

- other risk factors: results from the prospective Göttingen Risk Incidence and Prevalence Study (GRIPS). *Eur J Clin Invest.* 1994;24:444-453.
3. Routi T, Ronnemaa T, Joniken E, et al. Correlation of toddlers' serum lipoprotein(a) concentration with parental values and grandparents' coronary heart disease: the STRIP baby study. *Acta Paediatr.* 1996;85:407-412.
 4. Guazzelli R, Fatini C, Piazzini M, Lazzeri C. Lipoprotein(a): genetic marker of precocious myocardial infarction. *Ann Ital Med Int.* 1996;11:90-94.
 5. Gazzaruso C, Buscaglia P, Garzaniti A, et al. Lipoprotein(a) plasma concentrations, apolipoprotein(a) polymorphism and family history of coronary heart disease in patients with essential hypertension. *J Cardiovasc Risk.* 1996;3:191-197.
 6. Boerwinkle E, Leffert CC, Lin J, Lackner C, Chiesa G, Hobbs HH. Apolipoprotein(a) gene accounts for greater than 90% of the variation in plasma lipoprotein(a) concentrations. *J Clin Invest.* 1992;90:52-60.
 7. Hubinger L, Mackinnon LT, Lepre F. Lipoprotein(a) (Lp(a)) levels in middle-aged male runners and sedentary controls. *Med Sci Sports Med.* 1995;42:490-496.
 8. Duell PB, Hagemenas F, Connor WE. The relationship between serum lipoprotein(a) and insulinemia in healthy nondiabetic adult men. *Diabetes Care.* 1994;17:1135-1140.
 9. Holme I, Urdal P, Anderssen S, Hjermann I. Exercise-induced increase in lipoprotein(a). *Atherosclerosis.* 1996;122:97-104.
 10. Fletcher GF, Balady G, Blair SN, et al. Statement on exercise. Benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation.* 1996;94:857-862.
 11. Marrugat J, Elosua R, Covas MI, Molina L, Rubiés-Prat J. Amount and intensity of physical activity, physical fitness, and serum lipids in men. *Am J Epidemiol.* 1996;143:562-569.
 12. Taylor HL, Jacobs DR Jr, Schucker B. A questionnaire for the assessment of leisure time physical activities. *J Chronic Dis.* 1978;31:741-745.
 13. Elosua R, Marrugat J, Molina L, Pons S, Pujol E. Validation of the Minnesota Leisure Time Physical Activity Questionnaire among Spanish men. *Am J Epidemiol.* 1994;139:1197-1209.
 14. Jenner JL, Ordovas JM, Lamon-Fava S, et al. Effects of age, sex, and menopausal status on plasma lipoprotein(a) levels: the Framingham Offspring Study. *Circulation.* 1993;87:1135-1141.
 15. Covas MI, Martín S, Vila J, et al. Serum lipoprotein(a) distribution in a Spanish population. *Interciencia.* 1996;21:299-304.
 16. Paffenbarger RS Jr, Wing AL, Hyde RT. Physical activity as an index of heart attack risk in college alumni. *Am J Epidemiol.* 1978;108:161-175.
 17. Massod MF. Nonparametric percentile estimate of clinical normal ranges. *Am J Med Technol.* 1977;43:243-252.
 18. Buemann B, Tremblay A. Effects of exercise training on abdominal obesity and related metabolic complications. *Sports Med.* 1996;21:191-212.
 19. Ambrosio MR, Valentini A, Trasforini G, et al. Function of the GH/IGF-I axis in healthy middle-aged male runners. *Neuroendocrinology.* 1996;63:498-503.
 20. Chico A, Perez A, Caixas A, Ordonez J, Pou JM, de Leiva A. Lipoprotein(a) concentrations and non-insulin-dependent diabetes mellitus: relationship to glycaemic control and diabetic complications. *Diabetes Res Clin Pract.* 1996;33:105-110.
 21. Olivecrona H, Johansson AG, Lindh E, Ljunghall S, Berglund L, Angelin B. Hormonal regulation of serum lipoprotein(a) levels. Contrasting effects of growth hormone and insulin-like growth factor-I. *Arterioscl Thromb Vasc Biol.* 1995;15:847-849.

Morbidity and Mortality Attributable to Alcohol, Tobacco, and Illicit Drug Use in Canada

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ABSTRACT

Objectives. This study estimated morbidity and mortality attributable to substance abuse in Canada.

Methods. Pooled estimates of relative risk were used to calculate etiologic fractions by age, gender, and province for 91 causes of disease or death attributable to alcohol, tobacco, or illicit drugs.

Results. There were 33 498 deaths and 208 095 hospitalizations attributed to tobacco, 6701 deaths and 86 076 hospitalizations due to alcohol, and 732 deaths and 7095 hospitalizations due to illicit drugs in 1992.

Conclusions. Substance abuse exacts a considerable toll on Canadian society in terms of morbidity and mortality, accounting for 21% of deaths, 23% of years of potential life lost, and 8% of hospitalizations. (*Am J Public Health.* 1999;89:385-390)

There have been relatively few attempts to estimate morbidity and mortality attributable to alcohol, tobacco, or illicit drugs in Canada, and no study has estimated deaths and hospitalizations attributable to all types of substance abuse.¹ In this article, we present the results of a study designed to estimate mortality and morbidity attributable to alcohol, tobacco, and illicit drug use undertaken as part of a larger investigation of the economic costs of substance abuse in Canada in 1992.² This study used the definition of abuse adopted by Collins and Lapsley,³ whereby drug abuse encompasses any use that involves a social cost additional to the resource costs of the provision of that drug. The consequences of "abuse" are therefore not limited to those associated with dependence or heavy use and include morbidity and mortality associated with moderate use if such use incurs social costs to the community.

Methods

A list of potential causes of morbidity and mortality associated with substance abuse was developed from reviews of large-

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scale epidemiological studies on alcohol,⁴⁻⁶ tobacco,^{4,6,7} and illicit drugs.^{4,6,8} All conditions identified in these reviews that were, by definition, related to substance abuse were included. For some conditions in which substance abuse is a contributory but not a necessary cause, etiologic fractions were determined directly from case series data. Sources of directly determined etiologic fractions were both American⁵⁻⁹ and Canadian. (The major causes directly determined with Canadian data were motor vehicle accidents,¹⁰ fire injuries,¹¹ AIDS cases attributed to illicit drugs,² and suicide.¹²) For most conditions in which substance abuse is a contributory cause, estimates of the relative risk of particular disorders for different levels of alcohol, tobacco, or illicit drug use were combined with prevalence data on the number of persons consuming at different levels to derive the etiologic fraction, or proportion of cases that could be attributed to the use of alcohol, tobacco, or illicit drugs. The following formula was used: $[(P_0 + P_1(RR_1)) - 1] / [P_0 + P_1(RR_1)]$, where P_0 and P_1 are the prevalence rates for nonusers and users, respectively, and RR_1 is the relative risk for users relative to nonusers. In instances in which the etiologic fraction took different levels of use into account, as in the case of alcohol consumption, an appropriate alternative computation was used (see formula 1.9 in English et al.⁴).

Etiologic fractions were based on pooled estimates of relative risk rather than on single studies. For some causes of disease and death, separate estimates of the relative risk of morbidity vs mortality were calculated when there were sufficient studies. In cases in which it was established that the use of a psychoactive substance actually prevents rather than causes certain disorders (e.g., the protective effect of low-level alcohol consumption against coronary heart disease), numbers of deaths and hospitalizations prevented were calculated (and reported here) but not subtracted from the numbers of deaths and hospitalizations caused by the use of these substances, since the primary aim was to estimate total morbidity and mortality caused by substance abuse.

The prevalence data for alcohol were based on a linear interpolation of findings from national surveys conducted in 1990 (the Health Promotion Survey) and 1994 (Canada's Alcohol and Other Drugs Survey), adjusted to correspond to the normal quantity/frequency measures used in epidemiologic studies of relative risk.¹³ Abstinence and low-level, hazardous, and harmful drinking were defined, respectively, as less than 0.25, 0.26 to 40, 41 to 60, and 61 or more grams of ethanol per day for men and less than 0.25, 0.26 to 20, 21 to 40, and 41 or

more grams per day for women.⁴ Prevalence estimates for drinking among pregnant women were taken from the 1991 General Social Survey, and the proportion of pregnant women who smoked was estimated from the 1994 Survey on Smoking in Canada. Prevalence rates for opiate and cocaine use were derived from the 1994 Alcohol and Other Drugs Survey.

Relative risks and etiologic fractions were calculated, and the etiologic fractions were then applied to the reported number of deaths and hospitalizations for each cause of disease or death by age, gender, and province to estimate morbidity and mortality attributable to alcohol, tobacco, and illicit drugs in Canada in 1992. The diagnosis at the time of separation from a hospital stay is generally more complete and accurate than diagnosis at admission, so hospital separation data are used to indicate the number of hospitalizations.

Results

Tables 1 through 3 present the number of deaths, potential years of life lost (representing the difference between age of death and life expectancy after taking age and gender into account), and hospital separations and hospitalization days attributable to alcohol, tobacco, and illicit drug use in 1992. The diagnosis at the time of separation from a hospital stay is generally more complete and accurate than diagnosis at admission, so hospital separation data are used to indicate the number of hospitalizations.

Alcohol

It was estimated that, in 1992, 6701 Canadians lost their lives owing to alcohol consumption. The largest number of alcohol-related deaths stemmed from impaired-driving accidents. It was estimated that 1021 men and 456 women died in motor vehicle accidents caused by alcohol impairment. Alcoholic liver cirrhosis accounted for 960 deaths, and there were 918 alcohol-related suicides. Furthermore, the findings regarding years of potential life lost indicate that many of these deaths involved relatively young individuals. As a result of the high incidence of alcohol-related accidental deaths and suicides, the number of potential years of life lost was relatively high at 186 257 (134 495 for men and 51 762 for women). This represented 27.8 years of potential life lost per alcohol-related death. Motor vehicle accidents accounted for 22% of all alcohol-related deaths and 33% of potential years of life lost, indicating the relatively young age

of those involved in fatal alcohol-related traffic accidents. It was estimated that 86 076 alcohol-related hospitalizations (56 474 for men and 29 602 for women) occurred in 1992. Not taking comorbidity into account, the number of alcohol-related hospitalization days was estimated at 1 149 106 (755 205 for men and 393 902 for women). The greatest numbers of alcohol-related hospitalizations involved accidental falls (16 901), alcohol dependence syndrome (14 316), and motor vehicle accidents (11 154). The greatest number of hospitalization days involved accidental falls (308 224 days), indicating the serious nature of such injuries. Thus, although accidental falls accounted for only 6% of alcohol-related deaths, they accounted for 20% of hospitalizations and 27% of hospitalization days attributed to alcohol. In contrast, motor vehicle accidents accounted for 22% of deaths but only 13% of hospitalizations and 12% of hospitalization days attributed to alcohol.

These estimates of alcohol-attributable morbidity and mortality represented 3% of total mortality, 6% of total years of potential life lost, 2% of hospitalizations, and 3% of total hospitalization days due to any cause in Canada for 1992. It should also be noted, however, that alcohol prevented an estimated 7401 deaths (5162 in men and 2239 in women): 4205 deaths due to ischemic heart disease, 2965 deaths due to stroke, 183 deaths due to heart failure and other heart conditions, and 47 deaths from other causes. Thus, the number of deaths averted by low-level alcohol use was greater than the number of deaths caused by alcohol use. However, because alcohol-related mortality frequently involves relatively young persons, while the benefits apply mainly to older adults, the number of potential years of life lost due to alcohol was much greater than the potential years of life saved by alcohol use (186 257 vs 88 656). Furthermore, the number of hospitalizations averted by alcohol use (45 414) was much lower than the corresponding number of hospitalizations caused by alcohol (86 076).

Tobacco

The number of tobacco-related deaths in Canada was estimated at 33 498 for 1992. Smoking-related lung cancer accounted for the largest number of deaths (11 704), representing 35% of all deaths attributed to tobacco use. Tobacco-related ischemic heart disease accounted for 6762 deaths, and chronic obstructive pulmonary disease accounted for 5816. More than two thirds of those who died from tobacco-related causes in Canada were men. There were 208 095

TABLE 1—Morbidity and Mortality Due to Alcohol Use, by Cause and Gender: Canada, 1992

Cause	ICD-9 Code(s)	Mortality			Potential Years of Life Lost			Hospital Separations			Days Hospitalization		
		Male	Female	Total ^a	Male	Female	Total ^a	Male	Female	Total ^a	Male	Female	Total ^a
Lip and oropharyngeal cancer	140-141, 143-146, 148-149, 230.0	173	38	211	2 920	708	3 628	756	164	919	12 093	2 951	15 045
Esophageal cancer	150, 230.1	304	65	370	4 431	1 098	5 529	696	146	842	11 682	3 192	14 874
Liver cancer	155, 230.8	171	63	234	2 620	1 100	3 720	316	94	410	4 096	1 858	5 953
Laryngeal cancer	161, 231.0	170	17	186	2 535	302	2 837	722	108	830	12 071	1 770	13 841
Breast cancer	174, 233.0	0	189	189	0	4 204	4 204	0	898	898	0	8 970	8 970
Alcoholic psychoses	291	46	6	52	641	134	774	4 144	1 225	5 369	122 559	36 897	159 456
Alcohol dependence syndrome	303	416	117	533	8 093	2 766	10 859	10 670	3 646	14 316	112 394	38 693	151 087
Alcohol abuse	305.0	70	21	91	2 228	685	2 913	1 966	1 163	3 129	6 323	2 912	9 235
Epilepsy	345	21	16	37	662	516	1 177	655	569	1 224	7 497	6 698	14 195
Alcoholic polyneuropathy	357.5	0	0	0	0	0	0	41	13	54	838	564	1 402
Hypertension	401-405	23	7	30	278	81	360	329	134	462	2 894	1 259	4 153
Alcoholic cardiomyopathy	425.5	69	4	73	1 238	67	1 305	205	17	222	1 945	145	2 090
Cardiac dysrhythmias	427.0, 427.2, 427.3	56	48	103	493	441	934	2 984	1 620	4 604	16 114	10 257	26 371
Heart failure and ill-defined	428-429	8	5	12	90	43	133	359	211	570	5 142	3 940	9 082
Stroke	430-438	142	12	153	1 555	192	1 747	900	74	973	36 566	3 357	39 923
Esophageal varices	456.0-456.2	5	1	6	75	16	91	254	96	350	2 190	902	3 091
Gastroesophageal hemorrhage	530.7	3	0	4	37	7	43	218	97	315	1 013	427	1 441
Alcoholic gastritis	535.3	18	5	23	413	149	562	1 500	553	2 053	5 740	2 225	7 965
Alcoholic liver cirrhosis	571.0-571.3	719	241	960	14 652	6 425	21 077	3 750	1 470	5 220	56 182	22 008	78 190
Pancreatitis	577.0, 577.1	40	34	74	697	545	1 242	2 371	1 599	3 969	24 422	18 055	42 477
Pregnancy complications	634	0	0	0	0	1	1	0	382	382	0	529	529
Psoriasis	696.1	0	0	0	0	0	0	134	90	224	2 245	1 757	4 002
Neonatal conditions	760.7, 761.8	0	0	0	1	0	1	24	25	49	757	1 080	1 837
Excess blood alcohol	790.3	0	0	0	0	0	0	0	0	0	0	0	0
Alcohol toxicity	980.0, 980.1, or E860.0-E860.2 ^b	47	9	56	1 685	339	2 024	392	242	634	1 007	553	1 560
Medicolegal blood exam	V70.4	0	0	0	0	0	0	0	1	1	0	0	1
Motor vehicle accidents	E810-E819, E820-E825	1 021	456	1 477	41 920	18 990	60 910	7 185	3 969	11 154	87 760	47 157	134 917
Other road vehicle accidents	E826, E829	2	1	3	67	36	102	455	221	676	1 939	987	2 926
Water transport accidents	E830-E839	33	3	36	1 288	152	1 440	67	26	92	474	186	661
Airspace transport accidents	E840-E845	10	1	11	377	31	408	30	8	38	350	74	425
Accidental falls	E880-E888	233	175	408	3 723	2 094	5 817	9 290	7 611	16 901	165 408	142 816	308 224
Accidents by fire and flames	E890-E899	82	41	123	3 187	1 771	4 958	95	34	128	1 951	848	2 799
Accidental excessive cold	E901	13	4	17	380	100	480	97	31	128	1 896	305	2 201
Accidental drowning	E910	69	13	83	2 795	486	3 280	39	13	52	407	73	480
Aspiration vomitus	E911	25	20	45	514	323	837	94	73	167	3 052	1 606	4 658
Accidents with objects/machines	E917, E918, E919-E920	8	1	9	261	26	287	831	180	1 011	4 444	3 631	8 075
Accidents with firearm missile	E922	13	1	13	560	31	591	74	9	82	640	87	727
Suicide, self-inflicted injury	E950-959	788	131	918	29 634	5 391	35 025	2 319	2 053	4 372	21 732	17 724	39 456
Victim, assault	E960-E966, E968-E969	107	52	160	4 387	2 500	6 887	2 475	700	3 175	18 600	7 060	25 660
Victim, child battering	E967	1	0	1	59	13	71	39	37	76	781	345	1 126
Total		4 904	1 796	6 701	134 495	51 762	186 257	56 474	29 602	86 076	755 205	393 902	1 149 106
Rate per 100 000 population		34.8	12.5	23.6	954	361	655	401	206	303	5 359	2 746	4 041
Alcohol-attributed total, % of all-cause total		2.50	0.91	3.41	4.37	1.68	6.05	1.55	0.81	2.36	1.83	0.95	2.78

Note. ICD-9 = International Classification of Diseases, 9th Revision.

^aSum of male and female data may not equal total figures because of rounding.

^bN-codes were used with hospital data and E-codes were used with mortality data.

TABLE 2—Morbidity and Mortality Due to Tobacco Use, by Cause and Gender: Canada, 1992

Cause	ICD-9 Code(s)	Mortality		Potential Years of Life Lost		Hospital Separations		Days Hospitalization					
		Male	Female	Male	Female	Male	Female	Male	Female				
		Total	Total	Total	Total	Total	Total	Total	Total				
Lip and oropharyngeal cancer	140-141, 143-146, 148-149, 230.0	319	107	426	5 453	2 032	7 485	1 403	465	1 868	22 397	8 268	30 665
Esophageal cancer	150, 230.1	412	117	529	6 073	2 041	8 114	945	262	1 208	15 821	5 707	21 529
Stomach cancer	151, 230.2	160	67	227	2 339	1 251	3 589	406	150	556	6 966	3 028	9 994
Anal cancer	154.2-154.3, 230.5-230.6	7	5	12	123	82	205	60	80	141	641	1 422	2 064
Pancreatic cancer	157, 230.9	284	192	476	4 352	3 429	7 781	515	352	866	8 943	7 232	16 174
Laryngeal cancer	161, 231.0	290	39	329	4 329	720	5 050	1 232	256	1 488	20 557	4 190	24 747
Lung cancer	162, 231.2	8 255	3 449	11 704	117 917	67 986	185 903	17 290	7 734	25 024	285 511	137 728	423 239
Lung cancer (spousal environmental tobacco smoke)	162, 231.2	24	77	101	337	1 469	1 805	49	170	219	819	3 068	3 887
Cervical cancer	180, 233.1	0	72	72	0	2 094	2 094	0	1 118	1 118	0	8 627	8 627
Vulvar cancer	184.4	0	17	17	0	232	232	0	145	145	0	2 303	2 303
Penile cancer	187.1-187.4	7	0	7	89	0	89	48	0	48	544	0	544
Bladder cancer	188, 233.7	320	87	407	3 675	1 259	4 934	3 821	874	4 694	33 307	8 386	41 693
Renal cancer	189.0-189.2	226	89	316	3 450	1 633	5 083	885	417	1 301	14 235	6 472	20 707
Tobacco abuse	305.1	11	6	17	168	86	254	10	9	19	88	52	140
Ischemic heart disease	410-414	4 876	1 886	6 762	78 914	29 123	108 037	37 648	14 363	52 011	302 584	148 211	450 795
Pulmonary circulatory disease	415.0, 416-417	63	53	116	1 012	1 204	2 217	356	357	713	5 219	7 653	12 872
Cardiac dysrhythmias	427	262	143	404	4 422	2 424	6 846	5 895	4 130	10 025	33 385	25 865	59 250
Heart failure, ill-defined	428-429	321	206	527	3 923	2 534	6 457	6 598	4 235	10 833	83 642	74 674	158 316
Stroke	430-438	1 156	951	2 107	15 530	15 327	30 857	8 389	5 508	13 897	313 352	256 937	570 289
Arterial disease	440-448	1 128	596	1 724	12 022	6 670	18 693	8 594	3 534	12 129	152 758	88 167	240 925
Pneumonia and influenza	480-487	608	322	930	5 677	3 562	9 240	5 709	3 487	9 196	78 343	48 952	127 294
Chronic obstructive pulmonary disease	490-492, 496	3 998	1 817	5 816	38 377	23 237	61 614	22 595	14 277	36 872	381 254	249 028	630 282
Ulcers	531-534	147	74	221	1 767	960	2 728	5 198	2 675	7 873	41 509	24 479	65 988
Crohn's disease	555	8	9	17	149	171	320	1 095	2 231	3 326	12 859	24 839	37 698
Ulcerative colitis	556	4	3	7	47	40	87	351	239	590	4 683	2 896	7 579
Pregnancy complications	633-634, 640-641, 656.5, 658.1-658.2	0	0	0	0	15	15	0	8 280	8 280	0	31 561	31 561
Stillbirth	740-759, 760-779	53	40	93	3 954	3 236	7 191						
Neonatal conditions	760.1, 761.4, 761.8, 762.0-762.1, 764-765							354	287	641	7 355	6 008	13 363
Sudden infant death syndrome	798.0	49	39	88	3 628	3 176	6 804	7	5	11	8	5	13
Chemotherapy	V07.3, V58.1, V66.2							1 234	1 719	2 953	5 488	5 157	10 645
Accidents by fire and flames	E890-E899	32	16	48	1 232	685	1 917	37	13	50	754	328	1 082
Total		23 018	10 480	33 498	318 960	176 679	495 640	130 724	77 371	208 095	1 833 024	1 191 241	3 024 265
Rate per 100 000 population		163	73	118	2 263	1 232	1 743	928	539	732	13 008	8 305	10 635
Tobacco-attributed total, % of all-cause total		11.71	5.33	17.05	10.36	5.74	16.09	3.58	2.12	5.71	4.43	2.88	7.31

Note. ICD-9 = International Classification of Diseases, 9th Revision.

TABLE 3—Morbidity and Mortality Due to Illicit Drug Use, by Cause and Gender: Canada, 1992

Cause	ICD-9 Code(s)	Mortality			Potential Years of Life Lost			Hospital Separations			Days Hospitalization		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
AIDS	042-044	52	9	61	1 965	401	2 366	136	36	172	2 360	730	3 091
Viral hepatitis B	070.2-070.3	5	0	5	191	10	201	65	34	100	444	264	708
Viral hepatitis non-A, non-B	070.4-070.5	0	0	1	13	15	28	23	11	34	89	75	164
Drug psychoses	292	0	0	0	0	0	0	679	528	1 207	7 146	6 037	13 183
Opioid dependence/abuse	304.0, 304.7, 305.5	28	0	28	1 139	0	1 139	379	306	685	2 615	2 802	5 417
Cocaine dependence/abuse	304.2, 305.6	7	3	10	301	150	451	746	405	1 151	6 011	3 033	9 044
Cannabis dependence/abuse	304.3, 305.2	0	0	0	0	0	0	118	36	154	1 304	502	1 806
Amphetamine, etc. dependence/abuse	304.4, 305.7	0	1	1	0	45	45	25	22	47	286	319	605
Hallucinogen dependence/abuse	304.5, 305.3	0	0	0	0	0	0	103	22	125	692	80	772
Infective endocarditis	421	1	0	1	47	22	68	16	12	28	336	242	578
Pregnancy complications	640-641, 648.3, 656.5	0	0	0	0	3	3	0	649	649	0	2 762	2 762
Neonatal conditions	760.7, 762.0-762.1, 764-765, 779.5	3	3	6	252	219	471	74	67	141	1 464	1 433	2 897
Opiate poisoning	965.0 or E850.0, E850.1, E935.1 ^a	82	22	104	2 987	875	3 861	235	261	496	819	1 018	1 837
Cocaine poisoning	968.5 or E855.2 ^a	59	9	68	2 548	460	3 008	130	62	192	272	177	449
Psychotropic poisoning	969.6-969.9 or E854.1, E854.2 ^a	1	0	1	40	0	40	211	228	439	1 305	1 888	3 193
Motor vehicle traffic accidents	E810-E819	31	0	31	1 486	0	1 486	286	0	286	3 523	0	3 523
Suicide, self-inflicted injury	E950-E959	292	16	308	12 868	796	13 664	1 113	71	1 184	7 835	672	8 508
Victim, assault	E960-E969	44	4	48	1 917	220	2 137	5	0	5	33	0	33
Injury received during legal intervention	E970-E978	1	0	1	65	0	65	0	0	0	0	0	0
Poisoning, intent undetermined	E980	34	24	57	1 226	888	2 113	0	0	0	0	0	0
Total		641	91	732	27 044	4 103	31 147	4 345	2 750	7 095	36 536	22 035	58 571
Rate per 100 000 population		4.55	0.64	5.19	192	29	221	30.8	19.2	50.0	259	154	413
Illicit drug-attributed total, % of all-cause total		0.33	0.05	0.37	0.88	0.13	1.01	0.12	0.08	0.19	0.09	0.05	0.14

Note. ICD-9 = International Classification of Diseases, 9th Revision.

^aN-codes were used with hospital data and E-codes were used with mortality data.

hospitalizations due to tobacco use. The largest number of smoking-related hospitalizations involved ischemic heart disease (37 748 for men and 14 363 for women). There were more than 3 million hospitalization days resulting from tobacco use. The most common causes of tobacco-related hospitalization days were chronic obstructive pulmonary disease (630 282 days, representing 21% of all smoking-related hospitalization days), stroke (570 289 days, or 19% of the total), ischemic heart disease (450 795 days, or 15% of the total), and lung cancer (423 239 days, or 14% of the total). Tobacco-attributed morbidity and mortality accounted for 17% of total mortality, 16% of total potential years of life lost, 6% of hospitalizations, and 7% of all hospitalization days due to any cause in Canada in 1992. Tobacco use did not prevent nearly as many deaths or hospitalizations as it caused. It was estimated that 356 deaths were prevented (237 in men and 119 in women), mainly owing to the beneficial effects of smoking on Parkinson's disease (295 deaths averted) and endometrial cancer (59 deaths averted). The number of hospitalizations averted as a result of smoking was estimated at 3067 (1196 for men and 1871 for women).

Illicit Drugs

The number of illicit drug-related deaths in 1992 was estimated at 732, representing 0.4% of total mortality. Most of these deaths involved men (87%). Suicide accounted for 42% of illicit drug-related deaths, while opiate poisoning and cocaine poisoning accounted for 14% and 9%, respectively. AIDS acquired through illicit drug use accounted for 61 deaths (8% of all illicit drug-related deaths). Although illicit drug-related mortality was thus infrequent relative to deaths caused by alcohol and tobacco, such deaths involved younger victims. The 732 deaths resulted in 31 147 potential years of life lost, or 42.6 years per death and 1% of total years of life lost owing to any cause in 1992. No deaths were prevented by illicit drug use. There were 7095 hospitalizations (0.2% of total hospitalizations in 1992) and 58 571 hospitalization days due to illicit drug use. Drug psychosis (1207), assaults (1184), and cocaine abuse (1151) were the most common causes of illicit drug-related hospitalizations.

Discussion

The estimates of morbidity and mortality attributable to substance abuse described here are generally lower than American esti-

mates^{8,14} and those of prior Canadian studies.¹⁵ In particular, the estimate of tobacco-related deaths in this study is 18% lower than a Canadian estimate for 1991.¹⁵ The lower estimate of tobacco-related mortality in this study appears to be largely due to the use of pooled estimates of relative risk rather than reliance on a single study.¹⁶ For example, whereas the prior study estimated the relative risk of lung cancer for male smokers vs nonsmokers at 22, the corresponding estimate in this study (based on pooling of estimates from 10 other studies in addition to the study used in the prior estimate) was only 13. Pooled estimates of relative risk were similarly lower with regard to chronic obstructive pulmonary disease and ischemic heart disease.

The estimate of 6701 deaths attributable to alcohol in this study is much lower than the most recent estimate of 19 163 for 1991.¹⁷ This and similar differences with regard to morbidity were largely due to the use of much more precise estimates of relative risk (many of the studies we used were not available for earlier studies), the use of specific rather than broad disease categories (e.g., prior estimates applied a single etiologic fraction to all forms of cancer, including many types in which there is no evidence of a causal connection to alcohol use), and the control of age, gender, and province in this study (whereas prior estimates did not standardize for these variables, and thus, for example, even some childhood cancer deaths were attributed to alcohol).

While our estimates are lower than those of prior studies, they nevertheless indicate that alcohol, tobacco, and illicit drug use represent a major source of death and illness in Canada. Substance abuse accounts for 21% of total mortality, 23% of total potential years of life lost, 8% of total hospitalizations, and 10% of hospitalization days due to any cause. □

Contributors

E. Single planned the study, prepared the funding proposals, acted as liaison with the study's steering committee, and wrote the paper. L. Robson helped plan the study, conducted the spreadsheet work, and assisted in writing the paper. J. Rehm assisted in planning the study, conducted a special study of coroner reports, designed and carried out a sensitivity analysis, and assisted in writing the paper. X. Xie provided advice on the design of the study, verified the spreadsheet results, and assisted in writing the paper. All 4 authors are guarantors for the integrity of the research.

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References

1. Robson L, Single E. *Literature Review of Studies on the Economic Costs of Substance Abuse*. Ottawa, Ontario, Canada: Canadian Centre on Substance Abuse; 1995.
2. Single E, Robson L, Xie X, Rehm J. *The Costs of Substance Abuse in Canada*. Ottawa, Ontario, Canada: Canadian Centre on Substance Abuse; 1996.
3. Collins D, Lapsley H. *Estimating the Economic Costs of Drug Abuse in Australia*. Canberra, Australian Capital Territory, Australia: Commonwealth of Australia National Campaign Against Drug Abuse; 1991. Monograph 15.
4. English D, Holman D, Milne E, et al. *The Quantification of Drug Caused Morbidity and Mortality in Australia, 1992*. Canberra, Australian

Capital Territory, Australia: Commonwealth Dept of Human Services and Health; 1995.

5. Shultz J, Rice D, Parker D, Goodman R, Stroh G, Chalmers N. Quantifying the disease impact of alcohol with ARDI software. *Public Health Rep*. 1991;106:443-450.
6. Fox K, Merrill J, Chang H, Califano J. Estimating the costs of substance abuse to the Medicaid hospital care program. *Am J Public Health*. 1995;85:48-54.
7. Shultz J, Novotny T, Rice D. Quantifying the disease impact of cigarette smoking with SAMMEC II software. *Public Health Rep*. 1991;106:326-333.
8. Rice D, Kelman S, Miller L, Dunmeyer S. *The Economic Cost of Alcohol and Drug Abuse and Mental Illness 1985*. San Francisco, Calif: Institute for Health and Aging, University of California; 1990. DHHS publication ADM 90-1694.
9. Bincoe T, Faigin B. Economic impact of motor vehicle crashes—United States, 1990. *MMWR Morb Mortal Wkly Rep*. 1993;42:443-448.
10. *Motor Vehicle Accidents and Alcohol*. Ottawa, Ontario, Canada: Traffic Injury Research Foundation; 1996.
11. *Annual Report: Fire Losses in Canada, 1992*. Ottawa, Ontario, Canada: Association of Canadian Fire Marshalls and Fire Commissioners; 1996.
12. Rehm J, Ialomiteanu D, Walsh G, Adlaf E, Single E. *The Quantification of Mortality Caused by Illicit Drugs in Canada, 1992*. Toronto, Ontario, Canada: Addiction Research Foundation; 1996.
13. Rehm J, Walsh G, Adlaf E, Single E. *Assessment Methods, Prevalence of High Risk Drinking and Harm—A Sensitivity Analysis*. Toronto, Ontario, Canada: Addiction Research Foundation; 1996.
14. Public Health Practices Program Office. Cigarette smoking—attributed mortality and years of life lost—United States, 1990. *MMWR Morb Mortal Wkly Rep*. 1990;42:645-649.
15. Makamaski-illing E, Kaiserman M. Mortality attributable to tobacco use in Canada and its regions, 1991. *Can J Public Health*. 1995;86:257-265.
16. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*. Washington, DC: US Public Health Service; 1989. DHHS publication CDC 89-8411.
17. Williams R, Single E, McKenzie D. *Canadian Profile: Alcohol, Tobacco and Other Drugs 1995*. Ottawa, Ontario, Canada: Canadian Centre on Substance Abuse; 1995.