

Smoking-attributable Mortality, Years of Potential Life Lost, and Direct Health Care Costs for Puerto Rico, 1983¹

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The authors report the impact of smoking upon health in Puerto Rico for the year 1983. Using a microcomputer spread-sheet program that calculates smoking-attributable disease impact, they estimated that 2,468 deaths were attributable to smoking. This represented 11.5% of all deaths on the island in 1983 and resulted in approximately 19,445 years of potential life lost (YPLL).

It appears that cigarette smoking caused US\$55.9 million in direct health care expenditures for Puerto Rico in 1983, an amount equal to 10% of the island's yearly expenditures on health. Calculations such as these demonstrate the enormous disease impact of smoking and may assist policy-makers in planning prevention and intervention activities, both in Puerto Rico and elsewhere in Latin America.

Smoking is the principal cause of preventable mortality in the United States (1). An estimated 270,000–485,000 people die in the U.S. each year as a result of cigarette smoking (1–5), and over US\$20 billion is spent yearly on direct

medical care for treatment of smoking-related illness (2, 5). For the year 1984, it has been estimated that smoking was also responsible for lost productivity costing US\$43 billion (2). Worldwide, it is estimated that smoking causes at least 2.5 million premature deaths each year (6).

Prevention and treatment of tobacco use has been identified as a major priority in developing countries (7). Nevertheless, efforts to discourage tobacco use in the developing world have been hampered. For instance, little is known about the smoking behavior of Latin American populations because few surveys of smoking behavior have been done. In addition, developing nations have many impediments to public health efforts against tobacco use. In some there has been economic dependence on tobacco crops, and in others multinational tobacco companies have applied active marketing and trade pressure (7, 8).

Indeed, as tobacco use in North America has diminished, multinational tobacco companies have increased their sales ef-

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forts in developing countries. Lack of knowledge about the health consequences of smoking among residents of these countries may have been diverting attention from the need for effective public health efforts against these activities. In that case, calculating the health and economic consequences of smoking for specific individual populations would provide decision-makers with important information on which to base effective public health actions directed against tobacco.

In Puerto Rico, a tropical island with 3.3 million inhabitants where the principal causes of death are cardiovascular diseases and cancer (9), the public health and economic consequences of smoking have not been quantified. In fact, little is known about the current smoking behavior of Puerto Ricans, especially Puerto Rican men.

In 1982 the Puerto Rico Fertility and Family Planning Assessment (PRFFPA)⁶ interviewed a representative sample of women on the island between the ages of 15 and 49. Fifteen percent said that they were current smokers, while 14% said they were former smokers (10). (In the continental United States, 29% of all females 20 years or older were smokers in 1983–11.) However, there is no recent study of smoking behavior among Puerto Rican men. A 1965–1968 survey of 9,824 Puerto Ricans did ask men about risk factors for coronary heart disease. This survey found that 44% of the men 45–64 years old were current smokers, and that the incidence of smoking was significantly higher among urban men than among their rural counterparts (12). Also, the 1982–1984 Hispanic Health

and Nutrition Examination Survey (HHANES) in the United States interviewed 1,220 Puerto Ricans 20–74 years of age and included questions about the interview subjects' smoking status. This survey found that 39.8% of the men and 30.3% of the women among these residents of the New York area were current smokers (13).

When the Municipal Assembly of San Juan, Puerto Rico, was considering an ordinance to restrict smoking in city buildings in 1987, the city commissioner of health requested assistance in calculating smoking-attributable mortality, morbidity, and economic costs for the city proper. In response to this request, the U.S. Centers for Disease Control (CDC) performed disease impact calculations using San Juan-specific data. The researchers found that 275 deaths among people over 20 years of age were attributed to smoking in 1983. Smoking also accounted for \$8.8 million in direct medical care costs and 1,697 years of potential life lost in San Juan (14).

To help expand public knowledge about the health consequences and disease impacts of smoking for island residents, and also for policy-makers in other parts of Latin America, we expanded the calculations on smoking-attributable morbidity, mortality, and economic costs for 1983 to include the whole island. This article reports the results of those calculations.

MATERIALS AND METHODS

To facilitate calculation of smoking-attributable mortality and years of potential life lost (YPLL), we used microcomputer spread-sheet software known as SAMMEC (smoking-attributable mortality, morbidity, and economic costs) that was developed by the Minnesota Department of Health (15). This software uses the method of Rice et al. in these calcula-

⁶The PRFFPA was conjointly undertaken by the University of Puerto Rico School of Public Health, the Commonwealth of Puerto Rico Department of Public Health, and the Division of Reproductive Health, Center for Health Promotion and Education, U.S. Centers for Disease Control.

tions (2). Age- and sex-specific current and former smoking prevalences, disease-specific relative risk estimates, and mortality data are used by the software to produce smoking-attributable fractions of mortality and YPLL for a given population. The method does not take into consideration how long the subjects smoked nor for how long former smokers had refrained from smoking. Nevertheless, the calculations performed by the software result in disease impact estimates that do conservatively describe the population-attributable risk of smoking.

To begin with, the software calculates smoking-attributable deaths by gender and age for each of 24 diagnoses (Table 1) which have been associated with smoking and for which relative risk estimates of mortality exist. These smoking-attributable deaths are calculated using the following formula:

$$\begin{aligned} &\text{Smoking-attributable fraction} \\ &= \frac{(p_0 + p_1[RR_1] + p_2[RR_2]) - 1}{(p_0 + p_1[RR_1] + p_2[RR_2])} \end{aligned}$$

where p_0 = percentage of those who have never smoked, p_1 = percentage of current smokers, p_2 = percentage of former smokers, RR_1 = relative risk of death for current smokers (relative to those who have never smoked), and RR_2 = relative risk of death for former smokers (relative to those who have never smoked).

The relative risks used are weighted mean relative risks of mortality (Table 1) derived from four longitudinal studies of smoking-related illness (2). These studies were done in the 1950s and 1960s in developed countries. The reported relative risks were weighted by Rice et al. according to the length of the longitudinal study and the number of subjects in the study to arrive at a summary relative risk estimate. Differences in relative risks for males and females reflect the historically

longer exposure to tobacco experienced by men.

Recently, updated relative risk estimates were reported by the U.S. Department of Health and Human Services (1). These new relative risk estimates, based on a large prospective study of North Americans in the American Cancer Society's (ACS) Cancer Prevention Study II (completed in 1988), are substantially higher for several of the disease categories used in Rice's study. However, the older relative risk estimates are likely to be more appropriate for use in this analysis; for in considering populations such as that of Puerto Rico, the risks involved would tend to reflect relatively fewer person-years of exposure to tobacco as compared to the exposure history of the current U.S. population.

The software calculation estimates smoking-attributable pediatric mortality based on relative risk estimates (Table 1) for illnesses attributable to maternal smoking (16). These estimates include four pediatric conditions among children under five years of age.

One of the basic concepts employed in the study is "years of potential life lost" (YPLL). This measure of disease impact, one increasingly used in chronic disease epidemiology, has been described by the CDC in a recent publication (17). YPLL quantifies the years of potential life lost due to a particular disease or risk factor in a population. Smoking-attributable YPLL prior to age 75, the approximate average life expectancy in Puerto Rico, were calculated by summing all of the years of life lost due to the smoking-attributable deaths for each diagnosis listed in Table 1.

Smoking-attributable fractions of direct health care expenditures were also calculated. Relative rates of utilization of medical services for smokers compared with nonsmokers have been determined by Rice et al. using self-reported data for

Table 1. Relative risks of death due to smoking-related diseases in Puerto Rico, by gender and smoking status, 1983.

Code, ICD-9CM ^a	Diagnosis	Male		Female	
		Current smokers	Former smokers	Current smokers	Former smokers
010-012	<i>Infectious diseases:</i> Tuberculosis	2.56	1.95	1.00 ^b	1.00
140-149	<i>Neoplasms:</i> Lip, oral cavity	6.62	2.28	3.25	1.74
150	Esophagus	4.80	1.65	4.90	1.87
151	Stomach	1.49	1.17	2.30	1.00
157	Pancreas	2.00	1.37	1.48	1.26
161	Larynx	7.33	8.84	3.25	1.74
162	Lung	10.02	4.47	3.67	1.29
180	Cervix uteri	NA	NA	3.00	1.40
188	Urinary bladder	2.30	1.60	1.89	1.94
189	Kidney	1.47	1.63	1.50	1.02
401-405	<i>Cardiovascular diseases:</i> Hypertension	1.39	1.21	1.43	1.40
410-414	Ischemic heart disease (ages < 65)	1.88	1.38	1.67	1.17
410-414	Ischemic heart disease (ages ≥ 65)	1.49	1.20	1.28	1.27
427.5	Cardiac arrest	3.00	1.00	3.00	1.00
430-438	Cerebrovascular disease	1.32	1.00	1.45	1.28
440	Atherosclerosis	1.83	1.14	1.94	2.40
441	Aortic aneurysm	4.46	2.95	3.19	3.01
480-487	<i>Respiratory diseases:</i> Pneumonia/influenza	1.79	1.00	1.29	1.17
491-492	Bronchitis/emphysema	10.13	10.97	7.40	4.89
496	Airway obstruction	10.13	10.97	7.40	4.89
531-534	<i>Digestive diseases:</i> Ulcers	2.88	2.12	3.21	2.45
765	<i>Pediatric conditions:</i> Short gestation/low birthweight	1.76		1.76	
769	Respiratory distress syndrome	1.76		1.76	
770	Other respiratory conditions	1.76		1.76	
798.0	Sudden infant death syndrome	1.50		1.50	

^a World Health Organization, *International Classification of Diseases (Ninth Revision)*, Geneva, 1978

^b Absence of effect for females reflects lack of data in longitudinal studies used for calculating relative risk

U.S. citizens from the 1980 National Health Interview Survey (2). We assumed that Puerto Rico, with a well-developed and accessible health service, had rates of health care service utilization similar to those found in the U.S., and, lacking other data, employed the same relative rates of utilization for smokers versus nonsmokers. These relative rates

of utilization were applied to cost data specific for Puerto Rico for five broad categories of health expenditures (hospital care, physicians' services, drugs and sundries, other professional services, and nursing home care). Smoking-attributable cost estimates were rounded to the nearest ten thousand or hundred thousand dollars.

DATA SOURCES

Mortality and Health Care Expenditure Data

Mortality data for residents of Puerto Rico in 1983 were provided by the Office of Information Systems Development of the Puerto Rico Department of Health (PRDH) (personal communication, C. Ayoroa, January 1987). Health care expenditure data were provided by the Division of Analysis and Cost-Accounting, PRDH (personal communication, V. Martínez-Ortega, March 1987), Medicare (personal communication, J. A. Valdés, May 1987), Servicios de Seguros de Salud (personal communication, L. Mercado-Santini, May 1987), and the Finance Section of the Veterans' Administration Hospital (personal communication, V. Cruz, May 1987).

Smoking Prevalence Data

The SAMMEC software only uses smoking prevalence data for the broad age categories 20–64 and ≥ 65 . Weighted current and former smoking prevalence data for men and women ages 20–64 and ≥ 65 in our study were determined from several different sources, as described below. All of these sources employed the standard U.S. definitions of smoker, current smoker, and former smoker. That is, a smoker was defined as anyone who had ever smoked at least 100 cigarettes in his or her lifetime. Current smokers included those among the smokers who smoked cigarettes at the time of the survey. Former smokers were those who reported smoking 100 cigarettes in their lifetimes, but who did not smoke cigarettes at the time of the survey.

We obtained data for men from the U.S. Hispanic Health and Nutrition Examination Survey (HHANES) (13), de-

scribed above. We assumed that prevalences for Puerto Rican men living in New York would resemble prevalences for Puerto Rican men still living on the island; then, lacking island-specific data, we used these data from HHANES in the calculations.

Regarding women, age-specific smoking prevalences for 3,493 island women 15–49 years of age were available from the PRFFPA. This survey has been described in detail elsewhere (11). The smoking prevalences for women 20–64 and ≥ 65 years of age were estimated as follows. First, prevalences from the PRFFPA in five-year age groups (15–19, 20–24, etc.) were determined. (We chose to use the prevalence data for women from the PRFFPA rather than the HHANES because it was likely that the PRFFPA was more representative of women still living on the island.)

Next, lacking data for age groups beyond age 49, we assumed that the smoking prevalence in these groups was inversely and linearly associated with increasing age. We then used a linear regression model (18) derived from the available data on women 15–49 years old to estimate the prevalences for the age groups 50–54, 55–59, 60–64, and ≥ 65 . Finally, using the extrapolated prevalences, we collapsed the data for current and former smokers' prevalences into the 20–64 and ≥ 65 age groups.

International Comparison Data

Prevalence data from other Latin American nations have been obtained by the Gallup Organization, Inc., under contract to the American Cancer Society (19). Current and former smokers were defined exactly as in the HHANES. Data for current smokers from other selected Latin American countries are presented

here for comparison to the data from Puerto Rico.

RESULTS

The estimated 1983 prevalences of current and former smoking obtained for Puerto Rican men are substantially higher than those found for Puerto Rican women (Table 2). However, smoking prevalences are also higher for men than for women in all the Latin American countries listed in the American Cancer Society survey (Table 3). In general, the smoking prevalences estimated here for men and women in Puerto Rico are very similar to those reported by Gallup for men and women in other Latin American nations.

As shown in Table 4, of the 21,499 deaths among residents of Puerto Rico in 1983, 2,468 (11.5%) appear attributable to smoking. Almost all of this smoking-attributable mortality was due to cardiovascular diseases, neoplasms, and respiratory disorders, which respectively accounted for approximately 44%, 28%, and 23% of these deaths. Most of the smoking-attributable deaths (1,819, or about 74%) occurred in men, with cardiovascular diseases accounting for 749 (41%) of these. Cardiovascular disorders were also the main cause of smoking-at-

Table 2. Smoking prevalences: Percentages of current and former Puerto Rican smokers, by age group and sex, 1982 (females) and 1982-1984 (males).

Age group (in years)	Current smokers		Former smokers	
	Men ^a (%)	Women ^b (%)	Men ^a (%)	Women ^b (%)
<20	41.5	13.5	18.2	15.7
20-64	41.8	14.9	17.7	14.2
≥65	32.9	4.6	30.9	25.3

^aBased on data collected from Puerto Rican residents of the New York City area by the United States Hispanic Health and Nutrition Examination Survey, 1982-1984.

^bBased on data collected from the Puerto Rico Fertility and Planning Assessment Survey, 1982

Table 3. Smoking prevalences in selected Latin American countries, by sex, 1988.

Country	No. of respondents	Age group	Men (%)	Women (%)
Uruguay	799	16+	44	23
Argentina	826	18+	43	27
Chile	600	18+	41	37
Brazil	1,297	18+	40	36
Ecuador	1,323	13+	39	16
El Salvador	1,300	18+	38	12
Colombia	1,512	18+	37	18
Mexico	2,600	15+	37	17
Honduras	1,200	18+	36	11
Costa Rica	1,213	18+	35	20
Venezuela	852	18+	32	23
Peru	400	18+	28	17

tributable mortality among women, accounting for 340 (52%) of the 649 deaths involved. Not surprisingly, most smoking-attributable deaths among both men and women occurred in older age groups, with people age 65 and over accounting for 1,783 (72%) of the 2,468 smoking-attributable deaths.

As shown in Table 5, our data indicate that in 1983 there were approximately 19,445 smoking-attributable YPLL prior to age 75 in Puerto Rico. Cardiovascular diseases accounted for the largest proportion of these YPLL (6,893, or 35% of the total), followed closely by neoplasms (5,784, or 30%). As expected, deaths from perinatal conditions related to maternal smoking during pregnancy also accounted for a large proportion (19%) of the YPLL. Gender influenced the distribution of these causes of estimated YPLL, in a manner similar to the way it influenced causes of smoking-attributable mortality.

The estimated direct health care costs due to smoking in 1983 amounted to US\$55.9 million in Puerto Rico. The largest share (\$37.3 million, or 67%) of these costs was paid for inpatient hospitalization, \$7.6 million (13.6%) went for physician services, and \$5.8 million (10.4%) was spent on nursing home care (Table

Table 4. Total mortality and smoking-attributable mortality from selected diseases associated with smoking in Puerto Rico, 1983.

Diagnosis	Males		Females		Both sexes ^a	
	Total deaths	Smoking-attributable deaths	Total deaths	Smoking-attributable deaths	Total deaths	Smoking-attributable deaths
<i>Infectious diseases</i>	66	30	23	0	89(1%)	30(1%)
Tuberculosis	66	30	23	0	89	30
<i>Neoplasms</i>	1,011	572	492	112	1,503(15%)	684(28%)
Lip, oral cavity	138	99	33	10	171	109
Esophagus	160	101	48	19	208	120
Stomach	211	40	120	18	331	58
Pancreas	88	29	58	5	146	34
Larynx	91	73	14	4	105	77
Lung	256	208	123	35	379	243
Cervix uteri	NA	NA	55	14	55	14
Urinary bladder	44	17	32	6	76	23
Kidney	23	5	9	1	32	6
<i>Cardiovascular diseases</i>	3,555	749	3,020	340	6,575(64%)	1,089(44%)
Hypertension	534	89	498	51	1,032	140
Ischemic heart disease (ages < 65)	518	157	213	24	731	181
Ischemic heart disease (ages ≥ 65)	1,327	242	1,158	87	2,485	329
Cardiac arrest	119	54	81	17	200	71
Cerebrovascular disease	625	73	675	62	1,300	135
Atherosclerosis	383	103	382	94	765	197
Aortic aneurysm	49	31	13	5	62	36
<i>Respiratory diseases</i>	905	411	682	167	1,587(15%)	578(23%)
Pneumonia/influenza	593	146	441	26	1,034	172
Bronchitis/emphysema	107	91	72	42	179	133
Airway obstruction	205	174	169	99	374	273
<i>Digestive diseases</i>	54	27	27	9	81(1%)	36(1%)
Ulcers	54	27	27	9	81	36
<i>Pediatric conditions</i>	302	30	201	21	503(5%)	51(2%)
Short gestation/low birth-weight	162	16	114	12	276	28
Respiratory distress syndrome	90	9	46	5	136	14
Other respiratory conditions	47	5	39	4	86	9
Sudden infant death syndrome	3	0	2	0	5	0
<i>Total mortality (smoking-related diagnoses)</i>	5,893	1,819	4,445	649	10,338(100%)	2,468(100%)
<i>Total mortality (all causes)</i>					21,499	2,468

^aPercentages do not total 100% due to rounding.

6). Most of these health care expenditures (\$38.8 million, or 69%) were spent on men. It is also noteworthy that most of these estimated health care expenditures (58%) were used to treat people under 65 years of age, who accounted for 28% of the estimated smoking-attributable deaths.

DISCUSSION

This study seeks to quantify the disease impact of smoking in a Latin American population. Because of the paucity of studies on smoking prevalences in Puerto Rico, we had to include estimates of smoking prevalence based on male

Table 5. Smoking-attributable years of potential life lost (YPLL) in Puerto Rico, 1983.

Diagnostic group	Men	Women	Both sexes		Total YPLL	
			Ages 20-64	Ages ≥ 65	No.	%
Lung cancer	1,862	312	1,725	449	2,174	11
Other neoplasms	2,928	682	2,940	670	3,610	19
Ischemic heart disease	3,494	549	3,449	594	4,043	21
Other cardiovascular diseases	2,074	776	2,277	573	2,850	15
Respiratory diseases	2,022	481	1,844	659	2,503	13
Tuberculosis	304	0	259	45	304	1
Ulcers	170	16	155	31	186	1
Pediatric diseases (children ≤ 1 year old)	2,266	1,509	NA	NA	3,775	19
Total	15,120	4,325	12,649	3,021	19,445	100

U.S. residents of Puerto Rican descent as part of our calculations. This could have led to several biases. For instance, the HHANES survey found a relatively high prevalence of female Puerto Rican smokers (30.3%) in its New York population sample. Thus, the smoking prevalence of New York men of Puerto Rican descent may also be higher than the actual prevalence among men still living on the island. Or conversely, Puerto Rican males born in the U.S. or residing there for a long time could have been exposed to more anti-smoking education and thus may have had lower smoking prevalences than their counterparts on the island. Such factors could then have artificially raised or lowered the estimate of smoking-attributable mortality for Puerto Ricans living on the island. Nevertheless, because of the similarities between rates

used for Puerto Rico and those reported by Gallup in other Latin American countries, we feel that our estimates of Puerto Rican prevalences for both sexes are reasonable.

Our data indicate that smoking-attributable deaths accounted for 11.5% of all deaths in Puerto Rico in 1983. The CDC study for the city of San Juan found that a slightly smaller proportion (8%) of 1983 deaths in that city was caused by smoking (14), but a lower estimate of smoking prevalence among men was used in these calculations. That estimate was for Hispanic male respondents to the 1985 National Health Interview Survey rather than the HHANES as used in the present study.

When compared to other causes of death in Puerto Rico, smoking was found to cause four times the deaths due to traffic injuries, six times the deaths due to homicide, and seven and a half times the deaths due to suicide in 1983 (2,468 deaths versus 533, 426, and 324 deaths, respectively) (9). Although smoking is responsible for more deaths, these deaths usually occur in older people than do deaths due to traffic injuries, homicides, or suicides. Thus, smoking as a cause of death has less of an effect on YPLL than do injuries.

The estimated direct health care expenditures attributable to smoking

Table 6. Smoking-attributable direct health care costs in Puerto Rico in 1983, by sex of patient and type of cost (in millions of US dollars).

Type of cost	Men	Women	Total
Hospitalization	\$25.4	\$11.9	\$37.3
Physician services	6.2	1.4	7.6
Nursing home care	2.8	3.0	5.8
Drugs and sundries	2.4	0.6	3.0
Other professional services	2.0	0.2	2.2
Total personal health care expenditures	\$38.8	\$17.1	\$55.9

amounted to 10% of the island's total expenditure for medical treatment in 1983. This estimate does not include indirect morbidity and mortality costs attributable to smoking, which are usually included in calculations of smoking-attributable disease impact (12). Including those indirect costs would increase the entire estimated smoking-related cost for Puerto Rico substantially.

In the United States, per capita tobacco consumption and smoking prevalences have declined dramatically over the last 25 years (1). However, both production and consumption of tobacco are increasing in the developing world (6, 7). Because the population's exposure to tobacco has not yet reached its zenith in Latin America (as it did in the 1960s in the United States), the burden of smoking-related diseases has not yet approached its peak. The full extent of this burden may not yet be recognized by many Latin American nations.

Smoking has been widely discussed as an appropriate target for behavior intervention in Puerto Rico (20). Measures calculated to reduce smoking prevalence can include mass media and information campaigns, bans on cigarette advertising, bans on sales to minors, and bans on smoking in public places (21). Economic disincentives, such as higher taxes, may also be effective. Most important, public and school health education about the risks of smoking is needed to prevent development and spread of the smoking habit among adolescents.

Such interventions against tobacco could well prove appropriate elsewhere in Latin America. As smoking prevalence declines in the developed countries, increased knowledge and communication about the health consequences of smoking in other nations is becoming more important. To quantify the smoking problem and to evaluate interventions against smoking in Puerto Rico and other parts of

Latin America, periodic population-based surveys of smoking behavior will be needed. The data obtained from such surveys can help policy-makers and health care workers understand the magnitude of the smoking problem in their respective populations. In this vein, estimates of smoking-attributable disease impacts like the one presented here would be facilitated by survey data of this kind.

In general, data on deaths attributable to smoking provide support for efforts to combat the growing, worldwide epidemic of tobacco use. Those efforts are important, for there is good reason to think that a concerted multinational drive could reduce the coming epidemic of chronic diseases unleashed by smoking, and might prevent the epidemic from reaching levels already seen in countries with a longer history of exposure to tobacco.

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