WHO FRAMEWORK CONVENTION
ON TOBACCO CONTROL

Literature Review on the Health Effects of Smoke-free Policies in Light of the WHO FCTC

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Introduction

The WHO Framework Convention on Tobacco Control (WHO FCTC) was adopted by the World Health Assembly in May 2003 and as of April 2014 has been ratified by 178 countries *(1).* The WHO FCTC aims to protect present and future generations from the devastating health, social, environmental and economic consequences of tobacco consumption and exposure to tobacco smoke *(2).* As of 2012, 79% of Parties reported strengthening their existing legislation or adopting new tobacco control legislation after ratifying the Convention. Additionally, over half of the Parties to the WHO FCTC reported having developed and implemented comprehensive tobacco control strategies, plans and programmes as required in Article 5.1 of the Convention *(3).*

The WHO FCTC is described as an evidence-based treaty, implying that there is considerable research evidence that implementation of the measures contained in the Convention will result in such outcomes as a reduction in both tobacco use and exposure to second-hand smoke (SHS), ultimately reducing tobacco-related morbidity and mortality.

The Treaty has a specific public health objective of reducing morbidity and mortality due to tobacco use. However, there are time lags throughout the process from ratification of the WHO FCTC, the promulgation of the Treaty-compliant tobacco control legislation, and actual implementation and enforcement of the law. There is also a time lag from when the policies are implemented until behaviour changes in tobacco use (i.e. cessation or non-initiation by youth) are seen on a large scale within a country. There is also the time lag between behaviour change and the accrual of health benefits. Among smokers who quit, a reduction in risk of cancer may take about a quarter of a century to manifest, with the most immediate health benefit being a reduction in the risk of heart disease. At the population level, reduction in overall mortality may begin to show up about quarter of a century after implementation of tobacco control policies and reach full impact in about half a century *(4).* However, implementation of smoke-free policies has been shown to have more immediate health effects in populations, including significant reductions in acute myocardial infarctions (AMI). This will be discussed in more depth within the paper.

A current review of the literature shows that WHO FCTC Article 8, on protection from exposure to tobacco smoke, is one of the most widely implemented and studied articles of the Convention. There is also some literature on the effect of smoke-free policies on prevalence of tobacco use. However, the most extensive available evidence is on the health effects of smoke-free policies, including on reduction in acute heart attacks from implementation of these policies. This overview thus aims to cover the health effects of smoke-free policies in line with Article 8 of the WHO FCTC.

Methods

Searches on PubMed, with a focus on systematic reviews and meta-analysis were consulted first. Information from individual articles was then added to broaden the scope or update the material. Search terms included “tobacco policy impact”, “second hand tobacco smoke acute myocardial infarction”. Studies that were included in systematic reviews and meta-analysis were not abstracted in detail for inclusion in this paper except for inclusion of details of selected studies in tabular format.

Results

Impact of smoke-free policies on exposure to second-hand smoke

Article 8 of the WHO FCTC aims to provide protection from exposure to tobacco smoke. According to the Global Progress Report, 2012, Article 8 has been implemented in 83 countries (46.9%), the highest number of countries implementing any WHO FCTC article. By 2012, as many as 109 Parties reached their individual five-year time frame for implementation of public smoking bans. Eight-eight Parties also reported having mechanisms for the monitoring and enforcement of smoke-free measures (3).

A comprehensive review on the impact of public smoking bans was undertaken by the Cochrane group and published in 2009 (5). Fifty studies were reviewed, including a variety of methodologies and sizes, with all the studies having taken place in North America, Europe or Australasia. No meta-analysis was performed due to the heterogeneity of the studies. This review looked at studies measuring the actual reduction in SHS exposure *(5).*

Reduced exposure to SHS is the first outcome measure for a smoke-free policy. In this Cochrane review there were 31 studies reporting on exposure to SHS, mostly in workplaces. All of the studies clearly showed reduced self-reported exposure to SHS after policy implementation. This was either expressed as reduction in the length of time exposed (71% to 100% reduction) or in reduction in the proportion of those exposed (22% to 85%). Eighteen studies, using biomarkers, like salivary cotinine, to validate these self-reports found 39% to 89% reduction in exposure. The studies reviewed showed that after the public smoking bans were in place, there was consistent evidence that smoking bans reduced exposure to SHS in workplaces, restaurants, pubs and other public places. Hospitality workers showed a greater reduction in exposure than the general public *(5).*

As an illustration, three studies are summarised in **Table 1.** One of the studies that took place in Spain *(6)* is described in the review. Another study is from Mexico (7) and the other study is from India *(8).* The studies from Spain and Mexico document a decline in exposure to SHS in indoor workplaces and hospitality venues. The study from India shows the extent of further efforts needed for compliance with the law, but does not have measurements from before the policy came into force.

Table 1. Studies reporting an effect of public smoking bans on exposure to second-hand smoke.

Country and date of entry into force of FCTC	Policy	Area	Respondents	Period	Measurements
Spain 11/04/2005	Public smoking ban complete ban at workplaces and limited at bars & restaurants as of January 2006	Madrid	Residents 18-64 yrs	2005-6 i.e., Oct-Nov 2005 & Jan-July 2006 Before and after the ban: statements regarding the past month.	Exposure: • In workplaces: declined from 40% to 9.0%. • In bars: percentage of people who stated that tobacco smoke did not affect the atmosphere rose from 3.0% to 8.1%. • In restaurants: the perception • that the atmosphere was not affected by tobacco smoke increased: from 11.9% to 32.4%.
Mexico 27/02/2005	Public smoking ban effective August 2008 established smoke-free areas within public places and workplaces.	Four major cities: Mexico City, Guadalajara, Tijuana, and Ciudad Juárez	About 1080 adult residents interviewed (270 in each city)	During waves 2 and 3 of the ITC Survey (end of 2007 and end of 2008).	Self-reported SHS exposure inside of enclosed workplaces in the previous month decreased significantly in Mexico City, Guadalajara, and Tijuana. Self-reported SHS exposure at the last visit to restaurants and cafés, as well as in bars and cantinas, decreased at a faster rate in Mexico City (i.e., 75% to 5% and 100% to 31%, respectively) than in the other cities.
India 27/02/2005	Public smoking ban from October 2008	Mumbai	50 hospitality venues: restaurants, bars, pubs, hookah restaurants: Air quality	April to May 2009; Air sampling carried out for a minimum of 60 min. between 6:30 PM to 11:00 PM Note: Any $PM_{2.5}$ level above 301 µg/m3 is considered hazardous as it may trigger health emergencies	Smoking observed in 36% of venues. The average levels of air particles in milligrams per cubic meter, measured as $PM_{2.5}$ (μg/m), were as follows: 1) 363.04 µg/m where smoking was observed and 2) 97.19 µg/m^3 where smoking was not seen. The range was 16.97 to 1101.76 µg/m^3; the highest value found at hookah restaurants.

It should be pointed out that there are a large number studies from all over the world demonstrating substantial reduction in PM2.5 levels in enclosed spaces, especially in hospitality venues, after the implementation of smoke-free policies.

Impact of smoke-free policies on reduction in incidence of acute coronary events

Numerous studies have been conducted to find out whether public smoking bans could reduce the incidence of heart attacks in the area of implementation. There are several systematic reviews and meta-analysis that cover a range of studies, from small studies in small towns to larger studies in a whole state (e.g. New York State) and country (e.g. Italy).

The Cochrane review (5) included twelve studies reporting hospital admission rates for acute myocardial infarction (AMI) or chest pain caused by heart disease. The reduction in hospital admissions for such cardiac events after implementation of smoke-free laws was consistent across the studies.

A systematic review and meta-analysis on 11 studies in 2009 investigated the relationship between public smoking bans and risk for hospital admission for AMI *(9)*. This review included studies from 10 geographic locations (five in the United States, one in Canada, and four in Europe). The places ranged from small communities, to middle sized towns, large cities and whole states or regions. The meta-analysis found that AMI risk decreased by 17% comparing the AMI incidence before and after the ban went into force, the incidence rate ratio (IRR) being 0.83 (95% CI: 0.75-0.92). The greater protective effect was among younger persons and among non-smokers.

Another review and meta-analysis, published in 2010, examined 17 studies (10 from North America, 6 from Europe and 1 from Australasia) *(10),* of which 11 were the same as those analysed in the previous review *(7).* In this meta-analysis, the pooled estimate of risk reduction in AMI after the introduction of smoking bans was 10% (95%CI: 6%-14%) with $p<0.001$, the relative risk being 0.90 (95% CI: 0.86 – 0.94) *(10)*.

Another recent meta-analysis, published in 2013, reviewed 18 studies, of which 11 were in North America, 6 in Europe and 1 in New Zealand *(11).* Seven studies in this review overlapped with the previous two reviews *(9,10,11).* Results of this review suggested that the overall reduction in AMI after smoking bans were in place was 13% with a pooled relative risk of 0.87 (95% CI: 0.84-0.91).

A mathematical simulation study from India attempted to quantify the effects of various tobacco control measures, including a ban on public smoking, tobacco tax increases, and pharmacological treatment of tobacco dependence on myocardial infarction and stroke over the next ten years. Smoke-free laws and tobacco taxation appeared to be the most effective strategies from the population point of view in preventing deaths from myocardial infarction and stroke. This model assumed a rather low level of access to health care as per the current situation in the country *(12).*

Some additional recent and large studies not included in reviews described above are expanded upon further here.

An investigation was made on hospital admission rates for AMI and chronic obstructive pulmonary disease among Medicare beneficiaries in the United States (aged sixty-five or older) for the thirty-six month period following implementation of new public smoking bans for workplaces, restaurants and bars throughout the United States at different points of time during 1991-2008. Risk-adjusted hospital admission rates for AMI fell 20-21% and for chronic obstructive pulmonary disease fell 11% where workplace smoking bans were present and 15% where smoking bans also applied to bars *(13).*

In Uruguay, a comparison of the number of hospital admissions nationwide for AMI was made for a two year period before and a two year period after the adoption of a public smoking ban in the country on 1 March 2006. A total of 7949 hospital admissions were reviewed from 37 hospitals (representing 79% of all the hospitals in the country) for the four year period. A time series analysis was performed to compare the average monthly events before and after the law was adopted. Two years after the law was enacted, admissions fell by about 22% *(14).*

Analysis of a health insurance cohort ≥ 30 years of age as of 1 January 2004 (over 3.7 million adults) and continuously insured through 31 December 2008 in Germany was performed to determine any change in rates of hospital admission for AMI and angina. The insurance cohort represented 85% of the national population. After one year of implementation of the smoke-free law, there was a 13% decline in admissions for angina pectoris and an 8.6% decline in admission for AMI. Costs incurred for hospitalization also decreased for these two conditions *(15).*

For the state of Gujarat in India (over 50 million population), a mathematical model estimated that a complete public smoking ban would be more cost effective in terms of lives saved due to acute cardiovascular events and costs averted than a partial one, as is now in place, with the current law of 2008. While the cost of implementing the partial ban was $US 59 036 and the cost of implementing the total ban would be about $US 4 million, with a complete public smoking ban, around 17 000 cases of AMI could be avoided and the government of Gujarat could have a net savings of $US 36 million in medical treatment costs for heart disease *(16).*

A health impact assessment was conducted prior to the implementation of smoke-free public places legislation in Hungary to map the impact of this policy on disease burden. It was found that smoke-free policies would have an unambiguously positive public health impact, particularly as Hungary has such a high burden of tobacco-related diseases. Specifically, it was estimated that prohibition of smoking in public places would lead to about 1700 deaths postponed and 16 000 life years saved annually. The expected decrease in exposure to second-hand smoke was predicted to have a stronger contribution than just the reduction in smoking prevalence. Reduction in exposure to SHS would lead to quantifiable reductions in four diseases: coronary heart diseases, stroke, chronic pulmonary diseases, and lung cancer. More immediate effects were predicted for the first three diseases, with reductions in lung cancer seen after about a 15-20 year lag time *(17).*

Impact of smoke-free policies on respiratory symptoms

A number of studies from various regions, particularly in North America and Europe, have shown that implementation of 100% smoke-free legislation has led to significant improvement in respiratory symptoms within populations. In Norway, a study evaluated the effect of a total ban on indoor smoking on hospitality workers. A significant decrease in respiratory symptoms was found five months after enactment of the ban *(18).* In a study of 42 bars in Ireland, statistically significant improvements in lung function were found in non-smoking barmen one year after the ban *(19).* A study among bar and restaurant workers in the city of Neuquén, Argentina (which adopted sub-national smoke-free legislation in 2007), also showed that, consistent with the other studies, smoke-free legislation led to substantial and immediate reduction of respiratory symptoms (from pre-ban level of 57.5% to a post-ban level of 28.8%). There was also significant reduction in sensory irritation symptoms as well as significant improvement in the respiratory function of study participants as measured by spirometry *(20).*

Impact of smoke-free policies on perinatal and child health

A systematic review and meta-analysis of the effect of smoke-free legislation on child health (the first one ever conducted), was published in the Lancet in 2014. Researchers combined the results of 11 studies from Europe and North America published between 2008 and 2013 involving more than 2.5 million births and almost 250,000 cases of asthma exacerbations in children. After the results of the studies were pooled in a meta-analysis, it was found that hospital visits for childhood asthma and premature births both declined about 10% in the year after smoking bans took effect in each of the jurisdictions covered by the study (21).

Researchers concluded that smoke free legislation was associated with a 10% reduction in the relative risk of preterm birth (-10.4%, 95% Confidence Interval [CI] -18.8 to -2.0) and with a 10% reduction in the relative risk of hospital attendances for childhood asthma (-10.1%, 95% CI -15.2 to -5.0). According to the researchers, when considered along with the health benefits shown in adults, this study provides strong support for the implementation of smoke-free polices in line with the WHO FCTC (21).

It is important to note that despite fears that smoke-free policies would lead to more smoking at home, studies have shown the opposite to be true. Strong smoke-free laws change the social norms around smoking leading to reduced smoking at home, thus having a major impact on child health outcomes *(22).*

Impact of smoke-free policies on prevalence of tobacco smoking

Two reviews examined the relationship between tobacco control policies and prevalence of smoking *(5,23).* The first review, from the Cochrane group, specifically reported on eight studies that examined the effect of public smoking bans on prevalence. The Cochrane review found that smoking bans have a modest effect on active smoking (prevalence), but a there was a clear trend towards the decrease of prevalence *(5).* Another similar review included 20 studies, *(23)* three of which overlapped with the studies in the first review *(5).* Overall, this review found moderate evidence for a decrease in smoking prevalence although a large majority of the studies showed a significant decrease in prevalence after the ban. The percentage reduction in prevalence was as high as a 32% after 1 to 3.5 years of implementation of the ban on smoking in public places. In eight studies in the second review, there was no change in prevalence. A total of ten studies selected from the two reviews are summarized in **Table 2**.

Table 2. Studies reporting an effect of public smoking bans on smoking prevalence.

Country and date of entry into force of WHO FCTC	Policy	Area	Respondents	Period	% Change in smoking prevalence	Reference
Norway 27/02/2005	Ban on smoking in indoor work places in June 2004	National sample	1525 employees of bars, restaurant, cafeterias, aged ≥ 15 yrs	2004-5: May 2004 to May 2005 with midpoint 4 months, and end point 11 months post ban	4.6% decline among daily smokers 6.8% decline in employees smoking at work	Braverman, 2008 *(24)* (See also lung function & respiratory symptoms)
USA Signed only, 10/05/2004	Comprehensive smoking ban	One County: Lexington-Fayette, Kentucky	10,413 Respondents ≥ 25 yrs.	2001–2005	32% decline in intervention areas (25.7% prelaw to 17.5% post law); 2.8% reduction (28.4% to 27.6%) in control counties	Hahn, 2008 *(25)*
Canada 27/02/2005	Comprehensive smoking ban on July 1, 2004	One city: Saskatoon, compared to the State: Saskatchewan	1301 adult residents ≥ 18 yrs. randomly polled in 2003; 1,244 in 2005 on current daily or occasional smoking	2003-2005 4 yrs pre-ban and 1 yr post public smoking ban	24.5 % decline in Saskatoon city: from 24.1% in 2003 to 18.2% in 2005; no change in State overall, where no ban is in place: Saskatchewan remained at 23.8%	Lemstra, 2008 *(26)*
Italy 30/09/2008	Ban on smoking in indoor public places from 10 January 2005.§	147 municipalities in all 20 regions: national smoking surveys	Over 3000 respondents ≥ 15 yrs in every survey	2004-2006 (2 years)	7.3% decline among all adults pre and post adoption of comprehensive smoke-free legislation.	Gallus, 2007 *(27)*
Italy 30/09/2008	Ban on smoking in indoor public places from 10 January 2005.§	Rome	Data from health surveys of the Institute of Statistics (ISTAT).	Surveys during the years 2000 to 2003 and 2005,	12.6% decline in men: from 34.9% to 30.5%; and -1% in women from 20.6% to 20.4% Cigarette sales also decreased in Rome in 2005 compared with 2004 by 5.5%.	Cesaroni, 2008 *(28)*

Country and date of entry into force of WHO FCTC	Policy	Area	Respondents	Period	% Change in smoking prevalence	Reference
Ireland (Republic) 05/02/2006	Public smoking ban	Cork City	129 bar workers and 1240 members of the general public followed up	2004-5	4.7% decline among bar workers from pre ban prevalence 56.1% to 51.4% (P= 0.13 NS) but significant decline in cigarette consumption by 4 cigs per day: 1 yr post ban (29 March, 2004); -3.5% change (P = 0.06) in the general public	Mullally, 2009 *(29)*
USA Signed only 10/05/2004	Public smoking bans: 1) In Nov. 2005, a law covering most buildings open to the public, exempting most establishments serving alcohol, 2) In July 2007, a new law covered all workplaces and buildings open to the public, including establishments serving alcohol.	Louiseville, Kentucky	College students, 18–24 yrs, fulltime undergrads Note: alcohol drinking was a big predictor of smoking status.	2004-8 In Novem-ber 2006, the two colleges implemented a policy prohibiting smoking inside all University buildings and within some distance of them.	32% decline in the smoking rate among college under-graduates from pre-law- to post- comprehensive law in 2007. This was against a backdrop of a 16% decline in smoking among young adults in the state.	Hahn, 2010 *(30)*
Spain 11/04/2005	Public smoking ban came into force in 2006, which prohibited smoking in enclosed public and work places.	All Spain – national health survey	16–65 yrs	1993-2009	2.3% decline in number of smokers after the ban came into force (2006) +2.3% increase in number of ex-smokers; However, in 2009 new smokers increased marginally, while percentage of ex-smokers was the same.	Guerrero, 2011 *(31)*
Netherlands 27/04/2005	In 2003-2005, three new tobacco control measures implemented: a workplace smoking ban (Jan 1 2004) and two tax increases (Feb 1, 2004; Jan 1, 2005) on tobacco products.	Netherlands – national surveys on smoking: 2003, 2004, 2005,	16–65 yrs 32,014 respondents; Including 27,150 with paid work and 4,864 without paid work	2003-4	3.2% decline in daily smoking for employed after all three interventions: 27.5% before the implementation of the ban and both tax increases to 25.5% (NS) after the ban and to 24.3% ($p < .001$) after all interventions. Unemployed: no significant change from 21.2% before to 20.0% after the interventions.	Verdonic-Kleinjan, 2011 *(32)*

Sources of references: Callinan, 2010 *(5),* Wilson, 2012 *(23)*
§ Since August 2005, following an appeal to the Regional Administrative Court of Law, restaurant and café owners were no longer responsible for enforcing the legislation.
NS= Not significant
Year of WHO FCTC ratification: From: http://www.who.int/fctc/signatories_parties/en/

Conclusion

In a range of jurisdictions, including low-and middle income countries (LMICs), implementation of smoke-free policies in line with WHO FCTC Article 8 have significantly reduced rates of exposure to SHS. Although many of the resulting decreases in mortality and morbidity will be seen only after a few decades, there are, however, certain health effects which are seen in the short-term. Specifically, jurisdictions implementing smoke-free policies found an immediate protective effect towards a decrease in acute coronary events, especially among non-smokers, and the protective effect strengthened over time. Studies of short duration showed smaller effects than studies of longer duration (dose-response). The protective effect was weak or non-existent for active smokers but significant for non-smokers, providing further strength to causality of the relationship.

Implementation of smoke-free policies has also been found to significantly reduce respiratory symptoms in adults and improve lung function. In addition, smoke-free policies were also associated with substantial reductions in preterm births and hospital attendance for asthma attacks in children.

Although much of the available literature on the impact of tobacco control policies had previously come from high-income countries (HICs), this is now changing, and a number of the studies included in this paper are from LMICs. Many HICs have been implementing tobacco control policies progressively for several decades and have been carrying out studies on a variety of tobacco control issues. Most HICs also have regular national surveys which collect data on smoking parameters and have a system for recording health outcomes. However, many LMICs in addition to adopting strong tobacco control legislation are also establishing national systems for tobacco surveillance and related health indicators. Thus, more data is becoming available to monitor indicators that are impacted by tobacco control measures, such as exposure to SHS in public places and the resulting health effects. This data will also help in further quantifying the health impact of tobacco policies.

The health gains attributed to implementation of smoke-free policies that are discussed within this paper are indeed encouraging. As time goes by, it is expected that there will be an increasing number of studies showing the long-term improvement in public health outcomes from smoke-free policies as well. However, it is expected that current research showing immediate and significant public health gains can also serve as an important impetus for full implementation of smoke-free policies in line with Article 8 of the WHO FCTC.

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