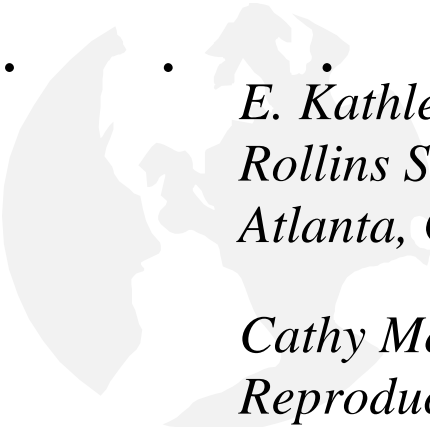




Background Paper

The Costs of Environmental Tobacco Smoke (ETS): An International Review



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Introduction

Identifying the magnitude of smoking attributable costs occurring in either the short or long run is valuable from several perspectives. The magnitude of external costs, costs to society more broadly, is needed to evaluate appropriate rates of cigarette taxation if the goal of taxation is to cover these social costs. Estimates of internal costs, or costs incurred by individuals and families, are informative to employers who self-insure, insurance companies or managed care organizations which now care for so many Americans. The magnitude of smoking attributable costs is also important for the management of public programs and meeting health care goals. For example, the publicly financed Medicaid program in the US now covers a larger proportion of pregnant women and children, while abroad, the financing of health care for women and children as well as others, is more generally public in nature. Finally, discerning the costs of conditions affected by smoking are important for evaluating the cost-effectiveness of smoking cessation programs in either domestic or foreign settings.

While some research indicates that the external costs of smoking are covered by current levels of excise taxes on cigarettes in the United States, a comprehensive review of this issue notes that far more information is needed on the costs related to environmental tobacco smoke (ETS). Costs from active smoke exposure for the unborn fetus and young children are likely a major portion of the total costs of ETS and some argue that the “protection of children constitutes the strongest argument favoring increased taxation of cigarettes” (Warner et al., 1995). There is also growing evidence that ETS increases the probability of adverse health outcomes for adults, exposed either in the home or working environment. Finally, there are effects of ETS in terms of maintenance of buildings and nuisance effects from exposure in public places. The goal of this paper is to pull together studies which provide estimates of the magnitude of smoking attributable ETS costs whether for adults, infants or children, domestically or abroad.

This paper is part of the World Health Organization’s (WHO) consultation meeting on ETS and child health held from 11-14 January in Geneva, Switzerland. The goal of this meeting is synthesize and share the latest information on the health and other effects of ETS; the goal of this paper is to bring to this effort information on the economic costs of ETS. In this paper we assume that involuntary smoking occurs when nonsmokers are exposed to tobacco combustion products in the indoor environment. This can occur as *non smoking* adults or children are exposed to smoke via mainstream smoke exhaled by the smoker or side stream smoke emitted by the burning tip of the cigarette in the home or elsewhere. The fetus is exposed directly through the linking of the maternal and infant circulatory systems and the infant can be further exposed through nursing. While maternal smoking during pregnancy is generally considered *active* rather than *passive* smoke exposure, studies of the costs of smoking at birth reviewed here only give estimates related to active smoking. We were, however, able to review some studies which estimated true ETS costs for adults and children.

The remainder of this paper is divided into three sections. The first provides background on the adverse effects of smoking, especially as they pertain to ETS, and on efforts at estimating smoking attributable costs. The next section discusses those studies summarized in Tables 1 and 2, that address, at least to some degree, the economic costs of ETS. In the third and final section we discuss the major differences across studies and the implications of these differences for their usefulness in formulating policy. We also note the major gaps in information that remain.

Background

The more general literature on the effects of active smoking has focused on morbidity in the overall population and on health outcomes (e.g. heart disease, cancer, etc.) which occur over a lifetime. Each year, smoking causes more than 140,000 deaths among women in the U.S. (Husten et al., 1996). The leading smoking related diseases include lung cancer, stroke and cardiovascular diseases (CDC, 1990; USDHHS, 1990). With respect to non-chronic conditions, numerous studies have shown a positive relationship between smoking and adverse maternal outcomes. These outcomes include spontaneous abortion, placental complications, preterm premature rupture of the membrane, and ectopic pregnancy (DiFranza and Lew, 1995; Castles et al., 1998). These conditions make delivery more complicated and more costly (Adams and Melvin, 1998). On the other hand, smoking has been found to be protective against pre-eclampsia (Klonoff-Cohen, Edelstein and Savitz, 1993; Sibai et al., 1995), thereby reducing expected maternal costs.

The effects of ETS on the general population are still debated (Gravelle and Zimmerman, 1994; Viscusi, 1995) but the effects of active smoking on the unborn fetus and ETS for young children are

better established. It is well known, for example, that cigarette smoke is associated with intrauterine growth retardation (IUGR). Studies have consistently shown that women who smoke during pregnancy have infants that are smaller at each gestational age than infants born to nonsmokers (Bakketeig et al., 1993; Cnattingius, 1989). Low birthweight infants are more likely to need neonatal intensive care at delivery and to have related health problems in their infancy and beyond. The British National Child Development Study revealed poorer performance in reading and math in children prenatally exposed to maternal smoking after controlling for gender, social class, maternal age and family size.

The effects of true ETS on infants, or the effects for non-smoking mothers exposed to smoke, has also been studied. The Australian government has pulled together extensive international data from studies on the effects of passive ETS exposure for pregnant women and its effects on birth outcomes (NHMRC, 1997). Numerous studies indicate there is a modest effect on birthweight after adjusting for confounders although some do not report statistical significance (Eskanazi et al., 1995; Mathai et al., 1992; Martinez et al., 1994; Zhang and Ratcliffe, 1993). The studies also vary in their ability to separate out the effects of direct versus ETS exposure during pregnancy. One multi-year study of data from the U.S. found a statistically significant effect of ETS on birthweight (OR = 2.42) and pre-term delivery (OR = 1.88) but only for smokers ages 30 or older (Ahluwalia et al., 1997).

In addition, maternal active smoking has strongly associated with the probability of Sudden Infant Death Syndrome (SIDS) (DiFranza and Lew, 1995; Schoendorf, 1992; Scragg, 1993) and ETS with respiratory illness in children (Stoddard and Miller, 1995). Studies have also established a relationship between ETS and SIDS for non-smoking mothers. One U.S. study established that there is an increased risk of SIDS due to ETS from fathers and live-in-adults for non-smoking mothers. This study also found an increase in the risk of SIDS for those infants whose mothers did not smoke during pregnancy but who exposed their infants after birth (Klonoff-Cohen et al., 1995).

The effects of ETS on the health of children were recently summarized by the California Environmental Protection Agency (CEPA). Drawing from numerous epidemiological and clinical studies CEPA concluded that the respiratory effects of passive smoke for children resulted in a significant number of attributable cases of middle ear infection, new and exacerbated cases of asthma among children and bronchitis or pneumonia among infants and toddlers under 18 months of age (CEPA, 1997). This study also estimated 9,700-18,600 smoking attributable cases of low birthweight developmental effects and 1,900 to 2,700 deaths from SIDS annually in the US. A recent study of US data found the odds of having asthma/wheezing or lower respiratory illnesses was higher (136) for children whose mothers smoked; the authors estimated approximately 380,000 excess cases of these conditions in 1987 (Stoddard and Miller, 1995). Studies in Finland and Poland (Jaakkola et al., 1996; Jedrychowski and Flak, 1997) are two examples of studies with similar findings regarding the effects of ETS on young children. An international review of studies of ETS on childhood outcomes is also available from the Australian government (NHMRC, 1997).

Efforts at estimating the costs of active smoking have generally focused on the overall population and long-run costs (Manning et al., 1989; Viscusi, 1994; Bartlett, et al., 1994; Shultz, et al., 1991). The Shultz et al. study presents the CDC Smoking Mortality, Morbidity and Economic Costs (SAMMEC) model which can be used to estimate smoking attributable deaths from chronic conditions as well as infant mortality. CDC used this model to report smoking attributable deaths including infant deaths, estimated burn deaths from injury surveillance data and used EPA estimates for lung cancer deaths related to ETS (CDC, 1993).

Studies of smoking attributable costs in the US have generally estimated the excess costs of health care for smokers and the economic value of lost productivity. Two major studies, the Manning et al. (1989) study and Bartlett et al. (1994) have both estimated health care costs per pack. The former study's estimate is \$0.38 per pack for the costs of adult, chronic conditions in 1986 (discounted) dollars while the latter's is \$2.06 per pack in 1993 dollars (Bartlett et al., 1994). These more recent estimates differ from those of Manning et al. (1989) in that they are a real-time estimate of the annual smoking attributable excess in direct medical expenditures as opposed to an estimate of life-time costs to society, balanced by the savings from the premature death of smokers. The primary difference, however, is that the Bartlett et al. estimates include both internal and external health care costs while the other includes only external health care costs. The Manning et al. work can be used to derive internal and external costs for medical expenditures, lost productivity due to illness, years of productive life lost and costs from fires;

this is estimated at \$2.53 in 1995 dollars (Gravelle and Zimmerman, 1994), much closer to the Bartlett et al. estimate.

A shortcoming of both of the above studies is that they omit the perinatal health care costs for low-birthweight infants related to active smoking exposure in utero. They also generally omit ETS costs for children and adults. This type of information, as noted, is informative to managed care organizations that want to serve women, infants and children in a less costly manner and by organizations concerned with the promotion of health and general reduction of health care costs. This is especially true in the US as we use managed care to control program expenses for the expanded number of pregnant women now eligible under Medicaid programs. While economists argue that those who smoke make conscious decisions about the internal costs incurred for themselves and their spouses, smokers generally start during their teen years perhaps without full information on its future addictive and health effects. There may also be a tendency for them to discount the future heavily. Further, smoking during pregnancy imposes this decision on the unborn fetus. The consequences of this decision are borne by the infant and potentially, society, through the costs of infant mortality and the short and long-term effects of low birthweight and other effects of smoking on the infant. These adverse effects of ETS on the fetus and child likely result in significant costs both domestically and abroad.

Studies of ETS Costs

There have been relatively few studies of the economic costs of ETS either in the US or abroad. Those that have provided some type of cost estimate, whether for one or several components of all ETS related costs, are summarized in Tables 1 and 2. Those in Table 1 are based on US data while those in Table 2 are from other countries. The major categories of costs addressed by these studies are listed in the first column; the EPA and Viscusi studies have been highlighted in Table 1 since the EPA study is the most comprehensive US study and the Viscusi study provides revised estimates of the EPA adult mortality costs. Where possible, the numbers have been adjusted, either for exchange rates or inflation, in order to compare across studies.

Although adjusting for inflation does not capture the effects of other changes over time (e.g. lower tar in cigarettes, lower prevalence of smoking, changes in the technology and methods of delivering health care services, etc.) it does allow us to make some comparison across the various studies. We use the medical component of the CPI to update morbidity costs and the overall CPI for other components of ETS costs with the exception of the EPA study. Since this study uses a willingness to pay method to value morbidity costs we use the overall CPI to update their estimates of morbidity costs.

In addition to the studies summarized in the tables, there are several studies which have shown an association between ETS exposure and the use of health care services (Cunningham et al., 1996; Chen, Li and Yu, 1986; Weiss et al., 1983; Harlap and Davies, 1974). The Cunningham study, for example, found an odds ratio of 1.7 for emergency room use among US and Canadian children while the Chen, Li and Yu study reported an odds ratio of 1.8 for admission for respiratory illness in Shanghai. An extensive review of the effects of ETS for children was completed, as noted, by the CEPA; this review summarized numerous studies and estimated that there are 0.7 to 1.6 million physician office visits for middle ear infections attributable to ETS among children and 7,500 to 15,000 hospitalizations for bronchitis or pneumonia in infants and toddlers annually in the US. These smoking attributable health care services have direct implications for health care costs.

Studies of ETS Costs in the US

Those US studies (Table 1) which provide estimates of ETS costs include those which are comprehensive in terms of the types of ETS costs analyzed (EPA, 1994) as well as those which provide only one piece of information related to ETS (Manning et al., 1990). The EPA study, as many other studies of smoking attributable costs, omits the maternal/infant and childhood costs that we consider perhaps the most important part of ETS costs. Several studies summarized in Tables 1 and 2, however, directly address these costs (Adams et al., 1997; Aligne and Stoddard, 1997; Marks et al., 1990; Stoddard and Gray, 1997; Foulds and Godfrey, 1995).

In an early study of the smoking attributable costs accruing to business, Kristein (1983) estimates that smokers impose \$53 to \$109 (updated to 1997 dollars) per involuntary smoker for costs such as absenteeism, accident and productivity impacts annually. This study is based on older data and methods, however, and the study's focus is not explicitly on measuring ETS costs. Gravelle and Zimmerman (1994) also provide rough estimates of the costs of passive smoke, building largely on the results presented by Manning et al., as high as \$.21 per pack in 1995 dollars. This latter estimate is based on willingness to pay and hence, is higher than those based on other approaches. The Gravelle and Zimmerman calculations also omit maternal and perinatal costs, however.

The most comprehensive US study addressing ETS costs is the 1994 EPA study by Mudarri (highlighted in grey in Table 1). This study provides estimates for the ETS costs related to adult mortality, childhood asthma, absenteeism and building maintenance that could be saved with the implementation of building restrictions in the Smoke Free Environment Act of 1993. While the EPA measures are based primarily on assumed reductions in ETS exposure in the non-home environment, assumptions are also made about the effect of quitting in the non-home environment on ETS exposure in the home.

The smoking attributable mortality costs from ETS estimated in the EPA study relate to lung cancer and heart disease only. The 1990 discounted dollars reported ranged from \$39 to \$71 billion; updated to 1997 dollars this range is \$48 to \$87 billion. This measure is an estimate of the annual costs of premature mortality discounted at 3% and under the baseline assumption that there were no building restrictions in place which would reduce these costs from smoking at the 1990 prevalence levels. There is also an assumed net effect of quitting, and reduced initiation is an average annual reduction between 4.2% and 8.5% in the smoking population. Viscusi (also highlighted in grey in Table 1) criticizes this estimate of the costs of premature mortality costs and makes adjustments for changes in the tar level of cigarettes over time, the assumed current exposure at work and inconsistencies in the relative risk estimate for lung cancer made by EPA and OSHA (Viscusi, 1995). Viscusi provides several sets of alternative estimates. Those closest to the EPA conceptually are provided in Table 1; other estimates of ETS costs in the Viscusi are markedly lower. Only the high end of Viscusi's estimates for the cost of adult mortality related to ETS approach those of the EPA.

The EPA study also provides estimates of ETS morbidity costs related to childhood conditions, property and loss of life due to fires. These are shown in Table 1. This study provides an estimate for the morbidity costs associated with cases of lower respiratory tract infections, ear infections and asthma related to ETS; most of the \$3.3 to \$8 billion estimate is related to the avoidance of asthma, a chronic condition that severely alters the life of a child. The EPA dollar estimates are based on a willingness to pay measure since using medical costs alone would underestimate the economic value that individuals and society place on avoiding such outcomes (EPA, 1994). This is illustrated by the lower dollar estimates of smoking attributable health care cost related to asthma and other conditions put forth by Aligne and Stoddard (1997) and Stoddard and Gray (1997). These estimates range from \$703 million for all respiratory conditions for children under six to \$897 million for a similar set of conditions but broader age group; the main difference between these two studies is the use of an attributable risk approach in the first and a multivariate analysis of the National Medical Expenditure Survey (NMES) in the latter.

The EPA study also provides an estimate of the dollar costs associated with property loss, injury and death due to smoke related fires in the non-home environment; these are estimated to be between \$ 7 and \$1.1 billion in 1997 dollars. The Manning et al. study which otherwise largely omits ETS costs, provides an estimate of property loss at home of over \$600 million in 1997 dollars. The Manning et al. study presents these household fire costs as external costs due to fire insurance whereas they treat the costs of premature death of family members related to ETS as internal costs. Most economists argue that the smoker makes decision on behalf of not only themselves but also on behalf of other family members, thereby "internalizing" the costs/benefits of their actions. These authors do note that if an estimated 2400 lung cancer deaths caused by passive smoke in the home are considered external, their estimates of external costs per pack would rise by \$0.14 (Manning et al., 1989).

The remaining cost estimates presented in Table 1 focus on infants and children. The cost estimates for infants are presented separately from those for children; recall that the former is largely reflective of active smoking by the mother while the latter is true ETS. These studies (Adams, et al., 1997; Aligne and Stoddard, 1997 and Marks, et al., 1990) also differ in the methods used. The Aligne and Stoddard and Marks et al. studies use an attributable risk approach whereas Adams et al. uses a

multivariate analysis to estimate smoking attributable costs. Yet, the estimates across these studies are rather consistent when expressed in 1997 dollars. Marks et al. estimates smoking attributable Neonatal Intensive Care Unit (NICU) costs of \$998 million while the Aligne and Stoddard estimate of these costs is \$1.4 billion. The Adams et al. study is based on a multivariate analysis of the NMES and includes not only smoking attributable costs from active smoking by the mother for the infant but maternal costs before and at delivery as well. All of these costs are estimated at \$1.5-\$2.1 billion in 1997 dollars.

The Aligne and Stoddard study also provides an estimate of the value of loss of life due to low birthweight and Sudden Infant Death Syndrome (SIDS) for infants and asthma deaths among children; based on \$1.3 million per child their estimate is \$7.1 billion for infants and \$2.1 billion for children (discounted 1993 dollars updated to 1997). Again, these indirect costs for lost infant lives are largely reflective of active smoking by the mother. The Marks et al. study also provides a component of costs not estimated by other studies. These are the costs related to the services needed to deal with the long term effects of low birth weight (e.g. special medical and educational services) believed to be related to active smoking during pregnancy. The estimate used by Marks et al. is a discounted dollar figure for the incremental costs of services needed from ages 1 to 35 by infants born of low birthweight; estimates of these costs were taken from earlier work done by the US Office of Technology Assessment (OTA, 1987). The dollar figure presented in Table 1 was derived from the data presented by Marks et al. and equals \$985 million (in 1997 dollars) for all smoking attributable low birthweight infants.

Studies of ETS Costs in Other Countries

In Table 2 we present estimates of some of the same components of ETS costs shown in Table 1 based on data from other countries. In general, there is not as much detail in these studies that is specific to the costs of ETS as we have defined it here. There are several studies that measure smoking attributable costs for smokers in other countries but give only a piece of information on costs specific to ETS. As in the US, most of the international studies of smoking attributable costs focus on the chronic conditions which affect the older age groups in these countries.

There has been a significant amount of work done on estimating smoking attributable risks and costs in Australia. The Winstanley, Woodward and Walker report (1995) summarizes this work. These authors refer to a key Australian study by Collins and Lapsley (1991). In the latter study, the authors estimate that approximately 10% of the direct costs of tobacco abuse are related to passive smoke, or ETS. Collins and Lapsley report a total smoking attributable cost, both tangible and intangible, in Australia equal to \$9.2 billion in 1992 (Winstanley, Woodward and Walker, 1995); they do not provide a breakdown of these costs into direct and indirect although intangible costs are \$8.6 billion of the total. A more recent study by Collins and Lapsley (1996) reports \$1.1 billion in health care costs in 1992 US dollars. Using the 10% rule stated by Collins and Lapsley and updating to 1997 US dollars, this would result in approximately \$135 million in health care costs due to passive smoke in Australia. This more recent report by these authors, however, does not discuss the use of the 10% rule to estimate these costs and states that these costs will be estimated when epidemiological research on passive smoking is completed.

This 10% approximation for the costs related to ETS is also used in the study of smoking attributable morbidity costs in New South Wales (Doran and Sanson-Fisher, 1996). This study estimates the publicly funded portion of a wide range of costs attributable to smoking (health care, absenteeism, some portion of the costs related to premature death, tobacco assistance by the government, and anti smoking campaigns) and reports ETS costs equal to 10% of selected components of direct costs (health care costs, anti smoking campaigns and tobacco assistance to industry). All direct costs equaled \$468.57 million in 1989-90 with \$42.6 million of this estimated to be due to ETS; when these dollars are converted and updated to 1997 US dollars the ETS costs equal \$50.5 million. Neither this study nor the Collins and Lapsley study, however, appear to include ETS costs related to the infant and child.

There are three studies reported in Table 2, however, which do provide estimates of ETS costs for infants/children (Forbes and Thompson, 1983; Foulds and Godfrey, 1995; Peters et al., 1998). Forbes and Thompson estimate the costs for smokers in Canada using a simulation approach. This study uses information on attributable risk and per capita health care expenses to simulate health care expenses for the total and a hypothetical non-smoking population; they attribute the difference in these amounts to the smoking portion of the population. This simulation is done for newborns and ages 0-4, 5-14, 15-24, 25-64 and 65+. We include in Table 2 the difference in costs presented by these authors for

newborns/infants as costs related to active smoking and the 0-4 plus 5-14 as ETS costs for children. The first is equal to \$8.4 million expressed in 1997 US dollars and the latter equals \$239.5 million.

The Foulds and Godfrey study reports “extra” health care costs for children whose parents smoke as 149 million Pounds (£) in 1992; their reference for this estimate is a study completed by the London Health Education Authority (LHEA) (1995). This original study reports an estimated cost of 143 million Pounds (£). The LHEA uses survey data on the use of health services by children exposed to passive smoking versus those not; they observed higher use of GP visits, prescription drugs, outpatient visits and inpatient episodes. The difference in use of services was costed out using averages of the costs of these services in the National Health System (NHS). In 1997 US dollars this estimate of ETS for English children equals \$278 million.

The Peters et al. study is based on children ages 8-13 in two school districts of Hong Kong. This study uses an estimate of the excess risk for cough, phlegm, and wheezing among those children exposed to ETS. Odds ratios adjusted for age, sex, school district, father’s education and type of housing were significantly related to ETS exposure. Although this study considers the costs of the doctor’s visit, lost work time and travel costs, they also present annual cost estimates based on only the costs of doctor’s care. Their estimates range from \$447 million for the costs of doctor’s visits only to \$1.3 billion for the costs of the visit, lost work time and travel costs.

The Kaiserman study uses the CDC Smoking Attributable Mortality, Morbidity and Economic Costs (SAMMEC) model, with some modifications, to estimate smoking attributable costs in Canada; this model has been used nationally and in many of the US states to estimate smoking attributable costs. This model is prevalence-based and provides the user with an estimate of excess mortality and morbidity for chronic conditions. It does omit, however, the morbidity related to perinatal and ETS related outcomes. The total Canadian estimate derived from this model was \$15 billion in 1991 Canadian dollars, \$80 million of which was related to damage from fires. The latter was imputed directly from Canadian data sources and equals \$81.5 million when converted to US dollars and updated to 1997 using the overall US CPI. As noted earlier, the costs of fires could be considered internal or external depending on whether the smoker takes into account the welfare of the household when deciding to smoke; if the fires occur in non residential settings they are more clearly external costs. Kaiserman reports a value of lost property for forest fires (\$22 million) and residential fires (\$58 million) in Canada in 1991.

Prevalence of ETS in the US and Abroad

One of the major differences across the cost studies presented here is the prevalence of smoking in the population studied. Prevalence rates are directly related to the level of smoking attributable costs. While smoking rates may be declining in general they are rising among certain subpopulations and they vary markedly internationally. To help gauge the variation in ETS exposure, we need information on the prevalence of smoking during pregnancy in the US and abroad as well as data on the proportion of children exposed to ETS in their homes or other environments. We also need to be aware of what countries are doing to reduce the ETS exposure in the work and other public environments. We review available information for several key countries.

In Sweden, smoking prevalence is among the lowest in Europe, 22% for males and 24% for females in 1994, and has declined since 1980. However, in 1994 smoking among girls aged 15-16 rose to 27% from the previous year. In Canada, a 1994 national survey reported the overall prevalence of smoking unchanged since 1991 and equal to 29% among females and 31% among males. As in most other countries, smoking prevalence was lowest among those with the highest education. Pertinent to our focus on ETS, the 1990 Ontario Health Status Survey was used to estimate that 14% of pregnant women reported they were daily smokers and 1.8% were occasional smokers (Edwards, et al., 1996). Yet, smoking during pregnancy is on the decline in this country. Canada has comprehensive laws aimed at tobacco control and smoking. All forms of direct advertising are banned and health warnings are among the most direct and prominent anywhere.

The percent of women smoking during pregnancy in Canada, 14-16%, appears quite close to the US estimate for 1996 of 13.6% (USDHHS, 1998). This estimate is derived from the self-reported data on US birth certificates and is lower than estimates reported in other national surveys; these range from 20-23% in recent data. Smoking during pregnancy is also on the decline in the US but with an important exception. Smoking among pregnant teenagers increased in 1996 particularly among those 15-17 years of age (USDHHS, 1998). Increases were also particularly large for Mexican, Puerto Rican and non-Hispanic black teenagers.

In contrast to these countries, it appears that smoking among all pregnant women is increasing in France. The French National Perinatal Surveys reveal a continuous increase in the percentage of women smoking during pregnancy as is occurring in the general population of French women. The percentage smoking during pregnancy has increased from 10% in 1972 to 17% in 1981, reaching 25% in 1995. Of those French women smoking during pregnancy, 27% consumed less than 5 cigarettes a day while 43% smoked at least 10 cigarettes daily. Those pregnant and smoking less than 5 cigarettes in the US was comparable, equal to 26.2% in 1996.

Data from Australia on smoking during pregnancy were not available but reports from the Australian government do provide significant information on ETS exposure (NHMRC, 1997). The data in this report on non-smoking women of childbearing age (20-44), indicate that from 9% to almost 20% have spouses who smoke. For males in this age range, the percentages are smaller, equal to almost 2% to 11%. This report also provides important detail on the exposure to ETS of children under 15 years of age. Overall, 43.4% of Australian children in this age range have one or both parents who smoke. Maternal smoking is reported for 27% of these Australian children and both parents are reported to smoke for 13%. Figures for children in the US show a comparable overall percentage, 38%, with exposure to ETS in the home.

Finally, there are alarming data in some countries on the prevalence of smoking among children themselves. In the US, approximately 22% of high school seniors in 1996 report smoking regularly, showing an increase from 1986; these data are based on the University of Michigan's Monitoring the Future Project. The CDC Youth Risk Behavior and Surveillance System indicates that 31% of 9th graders and 38% of 12th graders smoked at some time in the past 30 days. In Great Britain, while there has been a decrease overall in the prevalence of smoking, smoking among those 11 to 15 years of age has remained more or less stable. A 1994 survey of 11 to 15 year olds in England showed that 10% of boys and 13% of girls smoked at least one cigarette per week. A 1993/94 WHO study of 15 year olds found that 21% of boys and 26% of girls in Scotland smoked at least weekly as did 18% of boys and 26% of girls in Wales. These latter figures are close to those reported for high school seniors in the US in 1996. These patterns indicate there are continuing new cohorts of smokers in the US and abroad who are exposing themselves and others to the adverse effects of smoking.

The countries with ETS cost estimates differ not only in terms of prevalence but numbers of packs and cigarettes smoked as well as the content of each cigarette. Standardization on some measure would allow us to more readily compare the cost estimates. A simple metric to use is the size of the child population.

We used population estimates for the countries represented in Tables 1 and 2 to derive the costs per child under age 15; we used only those morbidity estimates related to true ETS or those presented for children, not infants, in the tables. Based on Aligne and Stoddard, the US costs for ETS are approximately \$15 per child while those estimated for the UK were around \$24 per child under 15. The Forbes and Thompson estimate for Canada results in a higher estimate of ETS costs per child, equal to \$39 per child under 15. The Australian estimates did not isolate costs for children and the Hong Kong estimates for ETS costs for children, even just inclusive of doctor visits, are many multiples of those for the US or other countries. Thus, while this standardization does make many of the estimates more comparable, there are others which remain quite high.

Discussion

While the studies reviewed here vary significantly in the methods used, they all present evidence of significant costs related to ETS exposure. In particular, they provide evidence that the costs of active smoking by mother and ETS for children are large in monetary terms in both the US and other countries. The studies do differ in terms of the scope of their analysis, the use of prevalence or incidence based measures, the use of attributable risk or other approaches to measuring smoking attributable costs, the

inclusion/exclusion of broader societal costs, as well as other study dimensions. These differences in the studies make it difficult to compare the studies directly but also have import for the relative usefulness of the results.

In deciding on the most useful approach to the measurement of costs, we must consider the ultimate application of the information. If the question is the appropriate level of excise taxation for reducing external costs, then the most appropriate measure is just those costs felt externally, or beyond the family unit. Manning et al. (1989) provides a summary of costs classified in this manner. Even if the policy application is the “correct” level of taxation, a large portion of ETS costs would be considered external costs although economists would generally argue that premature death for adult family members would be internal costs and ETS related outcomes for adults, especially in the nonhome environment, are still uncertain. We may use taxation to meet other goals, however. A recent meeting of economists on optimal cigarette taxation concluded that the usual free market assumption of informed rational choice may not apply to cigarette consumption among young people (Warner, 1995). Indeed, they concluded that protecting children constitutes the strongest argument favoring increased taxation of cigarettes in the USA.

If the final application of the information on ETS costs is to make broad-based societal policy, studies should take the societal perspective on costs, including both direct and indirect costs, and costs would ideally be based on willingness to pay in order to best reflect changes in consumer welfare; here losses in consumer surplus would need to be considered. The derivation of willingness to pay values for the wide range of conditions related to ETS would be a major undertaking however. Only the EPA study in the US takes the willingness to pay approach to costs and applies it to a wide range of ETS related costs. Yet, both the morbidity and morality costs related to active smoke exposure for the fetus are omitted from this study and the perspective of the study is limited to measuring the effects of a specific legislative change affecting primarily the non-home environment.

The viewpoint taken varies across the studies reviewed. If a societal view is taken, as noted, the study should include indirect costs such as loss of life. Premature loss of adult lives are a major part of the EPA cost estimates but only the Aligne and Stoddard study includes these estimates for the effects of ETS on children. Other studies in the US and abroad have taken a more narrow view in their presentation of ETS costs for children, measuring only smoking attributable health care costs. While the societal perspective is appropriate for broad-based cost benefit analyses, there are instances when we want to separate out certain sub components of costs. For example, as noted, for tax policy we would want to identify those which are truly external in nature recognizing that these will vary across countries and over time. In most industrialized countries, for example, far more of the nation’s health care expenses are publicly financed than they are in the US. While the US system is generally based on private financing, the publicly financed portion of maternal and child health, which is perhaps more affected by ETS, has increased significantly as the Medicaid program has continued to expand its eligibility criteria for pregnant women and children during the past decade.

A basic distinction in many of the studies of smoking attributable costs is the choice of a “prevalence-based” or an “incidence-based” model. In the first, the costs resulting from past and present smoke exposure are determined for a given year whereas authors using the “incidence-based” approach present the present value of the lifetime costs (e.g. Manning et al.) of cohorts of present smokers. The prevalence-based models reflect the historical exposure to smoke and hence, due to the long delay for chronic conditions may not reflect what will occur from current exposures. While the incidence-based approach is more useful for predicting the future effect of changes in current smoking patterns and is the only appropriate approach for corrective tax policy, this approach is very sensitive to as yet unknown changes in technology, demographic and medical treatment patterns. The distinction between these two approaches is less applicable, however, to the analysis of active smoking costs for the infant and ETS for the child as the effects are felt more immediately, rather than accumulating over long periods of time as with chronic conditions. Still, measuring the costs for infants and children must recognize current levels of exposure as well as current health care technology and prices.

In summary, the existing studies of the costs of ETS provide a broad range of methods and estimates of these costs. As a whole, the US studies provide an idea of the potential magnitude of these costs. However, estimates must be combined from an array of study years and analytic methods and are primarily based on older data. A major gap exists in that there is not consistent information on:

- costs based on current levels of ETS exposure in the home and non-home environment;
- health care costs based on current technology, practice patterns and prices;
- costs based on a current consensus of the relative risks for adult ETS;
- costs measured from the societal as well as alternative perspectives; and
- costs inclusive of the “nuisance” of ETS exposure.

These gaps are even more apparent for other countries. While had more difficulty finding and receiving studies which may exist for other countries, those which we reviewed did not provide information on the costs of mortality for adults and/or infants and children. While they did provide some measure of the morbidity costs in some countries these appear to omit perinatal costs. Much more work is needed to ascertain current estimates of the costs of ETS in countries where the exposure to ETS may be at a higher level currently and growing, instead of declining.

**Table 1: ESTIMATED COSTS OF ENVIRONMENTAL TOBACCO SMOKE (ETS) IN 1997 US DOLLARS
United States**

CATEGORIES OF COSTS	Adams, EK, Solanki, G and Miller, LS, <u>Morbidity and Mortality Weekly Review</u> , 46(44) November 7, 1997: 1048-1050.	Aligne CA and Stoddard JJ, <u>Archives of Pediatric Adolescent Medicine</u> , 151, July 1997: 648-653.	Manning, WG, Keeler EB, Newhouse, JP, Sloss EM and J Wasserman, <u>Journal of American Medical Association</u> , 261 (11), 1989: 1604-1609.	Marks, JS, Koplan, JP, Hogue CJR and Dalmat, ME, <u>American Journal of Preventive Medicine</u> , 6(5)1990:282-289.	Stoddard JJ and Gray B, <u>American Journal of Public Health</u> , 87(2), February 1997: 205-209.
	1997 Dollars	1997 Dollars	1997 Dollars	1997 Dollars	1997 Dollars
<u>Premature Death</u>					
Adults	--	--	--	--	--
Infants	--	\$7.1 billion*	--	--	--
Children	--	\$2.1 billion*	--	--	--
<u>Morbidity</u>					
Mother	\$1.5-2.1 billion** (mother/infant)	--	--	--	--
Infant	--	\$1.4 billion**	--	\$998 million **	--
Children	--	\$897 million**	--	--	\$703 million
Asthma	--	\$210 million**	--	--	**(<6yrs)
Other conditions	--	\$687 million**	--	--	--
<u>Productivity</u>					
Reduced work effort	--	--	--	--	--
Absenteeism	--	--	--	--	--
<u>Other</u>					
Fires	--	\$23 million **in morbidity and \$366 million *in premature death due to fires in above figures	\$498 million**** in property losses due to fires at home	--	--
Nuisance	--	--	--	--	--
Bldg./ Maintenance	--	--	--	--	--
Special Services (LBW)	--	--	--	\$985 million*****	--

- Monetary values determined based on willingness to pay for EPA (\$4.8 million for loss of life; \$1.5 million per case of asthma); based on combination of willingness to pay for child; based on wage-risk tradeoffs for Viscusi (\$5 million)
 - ** Monetary values determined based on health care costs
 - *** Monetary values determined based on lost wages/fringes for smokers—not really ETS costs.
 - **** Monetary values determined based on loss of property values, injury and death in nonresidential sites (EPA); based on loss of property value in residential sites
 - ***** Monetary values based on OTA (1987) study which estimated costs of special services ages 1-35 for conditions such as cerebral palsy, mental retardation etc.
- Note: All dollars expressed in 1997 dollars. The overall Consumer Price Index (CPI) was used to update willingness to pay, lost wages and other cost measures, etc.

**Table 2: ESTIMATED COSTS OF ENVIRONMENTAL TOBACCO SMOKE (ETS) IN 1997 US DOLLAR
Other Countries**

CATEGORIES OF COSTS	Collins,DJ and HM Lapsley,: Commonwealth Department of Human Services and Health, 1996.	Doran, CM and Sanson-Fisher, RW, <u>Australian and New Zealand Journal of Public Health</u> , 20(6) 1996.	Forbes, WF and Thompson, ME, <u>Canadian Journal of Public Health</u> , 74, 1983.	Godfrey, C, Raw, M, Sutton, M and Edwards, H, Health Education Authority, <u>The Smoking Epidemic</u> , 1993.	Kaiserman, MJ <u>Chronic Diseases Canada</u> , 18(1),
	Australian 1992 Dollars Converted and Updated to 1997 US Dollars	New South Wales 1989-90 Dollars Converted and Updated to 1997 US Dollars	Canadian 1980 Dollars Converted and Updated to 1997 Dollars	Great Britain 1992 Pounds Converted and Updated to 1997 US Dollars	Canadian 1992 Dollars Conv and Updated 1997 US Dollars
<u>Premature Death</u> Adults Infants Children	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
<u>Morbidity</u> Mother Infant Children Asthma Other conditions	Estimated \$135 million in health care costs due to passive smoke (10% of all smoking attributable health care costs)	\$50.5 million due to passive smoke*	-- \$8.4 million** \$239.5 million** -- --	-- -- \$267 million ** -- --	-- -- -- -- --
<u>Productivity</u> Reduced work effort Absenteeism	-- --	-- --	-- --	-- --	-- --
<u>Other</u> Fires Nuisance Bldg./ Maintenance Special Services (LBW)	-- -- -- --	-- -- -- --	-- -- -- --	-- -- -- --	\$81.5 million -- -- --

*Figured at 10% of all direct health care costs plus antismoking campaigns plus assistance to industry.

** Monetary values determined based on health care costs.

*** Estimate of \$1.3 billion includes health care costs, value of lost work time and travel costs.

****Costs included are extensive: productivity, monitoring and enforcement, litigation, fires, research and education, absenteeism, traffic accidents, morbidity and mortality.

References

- Adams, E.K. "Medical-Care Expenditures Attributable to Cigarette Smoking During Pregnancy - United States, 1995." *Morbidity and Mortality Weekly Report* 46 (43) (November 7, 1997): 1047-1050.
- Adams, E.K. and C. Melvin. "Estimates of Smoking Attributable Maternal Conditions Affected by Smoking During Pregnancy." *American Journal of Preventive Medicine* 15 (September 1998).
- Aligne, C.A. and J.J. Stoddard. "Tobacco and Children: An Economic Evaluation of the Medical Effects of Parental Smoking." *Archives of Pediatrics and Adolescent Medicine* 151 (July 1997): 648-53.
- Bakketeig, L.S., G. Jacobsen, H.J. Hoffman, G. Lindmark, P. Bergsjø, K. Molne and J. Odsten. "Pre-pregnancy Risk Factors of Small-for-Gestational Age Births Among Parous Women in Scandinavia." *Acta Obstetrica et Gynecologica Scandinavica*. 72(4) (1993): 273-9.
- Bartlett, J.C., L.S. Miller, D.P. Rice and W.B. Max. "Medical-care Expenditures Attributable to Cigarette Smoking—United States, 1993." *Morbidity and Mortality Weekly Report* 43 (25) (July 8, 1994): 469-472.
California Environmental Protection Agency "Health Effects of Exposure to Environmental Tobacco Smoke." Office of Environmental Health Hazard Assessment, Final Draft (February 1997).
- Castles, A., E.K. Adams, C. Melvin and K. Kelsch. "Effects of Smoking During Pregnancy: Five Meta-Analyses" (forthcoming) *American Journal of Preventive Medicine*. Fall 1998.
- Centers for Disease Control and Prevention. "Cigarette Smoking-Attributable Mortality and Years of Potential Life Lost – United States, 1990." *Morbidity and Mortality Weekly Review* 42 (33) (August 27, 1993): 645-49.
- Chen, Y., W. Li and S. Yu. "Influence of Passive Smoking on Admissions For Respiratory Illness in Early Childhood." *British Medical Journal* 293 (August 1986): 303-06.
- Cnattingius, S., M.R. Forman, H.W. Berendes, B.I. Graubard and L. Isotalo. "Effect of Age, Parity and Smoking on Pregnancy Outcome; A Population-Based Study." *American Journal of Obstetrics and Gynecology* 168 (1 Pt 1) (1993): 16-21.
- Collins, D.J. and H.M. Lapsley. "Estimating the Economic Costs of Drug Abuse in Australia." Canberra: Department of Community Services and Health (January, 1991).
- Cunningham, J., G.T. O'Connor, D.W. Dockery and F.E. Speizer. "Environmental Tobacco Smoke, Wheezing, and Asthma in Children in 24 Communities." *American Journal of Respiratory and Critical Care Medicine* 153 (January 1996): 218-24.
- DiFranza, J.R. and R.A. Lew. "Effect of Maternal Cigarette Smoking on Pregnancy Complications and Sudden Infant Death Syndrome." *Journal of Family Practice* 40 (1995): 1-10.
- Doran, C.M. and R.W. Sanson-Fisher. "A Cost-Benefit Analysis of the Average Smoker: A Government Perspective." *Australian and New Zealand Journal of Public Health* 20 (1996): 607-11.
- Edwards, N., N. Sims-Jones and S. Hotz. "Pre and Postnatal Smoking: A Review of the Literature." Community Health Research Unit, Department of Epidemiology and Community Medicine, University of Ottawa, Ottawa, Canada, 1996.
- Forbes, W.F. and M.E. Thompson. "Estimating the Health Care Costs of Smokers." *Canadian Journal of Public Health* 74 (May/June 1983): 183-90.
- Foulds, J. and C. Godfrey. "Counting the Costs of Children's Smoking." *British Medical Journal* 311 (October 1995): 1152-54.
- Gravelle, J. and D. Zimmerman. "Cigarette Taxes to Fund Health Care Reform: An Economic Analysis." Washington, DC: Congressional Research Report.
- Harlap, S. and A.M. Davies. "Infant Admissions to Hospital and Maternal Smoking." *The Lancet* (March 1974): 529-32.

- Husten, CG, J.H. Chrismon and M.N. Reddy. "Trends and Effects of Cigarette Smoking Among Girls and Women in the United States, 1965-1993." *Journal of American Medical Women Association* 51 (1996): 11-8.
- Jaakkola, M.S., J.J.K. Jaakkola, M.R. Becklake and P. Ernst. *Journal of Clinical Epidemiology* 49 (5) (1996): 581-86.
- Jedrychowski, W. and E. Flak. "Maternal Smoking during Pregnancy and Postnatal Exposure to Environmental Tobacco Smoke as Predisposition Factors to Acute Respiratory Infections." *Environmental Health Perspectives* 105 (March 1997): 302-06.
- Kaiserman, M.J. "The Cost of Smoking in Canada, 1991." *Chronic Disease in Canada* 18 (1) (1997): 13-19.
- Klonoff-Cohen H., S. Edelstein and D. Savitz. "Cigarette Smoking and Preeclampsia." *Obstetrical Gynecology* 81(4) (1993): 541-4.
- Kristein, M.M. "How Much Can Business Expect to Profit From Smoking Cessation?" *Preventive Medicine* 12 (1983): 358-381.
- Manning, WG, E.B. Keeler, J.P. Newhouse, E.M. Sloss and J. Wasserman. "The Taxes of Sin: Do Smokers and Drinkers Pay Their Way?" *Journal of the American Medical Association* 261(11): 1604-09.
- Marks, J.S., J.P. Koplan, C.J.R. Hogue and M.E. Dalmat "A Cost-Benefit/Cost-Effectiveness Analysis of Smoking Cessation for Pregnant Women." *American Journal of Preventive Medicine* 6(5) (1990): 282-289.
- Mudarri. The Costs and Benefits of Smoking Restrictions: An Assessment of the Smoke-Free Environment Act of 1993 (H.R. 3434). Indoor Air Division, U.S. Environmental Protection Agency. Washington DC (April 1994).
- National Health and Medical Research Council (NHMRC). "The Health Effects of Passive Smoking." Australian Commonwealth Department of Health and Family Services, (November 1997) NHMRC web site: <http://www.health.gov.au/nhmrc/advice/nhmrc>
- Office of Technology Assessment, U.S. Congress (May 1993). "Smoking Related Deaths and Financial Costs: Office of Technology Assessment Estimates For 1990." OTA Staff Memorandum, Washington DC, U.S. Government Printing Office.
- Office of Technology Assessment, U.S. Congress (September, 1985). "Smoking Related Deaths and Financial Costs," OTA Staff Memorandum, Washington DC, U.S. Government Printing Office.
- Office of Technology Assessment, U.S. Congress (1987). "Healthy Children: Investing in the Future" OTA-H-345, Washington DC, U.S. Government Printing Office.
- Schoendorf, K.C. and J.L. Kiely. "Relationship of Sudden Infant Death Syndrome to Maternal Smoking During and After Pregnancy." *Pediatrics* 90 (December 1992): 905-8.
- Scragg, R., E.A. Mitchell, B.J. Taylor, A.W. Stewart, R.P. Ford, J.M. Thompson, E.M. Allen and D.M. Becroft. "Bed Sharing, Smoking, Alcohol in the Sudden Infant Death Syndrome. New Zealand Cot Death Study Group." *British Medical Journal* 307(6915): 1312-8, 1993 Nov 20. Mar; 18(1): 113-20.
- Shultz J.M., T.E. Novotny and D.P. Rice. "Quantifying the Disease Impact of Cigarette Smoking with SAMMEC II Software." *Public Health Reports* 106(3) (1991): 326-33.
- Sibai B.M., T. Gordon, E. Thom, S.N. Caritis, M. Klebanoff, D. McNellis and R.H. Paul. "Risk Factors for Preeclampsia in Healthy Nulliparous Women: A Prospective Multi Center Study." *American Journal of Obstetrics and Gynecology* 172 (2 Pt 1) (1995): 642-8.
- Stoddard, J.J. and B. Gray. "Maternal Smoking and Medical Expenditures for Childhood Respiratory Illness." *American Journal of Public Health* 87 (February 1997): 205-09.
- Stoddard, J.L. and T. Miller. "Impact of Parental Smoking on the Prevalence of Wheezing Respiratory Illness in Children." *American Journal of Epidemiology* 141 (January 1995): 96-101.
- U.S. Department of Health and Human Services. Smoking and Health: A National Status Report. Second Edition. Washington D.C.: Government Printing Office, 1990.

- U.S. Department of Health and Human Services. "Report of Final Natality Statistics, 1996." *Monthly Vital Statistics Report* 46 (11S) (June 30, 1998).
- Viscusi, W.K. "Cigarette Taxation and the Social Consequences of Smoking." In: J.A. Poterba editor, *Tax Policy and the Economy*. Cambridge, Massachusetts: Massachusetts Institute of Technology Press (1995): 51-101.
- Warner, K.E., F.J. Chaloupka, P.J. Cook, W.G. Manning, J.P. Newhouse, T.E. Novotny, T.C. Schelling and J. Townsend. "Criteria for Determining an Optimal Cigarette Tax: The Economist's Perspective." *Tobacco Control* 4 (1995): 380-86.
- Weiss, S.T., I.B. Tager, M. Schenker and F.E. Speizer. "The Health Effects of Involuntary Smoking." *American Review of Respiratory Diseases* 128 (1983): 933-42.
- Winstanley, M., S. Woodward and N. Walker. *Tobacco in Australia: Facts and Issues*. Victorian Health Promotion Foundation, Australia (Quit Victoria) (1995)