

# Fire Injuries, Disasters, and Costs from Cigarettes and Cigarette Lights: A Global Overview<sup>1</sup>

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**Background.** Fires cause 1% of the global burden of disease. Fire (includes explosion) disasters have immense health, social, and environmental costs. We will provide initial estimates of overall U.S. and global fire tolls from smoking.

**Methods.** We tabulated and summarized smoking-related fire and disaster tolls from published documents. We compared those tolls to U.S. fire, burn, and fire death rates per billion cigarettes extrapolated globally. Smoking-attributable percentages of adult and child access to cigarette lighter and match ignitions (lights), and resultant fires, burns, and deaths ignited by young children, were estimated from likely smoking-attributable lights usage. Cigarette plus cigarette lights fire tolls were multiplied times published and estimated fire costs.

**Results.** Smoking is the leading cause of residential or total fire death in all eight countries with available statistics. Smoking is a leading cause of fires in many more countries. Cigarettes cause numerous fire disasters. Cigarette lights cause an estimated 100,000 U.S. and one million global, child-playing fires per year. Cigarette lights fire injuries likely rival U.S., and possibly global, cigarette fire injury numbers. Smoking causes an estimated 30% of U.S. and 10% of global fire death burdens. Smoking's estimated U.S. and global fire costs were \$6.95 (sensitivity range \$5.34–22.8) and \$27.2 (sensitivity range \$8.2–89.2) billion, respectively, in 1998 U.S. dollars.

**Conclusions.** Smoking likely causes large global fire tolls. U.S. fire tolls have fallen when smoking decreased. Further reducing smoking can substantially reduce fire and disaster tolls. © 2000 American Health Foundation and Academic Press

**Key Words:** fires; burns; risk factors; smoking; child; preschool; cost; wounds; injuries; blast injuries.

## INTRODUCTION

Fires cause 1% of the global burden of disease and 300,000 deaths per year [1]. Fire disasters continue to occur around the world, destroying cities [2,3], families, workplaces, workers [4], and wildlands [3]. Total fire costs are about 1% of gross domestic product (GDP)<sup>3</sup> in the United Kingdom, Japan, and virtually all of the 14 other countries with some available statistics [5].

U.S. fire tolls include about 5,000 deaths [6], 54,000 hospitalizations, 1.4 million injuries [7], two million fires, and 1–2% of GDP, perhaps over \$110 billion/year, in total fire costs [8]. Young child (ages <10 years) access to cigarette lighters and matches in the United States causes about 100,000 fires, 300–400 child deaths, and 11% of all injuries in reported fires, annually [8–11].

Smoking material (in essence cigarette [6,12]) fires are the leading cause of fire deaths in the United States [6] and the United Kingdom [13]. Perhaps more importantly, King County, Washington, smoker households have nearly five times the fire injury odds of nonsmoker households [14], and the fire excess in UK smoker households "is very much higher than the prevalence of fires directly caused by smoking [materials] . . ." [13]. The mechanisms of smoker households' fire excesses are unclear though they may be related to smoking-related disabilities, oxygen use, and cigarette consumption rates (an association that appears to be independent of sex, income, education, and binge alcohol use) [15].

Globally, over one billion often impoverished [16–19] and progressively debilitated [20,21] smokers light over

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<sup>3</sup> Abbreviations used: GDP, gross domestic product; SA%, smoking-attributable percent; child-playing fires, lighter or match fires started by children ages 0–10 years; lights, lighter or match ignitions; adults, people ages 10+ years.

six trillion cigarettes each year (200,000+ each second), each of which must be fully extinguished to avoid fires [17]. Debilitated heavy smokers often need to have cigarette lighters or matches readily accessible for lighting cigarettes, yet inaccessible to the agile 0- to 10-year-old children who start child-playing accidental fires [8]. Impoverished smokers must buy smoke detectors, batteries, and other safety equipment to avoid having excess fire losses. Those who are debilitated and distracted by their smoking [21,22] must extra carefully attend to their stoves, heaters, candles, and other ignition sources [8] to avoid the excesses of fires associated with disability [13].

The well-established fire [9,11] and disease threats from smoking enhance needs for fully accounting for the costs of smoking and the benefits of further public health, education, and taxation measures to reduce smoking. Yet in the United States, none of the \$90–140 billion/year in fire protection (including fire fighting and fireproofing) costs [23] or thousands of child-playing fire injuries per year [6,24] have been specifically charged to smoking in the medical literature. No global assessments of cigarette, cigar, bidi, pipe, smoking material, or cigarette lighter/match fire tolls, or fire protection costs, have been made [25].

We will provide initial U.S. and global assessments of smoking-attributable fire tolls, including reported cigarette lighter/match fire incidents. Given the possibility that fire control measures and their costs are often induced by disastrous fires [26], we will also tabulate smoking-related fire disasters.

## METHODS

We searched for fire tolls in documents indexed with both a smoking key word (cigar, cigarette, smoking, or lighter) and a fire or explosion key word. We searched the MEDLINE (1966–July 1997), PubMed, U.S. Fire Administration Learning Resource Center, National Newspaper Index, CDC Smoking and Health Databases, and the World Wide Web (via advanced queries on the AltaVista search engine). A request for citations on smoking-caused fires and explosions was posted on the GlobaLink (international tobacco) listserver. Smoking-caused fire tolls were requested from China, Japan, and Taiwan experts given their large, distinct populations. News reports of recent fire disasters were reviewed to investigate the fires' sources of ignition.

We estimated smoking-attributable (SA) percentages (SA%) of lighter or match fires accidentally started by young children (ages 0–10 years "child-playing" lighter or match fires) from the SA% of all lights (lighter or match ignitions) accessed and used by adults (ages 10+). We assumed that:

1. Young children are proportionately more likely to

play with lights, and start fires, if lights are more accessible to them and "lighting" behavior is more frequently modeled to them. This assumption is supported by the fire industry's recognition and ads emphasizing the need to keep lights out of reach, and light use out of sight, of young children [10].

2. Both the accessibility of lights in a household and the frequency with which the adults model "lighting" behavior, are directly proportional to the frequency with which the adults use lights. (This assumption may be conservative since heavy smoking likely disables [21] smokers, limiting their ability to keep lights out of reach and out of sight of children.) This assumption is supported by the observation that U.S. smokers' households are "the population at risk from fire-related hazards of cigarette lighters" [27]. Many U.S. smokers with young children leave cigarette lighters in diverse rooms of their houses, admittedly accessible to young children [27] and in some cases in their children's hands as toys [9].

3. Adults (ages 10+ years) use one light per cigarette. Children and pipe or cigar smokers use relatively few lights.

4. Cigarette lighter fires and injuries [11] are immensely more common than fire tolls from lighters other than cigarette lighters [28].

5. Smokers restrict their children's access to their average "light" as well as nonsmokers do, despite smokers' known excesses of alcohol or drug intoxication [29], sleep disturbance [30], debility, and distractions [22].

If those assumptions are correct, then the SA% of child-playing fires approximately equals the SA% of lights accessibility, which approximately equals the SA% of lights use. A conservative estimate of the SA% of lights use is equal to  $(\text{No. of lights used for cigarettes/year}) / [\text{No. lights for cigarettes/year} + (\text{No. other lights/adult/day} \times \text{No. adults} \times 365 \text{ days/year})]$ , where other lights are ignitions for combustibles other than tobacco. Nearly all child-playing fires are from lights [10]. So, lights fire tolls are equal to the SA% of child-playing fire tolls.

To estimate global fire tolls from cigarettes and their lights, we multiplied U.S. rates of reported (a) cigarette- and (b) estimated cigarette lights-ignited fires, injuries, and fire deaths per billion cigarettes consumed times global cigarette consumption. United States rates were used since they were comprehensive and accessible and seemed likely to be intermediate between the likely higher rates in less developed countries and the lower rates of other developed countries with higher levels of fire protection [31,32].

We next adjusted published 1990 U.S. cigarette fire costs [33] to 1998 dollar values and added lights fire costs. We multiplied each cigarette fire fighting and fire: injury, death, and property loss medical or general cost, times its respective: (a) medical care or overall

consumer price index (CPI) increase [34] and (2) sum of the percentages of fires ignited by cigarettes and cigarette lights in 1995 (including proportionate shares of the unknown cause fires [8]), divided by the percentage due to cigarette fires. We assumed that fire fighting costs were \$700 (in 1998 U.S. dollars) per fire, globally. This is less than 2–4% of the total U.S. professional plus volunteer fire service costs per fire seen in 1996 (\$36–82 billion/1.97 million fires) [23,35].

We then estimated U.S. fire costs per billion cigarettes and extrapolated those costs globally, adjusting for differing GDPs. We multiplied the U.S. fire costs per cigarette rate times China, less-developed world minus China, or developed world minus U.S. cigarette consumption times the respective regions' purchasing power parity GDP (GDP) per capita divided by U.S. GDP per capita [17,36]. We calculated less-developed world minus China GDP by subtracting China and developed country 1985 GDP [17] from the estimated 1998 world GDP [36] deflated to 1985 levels by the U.S. general inflation rate [34].

We then estimated a sensitivity range of costs. For the lower sensitivity limit we assumed that U.S. cigarette fire and fire fighting costs were 20% lower than previously, maybe conservatively, estimated and that smoking caused 70% of child access to cigarette lighters and matches (We assumed adults (ages 10+ years) used almost two (rather than one) lights per day for purposes other than smoking.) We also assumed that U.S. fire frequency, injury, death, and property loss rates per billion cigarettes were four times higher and medical, legal, and pain and suffering costs were two times higher per dollar of GDP than in other countries (given high U.S. medical [37] and legal costs). For an upper sensitivity limit, we increased our baseline cost estimates, minus fire fighting costs, by adding a share of total fire control costs that is arguably proportional to cigarette [33] plus cigarette lights' share of fire frequency. We inflated those possibly smoking-attributable total fire costs [33] from 1992 to 1998 dollars and extrapolated these costs globally, using the above methods.

## RESULTS

Table 1 lists the most recent cigarette, smoking material, or smoking material and match fire toll that was available from each country (or state or city, where country data were not available). Smoking materials, cigarettes, or smoking materials and matches were the leading cause of home or total fire fatalities (or fatal fires) in every country that reported a leading cause, including the United States, United Kingdom, Holland, Hungary, Japan, Denmark, New Zealand, and Israel. Smoking caused 37% of fire deaths in Hannover, Germany [38], the sole German population data found.

**TABLE 1**

Annual Fire Tolls or Percentages from Cigarettes, Smoking Materials, Lighters, Matches, or Combinations Thereof, Alphabetically by Nation, State, or Region

Location and year(s)	Attributable % or No./year of fires, injuries, deaths, etc. [Ref.]
Australia, about 1993	Cigarettes cause 1/4 of fire injuries [71].
Austria, 1989	Cigarettes and matches ignited 4.1% and child-set fires 2.2% of "significant fires" [72].
Canada, 1991	"Most fires . . . are ignited by smokers . . ." [39,73].
China, 1990–1996	Smoking caused 29,600 (10%) of fires with >\$1,000 in losses. They left 2,100 injured and 1,700 (11%) of resultant deaths [74].
Denmark, 1988–1993	Smoking was the ignition source for 51% of home fire fatalities [75].
Hannover, Germany, 1978–1987	Of 30 accidental burn or fire deaths, 11 were from smoking [38].
Holland, 1989	Child play with matches or lighters ignited 16.6%, and smoking materials ignited 4.5% of building fires. Smoking materials were the "leading cause of fire deaths" [72].
Hungary, 1990	Smoking caused 14% and children caused 6.9% of "fires with losses." Smoking caused 40%, a preponderance, of all fire deaths [72].
Israel, about 1995	"Cigarette smoking is the most common cause of [fatal] domestic fire" [76].
Japan, 1996	Cigarettes caused 3,822 building and 615 forest fires. Of 890 residential fire deaths, cigarettes caused 184 (21%, the leading cause) and lighters caused 49 (6%) [77].
New Zealand adults, 1978–1987	Smoking, at 37%, is "the most common source of ignition in fatal residential fires" [78].
South Africa, 1995	Over 6% of reported fires [79].
Taiwan, 1995–1997	Excluding Taipei and Kaohsiung, 17% of fires were from smoking [80].
Texas, U.S.A., 1986–1989	Smoking was the most common cause of hospital fires. Smoking was involved in all fires with patient injuries or deaths [81].
UK, 1989	Smoking materials and matches caused 234 = 37% of home fire deaths and 26+% of home + nonhome fire deaths [72].
U.S.A., 1995	Cigarettes, cigars, and pipes caused 3,789 injuries, 1,122 civilian deaths, \$500 million in property damage, and unknown fire control costs in 27,000 residential, 8,000 other building, 8,000 vehicle, and 110,000 outdoors reported fires [6].
U.S. fires from children playing with lighters, matches, or candles	11% of all residential fires with casualties, 32% of all fires with child casualties, and 320 deaths/year from 1982 to 1986 [10]. 14,700 match and 5,600 lighter fires caused 29 and 49%, respectively, of child injuries in child playing fires in 1993 [82].
The West[ern nations]	Smoking is the leading cause of fire death [83].

Smoking was a leading cause of fires in Australia, Canada [39], China, and South Africa. Residential cigarette fire and fire death rates per billion cigarettes in Japan [40] were one-fourth of U.S. residential rates [6,41].

Those national fire tolls suggest that smoking likely causes 10+% of non-suicide fire injuries or deaths in North America, Europe, Japan, China, New Zealand, and Australia (Tables 1 and 2). The tolls reported in Table 1 generally present fires ignited by cigarettes or tobacco and omit smoking-attributable fires from cigarette lighters, poverty, and debility. Still, the death tolls are over 20% in developed countries and 11+% in all countries with statistics that we were able to locate (the United States, China, United Kingdom, Japan, Hungary, New Zealand, and Denmark (Table 1), or nearly

two billion people). Other global regions probably have lower percentages of fires from smoking. If their cigarette fires, cigarette lights fires, and fires from smoking's possible poverty [18] and debilities [21] caused over 5% of their fire disease burden, smoking approximates 10+% of the global fire disease burden.

Larger fire or explosion disasters where smoking is a known or suspected cause are listed in Table 2. These include modern history's two largest single-building industrial fire losses of life, the largest U.S. fire dollar loss and industrial disaster death tolls, and, in part, the largest forest fire.

Given at least 6.05 trillion cigarettes consumed annually [17], 5.2 billion adults (age 10+ years) [42], and one other light per adult per day [all U.S. audiences

**TABLE 2**

Some Larger Disasters Known or Suspected to be from Smoking, Arranged by Date

Disaster and year	Location	Death, injury, cost, property . . . tolls	Smoking relatedness
Mont Blanc Tunnel Fire, 1999	Chamonix, France to Courmayeur, Italy	39 deaths, \$150 million for reconstruction, over \$800 million in economic losses [86]	Reportedly, preliminary, caused by smoking [87]
California wildland fires, 1929–1999	California, U.S.A.	Smoking ignited 102, 117, and, possibly, 964 structures in the 1964 Hanly, 1929 Mount Tamalpais [86], and 1999 Jones wildfires, three of California's worst 25 wildfires [87].	Caused [86] or possibly from smoking [88,89]
Fire during gas scavenging, 1998	Near Warri, Nigeria	"death toll . . . above 500, with many of an estimated 1,000 injured unlikely to survive" ". . . victims were women and children" [84].	"some news reports blamed a lit cigarette" [85]
Chernobyl, 1996	Ukraine	Evacuated villages around the reactors were destroyed in a wildland fire.	Apparently from a cigarette [90]
Kader Toy Factory fire, 1993	Thailand	188 dead, 449 taken to hospitals, >11 victims risk paresis, thousands jobless. World's worst single-building industrial fire death count [91].	Smoker arrested [92]
Oakland Hills Fire	California, U.S.A.	At 10,000 left homeless and over \$1.5 billion, the "largest dollar fire loss in United States history." 3,354 houses, 456 apartment units, and 2,000 vehicles destroyed [93].	Reportedly [94] or possibly from a cigarette [95]
Forest fires, 1991	Canada	"The smoking-attributable cost of forest fires was estimated to be about 10% . . ." [96]	
King's Cross Station, 1988	London, UK	30 deaths in the London Underground (which reportedly banned smoking as a result).	Probably a match or cigarette [97]
North Fork Fire, 1988	Yellowstone National Park, U.S.A.	At 635 square miles (1,652 km <sup>2</sup> ), the largest fire (about 1/3 of total fire acreage) in the park.	Started by a cigarette [98]
Great Black Dragon Forest Fires, 1987	Hingan Forest, Heilongjiang Province, China	3 million acres, 1/6 of China's timber reserves, about 220 deaths and 250 seriously burned, \$4–5 billion in 1987, 34,000 homeless, thousands injured, gutted five towns, part of the world's largest forest fire [99].	3 "careless smokers" arrested for starting parts of the fires [3]
Stadium fire, 1985	Bradford, England, UK	56 dead, many seriously injured.	Apparently from a cigarette [100]
Hotel New Japan, 1982	Tokyo, Japan	33 persons dead and 34 persons were injured.	Probably a cigarette [77]
In-flight jet fire, 1973	Near Paris, France	Complete destruction of a jet, with 123 dead passengers and crew due to an in-flight fire.	"strong possibility . . . origin was a cigarette" [101]
Ammonium nitrate explosion, 1959	Roseburg, Oregon, U.S.A.	Total devastation over an urban area six blocks in diameter. Thirteen dead.	From "a cigarette" [102]
Ammonium nitrate explosion/Texas City Disaster, 1947	Texas City, TX, U.S.A.	581 dead/missing, 380 hospitalized 2+ months, 4,100 casualties, 90+% of city's buildings damaged, > \$4 billion (1990 \$) in property lost. Worst U.S. industrial disaster death toll.	Per the FBI, probably from smoking [2]
Triangle Shirtwaist Factory Fire, 1911	New York City, U.S.A.	146 dead. World's second worst single building industrial fire loss of life.	Caused by a cigarette [103]

we have inquired of have averaged fewer than one other light per day per adult (unpublished data)], we estimate that the SA% of lights (lighter and match ignitions) is 80% globally. Given 487 billion cigarettes consumed in 1995 [41], 226 million U.S. adults (age 10+ years) in 1996, and one other light per adult per day, the U.S. SA% of lights use is 85%. The SA% of lights usage would be 50% at three other lights per day per adult (age 10+ years) globally or six other lights per day per adult (age 10+ years) in the United States.

The United States had 4,585 fire deaths in 1995 [6]. Despite mandated use of child-resistant cigarette lighters, child-playing fires caused an estimated 5.5% of fires, 3.3% of fire property losses, 11% of fire injuries, and 7.3% of U.S. fire deaths in 1995 [8]. If, as estimated above, 80% of these are due to smoking's cigarette lighters and matches, then child-playing smoking-attributable fires caused about 180 reported fires, 5 injuries, and 1 death per billion cigarettes consumed. Extrapolated globally, an estimated 1.1 million fires, 28,000 fire injuries, and 3,300 smoking-attributable fire deaths occur via cigarette lighters and matches, annually. This represents approximately 1% of all global fire deaths.

The 153,000 officially noted U.S. fires from cigarettes, cigars, and pipes in 1995 caused \$507 million in property losses [6] and 6% of fires, 22% of fire deaths, 10% of fire injuries, and 5% of fire property loss [8]. Cigarettes cause 97+% of U.S. fire tolls from lit tobacco [6]. U.S. cigarette consumption was 487 billion in 1995 [41]. Thus, there were about 300 cigarette fires sufficiently serious to receive fire department attention, 5 injuries, and 2 cigarette fire deaths, per billion cigarettes consumed. Those rates, times 6 trillion cigarettes per year consumed globally [17], represent an estimated 2 million cigarette fires, 32,000 injuries, and 14,000 deaths per year globally. If U.S. rates can be extrapolated globally, cigarette fires and cigarette lights fires total an estimated 17,000 deaths/year globally, representing 6% of all global fire deaths.

Table 3 presents estimated U.S., China, other developed, and other less-developed countries' cigarette plus lights attributable fire costs. The estimated \$1.066 (sensitivity range \$0.82–17.1) billion U.S. external property loss and fire fighting costs of smoking translate into about \$8 (sensitivity range \$6–120) per U.S. worker in 1998 [43]. Litigation costs were not added to these external costs since we lacked an estimate of litigation costs independent of medical insurance administrative costs [33] that were included in previous estimates of the overall external costs of smoking [44,45]. Cigarette lights caused an estimated 40, 33, 45, and 20% of U.S. smoking-attributed fire fighting, property loss, non-fatal injury, and death costs, respectively.

## DISCUSSION

Large numbers of fires or explosions from burning cigarettes, other tobacco, or cigarette lights are well documented in official or medical publications from North America, Europe, and Japan. Additional less official such tolls are available for China, Australia, South Africa, and some other countries (Tables 1 and 2).

We located little information on smoking's roles in fires in India, South America, the Middle East, and Africa. Those regions account for 90+% of the projected burden of disease from fires in the year 2000; have numerous kerosene caused fires [46–48]; have high female fire injury amounts [49]; have little female smoking [40]; and probably have lower SA% of fire burdens than in the developed world [despite the perhaps 1,000 dead in the recent possibly smoking-caused Nigerian disaster (Table 2)]. Our \$4 billion estimate of global property losses in cigarette and lights fires (Table 3) is consistent with the WHO estimated "billions" of such dollars [17].

We have reasonable, potentially conservative, data on smoking's cigarette [33] and cigarette lights fire costs in the United States and far less certain data about other countries. So we included a sensitivity range for U.S. smoking fire costs and a far broader sensitivity range for non-U.S. fire costs (Table 3). The sensitivity range allows for the possibilities that our baseline U.S. costs were too high or too low and that international differences in cigarette burn characteristics; alcohol use; fire resistance of clothing, furnishings, or homes; or costs per fire could reduce the GDP adjusted fire costs per billion cigarettes rate by nearly 90% outside the United States. (For a region with a GDP equal that of the United States, our lower sensitivity limit fire cost per billion cigarettes is one-eighth that of the United States.) There is substantial uncertainty as to whether most fire control costs included in the upper limit of our sensitivity range are rightly attributable to smoking's fires or would lessen significantly with less smoking [33]. Our speculative, but arguable [33], upper limit of fire costs globally (Table 3) is roughly equivalent to suggesting that smoking may cause not only 20–51% of total or residential fire deaths (Table 1), but also 30% of total fire costs, in developed countries (since total fire costs are 1% of GDP in nearly all of the 14 developed countries with available data) [5].

Our estimate of U.S. external property loss, fire fighting, and possible other fire control costs due to smoking is \$1.066 (sensitivity range \$0.82–17.1) billion, \$0.04 (sensitivity range \$0.03–0.62) per pack in 1998 dollars, or \$0.03 (sensitivity range \$0.02–0.42) in 1986 dollars. Our estimate is much higher than the usually used \$340 million in 1986 dollars estimate of such costs [44,50,51]. This suggests that overall U.S. external costs of smoking have been underestimated, perhaps significantly so

**TABLE 3**  
Estimated Cigarette and Cigarette Lights Fire Costs by Region, in 1998 US Dollars

	High-income countries		Low-income countries		World
	U.S.A.	Without U.S.A.	China	Without China	
1995 population (ages 15 + years) (million) [40]	205.21	491.46	898.95	2,318.29	3,913.91
1998 per capita GDP <sup>a</sup> [17,36]	\$17,780	\$14,013	\$1,493	\$2,931	\$4,493
1991 per capita cigarette consumption (ages 15+ years) [17,40]	2,670	2,557	1,900	1,220	1,620
Total cigarette consumption (billions)	547.91	1,256.46	1,708.01	2,828.31	6,340.68
Baseline cost components (\$ billions)					
Medical and transportation	0.16	0.3	0.04	0.14	0.65
Legal and administrative	0.09	0.17	0.02	0.08	0.36
Lost productivity	1.16	2.09	0.30	0.98	4.54
Pain and suffering	4.47	8.08	1.17	3.80	17.52
Property	0.88	1.59	0.23	0.75	3.46
Fire fighting	0.186	0.34	0.05	0.16	0.73
Fire costs (\$ billions)					
At lower sensitivity limit <sup>b</sup>	5.34	1.78	0.26	0.84	8.22
At upper sensitivity limit <sup>c</sup>	22.77	41.15	5.96	19.37	89.24
Fire costs per 20 cigarettes					
At lower sensitivity limit <sup>b</sup>	0.19	0.03	0.003	0.01	0.03
At upper sensitivity limit <sup>c</sup>	0.83	0.65	0.07	0.14	0.28

<sup>a</sup> Gross domestic product at purchasing power parity in 1985 U.S. dollars.

<sup>b</sup> The lower sensitivity limit values assume that (a) U.S. cigarette fire costs were 20% lower than previously estimated; (b) that smoking caused 70% of U.S. child access to cigarette lighters and matches; and (c) that U.S. fire injury, death, and property loss rates per billion cigarettes were four times higher and medical, legal, and pain and suffering costs per injury or death were two times higher than all other countries.

<sup>c</sup> The upper sensitivity limit values assume that fire costs equal the baseline estimates of smoking's fire injury and property loss costs plus an additional share of total fire costs in the United States that is proportional to cigarette and cigarette lights fires' share of all fires. Please see Methods.

if the upper sensitivity range estimate is correct. Costs of \$0.23 per pack in 1986 would have changed the conclusion of the leading medical literature study of the external costs of smoking [44].

It seems likely that some fire control costs, perhaps more than our assumed U.S. \$700 per fire for fire fighting, are due to smoking. Historically, the smoking-caused Triangle Shirtwaist Factory fire initiated substantial fire control measures [52] and presumably costs. Logically, billions of developed countries' fire control dollars could possibly be put to more cost-effective lifesaving uses if smoking cessation prevents much of the harm (deaths, injuries, and property losses) from fires (Tables 1–3). Cessation of smoking will likely prevent millions of fires; many developed world fire disasters, deaths, and injuries; six trillion potential ignition sources per year from cigarette butts; and ignitions from cigarette lighters in the hands of smokers' young children. California's high smoking cessation rate [53], other fire control measures, and reported decreases in fires help allow firefighters to spend the great majority of their time on emergency medical services, hazardous materials, water rescue, etc. [54]. It is less clear that any fire protection costs other than fire fighting have

possibly been reduced by smoking cessation. "Fire-safe," or less fire-prone cigarettes, fabrics, and furniture could help reduce fire costs as well [55,56].

The global numbers, percentages, and costs of fires and fire injuries that are ignited by cigarettes, other tobacco, and cigarette lights can only be estimated. Estimates that smoking has substantial global fire tolls are more likely correct if different methods of assessing those tolls round to the same result. Mortality estimates made based on (a) U.S. fires per billion cigarette rates (6% of fire deaths) and (b) national fire tolls, internationally (10% of fire deaths), modestly support each other. Fires cause 1% of the global burden of disease [1]. If smoking causes 10% of fires' disease burden, then smoking-caused fires and explosions represent 0.1% of the global burden of disease and an overlooked 4% of all global disease in 1990 that was attributed to tobacco [57].

Our estimates of the fire tolls from cigarettes, other tobacco, and cigarette lights omit fires tolls due to debility [58], distraction [22], or poverty [18] possibly from smoking. Those smoking-related fires could help explain smoker households' much higher odds of fires or fire injuries in the United States [14] or the United

Kingdom [13]. Both smoking's lights and smoking-caused debilities likely cause some such fires [13,58]. In particular, smokers often get debilitating lung disease and then are given extra oxygen which greatly feeds fires [59-62]. Many studies suggest that many of smokers' accident deaths [58], presumably including non-cigarette, non-lights accidental fire deaths, may be to smoking [15].

The SA% of lighter and match use appears likely to be 50%, to as high as 80+%, globally. SA% may be lower in underdeveloped countries lighting many candles and cooking fires. These SA% might be higher given: (a) the widespread access that young children have to smoking paraphernalia [63,64]; (b) lack of child-resistant cigarette lighters in many countries; and (c) smokers' impaired supervision of their children due to possible smoking-caused poverty [18], sleep disturbances [30], debilities, and distractions [65] and smoking-associated alcohol and drug intoxication [29]. In a 1990 U.S. sample of 200 smoker households with young children, most left a cigarette lighter in their living room or kitchen. One-quarter of the smokers left a lighter in a bedroom or bathroom and 7% left lighters within reach of the child [27]. Thus, smoking likely greatly contributes to the known substantial child-playing or lighter tolls in the United States, Hungary, Holland, Austria, and Japan (Table 1) and possibly globally [27,66].

Further research may be helpful. Surveys of cigarette, smoking material, cigarette lights, or child-playing fire tolls and the average non-smoking lights usage, when combined with tobacco consumption figures, can improve our imprecise estimates of smoking-attributable fire tolls and the SA% of lights usage. Research is needed to quantify cigarette or smoking material and smoking-attributable lights fire caused proportions of fire deaths in additional years and in populous or underdeveloped countries. Please report smoking's tolls or disasters to us. Research on the marginal costs of fires could help refine estimates of smoking's fire control costs.

Smoking-caused fires burn children, families [67], and their homes and cars (Table 1); burn factories and workers; destroy villages, towns, and probably cities [2,3,68]; and burn immense expanses of wildlands (Table 2). Stopping adult smoking can reduce toddlers' play with, and deaths from, smokers' lights; reduce smoking-caused fires and explosions; and reduce cigarette burns to the skin and eyes of children [22]. Two-thirds of all of the reduction in U.S. "smoking material" fire fatalities from 1984 to 1995 was attributed to reductions in cigarette consumption [6]. Reducing smoking lowers smoking's large fire injury and fire control costs and smoking's one-sixth of adult deaths [69] and 10% of the global burden of disease [57] by the year 2020. Policy makers, smokers, families, and the public should

have: (a) information on smoking-caused cigarette, cigar, pipe, cigarette lighter, and match fire and explosion risks; and (b) the opportunity to consider measures to reduce their burdens from smoking [70], including smoking-caused fires and resulting burns, deaths, disasters, and costs.

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