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The effect of MPOWER scores on cigarette smoking prevalence and consumption

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ABSTRACT

Background. The World Health Organization (WHO) introduced the MPOWER package to support policy implementation under the Framework Convention on Tobacco Control (FCTC). This study examined the effect of MPOWER policies on smoking prevalence and cigarette consumption in a global context.

Methods. The MPOWER composite score was constructed by adding up the six MPOWER scores for each country and survey year 2007–2008, 2010, 2012, and 2014, with a possible range between 6 (1 in each of the six score) and 29 (4 in M score and 5 in POWER scores). MPOWER composite scores that measured policy implementation were then linked to cigarette smoking prevalence and consumption data from Euromonitor International. Fractional logit and OLS regressions were employed to examine the effect of the composite MPOWER score on adult smoking prevalence and cigarette consumption, respectively.

Results. Results indicate that a 1-unit increase in the composite score reduces smoking prevalence by 0.2 percentage points ($p < 0.05$) among adults and 0.3 percentage points ($p < 0.01$) among adult males; and a reduction of 23 sticks of cigarette (1 pack of cigarettes) in cigarette consumption per capita per year. At this rate, if countries had implemented the MPOWER package to the highest levels during 2007–2014, they would have experienced a reduction in smoking prevalence of 7.26% among adults and 7.87% among adult males and a reduction of 13.80% in cigarette consumption.

Conclusions. MPOWER policies were effective in reducing cigarette smoking among adults. Parties should continue to implement MPOWER policies that have been recommended by the WHO FCTC to curb tobacco epidemic.

1. Introduction

The World Health Organization Framework Convention on Tobacco Control (WHO FCTC), one of the most rapidly ratified treaties in the history of the United Nations, is an international agreement that seeks to protect the world population from the global tobacco epidemic (WHO, 2013a). The treaty came into force on 27 February 2005 and, as of 2016, has been ratified by 180 countries that have agreed to take actions in reducing both the supply of and demand for tobacco products (WHO, 2009; WHO, 2017). In 2008, in order to assist the implementation of the WHO FCTC in party countries, WHO introduced the MPOWER package of six highly effective and cost-effective measures: (M) monitoring tobacco use and prevention policies, (P) protecting people from tobacco smoke, (O) offering help to quit tobacco use, (W) warning about the dangers of tobacco, (E) enforcing bans on tobacco advertising, promotion and sponsorship, and (R) raising taxes on tobacco (WHO, 2008a). These measures encompass a comprehensive set of policies that have been shown to reduce smoking and provide guidelines for countries where more actions are needed (WHO, 2015a). The potential impact of the MPOWER package was also estimated to be significant – a universal application in 2010 that had each MPOWER measure implemented at its highest level would lead to a 28% reduction in the global number of smokers by 2020 (Mendez et al., 2013).

The MPOWER package further allows researchers to assess the progress of the WHO FCTC and to evaluate the effectiveness of policies recommended by the Framework. Using the package data from 2007 to 2010, Dubray et al. assessed the effects of six MPOWER scores on smoking prevalence and found that M and R scores significantly reduced smoking prevalence (Dubray et al., 2015). Gravely et al. analyzed data from 126 countries and found that each additional score implemented at the highest level was associated with 0.94 percentage points or 3.18% decrease in smoking prevalence (Gravely et al., 2017). Anderson et al. found that higher policy scores in 2010 were negatively associated with change in smoking prevalence from 2010 to 2015 (Anderson et al., 2016). Levy et al. employed SimSmoke models to

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simulate the effects of MPOWER package and estimated that policy progress worldwide between 2007 and 2010 may have reduced the number of smokers by 14.8 million and averted 7.4 million smoking-attributable deaths (Levy et al., 2013). Using the same model, Levy et al. 2013) project that, if the complete set of MPOWER policies were implemented, they may within 40 years reduce smoking prevalence by 29–56% in four Eastern Mediterranean countries and avert in approximately 5 million deaths in total in these countries (Levy et al., 2016).

As the MPOWER package also contains individual policies that have been implemented or are being considered by governments and policymakers, a growing number of studies examines the effects for a single domain of policies. Shang et al. employed data from 130 countries to examine point-of-sale (POS) advertising bans reported in the MPOWER database and found that these bans were significantly associated with lowered smoking prevalence among youth (Shang et al., 2015a; Shang et al., 2016). Li et al. utilized data from six waves of the International Tobacco Control Southeast Asia Survey to examine graphic health warning labels (GHWLs) reported in the MPOWER database and found that the implementation of the GHWLs in Malaysia and Thailand where GHWL size increased from 50 to 55% in 2010 led to stronger warning reactions by thinking about the health risks and generated more quit attempts (Li et al., 2016). Using MPOWER data and Global Adult Tobacco Surveys, Shang et al. examined the educational disparity in the association between GHWLs and adult cigarette smoking and found that less educated population was more responsive to warnings in countries where cigarettes were the primary tobacco form (Shang et al., 2017).

Despite growing evidence on how a single policy or MPOWER score was associated with smoking, very few studies evaluated the impact of the WHO FCTC by linking the MPOWER package with actual cigarette use data and examining the average effects of the MPOWER composite scores. Studies using SimSmoke models relied on existing estimates in literature to simulate and project MPOWER impact and thus did not estimate the impacts of the progress of WHO FCTC tobacco use data. Other studies (Dubray et al., 2015; Gravely et al., 2017; Anderson et al., 2016) assess WHO FCTC policies by linking the MPOWER package with smoking prevalence data from limited time points, and thus could not control for country-specific factors that may over-estimate the effects of policies on smoking prevalence. In addition, those studies did not examine cigarette consumption.

Given the limited empirical evidence and the worldwide implementation of MPOWER policies, more research is needed to examine the effectiveness of the WHO FCTC. In the sixth session of the conference of the Parties (COP) to the treaty in 2014, the parties called for an impact assessment of the WHO FCTC implementation after its 10 years of operation, which was recently presented at the seventh session of the COP in Delhi, 7–12 November 2016 (WHO, 2014).

This study answers the call of COP 6 by conducting an assessment of the implementation of WHO FCTC and estimating the effects of MPOWER scores on cigarette smoking and consumption. Using MPOWER package data from 2007 to 2008, 2010, 2012, and 2014, this study addresses methodological limitations in previous studies using more waves of time-series data and thus has a unique strength in identifying the impact of policies on smoking. It also contributes to the existing literature by examining cigarette consumption in addition to smoking prevalence, which measure cigarette use at both the participation and the intensity margins.

2. Methods

2.1. Data and measures

2.1.1. MPOWER package

WHO's Reports on the Global Tobacco Epidemic that contain MPOWER package data were published for years 2007–2008, 2010, 2012, and 2014 (WHO, 2015a; WHO, 2008b; WHO, 2011; WHO, 2013b). The data included six MPOWER scores that categorize FCTC policy implementation into four or five levels, as aforementioned in introduction. For the M policy dimension, the score values range from 1 to 4 in which a score of 1 represents no known data or no recent data (since 2009) or data that is not both recent and representative (national population), and a score of 2–4 represents the weakest to the strongest level of the policy (WHO, 2015a). For the other 5-policy dimension (POWER), the score measures its overall strength on a scale of 1 to 5 in which a score of 1 represents a lack of data (missing data) and a score of 2–5 represents the weakest to strongest policies (WHO, 2015a).

Following Dubray et al. and for the sake of assessing the effect of the total MPOWER package (Dubray et al., 2015), we constructed an MPOWER composite score by adding up the six MPOWER scores for each country and survey year. This is also because, as countries gradually adopted the WHO FCTC policies in guidelines, these six scores that measure policy implementation became highly collinear, resulting in underestimated effectiveness of these scores in reducing smoking when they are estimated simultaneously. Using the composite score instead of individual scores will further allow us to employ as much variation in policy change as possible to estimate the effect of the combined WHO FCTC policy recommendation on reducing smoking. Finally, since each policy dimension was measured on a scale of 1 to 4 for M measure and a score of 1 to 5 for POWER measures, the possible range of the MPOWER composite score is from 6 (a 1 in each category) to 29 (a 4 in M category and a 5 in each POWER category).

2.1.2. Euromonitor International

Data on annual smoking prevalence and per capita cigarette consumption were obtained from Euromonitor International cigarette and tobacco country reports. These reports contain time-series data on smoking prevalence among all adults, males, and females for 63 countries during the study period. Adult smokers were defined as daily smokers who are older than the minimum legal smoking age in the country (EI, 2007). Smoking prevalence was measured as the percentage of daily smokers among the respective population.

These reports further included data on cigarette sales from both retail and illicit trade (in sticks). Following Ng et al., we added retail and illicit cigarette sales to measure the total amount of cigarette consumption in a country (Ng et al., 2014). In the next step, per capita cigarette consumption was derived as the ratio of total cigarette sales to the number of population aged 15 and over from the World Bank.

2.1.3. Demographic data from the World Bank

A series of demographic information was obtained from the World Bank database and included as controls in the analyses, including country-level GDP per capita, population aged 15–64, and population aged 65 and over. GDP per capita was measured in international dollars and converted to real terms using consumer price index. Population aged 15–64 and 65-over were defined as percentage of the total population that are in the age group 15–64 and 65 and over (WorldBank, 2016).

2.2. Methodology

Smoking prevalence in this study was measured at the country level using percentages between 0 and 1. Therefore, Fractional logit regressions (Papke and W., 2008), a type of generalized linear model for bounded outcomes between 0 and 1, were employed to examine the effect of the MPOWER composite score on smoking prevalence. OLS regressions were employed to examine their effect on cigarette consumption. Two-way fixed effects models, a method that expands the difference-in-difference approach to repeated treatments in multiple time periods, were used to assess the impact of MPOWER score on cigarette use (Angrist and Pischke, 2008; Imbens and Wooldridge, 2009). With country and year fixed effects entered as control variables, only with-in country changes over time in the composite MPOWER score were used for model identification, which teases out country-

specific unobservable factors that were not controlled for in the Dubray et al. (2015) study. All regressions controlled for country-level GDP per capita, population aged 15–64, population aged 65 and over, year fixed effects, and country fixed effects, with standard errors clustered at the country level to adjust for inter-temporal correlations. To further examine the average effect of MPOWER composite scores, we also simulated the reduction in smoking prevalence/cigarette consumption if countries had implemented MPOWER at the highest level during the 5 years: 2007, 2008, 2010, 2012, and 2014. The simulated reduction was calculated by first multiplying the estimated marginal effect of scores by the difference between the current implementation score and the highest score – 29, and then dividing this simulated percentage point reduction in smoking by 2007 smoking status to impute the relative reduction in percent that could have been achieved if MPOWER package was implemented at the highest level. Analyses were conducted using Stata v.13. 0.

2.3. Sensitivity analysis and falsification test

We conducted a series of sensitivity analyses and a falsification test to examine the validity of estimates. First, we examined another specification in which we included the MPOWER composite score and prices. As previous literature suggests, prices are arguably the most effective policy (Dubray et al., 2015; WHO, 2015b). Prices data from Economist Intelligence Unit (EIU) (EIU, 2007) were used because they provided a larger analytical sample. The average cigarette prices for a pack of 20 cigarettes at country-year level were constructed by taking the mean of cigarette prices across stores and brands in a country. Second, since prices and R score are related, we also examined the specification in which we took off the R score from the composite score and controlled for prices. Finally, we regressed the current (time = t) smoking prevalence and cigarette consumption on one lead (time = t + 1) of the MPOWER score to conduct a falsification test for a causal impact. If the future score was significantly associated with current smoking behaviors, there could be endogeneity issues that changes in policies are not independent from trends of smoking behaviors. Alternatively, if the future score was not significantly associated with the current smoking behaviors, this approach likely identifies a causal impact.

3. Results

Table 1 presents summary statistics for the dependent and independent variables. Samples were limited to countries with information on smoking prevalence and cigarette consumption and non-missing independent variables (MPOWER composite score, country-level GDP per capita, population aged 15–64, and population aged 65 and over). There were 310 observations representing 63 countries in the analytic sample for smoking prevalence and 374 from 75 countries for cigarette consumption. Smoking prevalence among adults, males, and females was 25%, 34%, and 16%, respectively. Average per capita cigarette consumption per year was 1505 sticks, which is equivalent to 75 packs of cigarette per year or approximately 6.3 packs of cigarette per month. The mean composite score was 20.5–21, indicating that there is much room for improving MPOWER implementation. The average GDP per capita was 2267–2367 USD. The percentage of population aged 15 and 64 was 67% and the percentage of population aged 65 and over was 12%.

Table 2 presents the results for the effect of the composite MPOWER score on smoking prevalence and cigarette consumption, estimated using fractional logit regressions and OLS regressions, respectively. The upper panel contains coefficients of interest and the lower panel contains marginal effects along with percent changes and simulation results if the MPOWER package was implemented at the highest level. Our benchmark models shows that a 1-unit increase in the composite score significantly lowers smoking prevalence among adults and males by 0.2 percentage points ($p < 0.05$) and 0.3 percentage points ($p < 0.01$), respectively. When the impacts were measured using percent changes, one-unit increase in the MPOWER composite score decreases smoking prevalence by 0.8% for both adults ($p < 0.5$) and males ($p < 0.01$). As the lower panel indicated, at this reduction rate, if countries had implemented the MPOWER package to the highest levels, they would have experienced a reduction of 7.26% and 7.87% in smoking prevalence during the study period for adults and males respectively. This association was not seen for female smoking prevalence.

The last column of Table 2 contains results for the effect of the composite score on per capita cigarette consumption, estimated using OLS regression methods. The result indicates that countries with higher MPOWER composite scores have lower cigarette consumption. To be specific, one unit increase in the MPOWER composite score was marginally associated with a reduction of 23 sticks of cigarette (approximately 1 pack of cigarette) per capita per year in cigarette consumption ($p < 0.1$). As the lower panel demonstrated, at this rate, if countries had fully implemented the MPOWER package to the highest level, they would have experienced a reduction of 13.8% in per capita cigarette consumption per year.

3.1. Sensitivity analyses

In Tables 3–5 we present results of sensitivity analyses and the falsification test. Sensitivity analyses using alternative specifications produce very similar results, suggesting that the findings are robust to different approaches to modeling prices. Moreover, sensitivity analyses

Table 1
Summary statistics.

Outcomes	Analytical samples			
	Smoking prevalence		Cigarette consumption	
	Mean	SD.	Mean	SD
Smoking prevalence	0.251	0.08		
Male smoking prevalence	0.344	0.123		
Female smoking prevalence	0.164	0.091		
Per capita cigarette consumption (thousand sticks)			1.505	0.895
Composite score	20.95	3.159	20.484	3.521
GDP per capita (thousand dollars)	2.367	1.547	2.267	1.613
Population aged 15–64 (%)	67.031	3.365	66.672	4.670
Population aged 65 and over (%)	12.516	5.392	11.251	5.765
Number of observations	310		374	
Number of countries	63		75	

Note: sample sizes and country composition are different for smoking prevalence and cigarette analytical samples due to data availability.

Table 2
The effect of composite scores on smoking prevalence and cigarette consumption.

	Smoking prevalence	Male smoking prevalence	Female smoking prevalence	Cigarette consumption
Composite score	−0.01* (−2.14)	−0.012** (−2.76)	−0.01 (−1.32)	−0.023+ (−1.77)
Year FE	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Marginal effect (S.E)	−0.002* (0.001)	−0.003** (0.001)	−0.001 (0.001)	−0.023+ (0.013)
% change (S.E)	−0.008* (0.004)	−0.008** (0.003)	−0.008 (0.006)	−0.055 (0.499)
Simulation, reduction if MPOWER implemented at the highest level				
% Reduction	7.26	7.87	–	13.80
Number of Obs.		310		374

Note: t-statistics in parentheses. +$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. All regressions controlled for country-level GDP per capita, population aged 15–64, population aged 65 and over, time and country fixed effects. Standard errors were clustered at the country level. Simulation, reduction if the MPOWER package was implemented at the highest level calculated using the formula: marginal effect* (29-2007 MPOWER composite score)/2007 smoking outcomes.

Table 3
The effect of composite scores on smoking prevalence and cigarette consumption with price control.

	Smoking prevalence	Cigarette consumption
Composite scores	−0.01**	−0.037**
	(−2.27)	(−3.32)
Year FE	Y	Y
Country FE	Y	Y
Marginal effect	−0.002*	-0.037**
(S.E)	(0.001)	(0.011)
Elasticity	−0.007*	-0.086
(S.E)	(0.003)	(0.361)
Number of Obs.	224	274

Note: t-statistics in parentheses. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. All regressions controlled for country-level GDP per capita, cigarette prices, population aged 15–64, population aged 65 and over, time and year fixed effects. Standard errors were clustered at the country level.

Table 5
Falsification Test. The Effect of Future MPOWER scores on Smoking Prevalence and Cigarette Consumption.

	Smoking prevalence	Male smoking prevalence	Female smoking prevalence	Cigarette consumption
Future composite score	−0.004	−0.005	−0.004	−0.013
	(−1.24)	(−1.41)	(−0.76)	(−1.44)
Marginal effect	−0.0008	−0.001	−0.0005	-0.013
(S. E)	(0.0006)	(0.002)	(0.004)	(0.009)
Elasticity	−0.003	−0.003	−0.003	-0.018
(S. E)	(0.003)	(0.002)	(0.004)	(0.015)
Number of Obs.		245		296

Note: t-statistics in parentheses. All regressions control for future composite scores, country-level GDP per capita, population aged 15–64, population aged 65 and over, time and country fixed effects. Standard errors were clustered at the country level.

suggest that the MPOWER composite score was significantly associated with lower cigarette consumption in these alternative specifications ($p \leq 0.05$). The falsification test results shown in Table 5 illustrates that the future MPOWER score does not significantly impact current smoking behavior, indicating that our results likely reflect the casual impact of the MPOWER package in reducing smoking.

4. Discussion and conclusion

This study examined the effect of the MPOWER package on smoking prevalence and cigarette consumption and found that increasing implementation of the policy package significantly reduced smoking prevalence and cigarette consumption during 2007–2014. If countries had implemented the MPOWER package at its highest level, the reduction in cigarette use during this period would be 7.26% and 7.87% in smoking prevalence for adults and males, and 13.8% in cigarette consumption per capita per year.

These estimates are comparable but slightly smaller than the estimates in Gravely et al. (Gravely et al., 2017). That study found each score at the highest level to be associated with a 3.18% reduction in smoking, whereas we found all scores implemented at the highest level were associated with a 7.26–7.87% reduction in smoking. This may be because Gravely et al. (2017) assessed scores at the highest level which may have a larger impact on smoking compared with a less radical increase in implementation. In addition, their smoking outcome was the change of smoking prevalence from 2005 to 2015, which may reflect a larger change in a longer period than our study that focuses on the change between 2007 and 2015.

When smoking prevalence is measured in percentage points, our estimates further imply that a one-unit increase in the MPOWER composite score reduced smoking prevalence by 0.2 percentage points ($p < 0.05$) among adults and 0.3 percentage points among males ($p < 0.05$). These estimates are smaller than the effects estimated in Dubray et al. (2015). That study found that a one-unit increase in M score is associated with a 1.04–1.07 percentage point lower smoking prevalence among adults and that a one-unit increase in R score is associated with a 0.41–0.95 percentage point lower smoking prevalence (Dubray et al., 2015). One explanation for this difference is that Dubray et al. (2015) study likely overestimated the effects of the MPOWER package as country-specific unobservable factors were not controlled for. In addition, compared with that study and Gravely et al. (2017), we utilized three more waves of MPOWER policy data and analyzed the average effects of MPOWER package over a period rather than comparing changes between two time points. Therefore, different policy impacts may be expected. Nonetheless, like previous studies, we show that higher implementation of the WHO FCTC was significantly associated with reductions in smoking prevalence. Our results further add to the evidence that the implementation of the WHO FCTC reduces consumption as well.

In terms of cigarette consumption, one-unit increase in the MPOWER composite score leads to a reduction of 23 sticks (approximately 1 pack) of cigarette consumption per capita per year, which corresponds to a 13.8% reduction if MPOWER was implemented at the highest level. These findings are similar to previous studies that compared price elasticity estimates for smoking prevalence and cigarette consumption and found that the latter tends to be bigger (Chaloupka et al., 2002).

We did not find significant association between MPOWER scales and female smoking prevalence. This finding is similar to that in Anderson et al. (2016), which shows that the negative relationship between policy implementation and changes in smoking was only found significant for males but not for females. In general, the non-significant results could be due to the low prevalence of smoking among females, which was only 16.4% in our analytical sample, compared to a smoking prevalence of 34.4% among males. In particular, female cigarette smoking is traditionally uncommon in many low- and middle-income countries (LMIC), in contrast to the high smoking prevalence among their male counterparts, and thus may not appear to respond to the increased implementation of tobacco control policies in these countries (Society, 2015). In addition, although female smoking prevalence is higher in high income countries (HIC) than in LMICs, female smokers in HICs may not be as responsive to tobacco control policies as male smokers due to weight concerns, contributing to the non-significant response to tobacco control policies (Shang et al., 2015b).

Our study has some limitations. First, the analyses were limited to Party countries where smoking prevalence and cigarette sales have been documented by the Euromonitor International. Therefore, non-party countries except the United States and countries that were not covered by Euromonitor were not included. Furthermore, since the majority of countries in Euromonitor data are upper-middle income

Table 4
The effect of composite scores (MPOWE) on smoking prevalence and cigarette consumption.

	Smoking prevalence	Cigarette consumption
Composite scores	−0.01*	−0.03*
	(−2.23)	(−2.08)
Year FE	Y	Y
Country FE	Y	Y
Marginal effect	−0.002*	-0.03*
(S. E)	(0.001)	(0.015)
Elasticity	−0.007*	-0.037
(S. E)	(0.003)	(0.031)
Number of observations	224	274

Note: t-statistics in parentheses. $+p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. All regressions controlled for country-level GDP per capita, cigarette prices, population aged 15–64, and population aged 65 and over, time and country fixed effects. Standard errors were clustered at country level.

countries or high-income countries, the actual effect of the MPOWER package may be greater than what we estimated if the effects are stronger in low and lower-middle income countries. Indeed, studies documented that MPOWER measures such as tax, warnings and advertising bans had greater impact in LMICS than HICs (Blecher, 2008; Chaloupka et al., 2012; Hammond, 2011). Second, we assigned the same weight to each of the six individual MPOWER scores to construct the composite score. It is possible that some MPOWER measures are more effective than other measures in reducing smoking and thus should be assigned greater weight. Third, it is possible that the effect of the MPOWER package is non-linear. That is, policy implementation at the highest level measured in the MPOWER package might have a greater or lower marginal impact, compared with an implementation at a lower level. Last, we matched MPOWER scores for 2007–2008 with smoking outcomes in years 2007 and 2008 without distinguishing policy implementation status for each calendar year, which may lead to measurement errors.

Despite those limitations, our study is one of the few that assess the impact of WHO FCTC implementation using the latest MPOWER scores, and to the best of our knowledge, the first study that examined the impact of MPOWER on cigarette smoking prevalence and consumption using a two-way fixed effect approach. Our study provides evidence that implementation of key WHO FCTC measures significantly reduces smoking prevalence and cigarette consumption. Increasing the implementation of the MPOWER measures will lead to significant reductions in smoking and its harmful consequences. Future studies may expand on these findings to further explore potential differential impacts of MPOWER measures on smoking in countries at different epidemic stages or with different demographic characteristics to inform policy makers about more effective tobacco control strategies.

Author contribution

AN wrote the manuscript and took the lead in analyses. AN, KWC, FC, and CS contributed to the study design, analysis, and interpretation of the results, revised the manuscript, and executed the research plan.

Conflicts of interest

All authors declare no conflicts of interest.

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