International Journal of Drug Policy 109 (2022) 103871

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Research Paper

The association between MPOWER tobacco control policies and adolescent smoking across 36 countries: An ecological study over time (2006–2014)

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A B S T R A C T

Objective: To examine associations over time between national tobacco control policies and adolescent smoking prevalence in Europe and Canada.

Design: In this ecological study, national tobacco control policies (MPOWER measures, as derived from WHO data) in 36 countries and their changes over time were related to national-level adolescent smoking rates (as derived from the Health Behaviour in School-aged Children study, 2006-2014). MPOWER measures included were: Protecting people from tobacco smoke (P), offering help to quit tobacco use (O), warning about the dangers of tobacco (W), enforcing bans on advertising, promotion and sponsorship (E) and raising taxes on tobacco (R).

Results: Across countries, adolescent weekly smoking decreased from 17.7% in 2006 to 11.6% in 2014. It decreased most strongly between 2010 and 2014. Although baseline MPOWER policies were not directly associated with differences in average rates of adolescent smoking between countries, countries with higher baseline smoke-free policies (P) showed faster rates of change in smoking over the time period. Moreover, countries that adopted increasingly strict policies regarding warning labels (W) over time, faced stronger declines over time in adolescent weekly smoking.

Conclusion: A decade after the introduction of the WHO MPOWER package, we observed that, in our sample of European countries and Canada, measures targeting social norms around smoking (i.e., smoke-free policies in public places and policies related to warning people about the dangers of tobacco) are most strongly related to declines in adolescent smoking.

Introduction

Tobacco use remains one of the largest threats to public health and a leading preventable cause of death in Europe, being responsible for over 300,000 deaths a year (OECD & EU, 2018). In 2003 the World Health Organization negotiated the Framework Convention on Tobacco Control (WHO FCTC), one of the most widely adopted UN Treaties to address the global tobacco epidemic. WHO introduced the MPOWER package, the acronym representing a comprehensive package of six 'cost-effective and high impact measures' that help countries reduce the demand for tobacco (WHO, 2021) (Table 1). Since the introduction of this package in 2008, European countries have increasingly implemented stricter national tobacco control policies (WHO, 2021).

While there is a large evidence base for the association between the MPOWER set of policies and a reduction in smoking among adults worldwide (Chung-Hall, Craig, Gravely, Sansone, & Fong, 2019; Feliu et al., 2019; Flor, Reitsma, Gupta, Ng, & Gakidou, 2021; Gravely et al., 2017; Ngo et al., 2017), less is known about the impact of the MPOWER policies on the adolescent population. This is remarkable given the long-lasting negative health effects of smoking among adolescents. Most adults who smoker initiate smoking during adolescence (Das, Salam, Arshad, Finkelstein, & Bhutta, 2016), and half of those who start smoking during adolescence will die of a tobacco-related disease if they continue to smoke (Centers for Disease Control and Prevention (CDCP), 2006). Policy interventions can reduce the uptake of the first cigarettes (initiation) (Pierce, White, & Emery, 2012).

Despite the enhanced global commitment to control tobacco use, the pace of progress in reducing adolescent smoking prevalence has been heterogeneous across geographies. While daily cigarette use among 15-year olds declined across 30 European countries from 20% to 12% between 1995 and 2019, prevalence rates in 2019 varied between 2.5% in Norway and 22% in Bulgaria (The ESPAD Group, 2020). Given the different stages of the tobacco epidemic and tobacco control across countries, consolidating the evidence base on the effectiveness of policies in

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https://doi.org/10.1016/j.drugpo.2022.103871

Table 1
The WHO MPOWER policy package.

MPOWER component	P Protect people from tobacco smoke	O Offer help to quit tobacco use	W Warn about the dangers of tobacco	E Enforce bans on advertising, promotion and sponsorship	R Raise taxes on tobacco
1	Data not reported	Data not reported	Data not reported	Data not reported	Data not reported
2	Complete absence of ban, or up to two public places completely smoke-free	None	No warnings or small warnings[1]	Complete absence of ban, or ban that does not cover national television (TV), radio and print media	< 25% of retail price is tax
3	Three to five public places completely smoke-free	NRT* and/or some cessation services** (neither cost-covered)	Medium size warnings[2] missing some[3] or many[4] appropriate characteristics[5] OR large warnings[6] missing many[4] appropriate characteristics[5]	Ban on national TV, radio and print media only	≥25% and <50% of retail price is tax
4	Six to seven public places completely smoke-free	NRT* and/or some cessation services** (at least one of which is cost-covered)	Medium size warnings[2] with all appropriate characteristics[5] OR large warnings[6] missing some[3] appropriate characteristics[5]	Ban on national TV, radio and print media as well as on some (but not all) other forms of direct[a] and/or indirect[b] advertising	≥50% and <75% of retail price is tax
5	All public places completely smoke-free (or at least 90% of the population covered by complete subnational smoke-free legislation)	National quit line, and both NRT* and some cessation services** (cost-covered)	Large warnings[6] with all appropriate characteristics[5]	Ban on all forms of direct[a] and indirect[b] advertising (or at least 90% of the population covered by subnational legislation completely banning tobacco advertising, promotion and sponsorship)	≥75% of retail price is tax

Note. Component "M" (monitoring tobacco use and prevention policies) is excluded from the analyses as it is not a demand-reduction measure.

* Nicotine replacement therapy.

** Smoking cessation support available in any of the following places: health clinics or other primary care facilities, hospitals, office of a health professional, the community or other settings.

[1] Average of front and back of package is less than 30%

[2] Average of front and back of package is between 30 and 49%.

[3] One to three.

[4] Four or more.

[5] Appropriate characteristics: specific health warnings mandated; appearing on individual packages as well as on any outside packaging and labelling used in retail sale; describing specific harmful effects of tobacco use on health; are large, clear, visible and legible (e.g. specific colours and font style and sizes are mandated); rotate; include pictures or pictograms; written in (all) the principal language(s) of the country.

[6] Average of front and back of the package is at least 50%.

[a] Direct advertising bans: national television and radio; local magazines and newspapers; billboards and outdoor advertising; point of sale (indoor).

[b] Indirect advertising bans: free distribution of tobacco products in the mail or through other means; promotional discounts; non-tobacco goods and services identified with tobacco brand names (brand stretching); brand names of non-tobacco products used for tobacco products (brand sharing); appearance of tobacco brands (product placement) or tobacco products in television and/or films; sponsorship (contributions and/or publicity of contributions).

reducing adolescent smoking is necessary as countries plan on how to do better.

Existing research on the impact of MPOWER tobacco control policies on adolescent smoking is limited to studies assessing the impact of changing tobacco control policies at the national or state level (e.g. Hawkins, Bach, & Baum, 2016) and cross-national studies examining the association between tobacco control policies and adolescent smoking at one moment in time (e.g., Hublet et al., 2009). Moreover, many studies focus on only one or two types of the MPOWER tobacco control policies (Haw et al., 2020; Shang, Huang, Cheng, Li, & Chaloupka, 2016). In order to better understand the effectiveness of tobacco control policies for adolescents across countries as well as over time, the current study examines the effectiveness of the demand-reduction MPOWER tobacco control policies for the adolescent population across 36 mainly European countries in the decade after the framework was introduced.

Methods

Study design

In this ecological study, WHO national-level data on adoption MPOWER tobacco control policies in 2007, 2010 and 2014 were combined with aggregated individual-level data from the international Health Behaviour in School-aged Children (HBSC) study in 2006, 2010 and 2014.

Sources of information

The World Health Organisation MPOWER package

We used WHO FCTC data regarding the national-level adoption of the MPOWER tobacco control policies (see Table 1) (WHO, 2021). The M component is not a demand-reduction measure and thus was not included in the current analyses. For the other 5-policy dimensions (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 (for a detailed description of what each score entails for each policy, we refer to Table 1). There were 19 missing values on the P component; the other components had no missing values. The MPOWER data for 2007 and 2014 were included in the current analysis. In both years, a total policy score was also calculated by taking the mean of all policy components (P,O,W,E and R).

The WHO data on the MPOWER tobacco control policies were, for each country, based on the assessment of the national legislation by two expert staff from two different WHO offices in each country (generally one from WHO headquarters and the other from the respective WHO Regional Office). Any inconsistencies were reviewed by the two WHO expert staff involved and, if needed, by a third expert staff member not yet involved in the appraisal of the legislation. Disagreements in the interpretation of the legislation were resolved by, among others,

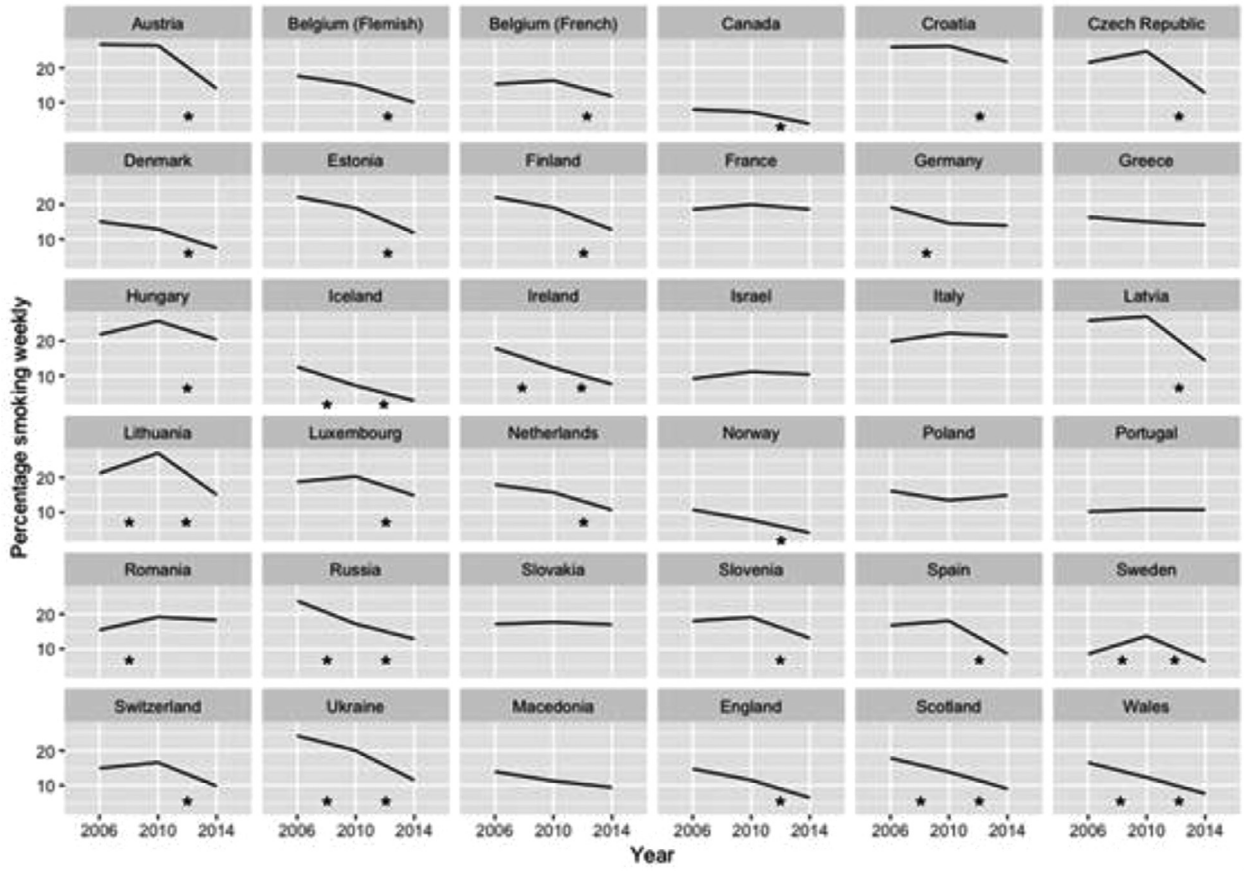

Fig. 1. Trends over time in adolescent weekly smoking in 36 countries.
Note. A star indicates that the trend in the corresponding time period was significant ($p < .05$).

checking the original texts of the legislation and obtaining clarification from judges or lawyers in the concerned country. Finally, the agreed data for each country were sent to the respective governments for review. In cases where national authorities requested data changes, the requests were assessed by WHO expert staff according to both the legislation/materials and the clarification shared by the national authorities.

The Health Behaviour in School-aged Children (HBSC) study

HBSC is an international survey on adolescent health, well-being and the social context of health that is carried out in a classroom setting. The survey has taken place every 4 years since 1983 in a growing number of European and North American countries (Inchley et al., 2020). For the current analysis, data from the international HBSC study in 2006, 2010 and 2014 were used. Stratified samples of schools, representing the regional, economic, and public–private distribution of schools in each country, were recruited according to a common protocol (Currie et al., 2014). Each participating country obtained ethical approval to conduct the survey from their ethics review board or equivalent regulatory institution. Participation was voluntary and anonymous and consent was obtained from school administrators, parents, and children, as per national human participant requirements. Response rates at the school and individual student level varied by survey cycle and country, but were >70% in almost all countries and survey years. Response rates were highest in countries with implicit consent requirements.

In total, 36 countries were included in this analysis (for an overview of the countries, see Figure 1). Separate HBSC studies were carried out in Belgium (Flanders and Wallonia) and the UK (England, Scotland and Wales). While the HBSC study collects data on 11-, 13- and 15-year olds (total $N = 587{,}131$), the current analyses were limited to 15-year olds, as smoking rates among 11- and 13-year olds in the period 2006-2014 were typically low, which impedes detecting meaningful effects of national policies. The total sample included $N = 199{,}244$ adolescents (50.9 % girls and 49.1% boys; also see Table 2).

Table 2
Sample characteristics by survey cycle across 36 countries.

	2006 ($N = 63{,}756$)	2010 ($N = 68{,}640$)	2014 ($N = 66{,}848$)
Individual characteristics			
Sex (female)	32,752 (51.4%)	34,514 (50.3%)	34,118 (51%)
Family Affluence Scale (mean, scale 0–9)	5.15 (SD= 2.01)	5.81 (SD = 1.96)	5.80 (SD = 1.93)
Weekly smoking	11,176 (17.7%)	11,374 (16.7 %)	7,603 (11.6%)
Country characteristics			
MPOWER measure P (mean, scale 2-5)	2.8	3.0	3.3
MPOWER measure O (mean, scale 2-5)	3.8	4.0	4.1
MPOWER measure W (mean, scale 2-5)	3.1	3.4	3.6
MPOWER measure E (mean, scale 2-5)	3.7	3.9	3.9
MPOWER measure R (mean, scale 2-5)	4.4	4.6	4.6
Adult smoking (mean)	27.8%		
Gross National Income per capita (mean in current US$)	24,607 (SD = 20,524)		

Data are N (%) or mean (SD).

Weekly smoking status was defined based on the HBSC question "How often do you smoke tobacco at present?" The four original answer categories (never, less than weekly, weekly but not daily, daily) were recoded into two: weekly smoking (1) and less than weekly smoking (0). This measure was part of the international HBSC mandatory questionnaire in 2006, 2010 and 2014, and was then discontinued as a mandatory item of the international survey. 1.2% of the respondents had a missing value on this variable.

Statistical analysis

To assess time trends in adolescent weekly smoking, smoking prevalence in each country and survey year was estimated using a logistic regression analysis (RQ 1). Individuals with missing values were excluded from the analysis. Survey year dummies (2006 being the reference category) were added as a predictor to estimate trends over time in weekly smoking, for each country separately as well as across countries. Next, change over time in the adoption of MPOWER measures was tested using a repeated measure ANOVA for each of the five dimensions, with survey year dummies as a predictor (RQ 2).

The impact of the MPOWER policies on adolescent smoking was tested using a two-step meta analysis of individual participant data, where each study in each HBSC round was treated as a separate study. The analyses were conducted in R, using the R package *metaphor*. Thirty-six HBSC research teams conducted the survey on independent samples in 2006, 2010, and 2014, altogether a total of 108 studies. As the same country has repeated prevalence (in 2006, 2010 and 2014), the correlation across countries was accounted for by running a mixed effect meta-analysis with three levels: sampling error at level 1, survey-year variance at level 2, and between-country variance at level 3. The within country variance component captured within-country variability of smoking prevalence, whereas the between country variation captured country level differences in smoking rates. As heterogeneity of smoking prevalence was expected, the random effects analysis was followed by a series of meta regression models.

Three different sets of analyses were conducted. First, to assess the extent to which the adoption of MPOWER policies at baseline (i.e., in 2007) was associated with adolescent smoking in the period 2006-2014, the mean adolescent smoking prevalence was specified as a function of baseline policies (RQ 3). Second, to examine whether the decline in adolescent smoking in the period 2006-2014 was stronger as a function of the adoption of MPOWER measures at baseline, we conducted a moderation analysis, using baseline policy as a moderator for the amount of change in adolescent smoking, by including baseline policy by time interaction terms (RQ 4). Third, to test whether changes over time in the adoption of MPOWER policies (2007-2014) predicted changes over time in adolescent weekly smoking rates (2006-2014), the change over time in smoking policies was entered as a predictor of adolescent weekly smoking in the multilevel model (RQ 5). The change over time in smoking policies was calculated by centering smoking policies (2010 and 2014) on the baseline smoking policies (i.e., those from 2007).

All analyses controlled for adolescent sex (no missing values) and the HBSC Family Affluence Scale (Currie et al., 2008) (4.9% missing values) at the individual level. At the country-level, analyses were controlled for Gross National Income (GNI) per capita (World Bank, 2020) and adult smoking rates (WHO Health for All database, 2020) in 2006.

Results

Across 36 countries, smoking rates decreased in the period between 2006 and 2014. While the country average of weekly smoking of 15-year-olds was 17.7% (95% CI: 17.4–18.0%) in 2006, it decreased to 16.7 % (95% CI: 16.5–17.0%) in 2010 (however, not statistically significant; p= 0.129) and 11.6% (95% CI: 11.3–11.8%) in 2014 ($p < 0.001$).

Figure 1 presents the prevalence of weekly smoking for 15-year olds by country and year. Smoking prevalence decreased significantly between 2006 and 2014 in 26 out of 36 countries. The largest decreases in adolescent weekly smoking can be observed in the period from 2010–2014; 26 out of 36 countries show a significant decrease during this period. In contrast, only 7 countries (Germany, Iceland, Ireland, Russia, Scotland, Ukraine, and Wales) decreased significantly from 2006–2010, and six (apart from Germany) then also continued to decrease between 2010 and 2014. In 8 countries, adolescent weekly smoking did not change significantly (France, Greece, Israel, Italy, Poland, Portugal, North Macedonia and Slovakia). In two countries (Lithuania and Sweden) smoking rates first significantly increased from 2006–2010 and then significantly decreased from 2010–2014. Only in Romania was there a significant, overall increase in adolescent weekly smoking from 2006–2014.

Table 3
Trends of MPOWER policy implementation across the 36 countries.

MPOWER Policy	2007 (baseline)	2010	2014	Time trend (2007–2014)
P Smoke-free policies	2.76	3.10	3.32	+ 0.56*
O Cessation programmes	3.75	4.03	4.14	+ 0.39*
W Warning labels	3.14	3.42	3.61	+ 0.47*
E Bans on advertising, pro-motion & sponsorship	3.72	3.86	3.94	+ 0.22
R Taxation	4.39	4.58	4.61	+ 0.22*

Note. Values are averages in policy implementation of the 36 countries in the sample. Policy levels range from 2–5 for each MPOWER dimension.
* $p < .05$.

Table 3 shows the levels of adoption of the MPOWER policies across the 36 countries. The policy measures **P** (Smoke-free policies) and **W** (Warning labels) have had the lowest adoption in 2007 but increased most until 2014. By contrast, the policy measures O, E and R were already higher at baseline in 2007 and show a smaller increase over time (although non-significant for E). Especially measure R (taxation) was already close to the highest level of policy adoption in 2007.

In order to test whether *baseline* policies are predictive of between country differences in smoking prevalence, we added the baseline adoption for each of the policy indicators in 2007 as a predictor of smoking prevalence in the mixed effect meta regression model. Table 4 expresses the association between policy adoption and smoking prevalence as odds ratios of smoking for a one unit increase in policy change. A higher baseline level of the components **P** and **W** was associated with lower smoking rates in the single component model. Thus, adolescents were less likely to smoke weekly if they lived in countries that had stricter baseline policies regarding smoke free policies (MPOWER component P) and warning labels on cigarette packages (MPOWER component W). In the adjusted models, none of the policy components was significantly related to adolescent weekly smoking.

In testing whether countries with the highest initial adoption of policies reported the strongest decline in smoking prevalence, we used baseline policy as a moderator for the change over time in adolescent smoking. We found that, both in the crude and adjusted models, the baseline level of the P component moderated the 2006-2014 time effect (adjusted model: OR = 0.82, CI= 0.72-0.95; not in Table), thus countries that had a higher baseline level of **P** (protecting people against tobacco smoke), showed a stronger decrease in smoking levels in the years 2006–2014. In addition, **R** (raising taxes) showed a significant interaction only in the adjusted model (OR = 1.39, CI = 1.06-1.82; not in Table), indicating that countries with a higher level of taxation at baseline, showed a weaker decline in adolescent smoking between 2006 and 2014.

When changes over time in MPOWER policies were entered as predictors of adolescent smoking, results showed that stricter adoption of the components **P, W** and **E** over time were related to the decline over time in adolescent smoking (Table 4). Thus, countries that introduced stricter policies regarding smoke-free policies, bans on advertising, promotion and sponsorships and regarding warning labels in the period

Table 4
Results of meta regression of adolescent weekly smoking (2006-2014) regressed on baseline MPOWER policy components and change in policy components (2007-2014).

	Single component model			Full model, adjusted forall other policy components		
Component	OR	LO	HI	OR	LO	HI
P						
Baseline policy	**0.87***	0.77	1.00	0.93	0.78	1.11
Change in policy	**0.87***	0.77	0.99	0.98	0.85	1.14
O						
Baseline policy	0.85	0.71	1.03	0.99	0.75	1.29
Change in policy	0.91	0.79	1.06	0.90	0.75	1.08
W						
Baseline policy	**0.70***	0.54	0.90	0.77	0.53	1.12
Change in policy	**0.76***	0.65	0.87	**0.69***	0.54	0.89
E						
Baseline policy	1.15	0.94	1.42	1.08	0.84	1.37
Change in policy	**0.81***	0.68	0.96	1.07	0.85	1.35
R						
Baseline policy	0.98	0.76	1.27	1.07	0.75	1.51
Change in policy	1.02	0.83	1.25	1.25	0.99	1.57
Total policy						
Baseline policy	0.77	0.55	1.08	NA	NA	NA
Change in policy	**0.71***	0.57	0.90	NA	NA	NA

Note. (**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; (**R**) raising taxes on tobacco.
* $p < 0.05$.

2007-2014 showed a stronger decline in adolescent weekly smoking between 2006 and 2014. In the adjusted analysis, the **W** component remained significantly related to adolescent weekly smoking, implying that, taking all policy measures into account, stricter policies regarding warning labels were most strongly related to declines in adolescent weekly smoking.

Discussion

This study examined the extent to which the adoption of WHO's MPOWER national-level demand-reduction tobacco control policies related to changes over time in adolescent smoking across 36 high-income countries. Adolescent weekly smoking declined between 2006 and 2014 in most countries. Across countries, policies regarding advertising bans, cessation programs, and especially taxation policies (MPOWER components O, E and R, respectively) were already relatively strict at baseline (i.e., in 2007). Policy measures P (smoke-free policies) and W (warning labels) had the lowest level of adoption in 2007 and increased most over time. Although baseline policies were not directly associated with differences in average rates of adolescent smoking between countries when adjusted for other MPOWER components, countries with higher baseline smoke-free policies (P) showed faster rates of change in smoking over the time period. Moreover, countries that adopted increasingly strict policies regarding warning labels (W) over time, faced stronger declines over time in adolescent weekly smoking. Our findings thus suggests that especially smoke-free policies and warning labels play an important role in reducing adolescent smoking in a context where other tobacco control measures are already strictly implemented.

This study assessed the association between the MPOWER policies and adolescent weekly smoking, both in a single component and an adjusted model. The latter model typically gives insight into which policy measure(s) have the largest impact if all policies are considered. As the policies are highly interrelated and there is much common variance (i.e., countries that aim to have stricter tobacco control policies are likely to implement various policies simultaneously), some of the significant results from the single component models became non-significant in the adjusted models. This does not mean these policies do not have any impact; it merely reflects the high interrelatedness of these policies. Moreover, countries that had adopted increasingly strict tobacco control measures over time as measured by the total (or average) MPOWER score, faced strong declines over time in adolescent smoking, suggesting that comprehensive tobacco control policies are likely to be successful in reducing smoking among adolescents.

Smoke-free policies and policies regarding warning labels both relate to social norms around smoking. Thus, our findings suggest that interventions targeting a change in norms around smoking may be particularly effective in reducing cigarette uptake among adolescents. Existing research has shown the effectiveness of norms in the family context on adolescent smoking (Hiemstra, de Leeuw, Engels, & Otten, 2017). This study extends these findings at a broader, national level.

This study suggests that smoke-free public places protect young people from taking up smoking habits. Other research shows that they may also impact the health of pre-adolescents, children and babies. A review of 41 studies (Faber et al., 2017) found that smoke-free legislation was consistently associated with positive child health outcomes, including lower rates of preterm birth, and hospital admissions for childhood asthma and respiratory tract infections, with stronger associations for comprehensive bans than partial bans. Given these findings, it is noteworthy that, although our study shows that many countries enforced stricter legislation of smoke-free public places in the period 2007-2014, smoking is oftentimes still allowed in public places outside, including places that are frequented by young people, such as playgrounds and terraces. As the adoption of smoke-free places appears to be effective in enhancing young people's health, from baby to adolescent, further enforcing and extending this policy measure may be justified.

Between 2007 and 2014, many countries implemented stricter policies on warning labels on cigarette packages. A recent review indicated that young people perceive graphic warning labels as more effective than text-only warnings, with warnings depicting lung cancer, and oral diseases being perceived as particularly effective (Drovandi, Teague, Glass, & Malau-Aduli, 2019). By increasing viewer fear, anxiety, shock, and guilt, these warnings may be effective in preventing those who do not smoke from experimenting with tobacco and prompting adolescents who currently smoke to quit. Introduction of plain packaging since 2012 has also been effective in decreasing sales of cigarettes and increasing prices (Bonfrer, Chintagunta, Roberts, & Corkindale, 2019; Scollo, Zacher, & Coomber, 2015), however evidence of its impact on consumption, particularly among young people, is less clear (El-Khoury Lesueur, Bolze, & Gomajee, 2019; Scollo et al., 2015). None of the countries in this paper introduced plain packaging within the study period.

An unexpected finding was that a low level of adoption of taxes at baseline (i.e. in 2007) was related to a stronger decline in adolescent smoking. Price changes in cigarettes have been shown to have a particularly strong direct effect on reducing adolescents smoking rates (even more so than adults) (Gallet & List, 2003; Kjeld, Jørgensen, Aundal, & Bast, 2021), as well as indirect effects through changes in availability via friends and family and changing attitudes about smoking (International Agency for Research on Cancer, 2011). It is possible that countries with a low level of taxation at baseline implemented stricter policies over time, while countries that already had high taxation levels (i.e., score 4 or 5 in the MPOWER index) could not increase their score on the MPOWER indicator. As a result, those countries that had low levels of taxation at baseline may have faced a stronger decline in adolescent smoking. This suggests that taxation may still be an effective tool for reducing adolescent smoking uptake, but there may not have been enough variance between the countries in our sample at baseline to detect this effect. It is also worth considering that the MPOWER measure is a relative taxation rate, and as such does not reflect actual prices of cigarettes, and corresponding absolute price rises. It is for example feasible that some countries with lower levels of taxation at baseline already had relatively high costs for cigarettes.

Although adolescent weekly smoking has decreased between 2006 and 2014, the WHO European Region still has some of the highest prevalence rates of tobacco use among adolescents worldwide. Moreover, electronic nicotine delivery systems (ENDS), are on the rise (The ESPAD group, 2020). Some research suggests that ENDS are associated with increased risk for cigarette initiation and use, particularly among low-risk youth (Chaffee, Watkins, & Glantz, 2018). The addictive nature of ENDS, as well as the targeted nature of its marketing tactics, may thus lead adolescents to take up more harmful forms of tobacco use. We cannot rule out that the growing use of ENDS and other novel tobacco products partly explains the decline in cigarette smoking in recent years. It will be critical to evaluate whether existing and newly developed policies address new forms of nicotine delivery and their impact on young people. One way to address this would be to include youth in the development, adoption and evaluation of tobacco control policies that seek to address them (Gavine et al., 2017).

Finally, parallel to the decline in adolescent smoking, declines have been observed in other forms of adolescent substance use, such as alcohol and cannabis use (Borodovsky et al., 2021; De Looze et al., 2019). Decreasing face-to-face contact with peers appears to be a common underlying driver of these declines (Borodovsky et al., 2021; De Looze et al., 2019). Also, there are indications that norms about tobacco use have changed among youth, with decreased adolescent approval of smoking over the years (Johnston et al., 2020.). It is likely that all of these trends are interrelated, and they may all have contributed to the decline in adolescent smoking. As such, the findings of this study may be best understood in the context of a wider societal trend in which adolescent smoking is becoming increasingly unaccepted and a less prominent part of contemporary youth culture.

Strengths and limitations

Limitations include the use of self-reported data on smoking in the HBSC studies, which entails the risk of bias due to socially desirable answers, depending on the social norms of the country or populations (although anonymity was stressed in all countries, as per the protocol). Also, the scoring of the MPOWER measures is based on the assessment of two expert staff from two different WHO offices in each country. Although efforts are made to standardize the approach across countries and reviewers (WHO, 2021), we cannot rule out a degree of subjectivity in these assessments. Moreover, it is important to note that the MPOWER scores represent the legislation and not the implementation (or level of compliance) of the policies. Furthermore, the relatively short time frame of this study and the relatively high levels of MPOWER legislation at baseline may have reduced the likelihood to detect significant associations. Associations between the MPOWER package and adolescent smoking rates may be greater in low and lower-middle income countries. Moreover, there may be socioeconomic inequalities in the impact of tobacco control policies (Pförtner et al., 2016), and the impact may be non-linear. Future studies need to address these issues for a more nuanced understanding of the impact of the measures.

Strengths include the inclusion of 36 countries and a time frame of eight years (2006-2014), reflecting the first decade of adoption of WHO's MPOWER measures, thus the critical period when most of an effect would be expected. Second, the explanatory analyses incorporated both cross-national differences and trends over time in MPOWER policy adoption as well as adolescent smoking; a combination that is rarely encountered in the existing literature.

Conclusion

This study identified that two of WHO's key-reduction MPOWER policy measures (i.e. smoke-free public places and warnings) were especially linked to declines in tobacco use among adolescents in a sample of high-income countries. It underlines the importance of measures targeting social norms around smoking and the need for countries to continue investing in comprehensive tobacco control policies to advance the achievement of the SDGs and the goal of the European strategy for child and adolescent health to achieve a tobacco-free generation.

Data statement

Data is available by request to the corresponding author.

Disclaimer

M.W.W. is a WHO staff member. The expressed opinions are his and do not necessarily express the positions and policies of the World Health Organization.

Ethics statement

Each participating country obtained ethical approval to conduct the survey from their ethics review board or equivalent regulatory institution. Participation was voluntary and anonymous and consent was obtained from school administrators, parents, and children, as per national human participant requirements.

Declarations of Interest

The authors declared that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are thankful to all adolescents who participated in the HBSC study and to the national HBSC teams that collected data in the 36 countries that were included in this study.

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