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Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries

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Summary

Background
Exposure to second-hand smoke is common in many countries but the magnitude of the problem worldwide is poorly described. We aimed to estimate the worldwide exposure to second-hand smoke and its burden of disease in children and adult non-smokers in 2004.

Methods
The burden of disease from second-hand smoke was estimated as deaths and disability-adjusted life-years (DALYs) for children and adult non-smokers. The calculations were based on disease-specific relative risk estimates and area-specific estimates of the proportion of people exposed to second-hand smoke, by comparative risk assessment methods, with data from 192 countries during 2004.

Findings
Worldwide, 40% of children, 33% of male non-smokers, and 35% of female non-smokers were exposed to second-hand smoke in 2004. This exposure was estimated to have caused 379 000 deaths from ischaemic heart disease, 165 000 from lower respiratory infections, 36 900 from asthma, and 21 400 from lung cancer. 603 000 deaths were attributable to second-hand smoke in 2004, which was about 1·0% of worldwide mortality. 47% of deaths from second-hand smoke occurred in women, 28% in children, and 26% in men. DALYs lost because of exposure to second-hand smoke amounted to 10·9 million, which was about 0·7% of total worldwide burden of diseases in DALYs in 2004. 61% of DALYs were in children. The largest disease burdens were from lower respiratory infections in children younger than 5 years (5 939 000), ischaemic heart disease in adults (2 836 000), and asthma in adults (1 246 000) and children (651 000).

Interpretation
These estimates of worldwide burden of disease attributable to second-hand smoke suggest that substantial health gains could be made by extending effective public health and clinical interventions to reduce passive smoking worldwide.

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Introduction

The harmful effects of second-hand smoke have been recorded since 1928.[1] In the 1970s, scientific interest in potential adverse health effects of second-hand smoke expanded.[2], [3] Since then, evidence about ill health because of second-hand smoke has accumulated from many studies done in different parts of the world. However, second-hand smoke remains a common indoor air pollutant in many regions. Comprehensive legislation to protect non-smokers from exposure to second-hand smoke in all indoor workplaces and public places has been implemented in some countries and subnational jurisdictions, but 93% of the world's population is still living in countries not covered by fully smoke-free public health regulations.[4–8]

Knowledge about the links between second-hand smoke and specific diseases has been summarised in comprehensive assessments or reviews by the International Agency for Research on Cancer,[9] WHO,[10] the California Environmental Protection Agency,[11] and the US Surgeon General.[12] Studies of the effects of smoke-free laws have drawn attention to the importance of second-hand smoke as a preventable cause of disease and disability. The International Agency for Research on Cancer reported in 2009 that "wide-ranging bans on smoking in the workplace are followed by as much as a 10–20% reduction in acute coronary events in the first year post-ban".[13], [14] The 171 countries that are parties to the WHO Framework Convention on Tobacco Control "recognize that scientific evidence has unequivocally established that exposure to tobacco smoke causes death, disease, and disability".[15] Furthermore, they recognise that there is no safe level of exposure to tobacco smoke and therefore recommend effective measures to provide protection from exposure to tobacco smoke, as envisioned by Article 8 of the WHO Framework Convention. The guidelines for implementation of Article 8 stipulate that smoking and tobacco smoke be totally eliminated in all indoor workplaces, indoor public places, and on public transport, and be eliminated as appropriate in other public places.[16]

Some country-specific studies of the health effects attributable to second-hand smoke have been reported;[17–19] however, this study provides the first assessment of the worldwide burden of disease from second-hand smoke. Information about the magnitude and distribution of the burden of disease from second-hand smoke is particularly important for policy makers to plan preventive strategies. We aimed to estimate the worldwide burden of disease attributable to second-hand smoke, measured as deaths and disability-adjusted life-years (DALYs) lost for children and adult non-smokers.

Methods

Framework for estimation

We estimated the burden of disease from second-hand smoke by the comparative risk assessment method.[20], [21] In this approach, the contribution of a risk factor to disease is based on the population attributable fraction, which is derived from the proportion of people exposed to the pollutant of interest and the relative risk of disease related to the exposure, and defined as the proportional reduction in disease or death that would occur if exposure was reduced to zero.[20], [21]

Proportion exposed and relative risk were specified for every outcome, age-group, and sex. Estimates were calculated for 192 countries and then grouped into 14 regions (panel) for comparability with previous worldwide assessments of other risk factors.[22] The assessment was done for 2004, the most recent year for which comprehensive disease data were available for analysis by country, disease, age, and sex.[23]

Panel

WHO subregional country grouping, by region

Africa

Region D

Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo

Region E

Botswana, Burundi, Central African Republic, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, Tanzania, Zambia, Zimbabwe

The Americas

Region A

Canada, Cuba, USA

Region B

Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela

Region D

Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru

Eastern Mediterranean region

Region B

Bahrain, Iran, Jordan, Kuwait, Lebanon, Libya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates

Region D

Afghanistan, Djibouti, Egypt, Iraq, Morocco, Pakistan, Somalia, Sudan, Yemen

Europe

Region A

Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, UK

Region B

Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Poland, Romania, Serbia and Montenegro, Slovakia, Tajikistan, Former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Uzbekistan

Region C

Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine

Southeast Asia region

Region B

Indonesia, Sri Lanka, Thailand

Region D

Bangladesh, Bhutan, North Korea, India, Maldives, Myanmar (Burma), Nepal, Timor Leste

Western Pacific region

Region A

Australia, Brunei, Japan, New Zealand, Singapore

Region B

Cambodia, China, Cook Islands, Fiji, Kiribati, Laos, Malaysia, Marshall Islands, Micronesia, Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, South Korea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Vietnam

Data for 2004. Regions are categorised as follows (WHO-approved classifications): A=very low child mortality and very low adult mortality; B=low child mortality and low adult mortality; C=low child mortality and high adult mortality; D=high child mortality and high adult mortality; E=high child mortality and very high adult mortality. Adapted from WHO.[22]

Estimation of exposure

We estimated the proportion of people exposed to second-hand smoke with methods matching as closely as possible the measures used in the epidemiological studies that provided the relative risks of diseases from second-hand smoke. Exposure to second-hand smoke was estimated for every country, separately for children (classified as 0—14 years for this assessment), and for men and women (older than 15 years).

For children, exposure to second-hand smoke was often operationally defined as having one or both parents who smoke or being exposed to tobacco smoke or to a person who smokes indoors. For adults, the definitions of exposure were often based on having a spouse who smokes or exposure to tobacco smoke at work, and can be further characterised by the number of cigarettes smoked by the spouse, the duration of exposure (in years), or the frequency of exposure (in number of days per week).[11], [12]

Estimates of the exposure of children to second-hand smoke were obtained mainly from the global youth tobacco survey (GYTS),[24] a school-based survey of children aged between 13 years and 15 years in more than 120 countries. Data for children and adults were also obtained from various national and multinational surveys. To identify national data for second-hand smoke, the keywords “second hand smoke”, “environmental tobacco smoke”, and “passive smoking” were combined with names of countries or regions, by searching Google and the PubMed database from January, 1980, to December, 2007. We used data from 1980 to 1995 when estimating the burden from lung cancer because of the long latency period for this disease,[25] and data for exposures since 2000 were included in the calculations for other disease outcomes. 19 studies could be used in the analysis, five of which reported data for several countries. 186 datapoints on exposure to second-hand smoke were extracted from these studies, most of which were for children.

Data were selected as follows: information indicating regular exposure was preferred (eg, having a parent who smoked or being regularly exposed to tobacco smoke); nationally representative survey data were used when possible; if several GYTS reports were available, the survey closest to 2004 was selected; when several subnational GYTS reports were available, the mean value was calculated; and for a few countries, only one subnational survey was available and was used for the whole country in the absence of other data.

For countries without survey data about second-hand smoke, exposure was modelled. Models using linear, power, and logarithmic regressions were tested and selected according to the highest coefficient of determination (R^2) value obtained. Several covariates were tested: whether smokers were women, men, or parents; the percentage of urban population and the per head gross national income (webappendix p 1). For children, separate exposure models were tested for every region. For adults, the sparse data available allowed only for separate models for men and women worldwide and for women in developing countries. Webappendix pp 2—4 provides detailed information about data availability, models used, and data sources.

Many reports on exposure estimates with biomarkers are also available from many regions,[12] including an assessment of hair nicotine content for people from 31 countries across three continents.[26] Biomonitoring data were not directly used in exposure estimation in this analysis because exposure measures in relevant epidemiological studies were almost invariably self-report survey questions. However, we did use biomarker data for comparison of exposure intensity across continents.

Selection of exposure-risk relations

Health outcomes were included in the burden of disease estimates if recent reviews judged the evidence to be sufficient for inferring a causal association with second-hand smoke, and if national incidence statistics were available. The exposure-risk relation was taken from the most up-to-date meta-analysis; if none was available, this information was taken from the results of large, high-quality epidemiological studies. Table 1 provides the outcomes that were selected on this basis, alongside the ratings of the strength of evidence.

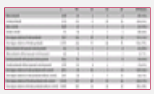

Table 1 Table image

Health outcomes included in this assessment, effect estimate for exposure to second-hand smoke, and rating of the strength of evidence for every outcome

In addition to the health outcomes listed in table 1, low birthweight and sudden infant death syndrome had sufficient evidence for quantification. However, no worldwide statistics exist for these outcomes, so they could not be included in this estimation of disease burden. Several other health outcomes have been linked to second-hand smoke, but available evidence is deemed insufficient or non-supportive for a

causal relation.[11], [12]

Estimation of burden of disease

The attributable burden of disease (AB), in deaths or DALYs, was estimated for every outcome by multiplication of the population attributable fraction (PAF_{SHS}) by the total burden attributable to that disease (B):

$$AB=PAF_{SHS}\times B$$

The population attributable fractions were applied equally to the burden in deaths and DALYs, and we assumed that the case fatality of cases related to second-hand smoke was the same as the mean case fatality of the disease. Results were calculated separately for every age-group, sex, and country, and then summed as appropriate.

For adults, the population attributable burden was estimated for non-smokers only because studies of health effects of second-hand smoke exposure have, with few exceptions, included only non-smokers. The following equation was used to approximate the burden of relevant health outcomes in non-smokers:

$$B_{ns}=[B-(B\times PAF_{sm})]\times(1-p_{sm})$$

where B_{ns} is the total burden, in deaths or DALYs, of non-smokers, p_{sm} is the active smoking rate, and PAF_{sm} is the population attributable fraction from active smoking. All children were regarded as non-smokers.

The attributable burden of disease (AB), in deaths or DALYs, was estimated for every outcome by multiplication of the population attributable fraction (PAF_{SHS}) by the total burden attributable to that disease in non-smokers (B_{ns}):

$$AB=PAF_{SHS}\times B_{ns}$$

We used country-specific estimates of population attributable fractions from active smoking for lung cancer, ischaemic heart disease, and asthma supplied by Colin Mathers (Department of Health Statistics and Informatics, World Health Organization, Geneva, Switzerland, personal communication). These figures were based on WHO 2009 data[31] that used methods previously developed by Ezzati and Lopez.[32]

Support for the estimation of country-specific disease burden from second-hand smoke is available as a methods guide by WHO on the assessment of the burden of disease at national and local levels.[33] Öberg and colleagues[34] provide additional details about the data and methods presented in this manuscript.

Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Worldwide, 40% of children, 33% of male non-smokers, and 35% of female non-smokers were exposed to second-hand smoke. The highest proportions exposed were estimated in Europe, the western Pacific, and region B of southeast Asia, with more than 50% of some population groups exposed (table 2). Proportion of people exposed was lower in the Americas and eastern Mediterranean regions and the lowest in Africa (table 2).

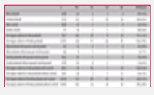

Table 2 Table image

Proportion of children and adult non-smokers exposed regularly to second-hand smoke based on survey data and modelling for 2004, by WHO subregion*

Second-hand smoke was estimated to have caused 603 000 premature deaths and the loss of 10·9 million DALYs in 2004. The largest number of estimated deaths attributable to second-hand smoke exposure in adults was caused by ischaemic heart disease, followed by lower respiratory infections in children, and asthma in adults (table 3). In assessment of burden of disease in terms of DALYs lost because of exposure to second-hand smoke, most DALYs lost were from lower respiratory infections, followed by those from ischaemic heart disease and then from asthma in adults (table 4). Almost half of the total burden attributable to exposure to second-hand smoke was in southeast Asia and the western Pacific, with a high burden of disease also estimated in eastern Europe, Africa, and eastern Mediterranean region D (table 3, table 4, and webappendix p 5.

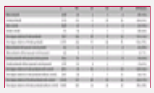

Table 3 Table image

Number of deaths from exposure to second-hand smoke in 2004, by WHO subregion*

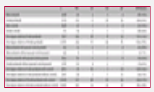

Table 4 Table image

Number of DALYs from exposure to second-hand smoke in 2004, by WHO subregion*

In non-smokers, there are clear inequalities in the burden of disease from second-hand smoke according to sex and age. Women have the greatest burden of deaths of the total attributable to second-hand smoke, whereas children are most affected in terms of DALYs (figure).

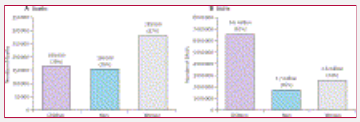

Figure Full-size image (39K) Download to PowerPoint

Distribution of disease burden from second-hand smoke in non-smokers by age and sex in 2004

(A) Total deaths attributable to second-hand smoke. (B). Total DALYs attributable to second-hand smoke. DALY=disability-adjusted life-year.

Discussion

Exposure to second-hand smoke is still one of the most common indoor pollutants worldwide. On the basis of the proportions of second-hand smoke exposure, as many as 40% of children, 35% of women, and 33% of men are regularly exposed to second-hand smoke indoors. We noted wide regional variations of exposure, ranging from 13% or less in Africa to 50% or more in the western Pacific or eastern Europe. These differences can be mostly explained by the stages of the tobacco epidemic of a country because second-hand smoke is closely related to active smoking rates where no robust and extensive smoke-free indoor policies exist.

We have estimated that second-hand smoke caused 603 000 deaths and 10·9 million DALYs worldwide in 2004, corresponding to 1·0% of all deaths and 0·7% of the worldwide burden of disease in DALYs in this year. These deaths should be added to the estimated 5·1 million deaths[31] attributable to active smoking to obtain the full effect of both passive and active smoking. Smoking, therefore, was responsible for more than 5·7 million deaths every year in 2004. Worldwide, children are more heavily exposed to second-hand smoke than any other age-group, and they are not able to avoid the main source of exposure—mainly their close relatives who smoke at home. Furthermore, children are the group that has the strongest evidence of harm attributable to second-hand smoke. These two factors should form the basis of public health messages and advice to policy makers.

Almost two-thirds of all deaths in children and adults and a quarter of DALYs attributable to exposure to second-hand smoke were caused by ischaemic heart disease in adult non-smokers. Smoke-free laws banning smoking in indoor workplaces rapidly reduce numbers of acute coronary events.[35], [36] Therefore, policy makers should bear in mind that enforcing complete smoke-free laws will probably substantially reduce the number of deaths attributable to exposure to second-hand smoke within the first year of its implementation, with accompanying reduction in costs of illness in social and health systems.

The largest effects on deaths occurred in women. The absolute number of deaths is higher in women than in men for two main reasons. First, the number of female non-smokers (thus susceptible to be exposed to second-hand smoke by definition) is about 60% higher than that of male non-smokers.[4] Second, in Africa and some parts of the Americas, the eastern Mediterranean, and southeast Asia, women are at least 50% more likely to be exposed to second-hand smoke than are men. Our data do not specify where the burden occurs; however, some setting-specific information about exposure is available. In the European Union, for example, exposure is almost equally distributed between the workplace and home, and women constitute about 40% of the workforce.[37] In the western Pacific and east Asia, women equally constitute an important part of the workforce[38] and about half of the women are exposed to second-hand smoke. In the eastern Mediterranean region, 32% of women, substantially more than the 22% of men, are exposed to second-hand smoke. Because these women constitute only 25% of the labour force, much of the exposure probably occurs at home.

We estimated that 165 000 children younger than 5 years die every year from lower respiratory infections caused by exposure to second-hand smoke. Two-thirds of these deaths occur in Africa and south Asia. Children's exposure to second-hand smoke most likely happens at home. The combination of infectious diseases and tobacco seems to be a deadly combination for children in these regions and might hamper the efforts to reduce the mortality rate for those aged younger than 5 years as sought by Millennium Development Goal 4. In addition to ischaemic heart disease in adults and asthma in children and adults, lower respiratory infections were also the cause of many DALYs lost

because of second-hand smoke exposure. The largest burden of DALYs from second-hand smoke exposure was in children.

Information about the magnitude and distribution of the burden of disease caused by second-hand smoke is particularly pertinent to policy makers because the harm done by second-hand smoke is eminently preventable. There are well documented and effective interventions to reduce exposure to second-hand smoke in public and private places. For example, by the end of 2007, 16 countries had passed national smoke-free legislation covering all workplaces and public sites,[39] and many other countries have state or local government ordinances that restrict smoking. In a review of the effectiveness of legislation of this type, exposure to second-hand smoke in high-risk settings (such as bars and restaurants) was typically reduced by about 90%, and the exposure of adult non-smokers in the general population to second-hand smoke cut by as much as 60%.[13]

Most epidemiological studies have been done in developed countries. Conditions in developing countries can differ from those in high-income countries, and, in particular, exposure to second-hand smoke in the home is often not well characterised by the presence or absence of parents or spouses who smoke. Factors contributing to the differences in intensity of indoor exposure to second-hand smoke between developing and developed countries include: intensity of tobacco smoking (mean cigarettes and other smoking tobacco per day per smoker); natural ventilation (eg, the climate allows open architectural structures or opening of windows); crowding at home (eg, sharing of bedrooms with people who smoke); the pathogens most frequently associated with respiratory illnesses; smoke from solid fuels used for cooking; and enforcement of legal protection from exposure to second-hand smoke in indoor workplaces and public places. However, on the basis of the biomarker and epidemiological data reviewed and additional analyses done, we concluded that exposures in households in which someone smokes are broadly the same across regions, with higher intensities in Asia and the Middle East than in Europe, and lower levels in Latin America. Factors such as crowding, ventilation, and smoke from solid fuels seem to have little effect on actual exposure and health effects across regions on the basis of available evidence (webappendix pp 6—9). Webappendix p 10 shows results of the sensitivity analyses.

There are uncertainties inherent in any assessment of this type. These limitations include uncertainties in: the underlying health data; the exposure data; the choice of study population (particularly the exclusion of potential effects in smokers); the effect sizes and their transferability to other populations and exposure conditions; the burden of active smoking (deduced from the total burden before estimation of the burden from second-hand smoke); and the susceptibility of ex-smokers. Estimation of exposure is one of the weaknesses of this approach because of the gaps in data for specific regions, the age-groups that had to be completed by modelling, and the variations in definitions of exposure across available studies. Webappendix p 10 shows the results of sensitivity analyses that tested the effects of varying the key assumptions on the number of deaths attributable to second-hand smoke per year. We took the most parsimonious approach to change only one variable at a time. We varied the effect sizes within their confidence interval, used specific effect sizes by region and by sex when available, and used different hypotheses of susceptibility of smokers and ex-smokers to second-hand smoke. The number of deaths was most sensitive to the assumption that smokers are not affected by second-hand smoke, which would otherwise have been 30% higher.

Previously reported national estimates of the burden of disease caused by second-hand smoke are generally similar to those reported here. Variations result from differences in the burden from active smoking, the active and passive smoking rates used, and the methods used (eg, whether or not active smokers are deemed susceptible). The size of the relative risk estimates used did not generally vary across studies of health effects from exposure to second-hand smoke.

This assessment shows that second-hand smoke poses a substantial health risk and disease burden for children and adult non-smokers worldwide. The findings are relevant to health policy decisions and public health strategies in all regions.

Only 7·4% of the world population lives in jurisdictions with comprehensive smoke-free laws at present, and the enforcement of these laws is robust in only a few of those jurisdictions.[4] We recommend that the provisions of the WHO Framework Convention on Tobacco Control[15] should be enforced immediately to create complete smoke-free environments in all indoor workplaces, public places, and on public transport. When policy makers implement these measures they are likely to record a substantial and rapid decline in the mortality attributable to tobacco and long-term reduction of DALYs lost from second-hand smoke. Fully smoke-free policies have a net positive effect on businesses, including the hospitality sector, and enforcement and education about smoke-free policies will have minimum costs to governments. Additionally, they are supported by much of the population, and this support increases after its enforcement—even in most smokers.[13] In addition to the protection they offer to non-smokers, such smoke-free policies reduce cigarette consumption among continuing smokers and lead to increased successful cessation in smokers. Above all, these policies contribute decisively to denormalise smoking, and help with the approval and implementation of other policies that reduce tobacco demand, such as increased tobacco taxes and a comprehensive ban of tobacco advertising, promotion, and sponsorship.

Policy makers should also take action in two other areas to protect children and adults. First, although the benefits of smoke-free laws clearly extend to homes, protection of children and women from second-hand smoke in many regions needs to include complementary educational strategies to reduce exposure to second-hand smoke at home. Voluntary smoke-free home policies reduce exposure of children and adult non-smokers to second-hand smoke, reduce smoking in adults, and seem to reduce smoking in youths.[13] Second, exposure to second-hand smoke contributes to the death of thousands of children younger than 5 years in low-income countries. Prompt attention is needed to dispel the myth that developing countries can wait to deal with tobacco-related diseases until they have dealt with infectious diseases. Together, tobacco smoke and infections lead to substantial, avoidable mortality and loss of active life-years of children.

Contributors

MÖ and AP-U reviewed the literature and developed the methods and estimates. AP-U drafted the report. MJ, AW, and AP provided input to the development of the methods and to the drafting process.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

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WebExtra Content

Supplementary webappendix

PDF (144K)

References

1 Schönherr E. Contribution to the statistical and clinical features of lung tumours (in German). *Z Krebsforsch* 1928; **27**: 436-450. PubMed

2 US Department of Health, Education, and Welfare. The Health Consequences of Smoking. A Report of the Surgeon General: 1972. Washington, DC, USA: Public Health Service, Health Services and Mental Health Administration, 1972. DHEW Publication No.(HSM) 72-7516 http://profiles.nlm.nih.gov/NN/B/B/P/M/_/nnbbpm.pdf. (accessed Oct 19, 2010).

3 Musk AW, de Klerk NH. History of tobacco and health. *Respirology* 2003; **8**: 286-290. CrossRef | PubMed

4 World Health Organization. WHO Report on the Global Tobacco Epidemic 2009: implementing smoke-free environments. Geneva: World Health Organization, 2009. http://www.who.int/tobacco/mpower/2009/en/. (accessed March 22, 2010).

5 Eriksen MP, Cerak RL. The diffusion and impact of clean indoor air laws. *Annu Rev Public Health* 2008; **29**: 171-185. CrossRef | PubMed

6 McNabola A, Gill LW. The control of environmental tobacco smoke: a policy review. *Int J Environ Res Public Health* 2009; **6**: 741-758. PubMed

7 Fontana L, Di Martino T, Iavicoli I. Application and effects of smoking ban in bars and restaurants of Rome (in Italian). *G Ital Med Lav Ergon* 2007; **29**: 484-485. PubMed

8 Jaakkola MS, Jaakkola JJK. Impact of smoke-free workplace legislation on exposures and health: possibilities for prevention. *Eur Respir J* 2006; **28**: 397-408. CrossRef | PubMed

9 International Agency for Research on Cancer. Tobacco Smoke and Involuntary Smoking. Lyon: International Agency for Research on Cancer, 2004. http://monographs.iarc.fr/ENG/Monographs/vol83/index.php. (accessed March 22, 2010).

10 WHO. International Consultation on Environmental Tobacco Smoke (ETS) and Child Health. Geneva: World Health Organization, 1999. http://www.who.int/tobacco/research/en/ets_report.pdf. (accessed Oct 19, 2010).

11 California Environmental Protection Agency: Air Resources Board. Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant. Sacramento: California Environmental Protection Agency, 2005. http://oehha.ca.gov/air/environmental_tobacco/2005etsfinal.html. (accessed Oct 13, 2009).

12 US Surgeon General. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2006. http://www.surgeongeneral.gov/library/secondhandsmoke/. (accessed Sept 24, 2009).

13 International Agency for Research on Cancer. Evaluating the effectiveness of smoke-free policies. Lyon: International Agency for Research on Cancer, 2009. http://www.iarc.fr/en/publications/pdfs-online/prev/handbook13/handbook13.pdf. (accessed Dec 22, 2009).

14 Menzies D, Nair A, Williamson PA, et al. Respiratory symptoms, pulmonary function, and markers of inflammation among bar workers before and after a legislative ban on smoking in public places. *JAMA* 2006; **296**: 1742-1748. CrossRef | PubMed

15 World Health Organization. WHO Framework Convention on Tobacco Control. Geneva: World Health Organization, 2009. http://www.who.int/fctc/text_download/en/index.html. (accessed March 17, 2010).

16 World Health Organization. Guidelines for implementation of the WHO Framework Convention on Tobacco Control. Geneva: World Health Organization, 2009. http://libdoc.who.int/publications/2009/9789241598224_eng.pdf. (accessed March 17, 2010).

17 Gan Q, Smith KR, Hammond SK, Hu TW. Disease burden of adult lung cancer and ischaemic heart disease from passive tobacco smoking in China. *Tob Control* 2007; **16**: 417-422. CrossRef | PubMed

18 Woodward A, Laugesen M. How many deaths are caused by second hand cigarette smoke?. *Tob Control* 2001; **10**: 383-388. CrossRef | PubMed

19 Lopez M, Perez-Rios M, Schiaffino A, et al. Mortality attributable to passive smoking in Spain, 2002. *Tob Control* 2007; **16**: 373-377. CrossRef | PubMed

20 Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJL. Selected major risk factors and global and regional burden of disease. *Lancet* 2002; **360**: 1347-1360. Summary | Full Text | PDF(199KB) | CrossRef | PubMed

21 World Health Organization. Comparative quantification of health risks. In: Ezzati M, Lopez AD, Rodgers A, Murray CJL, eds. . Geneva: World Health Organization, 2004. http://www.who.int/healthinfo/global_burden_disease/cra/en/index.html. (accessed Feb 22, 2010).

22 World Health Organization. The world health report 2002—reducing risks, promoting healthy life. Geneva: World Health Organization, 2002. http://www.who.int/whr/2002/en/index.html. (accessed Feb 18, 2010).

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