

Integrating a quantitative risk appraisal in a health impact assessment: analysis of the novel smoke-free policy in Hungary

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Background: Although the quantification of health outcomes in a health impact assessment (HIA) is scarce in practice, it is preferred by policymakers, as it assists various aspects of the decision-making process. This article provides an example of integrating a quantitative risk appraisal in an HIA performed for the recently adopted Hungarian anti-smoking policy which introduced a smoking ban in closed public places, workplaces and public transport vehicles, and is one of the most effective measures to decrease smoking-related ill health. **Methods:** A comprehensive, prospective HIA was conducted to map the full impact chain of the proposal. Causal pathways were prioritized in a transparent process with special attention given to those pathways for which measures of disease burden could be calculated for the baseline and predicted future scenarios. **Results:** The proposal was found to decrease the prevalence of active and passive smoking and result in a considerably positive effect on several diseases, among which lung cancer, chronic pulmonary diseases, coronary heart diseases and stroke have the greatest importance. The health gain calculated for the quantifiable health outcomes is close to 1700 deaths postponed and 16000 life years saved annually in Hungary. **Conclusion:** The provision of smoke-free public places has an unambiguously positive impact on the health of the public, especially in a country with a high burden of smoking-related diseases. The study described offers a practical example of applying quantification in an HIA, thereby promoting its incorporation into political decision making.

Introduction

A health impact assessment (HIA) is a powerful tool used to predict the possible health effects of policies, programmes and projects. The primary goal of an HIA is to assist policymakers and thus to contribute to the strategy of health in all policies, although the incorporation of an HIA in the decision-making process presents challenges.^{1,2} In this article, the authors provide an example of using epidemiological evidence and empirical data in a quantitative risk assessment integrated in the HIA of the recently adopted Hungarian anti-smoking policy.

A comprehensive HIA ideally integrates both qualitative and quantitative evidence and methods.³ Solely qualitative assessments dominate in practice, although quantitative estimates are favoured by decision makers because they enable them to consider the size of effects in terms of priority, to summarize positive and negative impacts and to weigh the health effects against each other so as to effectively assist the bargaining process.⁴ A quantitative assessment is typically used to forecast health consequences due to environmental exposures, for which methods borrowed from toxicology and environmental impact assessments can be applied.⁵ While the basic methodological concepts to quantify health effects of non-environmental factors in an HIA have been developed and are continuously refined, few studies exist that apply epidemiological methods for the prediction of health outcomes and integrate these methods in the assessment process, especially in HIAs of policy proposals.^{3,4} Calculation of the disease burden is a feasible way to numerically explain health gain in a combined measure.⁶

Tobacco use is one of the leading preventable causes of morbidity and mortality worldwide. Diseases associated with smoking pose a significant health burden on individuals, societies and health care systems. Tobacco smoke exposure has been related to a wide range of health effects.^{7,8} Smoking as a lifestyle factor affects not only active smokers but also those who are in the vicinity of the smoker via environmental tobacco smoke (ETS) exposure, especially in indoor environments.⁹

There have been several initiatives made and programmes launched worldwide to tackle the serious public health problem of tobacco smoking. Both the Recommendation of the Council of the European Union on smoke-free environments (2009/C 296/02) and the Framework Convention on Tobacco Control (FCTC) of the World Health Organization (WHO) aim to reduce smoking and its health damaging effects.¹⁰ One of their major goals is the protection of non-smokers from ETS exposure. The WHO's MPOWER package discusses the six available anti-smoking interventions among which tax increases, bans on advertising tobacco products and prohibition of smoking in public places are reported as the most effective measures.^{11,12}

In the last decade, several countries have introduced comprehensive anti-smoking policies. Hungarian political decision makers have also realized the need for amending the existing anti-smoking legislation by enacting a full restriction of smoking in indoor public places. The demand was driven by the large amount of scientific information and experience accumulated on the topic during the last decade, as well as by the country's international obligations.

Hungary ratified FCTC and accepted the goals of the Green Paper of the European Commission 'Towards a Europe free from tobacco smoke: policy options at EU level'.^{10,13} The special importance of tightening anti-smoking policies is also underpinned by the high prevalence of smoking and the large burden smoking-related diseases pose on Hungarian society. In the last decade, premature mortality due to lung cancer, chronic obstructive pulmonary diseases, ischaemic heart diseases and stroke were 2.3–2.6, 2.5–4.6, 2.9–3.7 and 3.5–4.0 times higher, respectively, than the EU15 countries' average according to the Health for All Database.¹⁴

In 2009, the strengthening political commitment had reached the point at which a proposal was prepared for the amendment of the existing Hungarian anti-smoking legislation that allowed the designation of smoking sites in most indoor public places as well as smoking in catering facilities where no hot meals for local consumption were served. As a basic rule, the proposal called for all indoor public places to become non-smoking establishments, with very few exceptions. It also placed a restriction on smoking in some open public areas, such as playgrounds, underpasses and public transport stations. The proposal was adopted by the Hungarian Parliament in 2011 and has been legally binding from 1 January 2012.

During the preparatory phase of the proposal, a need arose for the assessment of its health effects, and an HIA incorporating the quantification of several health outcomes was completed. Beyond conducting a regular qualitative assessment, this study attempted to prioritize causal pathways, identify those where quantification was feasible and thus integrate a quantitative risk appraisal in the HIA methodology.

Methods

A comprehensive, prospective HIA was performed in 2009–10 for the proposed amendment of Act No. XLII of 1999 on the protection of non-smokers and on certain rules of the consumption and trade of tobacco products, commissioned by the Ministry of Health, Hungary. The assessment used the broad model of health and applied a range of public health and epidemiological methods within a structural framework based on the Gothenburg consensus paper. The original, qualitative work was completed with a quantitative assessment within the framework of the EU-funded 'Risk Assessment from Policy to Impact Dimension' project.

The full causal chain of health impacts of the proposal was mapped and analysed through the changes predicted at the level of health determinants and risk factors to the direct health effects. The health outcomes of primary importance were identified by the HIA team in a transparent selection process. In the prioritization, strength of evidence for causality, the severity and reversibility of the condition as well as the frequency of occurrence in the population, i.e. its public health importance, were taken into consideration. Special attention was given to those health outcomes for which both exposure and outcome assessments could be performed in a quantitative manner.

Among the health determinants influenced by the proposal, substance use and air quality were identified as the highest priorities. In accordance, changes in the prevalence of active smoking and in the pattern of ETS exposure were found to have a primary importance at the risk factor level. A quantitative exposure assessment could be carried out on the same impact pathways using experiences from countries that had previously introduced similar restrictions. A 7% reduction in the prevalence of active smoking, a 95% decrease in the prevalence of ETS exposure in the hospitality sector, 70% in the workplace and 5.9% in households were used to estimate the policy effect on exposures.^{15–19} The impact of decreased passive smoking was considered only among non-smokers; for those of them who were exposed to ETS in more than one location, the location with the smallest reduction of exposure was applied. The analysis of causal pathways found 17 diseases influenced by the

changing prevalence of active smoking and 4 diseases affected by the reduction in ETS exposure in a quantifiable way.

Frequency measures of the quantifiable health outcomes were taken from the most reliable sources. Age- and sex-specific demographic and mortality data were provided by the Central Statistical Office. Morbidity data of circulatory system diseases were derived from the General Practitioners Morbidity Sentinel Stations Programme, morbidity data of cancer from the National Cancer Registry and of chronic respiratory diseases from the Koranyi National Institute for Tuberculosis and Pulmonology.²⁰ Age- and sex-specific exposure data (prevalence of active and passive smoking at various sites) were provided by the 2005–06 study on the aetiology of chronic liver disease by the School of Public Health, University of Debrecen, which collected information on the smoking habits and on the daily time spent indoors with ETS exposure at the workplace, at home or during spare time activities. Passive smoking status was established when at least one minute's ETS exposure was indicated. As all required data were available for 2006, this year was chosen to calculate the baseline values.

Association measures were acquired from the literature. In the selection process of sources, preference was given to relative risks (RRs) provided by meta-analyses and large-scale cohort studies. Regarding active smoking, RRs for neoplastic diseases were used from the meta-analysis by Gandini carried out on 216 studies and RRs for circulatory and respiratory diseases from Thun who analysed the results of the nationwide prospective Cancer Prevention Study II of nearly one million US adults.^{21,22} In the case of passive smoking, different association measures were applied for ETS exposure suffered during spare time activities, at the workplace, and at home. RR values for lung cancer were acquired from Zhong and Boffetta and for coronary heart disease from He, Wells and Thun.^{23–27} Association measures for stroke were taken from Lee and Bonita and for chronic pulmonary disease from Eisner.^{28–30}

For the quantifiable diseases, age- and sex-specific population attributable risk fractions (PAFs) were determined using exposure data and association measures. To calculate attributable death and disability-adjusted life years (DALYs) as the sum of the potential years of life lost (PYLL) and the years of life lived with disability (YLD), the methodology applied by the WHO in the Global Burden of Disease 2004 study was used.³¹ PYLL were determined using age- and sex-specific Hungarian life expectancies for 2006. To calculate YLD, the WHO age-specific disability weights for treated cases were applied. The DisMod II software (version 1.01) provided by the WHO was used to estimate the average duration lived with a disease, as these data were not readily available. Cause-, age- and sex-specific incidence, prevalence and mortality rates, as well as age- and sex-specific population numbers and mortality rates, served as input variables for DisMod computation. In the calculation of DALY, the standard 3% discount rate and the standard age weights ($\beta = 0.04$, $C = 0.1658$) were used as proposed by Murray.⁶ The average annual disease burden was calculated for the baseline year of 2006 and for the predicted future situation that is expected within two decades after the full smoking ban in closed public places became effective in 2012. It is reported that 20 years after cessation the risk of all major smoking-related diseases decreases to the normal level, except that of lung cancer; however, that is significantly reduced, too.^{32,33} The difference of disease burden between the baseline and the predicted future scenario was considered to be the health gain of the proposal.

Univariate sensitivity analysis was performed to characterize how sensitive the impact estimates are to the uncertainty of various input variables. The analysis included the policy effect on exposure using the lowest and highest values published in the literature as well as the association measures and exposure prevalence estimates with their reported 95% confidence intervals. The influence of discounting and age-weighting on the outcome was also assessed.

Results

Based on the model applied, the disease burden of active smoking for the quantifiable health outcomes is 15 097 attributable deaths and 162 766 DALYs in 2006. The burden of passive smoking is about one order of magnitude lower (1852 deaths and 17 307 DALYs). The new regulation is expected to reduce the combined annual burden of active and passive smoking by 9.9% of attributable deaths (1685 deaths) and 8.9% of DALYs (15 986 life years) in the long term in the Hungarian population of 10 million people due to avoiding early mortality and disabled living. Reduced ETS exposure has a larger contribution to the overall impact than the decreased prevalence of active smoking. This observation is true for both measures; the health gain is 633 and 1052 attributable deaths as well as 6068 and 9918 DALYs related to active and passive smoking, respectively.

The highest disease burden associated with active smoking was calculated for lung cancer (ICD C33-34), chronic respiratory diseases (J40-44), coronary heart diseases (I20-25), stroke (I60-69) and arterial diseases other than heart and cerebrovascular diseases (I70-78). The disease burden of all neoplastic diseases other than lung cancer attributable to active smoking was approximately one order of magnitude smaller.

Figure 1 illustrates the decreased number of attributable deaths due to the expected fall in the prevalence of active smoking. The largest reduction in attributable death was estimated for coronary heart diseases, followed by lung cancer, stroke and pulmonary diseases. The effect was found to be larger in males for all

quantified diseases, the gender difference is especially pronounced in malignancies other than lung cancer. Expressing disease burden in DALY, the most significant health benefit is identified for coronary heart diseases, followed by lung cancer and chronic pulmonary diseases (figure 2). The male dominance remains but the gender difference is smaller, e.g. for chronic pulmonary diseases it almost disappears.

The forecasted reduction in the frequency of ETS exposure in hospitality venues, workplaces and households was predicted to have the largest effect on circulatory disease mortality. Stroke and coronary heart diseases were determined to have the greatest decrease in attributable death, followed by much smaller reductions for lung cancer and chronic pulmonary diseases (figure 3). Males contribute with a considerably larger share to the reduction seen for lung cancer and pulmonary diseases, but the gender difference decreases for coronary heart diseases, and even reverses for stroke. When expressing the disease burden in DALY, the highest decrease was found for coronary heart diseases and stroke, too (figure 3). The contributions of chronic pulmonary diseases and lung cancer to the reduction in DALY are approximately half and one-third of that of circulatory diseases. The sex-specificity of effects is similar to that observed for attributable deaths with the exception of pulmonary diseases where share of females is increased and of stroke that is observed with equal contribution of genders.

Sensitivity analysis reveals a significant, close to 70% increase in the estimated overall effect of the proposal when neither discounting nor age-weighting are applied in the calculation of

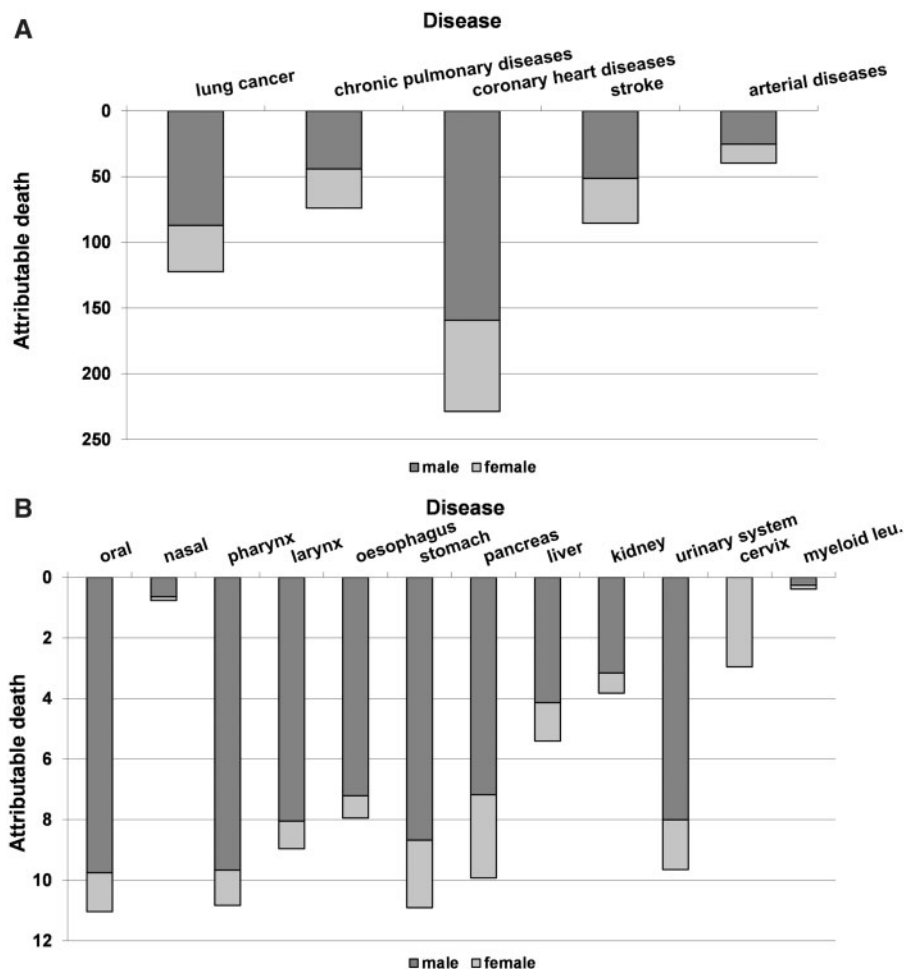


Figure 1 The reduction in attributable death of high-burden (A) and other diseases (B) caused by the predicted decrease in the prevalence of active smoking, expected within two decades after the introduction of the full smoking ban in closed public places in Hungary

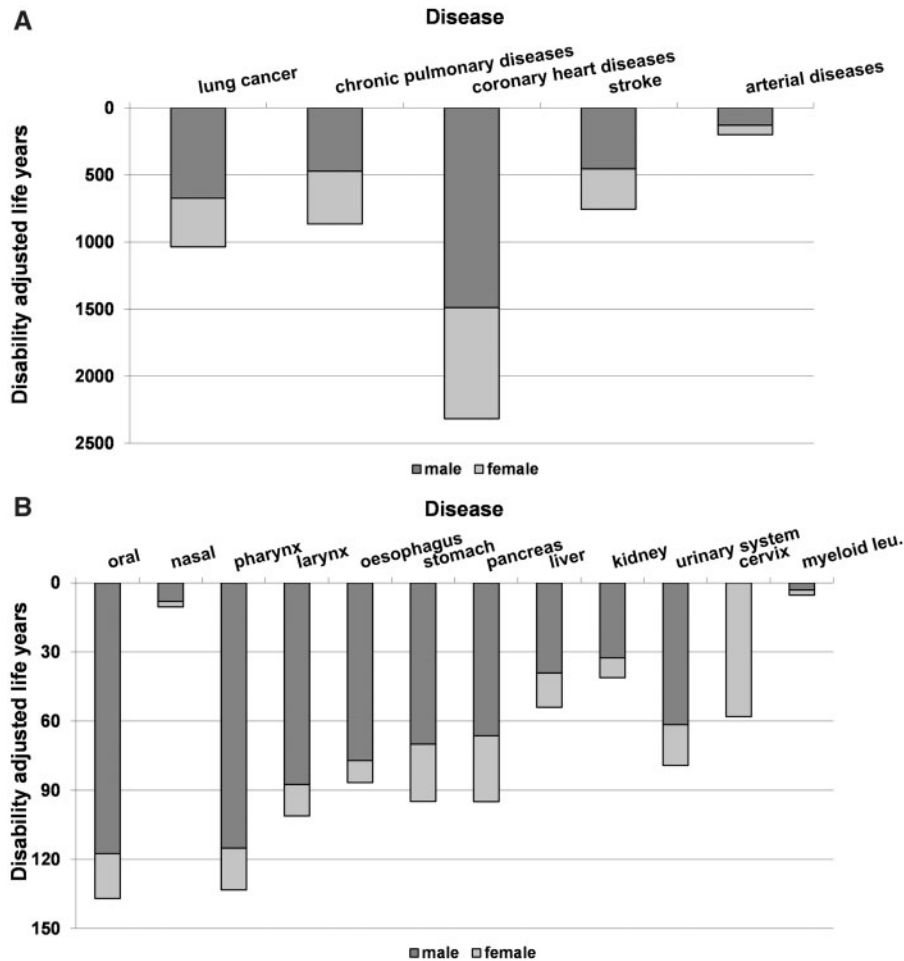


Figure 2 The reduction in DALYs of high-burden (A) and other diseases (B) caused by the predicted decrease in the prevalence of active smoking, expected within two decades after the introduction of the full smoking ban in closed public places in Hungary

DALY (table 1). The policy effect on exposure shows a limited impact towards the lower limit and a larger influence on the upper limit that reflects the conservative nature of our point estimates. The highest uncertainty is related to the association measures that have around 40% impact on either side, while the uncertainty of the exposure estimates has a smaller contribution to the uncertainty of the outcome, especially on the lower limit.

Discussion

Our results revealed a sizable disease burden of active and passive smoking in Hungary. There are very few studies that quantitatively assess smoking-related burden in the country, and those that exist typically analyse only mortality data and related expenses. The GKI Economic Research Institute calculated 123 538 lost years of life due to active smoking for 1998.³⁴ We estimated a similar disease burden in 2006 when 118 155 life years were lost in Hungary as a consequence of early deaths due to selected smoking-related diseases. The benefit of the prohibition of smoking in public places calculated only for the quantifiable health outcomes was found to be close to 1700 deaths postponed and 16 000 life years saved annually in the long term in Hungary, for which decreasing ETS exposure has a stronger contribution than the reduction in smoking prevalence. The size of the effect is larger among males than among females.

Observations from other countries were used to estimate exposure change; although limitations in extrapolating data from one society to another must be acknowledged. Professional consensus on the information sources used in the model was reached via two

principal considerations: cultural similarities between societies and precaution, i.e. giving greater weight to lower reductions in exposure levels reported by various sources. This intention is justified by the sensitivity analysis that indicates a small negative influence of the inputted policy effect size on the output measures of the impact assessment.

The findings in this study are comparable to those in the literature that examine the short-term effects of smoking restrictions on acute circulatory events. Meyers *et al.*³⁵ conducted a systematic review and meta-analysis of studies dealing with decreased hospital admissions for acute myocardial infarction (AMI) after the introduction of a smoking ban. The authors found 11 reports from 10 study locations and concluded that there was a 17% overall risk reduction. Significant improvement of respiratory and sensory symptoms was similarly observed among hospitality workers in Scotland and elsewhere.³⁶ Unfortunately, there has not yet been substantial evidence to make comparisons of the other chronic health effects analysed in this article.

Tobacco control policies impact the genders differently. Policy measures can have dissimilar influence on the genders as seen in the school-based prevention of substance misuse, or in the taxation of tobacco products.^{37,38} Other determinants of sex-specific impact are the differing exposure patterns, age-specific morbidity and mortality rates and strengths of association between exposures and outcomes. Our results revealed gender differences in the impact of the analysed Hungarian smoking ban, too. The absolute size of effect was found larger in males than in females (1031 vs. 654 attributable deaths and 9939 vs. 6047 DALYs, respectively) but the rate of

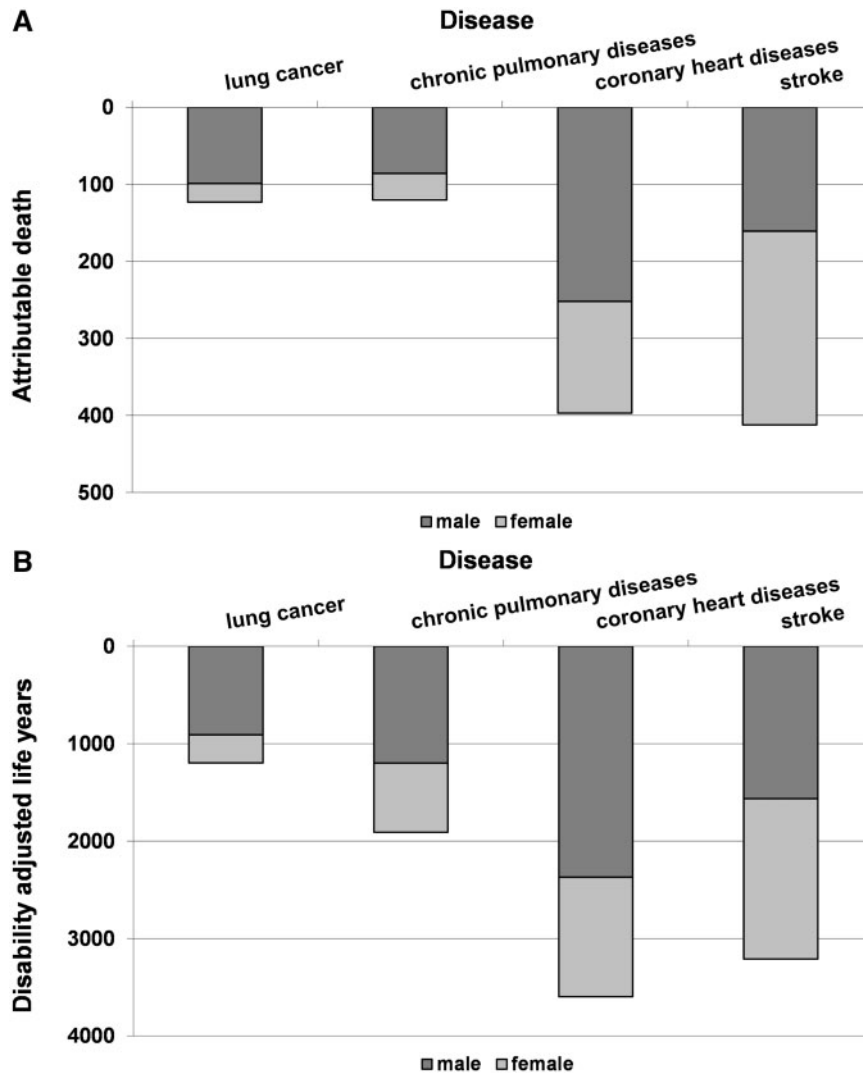


Figure 3 The reduction in attributable death (A) and DALYs (B) caused by the predicted decrease in the prevalence of ETS exposure in hospitality venues, at workplaces and in households, expected within two decades after the introduction of the full smoking ban in closed public places in Hungary

Table 1 Sensitivity analysis of the predicted health impact of the prohibition of smoking in closed public places in Hungary

Input parameters	Attributable death (%)	DALYs (%)
Three percent discounting, no age-weighting		137
No discounting and age-weighting		169
Policy effect on exposure		
Lower limit	91	92
Upper limit	134	136
Association measure		
Lower limit	63	63
Upper limit	146	145
Exposure prevalence		
Lower limit	82	84
Upper limit	143	126

Alternative results are expressed as the percentage of the corresponding point estimate

reduction was more pronounced in females than in males (13.5 vs. 8.5% decrease in attributable deaths and 10.1 vs. 8.3% in DALYs, respectively).

The burden of disease model applied in this study has an essentially static nature assuming a baseline scenario with constant

exposure rates and ignored long-term health effects of past changes in smoking. It is unable to follow the health impact over time; however, observations made by Kabir *et al.*³⁹ indicate that there is a 20- to 30-year time lag between the reduction of tobacco consumption due to the introduction of anti-smoking policies and the observed effects on lung cancer outcomes. Therefore, the predictions of this study can be expected to occur in ~15–20 years, taking into consideration the more rapid effects on non-neoplastic diseases, too. A dynamic model could simulate the effects of past exposure trends. The DYNAMO-HIA software, which was published after the completion of this study, provides a promising tool for dynamic modelling.⁴⁰

Quantitative estimates are favoured by decision makers, in spite of the disadvantages, such as hiding complexity, the potential for double counting, obscured uncertainty and the limited possibility of a participatory approach. The effective assistance of the political process promotes the integration of HIA with quantitative predictions in political decision making. The presented HIA has also been welcomed by policy makers but was not acted upon due to the approaching parliamentary elections in 2010. The new government revived the issue and the amendment of the policy was adopted in 2011. Despite the uncertainties regarding the extrapolation of policy effect size on exposure levels from one society to another, the

estimation of the average duration lived with a disease in a DisMod model, as well as the limitations of the static model as mentioned above, the presented methodology offers a practical approach for a quantitative risk appraisal in the HIA.

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Conflicts of interest: None declared.

Key points

- This article presents an example for how to use epidemiological evidence and empirical information to quantitatively assess the impact of the recently approved Hungarian smoke-free policy on a broad range of health outcomes for which quantification is feasible.
- The long term health benefit of the prohibition of smoking in closed public places is significant in Hungary. The effect of decreasing ETS exposure is larger than that induced by the reduction in the prevalence of active smoking. The absolute impact is higher among males than among females.
- The integration of a quantitative assessment in the process of a HIA allows for numerical predictions that effectively assist the bargaining process and thus facilitate the use of HIA results in political decision making.

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Health impact of motorised trips that could be replaced by walking

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Background: We aimed to quantify the number of women and men, in Catalonia, among those not achieving physical activity recommendations, making short motorized trips which could have been made on foot, and to estimate the annual economic benefit due to reducing mortality as a result of replacing one short, daily, motorized journey with walking. **Methods:** Cross-sectional study. Mobility data came from individuals >17 years who reported, in the 2006 Daily Mobility Survey, having travelled on the referred working day ($N=80\,552$). The health economic assessment tool for walking (HEAT) from the World Health Organization (WHO) Regional Office for Europe was used to calculate the economic benefit. **Results:** Of those not meeting recommendations, 15.6% of men (95% CI 15.2–16.1) and 13.9% of women (95% CI 13.5–14.4) would go on to meet them if they were to replace at least one short motorized trip per day by walking. If applied to the entire population of Catalonia, this change would increase up to 326 557 men (95% CI 313 373–339 740) and up to 252 509 women (95% CI 240 855–264 163) who would achieve recommendations through walking rather than driving. According to HEAT estimations, this would suppose a saving of €124 216 000 (95% CI 120 182 000–128 250 000) in men and €84 927 000 (95% CI 81 774 000–88 079 000) in women, derived from the reduction in mortality gained from walking accumulated over one year. **Conclusion:** This study demonstrates the potential of trips on foot as a source of physical activity. It also points out that both benefits for the health of the population and a huge economic benefit could have been gained through active transportation interventions.

Introduction

There is evidence that a sedentary lifestyle contributes to the decline in health at different levels¹ and that physical activity is essential to maintain good health.^{2,3} Moreover, the World Health Organization (WHO), through the Global Strategy on Diet, Physical Activity and Health, concluded in 2004,⁴ and confirmed in 2010, that at least 150 minutes of moderate-intensity aerobic physical activity undertaken throughout the week is sufficient in adults, aged 18–65 years.⁵

Walking as a means of transport is considered a moderate physical activity, suitable for achieving recommended activity levels. Despite its numerous reported health benefits⁶ walking has mainly

been studied as a leisure time activity, while most studies of mobility conducted in Spain or Europe have been undertaken by the transport sector,^{7–9} with the aim of planning motorized transport.

However, in recent years strategies attempting to integrate active transport into daily life have gathered force in many countries, promoted by the global strategies developed by the WHO,¹⁰ or the Centers for Disease Control and Prevention (CDC).¹¹ Promotion of the use of active transport is seen as a tool to combat the trend of increasing sedentarism in the population.¹² This has also been proposed by the new WHO Action Plan for the implementation of the European Strategy for the Prevention of Noncommunicable Diseases 2012/2016,¹³ which identifies the promotion of