organization (2008) MPOWER: a policy package to reverse the tobacco epidemic. Geneva.
21. World Health Organization (2010) WHO technical manual on tobacco tax administration. Geneva.
22. World Health Organization (2015) WHO report on the global tobacco epidemic 2015: raising taxes on tobacco.
23. Vardell E (2020) Global health observatory data repository. Medical reference services quarterly, 39(1), pp.67-74.
24. The World Bank (1999) Curbing the epidemic: governments and the economics of tobacco control. Tobacco Control 8:196
25. Wilson LM, Avila Tang E, Chander G et al (2012) Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review Journal of environmental and public health 2012
26. Winkler V, Lan Y, Becher H (2015) Tobacco prevention policies in west-African countries and their effects on smoking prevalence BMC Public Health 15:1216 https://doi.org/10.1186/s12889-015-2562-z

Figures

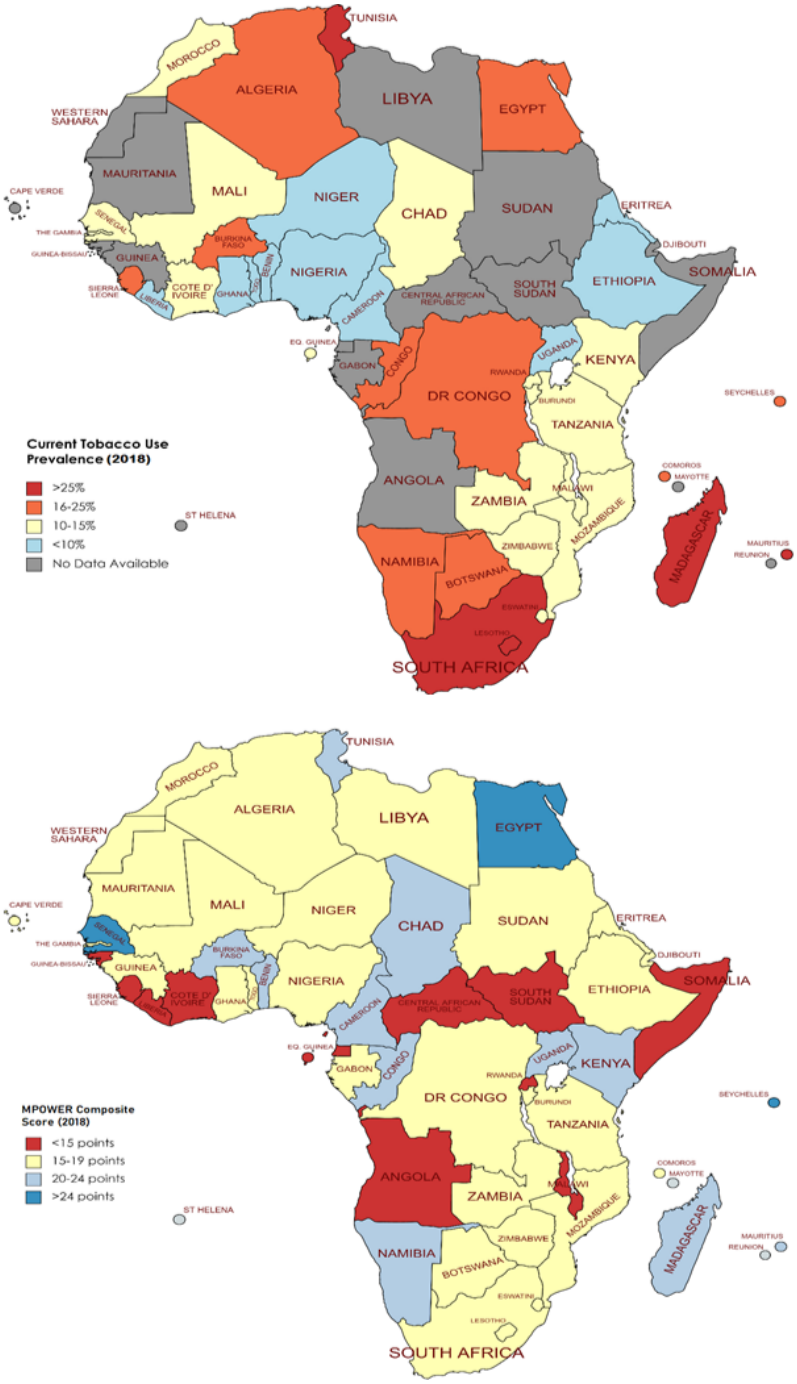

Figure 1

Colour-coded maps of Africa showing the geographical distribution of tobacco use prevalence and MPOWER composite scores in 2018

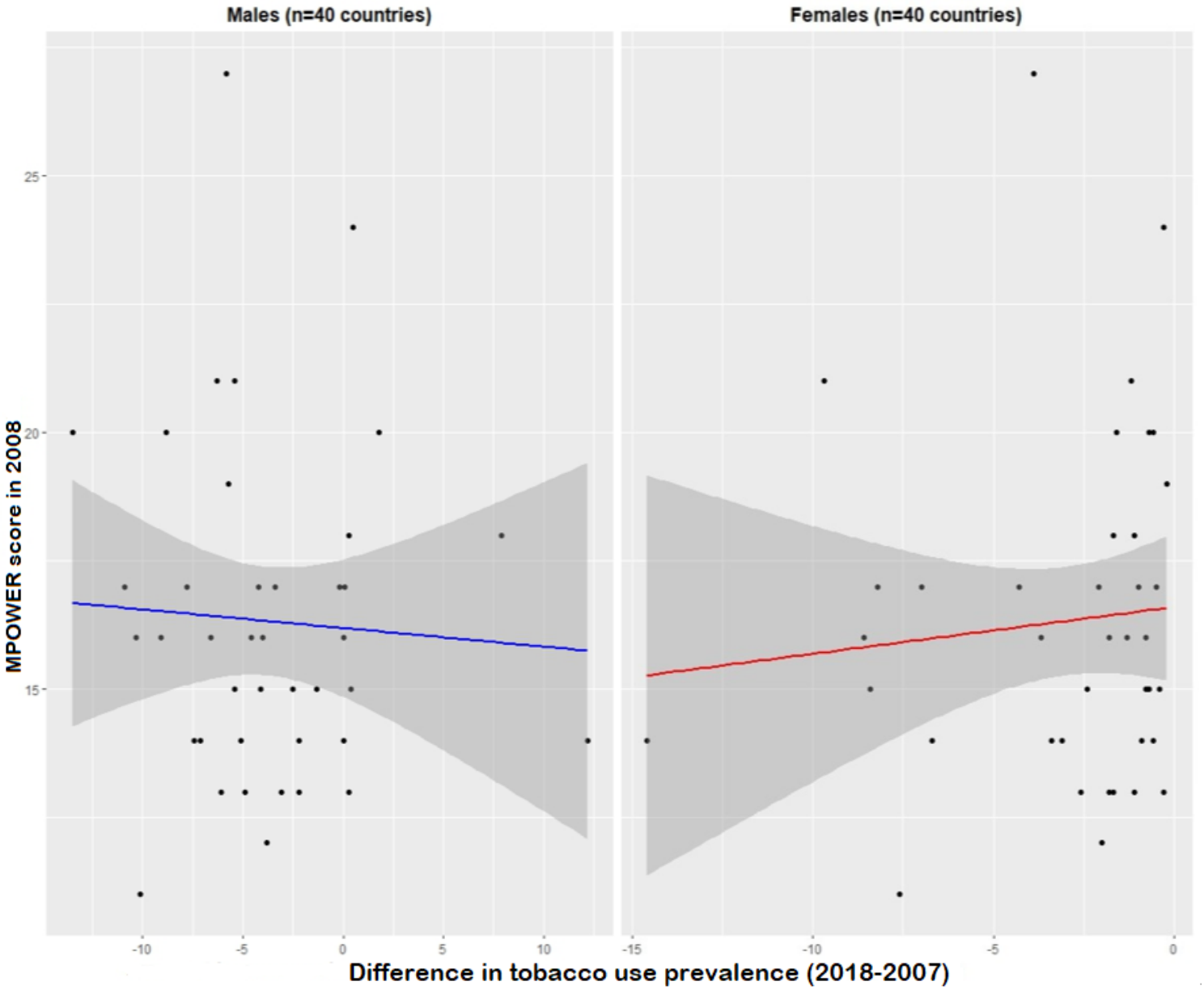

Figure 2

Scatterplot of MPOWER score (2008) vs change in adult tobacco use prevalence (2018 minus 2007)

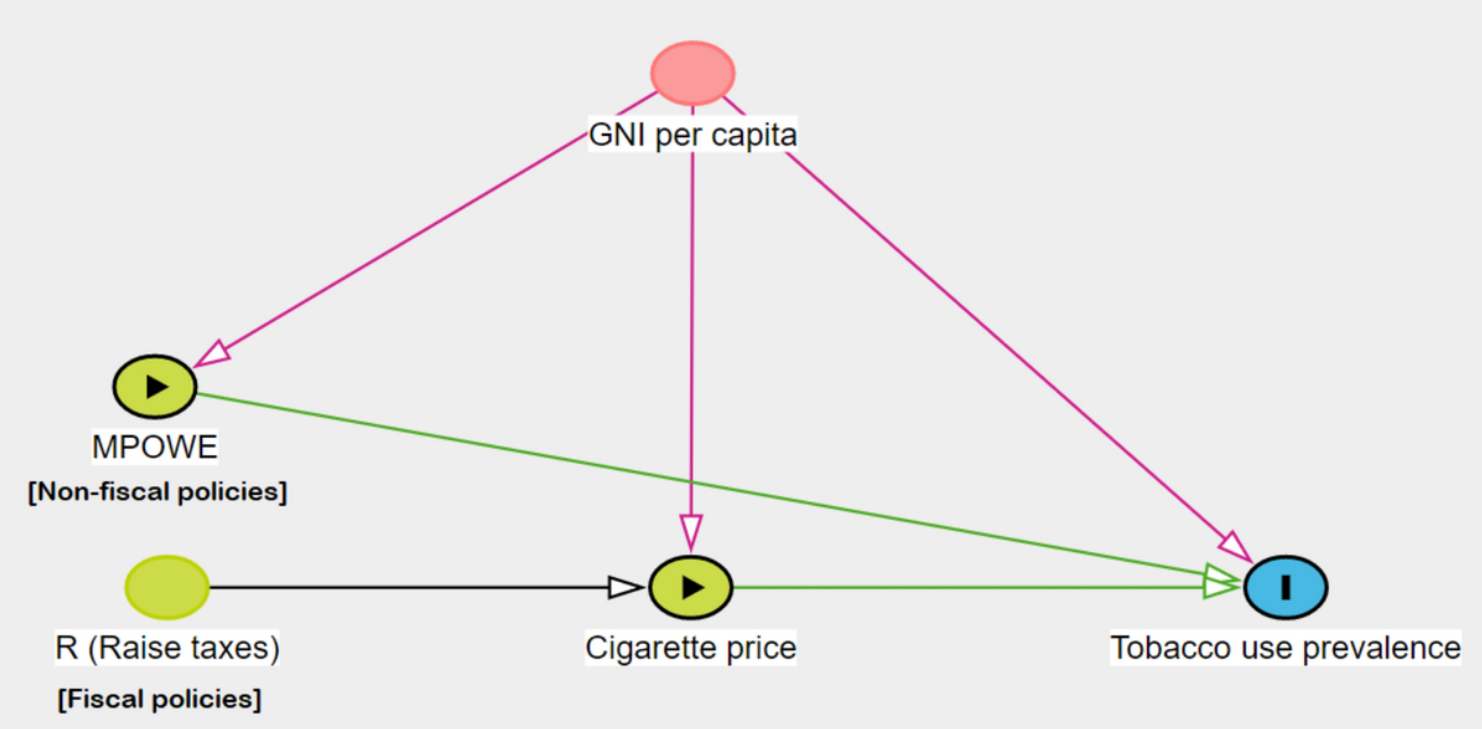

Figure 3

Directed Acyclic Graph showing the rationale for substituting cigarette price for the “R” component of MPOWER. Price provides a practical measure of tobacco taxation policies (the R score), which on its own, simply represents the presence of policy rather than its implementation. Also, including both R and Price will amount to conditioning on a mediator (price), which is incorrect in the circumstances, as it does not provide the total effect of fiscal policies.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- APPENDICES.doc