Medical Costs and Productivity Losses Due to Interpersonal and Self-Directed Violence in the United States

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Background: Violence-related injuries, including suicide, adversely affect the health and welfare of all Americans through premature death, disability, medical costs, and lost productivity. Estimating the magnitude of the economic burden of violence is critical for understanding the potential amount of resources that can be saved if cost-effective violence prevention efforts can be broadly applied. From 2003 to 2005, the lifetime medical costs and productivity losses associated with medically treated injuries due to interpersonal and self-directed violence occurring in the United States in 2000 were assessed.

Methods: Several nationally representative data sets were combined to estimate the incidence of fatal and nonfatal injuries due to violence. Unit medical and productivity costs were computed and then multiplied by corresponding incidence estimates to yield total lifetime costs of violence-related injuries occurring in 2000.

Results: The total costs associated with nonfatal injuries and deaths due to violence in 2000 were more than $70 billion. Most of this cost ($64.4 billion or 92%) was due to lost productivity. However, an estimated $5.6 billion was spent on medical care for the more than 2.5 million injuries due to interpersonal and self-directed violence.

Conclusions: The burden estimates reported here provide evidence of the large health and economic burden of violence-related injuries in the U.S. But the true burden is likely far greater and the need for more research on violence surveillance and prevention are discussed.
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Introduction

Violence is a leading cause of mortality and morbidity in the United States, resulting in approximately 50,000 deaths and 2.2 million injuries annually that require medical attention.[1] Violence-related injuries are defined as those that result from the intentional use of physical force or power against oneself, another person, or a group or community. This definition encompasses injuries that result from acts of interpersonal violence such as homicide, child maltreatment, youth violence, intimate partner violence, and other types of assaults. It also includes acts of self-directed violence such as suicide, suicide attempts, and self-mutilation. Violence adversely affects the health and welfare of all Americans through premature death, disability, medical costs, and lost productivity. Estimating the magnitude of the economic burden of violence is critical for understanding the potential amount of resources that can be saved if cost-effective violence prevention efforts can be broadly applied.

This study analyzed the incidence and rate (per 100,000), lifetime medical costs, and lifetime productivity losses of physical injuries from interpersonal and self-directed violence requiring medical attention in the U.S. in 2000. These results are part of a larger effort[2,3] that combines the best available incidence and cost data to date to assess the incidence and economic burden of all injuries, including injuries caused by violence and unintentional mechanisms.

These findings are an important first step in estimating the economic burden of interpersonal and self-directed violence, for determining the appropriate level of investment for specific violence prevention activities, and for assessing the relative burden of violence compared with the burden of other health outcomes of interest. While unique and an important contribution to the field, this analysis provides impor-

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tant insight into deficiencies in data availability that inhibit a full understanding of the economic burden of violence. The authors suggest some important directions for improved surveillance of violence incidence and costs in order to establish more complete estimates of the costs of violence in the future.

Methods

Injuries associated with interpersonal violence are defined by International Classification of Diseases-9-Clinical Modifications (ICD-9-CM) diagnoses codes E960–E969 (X85–Y09, Y871), and injuries associated with self-inflicted violence are defined by diagnosis codes E950-E959 (X60–X84, Y870) within the national data sources described below. Violence-related injury incidence counts and rates (per 100,000) are presented for two mutually exclusive categories that reflect injury severity: (1) injuries resulting in death, including deaths occurring within and outside a healthcare setting, and (2) total injuries, which represent injury deaths, injuries resulting in hospitalization with survival to discharge, and injuries that receive medical attention without hospitalization (including emergency department visit, an office-based visit, or a hospital outpatient visit). Unduplicated injuries are summed to quantify total injuries. Injuries that are not medically treated are not included in this analysis.

The incidence, lifetime medical costs, and lifetime productivity losses for interpersonal and self-inflicted injuries are stratified by gender by age group, and then separately by gender by mechanism. Unit cost estimates are reported for injuries resulting in death, hospitalization, and nonhospitalization. All analyses were conducted from 2003 to 2005 and a full description of the methods is provided in Finkelstein et al.,[2] with a briefer discussion specific for violence-related injuries provided below and in the online appendix (www.ajpm-online.net).

Incidence

Incidence data were obtained from the best nationally representative data sources available. Fatal injury counts were taken from the 2000 National Vital Statistics System (NVSS) data. The 2000 Healthcare Cost and Utilization Project–Nationwide Inpatient Sample (HCUP-NIS) was used to estimate the incidence of nonfatal violent injuries resulting in hospitalization. The 1999 Medical Expenditure Panel Survey (MEPS), the 2001 National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP), the 1999 and 2000 National Hospital and Ambulatory Medical Care Survey (NHAMCS), and the 1999 and 2000 National Ambulatory Medical Care Survey (NAMCS) were used to estimate the incidence of nonfatal, nonadmitted medically treated injuries. Overall incidence counts were obtained from MEPS, and the NEISS-AIP, NHAMCS, and NAMCS were used to stratify incidence counts by intent and mechanism.

Population counts from the 1999 MEPS, which provided most of the injury incidence counts, were used to compute incidence rates. These data cover the civilian, noninstitutionalized resident population of the U.S. Its 276.4 million estimate is only slightly lower than the U.S. Census Bureau's broader estimates of total U.S. residents, including those in institutions, of 279.0 million for 1999 and 281.4 million for 2000.[4] Although a mix of data from 1999 through 2001 was used in this analysis, it was assumed that the incidence of injuries did not substantially differ during this period. Injuries are reported as if occurring in a single year, 2000.

Costs

Unit costs for injuries were computed using the strata identified for incidence, and they were calculated separately for fatal and nonfatal injuries. These costs were then multiplied by corresponding incidence estimates to yield total costs. All costs were converted costs to year-2000 U.S. dollars using the relevant component of the U.S. Consumer Price Index.[5] Costs were assessed from a societal perspective (i.e., including all costs regardless of payer or to whom they accrue), and future costs were converted to present value using a 3% discount rate.

Medical costs varied by severity of injury (fatal or nonfatal) and place of treatment. For fatal injuries, depending on place of death, medical costs included: ambulance transport, coroner/medical examiner costs, emergency department, inpatient hospitalization, and/or nursing home costs. HCUP-NIS data and cost-to-charge ratios from the Agency for Healthcare Research and Quality were used to compute inpatient facility costs. Adjustments were made to inpatient facility costs to quantify nonfacility costs (e.g., for specialist care) incurred during an inpatient admission.

For nonfatal violence injuries resulting in hospitalization, medical costs included inpatient hospitalization costs (with the adjustment for nonfacility costs described above), and some proportion incurring ambulance transport, emergency department costs, hospital readmission costs, hospital rehabilitation, nursing home costs, and adjustments for short- to long-term follow-up care post-admission (see Finkelstein et al.[2] and the online appendix for full details of adjustments).

Medical Expenditure Panel Survey data were used to estimate costs of nonhospitalized injuries, divided into three categories of treatment location: emergency department, outpatient but no office-based or emergency department utilization, and office-based but no emergency department utilization. The cost of ambulance transport was added to some proportion of emergency department visits.

Productivity losses were also estimated separately for fatal and nonfatal injuries using the strata identified above. For a person of a given gender and age who sustained a fatal or permanent injury, the net present value of future wage earnings (plus adjustments for fringe benefits, growth in earnings over time, and losses in household productivity) was used to approximate productivity losses.[6] Average daily wage and fringe benefit costs were estimated from the 2000 Current Population Survey. For nonfatal injuries, productivity loss equaled the sum of the value of wage and household work lost due to short- or long-term disability in the recovery phase. Probabilities of short- to long-term losses in productivity were taken from the literature.[7] Following numerous other studies,[7–9] the value of lost household work as a percentage of wages lost was used to impute a value for lost household work.

Table 1. Incidence counts and rates (per 100,000) and total lifetime costs (in millions) of assault injuries by age category and gender, 2000

	Fatal incidence	Fatal rate	Fatal medical costs ($)	Fatal productivity losses ($)	Fatal total costs ($)	Total incidence	Total rate	Total medical costs ($)	Total productivity losses ($)	Total costs ($)
Total	**16,830**	**6**	**83**	**21,988**	**22,070**	**2,204,098**	**797**	**4,277**	**32,826**	**37,103**
0–4	708	4	8	712	720	41,424	210	91	838	929
5–14	373	1	2	467	470	265,024	642	281	1,058	1,339
15–24	4,958	13	23	7,896	7,919	742,325	1,986	1,376	11,626	13,002
25–44	7,418	9	33	10,717	10,749	901,279	1,090	1,849	15,937	17,786
45–64	2,497	4	13	2,079	2,092	233,350	390	593	3,217	3,810
65–74	444	3	2	90	92	11,064	63	46	110	156
≥75	432	3	2	26	29	9,632	64	41	39	80
Male	**12,880**	**10**	**67**	**18,653**	**18,720**	**1,203,680**	**894**	**3,095**	**26,911**	**30,006**
0–4	404	4	5	473	478	21,049	205	55	552	607
5–14	229	1	1	329	331	173,303	828	186	844	1,030
15–24	4,220	22	20	7,074	7,094	442,526	2,332	1,044	10,032	11,076
25–44	5,713	14	27	9,027	9,055	445,807	1,106	1,339	12,931	14,270
45–64	1,825	6	10	1,680	1,690	110,346	382	416	2,464	2,880
65–74	280	4	1	59	61	6,563	82	32	71	103
≥75	209	4	1	11	13	4,085	69	23	16	39
Female	**3,950**	**3**	**16**	**3,334**	**3,350**	**1,000,418**	**705**	**1,182**	**5,916**	**7,098**
0–4	304	3	3	239	242	20,376	216	36	286	322
5–14	144	1	1	138	139	91,721	451	95	214	309
15–24	738	4	2	823	825	299,799	1,630	333	1,593	1,926
25–44	1,705	4	5	1,689	1,695	455,472	1,076	510	3,006	3,516
45–64	672	2	3	400	403	123,004	399	177	753	930
65–74	164	2	0.5	31	31	4,501	47	14	39	53
≥75	223	2	1	15	16	5,547	60	18	23	41

Results

In 2000, more than 2.5 million injuries were due to interpersonal and self-directed violence, resulting in total lifetime costs of >$70 billion. An estimated $5.6 billion were spent on medical care for these violence-related injuries, and $64.7 billion were lost in work and household productivity.

Interpersonal Violence

Table 1 provides incidence counts and rates (per 100,000) and total lifetime costs of injuries due to interpersonal violence by age category and gender. In 2000, Americans suffered >2.2 million medically treated injuries due to interpersonal violence. This equates to roughly nine interpersonal violence-related injuries per 1000 males and 7 per 1000 females. The total lifetime cost of injuries due to interpersonal violence occurring in 2000 was approximately $37 billion—$4 billion for medical treatment and $33 billion for lost productivity. Nearly 17,000 acts of interpersonal violence resulted in homicide, costing society $22.1 billion in medical costs and lost productivity.

Average cost per case for a fatal assault was $4906 in medical costs and $1.3 million for lost productivity. Average cost per case for a nonfatal assault resulting in hospitalization was $24,353 in medical costs and $57,209 in lost productivity. Average cost per case for a nonfatal assault treated in a nonhospital setting (either an emergency department visit, an office-based visit, or a hospital outpatient visit) was $1002 in medical costs and $2822 in lost productivity.

People aged 15 to 44 years, who represent 44% of the U.S. population, accounted for almost 75% of injuries and 83% of total costs due to interpersonal violence. The overall incidence of these injuries was higher for males than females. For homicides, males accounted for more than 75% of the total incidence and 85% of total fatal costs.

Table 2 provides incidence and costs for injuries due to interpersonal violence by gender and mechanism. Overall, being struck by or against an object was the most common form of interpersonal violence-related injury, accounting for nearly 77% of the total incidence. For both males and females, homicides most frequently involved a firearm.

For both males and females, struck by/against injuries accounted for the greatest burden from medical costs, and firearm/gunshot-related injuries caused the greatest burden from productivity losses. Overall, total costs were highest for males experiencing firearm/gunshot injuries, accounting for 52% of the total costs for males, and total costs were highest for females reporting struck by/against injuries, accounting for 34% of the total costs for females.

Table 2. Incidence counts and rates (per 100,000) and total lifetime costs (in millions) of assault injuries by mechanism and gender

	Fatal incidence	Fatal rate	Fatal medical costs ($)	Fatal productivity losses ($)	Fatal total costs ($)	Total incidence	Total rate	Total medical costs ($)	Total productivity losses ($)	Total costs ($)
Total	**16,830**	**6**	**83**	**21,989**	**22,072**	**2,204,098**	**797**	**4,277**	**32,826**	**37,103**
MV/other road user	106	0	0.7	123	124	13,938	5	51	203	254
Falls	18	0	0.2	23	23	18,290	7	35	73	108
Cut/pierce	1,810	1	8	2,203	2,211	135,690	49	376	3,259	3,635
Struck by/against	350	0	4	397	401	1,688,001	611	2,384	6,893	9,277
Fire/burn	186	0	3	180	183	9,865	4	24	228	252
Poisoning	57	0	0.2	55	55	5,573	2	12	69	81
Firearm/gunshot	10,840	4	43	15,380	15,423	53,750	19	822	16,602	17,424
Other[a]	3,463	1	24	3,628	3,652	278,991	101	574	5,499	6,073
Male	**12,880**	**10**	**67**	**18,653**	**18,720**	**1,203,680**	**894**	**3,095**	**26,911**	**30,006**
MV/other road user	61	0	0.3	82	82	7,606	6	30	135	165
Falls	11	0	0.2	16	16	9,715	7	22	54	76
Cut/pierce	1,287	1	7	1,757	1,764	99,328	74	316	2,678	2,994
Struck by/against	266	0	3	338	341	925,062	687	1,605	5,315	6,920
Fire/burn	83	0	1	95	96	5,975	4	15	130	145
Poisoning	26	0	0.1	34	34	2,803	2	6	45	51
Firearm/gunshot	9,044	7	37	13,804	13,841	45,983	34	734	14,932	15,666
Other[a]	2,102	2	18	2,526	2,544	107,207	80	368	3,620	3,988
Female	**3,950**	**3**	**16**	**3,334**	**3,350**	**1,000,418**	**705**	**1,182**	**5,915**	**7,098**
MV/other road user	45	0	0.3	41	41	6,331	4	21	68	89
Falls	7	0	0.03	6	6	8,575	6	13	19	32
Cut/pierce	523	0	2	445	447	36,362	26	60	581	641
Struck by/against	84	0	1	58	59	762,939	538	780	1,577	2,357
Fire/burn	103	0	2	85	87	3,890	3	9	98	107
Poisoning	31	0	0.2	21	21	2,770	2	6	24	30
Firearm/gunshot	1,796	1	5	1,577	1,582	7,767	5	88	1,669	1,757
Other[a]	1,361	1	6	1,101	1,107	171,784	121	206	1,879	2,085

[a]Injuries categorized as "Other" resulted from varied mechanisms, including drowning/submersion and inhalation/suffocation.
MV, motor vehicle.

Self-Inflicted Violence

In 2000, Americans suffered more than 324,000 medically treated injuries due to self-inflicted violence. The total lifetime cost of self-inflicted injuries occurring in 2000 was approximately $33 billion, including $1 billion for medical treatment and $32 billion for lost productivity. More than 29,000 (9%) of self-inflicted injuries resulted in suicide, for a total cost of $30.4 billion, or 91% of the total cost of self-inflicted injury.

Average cost per case for a fatal self-inflicted injury (suicide) was $2596 in medical costs and $1.0 million in lost productivity. Average cost per case for a nonfatal self-inflicted injury resulting in hospitalization was $7234 in medical costs and $9726 in lost productivity. Average cost per case for a nonfatal self-inflicted injury treated in a nonhospital setting was $1139 in medical costs and $1015 in lost productivity.

Table 3 provides incidence counts and rates (per 100,000) and total lifetime costs of injuries due to self-inflicted injury by age category and gender. The overall suicide rate was higher for males than for females. However, when including nonfatal self-inflicted injuries, the overall rate of self-inflicted injuries was higher for females compared to males. Overall, people aged ≥75 years had the highest suicide rate, although the trend is different for females, where those aged 45 to 64 had the highest suicide rate. For both males and females, the total self-inflicted injury rate was highest in persons aged 15 to 24 years. Males accounted for 45% of self-inflicted injury-related medical costs and 85% of self-inflicted injury-related productivity losses, which, like injuries due to interpersonal violence, is due in part to the higher incidence of fatal injuries in males compared to females, and the higher per incident productivity loss estimates for males.

Table 4 provides incidence and costs of self-inflicted injuries by gender and mechanism. Overall, poisonings (66%) and cuttings/piercings (18%) were the most common forms of self-inflicted injuries. Firearms were used in 56% of suicides, of which 87% were committed by men. Overall, the rate of self-inflicted firearm injury among males was six times higher than the rate for females. The rate of self-inflicted poisoning injury for females was 60% higher than the rate for males.

Table 3. Incidence counts and rates (per 100,000) and total lifetime costs (in millions) of self-inflicted injuries by age category and gender, 2000

	Fatal incidence	Fatal rate	Fatal medical costs ($)	Fatal productivity losses ($)	Fatal total costs ($)	Total incidence	Total rate	Total medical costs ($)	Total productivity losses ($)	Total costs ($)
Total	**29,416**	**11**	**76**	**30,297**	**30,374**	**324,053**	**117**	**1364**	**31,957**	**33,321**
0–4	0	0	0	0	0	0	0	0	0	0
5–14	307	1	3	428	431	15,876	38	44	487	531
15–24	4,009	11	11	6,382	6,393	100,351	269	311	6,804	7,115
25–44	11,388	14	27	16,086	16,112	145,664	176	633	17,019	17,652
45–64	8,393	14	21	6,772	6,793	49,866	83	293	7,001	7,294
65–74	2,294	13	5	457	462	5,822	33	37	467	504
≥75	3,025	20	10	173	183	6,472	43	46	179	225
Male	**23,677**	**18**	**58**	**26,157**	**26,214**	**145,375**	**108**	**650**	**27,167**	**27,817**
0–4	0	0	0	0	0	0	0	0	0	0
5–14	244	1	2	364	366	3,943	19	14	396	410
15–24	3,438	18	9	5,749	5,759	41,675	220	151	6,014	6,165
25–44	9,082	23	21	13,869	13,889	68,411	170	304	14,437	14,741
45–64	6,424	22	14	5,649	5,663	23,817	82	136	5,786	5,922
65–74	1,890	24	4	383	386	3,277	41	19	389	408
≥75	2,599	44	8	143	151	4,251	72	26	146	172
Female	**5,739**	**4**	**19**	**4,141**	**4,159**	**178,678**	**126**	**714**	**4,790**	**5,504**
0–4	0	0	0	0	0	0	0	0	0	0
5–14	63	0	1	64	65	11,934	59	31	89	120
15–24	571	3	2	632	634	58,676	319	161	789	950
25–44	2,306	5	6	2,217	2,223	77,253	183	330	2,581	2,911
45–64	1,969	6	7	1,123	1,130	26,049	84	157	1,216	1,373
65–74	404	4	1	75	76	2,545	26	18	78	96
≥75	426	5	2	29	31	2,221	24	19	34	53

For both males and females, the highest percentage of medical costs from self-inflicted injuries was from poisonings, followed by firearm/gunshot injuries for males and cut/pierce injuries for females. Productivity losses caused by firearm/gunshot-related injuries were the largest for males; productivity losses caused by poisonings were the largest for females. Overall, total costs were highest for males experiencing a self-inflicted injury by a firearm/gunshot, accounting for 54% of the total costs for males. Total costs were highest for females using poisoning as the self-inflicted injury mechanism.

Discussion

The results reported in this study should be viewed as the best available estimates of violence incidence and costs in the U.S. to date. The finding that violence-related injuries cost the United States $5.6 billion in medical costs and another $64.8 billion in productivity losses provides an indication of the extent to which interpersonal and self-inflicted violence are draining U.S. society of vital resources. This is particularly true for males and young adults. Although there were some notable exceptions, overall most of the total losses for injuries from interpersonal and self-directed violence were attributed to injuries among males and people aged 15 to 44 (i.e., 68% of losses due to assaults and 63% of losses due to self-inflicted injuries were to males aged 15 to 44). These losses are largely driven by the contribution of injury fatalities to productivity losses. In fact, each death due to assault resulted in $1.3 million in productivity losses and each suicide resulted in $1.0 million in productivity losses. These findings indicate that slightly over 50% of the total economic costs of injuries due to violence (assault and self-inflicted injury combined) are associated with fatalities among males aged 15 to 44 years, a majority of which are inflicted by firearms. These cost estimates can be valuable for assessing the relative burden of violence and can guide national decisions about how to prioritize violence prevention among competing health concerns and competing populations, and for making choices about how limited resources for violence prevention programs should be spent. These estimates also provide a benchmark for efforts to quantify the costs and benefits of violence prevention strategies.

Except for the work by Miller et al.,[10,11] very few studies have attempted to estimate the national costs of interpersonal violence in the United States.[12] Miller et al.[11] estimated the lifetime cost of interpersonal violence to be $105 billion (1993 dollars) when including medical losses, lost earnings, and public program costs related to victim assistance. This estimate is not comparable to ours (even when inflated to 2000 dollars, at $125 billion), however, because it includes violent incidents regardless of whether they resulted in a physical injury, as well as victim services, and the study

Table 4. Incidence counts/rates (per 100,000) and total lifetime costs (in millions) of self-inflicted injuries by mechanism and gender

	Fatal incidence	Fatal rate	Fatal medical costs ($)	Fatal productivity losses ($)	Fatal total costs ($)	Total incidence	Total rate	Total medical costs ($)	Total productivity losses ($)	Total costs ($)
Total	**29,416**	**11**	**76**	**30,297**	**30,374**	**324,053**	**117**	**1364**	**31,957**	**33,321**
MV/other road user	103	0	0.4	112	112	1,133	0	10	132	142
Falls	621	0	3	654	657	2,027	1	64	722	786
Cut/pierce	383	0	1	367	368	56,690	21	172	1,044	1,216
Struck by/against	—[a]	—[a]	—[a]	—[a]	—[a]	3,935	1	5	6	11
Fire/burn	162	0	4	179	183	1,841	1	20	205	225
Poisoning	4,862	2	17	4,766	4,783	213,248	77	856	5,231	6,087
Firearm/gunshot	16,604	6	35	16,242	16,277	18,545	7	124	16,324	16,448
Other[b]	6,681	2	15	7,978	7,993	26,632	10	114	8,293	8,406
Male	**23,677**	**18**	**58**	**26,157**	**26,214**	**145,375**	**108**	**650**	**27,167**	**27,817**
MV/other road user	75	0	0.3	92	92	887	1	7	107	114
Falls	445	0	2	534	536	1,380	1	34	581	615
Cut/pierce	304	0	1	320	321	26,584	20	87	722	810
Struck by/against	—[a]	—[a]	—[a]	—[a]	—[a]	2,977	2	4	5	8
Fire/burn	121	0	3	149	152	1,230	1	11	163	174
Poisoning	2,795	2	8	3,276	3,284	79,100	59	330	3,492	3,822
Firearm/gunshot	14,470	11	31	14,695	14,726	15,991	12	101	14,764	14,865
Other[b]	5,467	4	12	7,092	7,104	17,226	13	76	7,333	7,409
Female	**5,739**	**4**	**19**	**4,141**	**4,159**	**178,678**	**126**	**714**	**4,790**	**5,504**
MV/other road user	28	0	0.1	20	20	247	0	4	24	28
Falls	176	0	1	120	121	647	0	30	142	171
Cut/pierce	79	0	0.4	47	47	30,106	21	85	322	407
Struck by/against	—[a]	—[a]	—[a]	—[a]	—[a]	958	1	1	1	3
Fire/burn	41	0	1	31	32	611	0	9	42	51
Poisoning	2,067	1	9	1,490	1,499	134,148	95	527	1,739	2,265
Firearm/gunshot	2,134	2	4	1,547	1,551	2,554	2	23	1,560	1,583
Other[b]	1,214	1	3	886	889	9,406	7	37	960	997

[a]Indicates small *n*, not 0; included in "Other" category.
[b]Injuries categorized as "Other" resulted from varied mechanisms, including drowning/submersion and inhalation/suffocation.
MV, motor vehicle.

was conducted at a time when rates of interpersonal violence were higher than they were in 2000.

Only one study[13] in the 1995–2007 period has estimated the national lifetime costs of self-inflicted injuries. Palmer et al.[13] estimated that in 1994, nonfatal self-inflicted injuries resulted in $581 million and $3.1 billion in medical costs and lost productivity, respectively; and that suicides further resulted in $17.9 million and $12.8 billion in medical costs and lost productivity, respectively. Inflated to 2000 dollars, their total estimate of $19.2 billion is almost 40% lower than the current estimate. Again, direct cost comparisons are not possible because they used different modeling assumptions (a 4% discount rate to calculate net present value) and they only included self-inflicted injuries resulting in death or hospitalization, with no attempt to include follow-up medical care.

There are several limitations of this study that should be noted when interpreting the results.[2] For nonhospitalized, non-emergency department visits recorded in the MEPS data, only seven broad mechanism categories (i.e., motor vehicle, fall, firearm, other weapon, fire/burn, poisoning, drowning, and other) and no information on intent were available. As such, incidence estimates exclude 2 million oral-facial injury patients annually treated in dental offices. It is possible that some proportion of these injuries result from interpersonal violence and are not captured in the estimates.

Furthermore, available estimates of the prevalence of interpersonal and self-inflicted injuries are likely underestimates because intent of nonfatal injuries can be difficult to determine.[14–22] Health professionals often do not ask about the intent of an injury and, even when asked, patients may not be willing to provide factual information. Victims of interpersonal violence give many reasons for not wanting to report their victimization to officials, including the belief that it is a private matter, the fear of reprisal by the offender, or because they want to protect the offender.[23] Similarly, patients may be unable or unwilling to report that their injuries are due to a suicide attempt. They may, for example, be concerned about the stigma associated with suicidal behavior or fear of losing insurance coverage.

The economic burden estimates presented here are also likely to be under-estimates because the data did not allow for inclusion of nonmedically treated injuries. Given that almost all costs reported in this study are productivity losses, the impact of this omission could be substantial. In unpublished data available from one of the authors,[24] a national random-digit-dial telephone survey conducted in the U.S. found that for those respondents reporting being struck during an assault, only 33.2% reported that they were physically injured. Of those reporting being physically injured, only 19.3% reported any use of medical services. Thus, if it is likely that those reporting assault and injury (but no use of medical services) sustained any productivity losses, then these productivity loss estimates are an under-estimate of the true burden of violent injuries.

The methods for estimating productivity losses have other limitations. First, because women, the elderly, and children earn lower wages, the human capital approach applied in this analysis under-values violent injuries to these groups. Second, the approach places lower values on the work of full-time homemakers than the work of people participating in the labor market, which further depresses the value placed on women's losses due to violence relative to men's losses. Third, because productivity losses are based on the average wage for the U.S. population, if violent injuries are more likely to occur in persons with lower socioeconomic status (SES), the productivity losses are potentially over-estimated. Cook and Ludwig[25] have found evidence of lower SES in gunshot victims. But because the data used in this analysis did not consistently capture SES, it was not possible to make this adjustment in productivity losses. Finally, the productivity losses used in this analysis exclude productivity lost by people other than those injured as the result of a violent injury. These losses may include the time that family, friends, and professionals spend caring for the injured, and time spent investigating, prosecuting, and punishing violent perpetrators.

The costs reported here provide an incomplete picture of the overall toll that violence has on victims and society because victims of violence experience significant, lasting negative consequences that extend beyond their immediate physical injuries and may even occur in the absence of physical injury. Epidemiologic and clinical studies consistently find that victims of violence, regardless of the type of violence, are more likely than nonvictims to experience post-traumatic stress disorder, depression, anxiety, suicidal ideation, and substance abuse as well as a range of related physical and psychosocial problems. For example, the long-term consequences of child maltreatment include a greater susceptibility to lifelong physical and mental heath problems, including cardiovascular disease, hypertension, diabetes, anxiety disorders, depression, and substance abuse.[26,27] Adolescent girls who are victims of physical or sexual dating violence are at greater risk of substance use, unhealthy weight control behaviors, pregnancy, suicidality, and revictimization.[28,29] Adult victims of intimate partner violence, both females and males, are more likely than nonvictims to report chronic physical and mental health problems, symptoms of depression, and substance use.[30] Victims of elder abuse often experience feelings of hopelessness, alienation, guilt, shame, fear, and anxiety.[26] The long-term physical, emotional, and social consequences of victimization, and the use of health-compromising coping strategies represent substantial costs that are beyond the scope of this study.

Neighborhoods also suffer the social consequences of violence. Fear of being victimized may prevent people from being active in their communities or being willing to help when they see others in need. Schools are significantly affected as well. Data from the 2005 national Youth Risk Behavior Survey indicate that 6% of high school students in the U.S. reported missing at least 1 day of school in the past 30 days because of safety concerns.[31] Students who report exposure to violence in their neighborhood and school are at higher risk for school behavior problems.[32] Clearly the cost to society from violence is far greater than the financial costs that were examined in this study.

These limitations notwithstanding, the results suggest that in order to reduce the economic burden associated with violence-related injuries, priority should be given to preventing firearm-related homicides and suicide among adolescent and young adult males. This target group accounts for the bulk of the economic costs associated with injuries from violence, although, as indicated, there were many costs not included in this study that if enumerated could shift, to an unknown extent, the nature of this burden.

There are two broad directions to consider for prevention in this target group. The first broad strategy is to improve emergency trauma care and the acute treatment of these types of injuries. Unless death occurs immediately, the outcome of an injury from violence depends not only on its severity, but also on the speed and appropriateness of treatment.[33] However, it is important to note that because of the severity of their wounds, many homicide and suicide victims expire before trauma care can be of help. Thus, a second critical broad strategy is to invest in the primary prevention of interpersonal and self-directed violence to reduce the likelihood that injuries will occur in the first place or the likelihood that a firearm will be used. It is important for prevention planners to address individual, family, school, and community risks for violence and to take advantage of evidence-based prevention strategies. Fortunately, there are a range of strategies that are effective or have great potential to prevent injuries from interpersonal violence or reduce the lethality of violence.[34–46] Although much progress has

been made in understanding how to prevent assault-related injuries, additional evaluation research is needed, particularly for the prevention of intimate partner and sexual violence. Also, while definitive evidence for the effectiveness of specific suicide prevention strategies is still lacking, there are many promising avenues to pursue.[47,48]

Finally, this analysis highlights the importance of improving available estimates of the costs of interpersonal and self-directed violence. There are four strategies that will help in developing more accurate estimates. First, data on the incidence of violence need to be improved. Routinely available and accurate data are lacking on key dimensions of violence, including the magnitude of intimate partner violence, sexual violence, and child maltreatment. These aspects of interpersonal violence are often hidden and difficult to measure, but may contribute disproportionately to the long-term costs of violence. Second, the identification and documentation of violent injuries in emergency departments and other medical care settings need to be enhanced. These improvements require that not only physicians and other healthcare professionals be trained in identifying violence, but also that medical record systems be enhanced in such a way as to fully capture information on these events. Third, the link between exposure to violence and long-term health and social consequences needs to be more firmly established. These linkages and their associated costs are difficult to estimate, but may represent the largest proportion of economic costs associated with violence. Fourth, the costs associated with violence that does not result in a physical injury need to be considered. The stress associated with exposure to violence, particularly where it is an ongoing experience in a victim's life, can have devastating consequences for the physical and mental health of victims even in the absence of a physical injury. Studies linking survey data on violence to annual medical expenditures for representative population samples should be conducted as the most efficient strategy for moving forward on the key directions outlined above.

The analyses and results presented here represent those of the authors and not necessarily those of the Centers for Disease Control and Prevention.

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Appendix: Data and Methods

Incidence and lifetime costs for either fatal or medically treated injuries were stratified by age group and gender (for males and females in the following age categories: 0 to 4, 5 to 14, 15 to 24, 25 to 44, 45 to 64, 65 to 74, or ≥75) and mechanism (including motor vehicle/other road user, fall, struck by/against, firearm/gunshot, poison, cut/pierce, fire/burn, drowning/submersion, and other).

Incidence

Fatal injury counts were taken from the 2000 National Vital Statistics System (NVSS) data, which include a census of fatalities in the United States. These data are coded using the International Classification of Diseases (ICD-10), 10th Edition, and provide information on the age and gender of the deceased.

The incidence of nonfatal injuries that resulted in medical treatment without hospitalization or emergency department treatment was estimated from the 1999 Medical Expenditure Panel Survey (MEPS). The 1999 MEPS is a survey of the civilian, non-institutionalized population that quantifies the use of healthcare services (including inpatient services, emergency department visits, ambulatory care, prescription drugs, home health care, vision aids, dental visits, and medical devices) and corresponding medical expenditures for 24,618 individuals, with sampling weights to generate nationally representative estimates. Medical conditions self-reported by participants are recorded by interviewers as verbatim text, which is then translated to 3-digit ICD codes (coded with the 9th edition). The 1999 MEPS estimates a total of 19.6 million injuries treated in a doctor's office (without an emergency department visit or inpatient stay) and 0.6 million injuries treated in an outpatient department (without an emergency department visit, inpatient stay, or doctor's office visit).

Because the MEPS sample size for nonfatal hospitalized and emergency department–treated injuries is small, the incidence of these injuries using other sources was estimated with much larger samples. The 2000 Healthcare Cost and Utilization Project–Nationwide Inpatient Sample (HCUP-NIS) was used to estimate counts of hospitalized injuries. The HCUP-NIS provides annual information on approximately 5 to 8 million inpatient stays (that resulted in live discharges in 2000) from about 1000 hospitals. Sampling weights allow for generating nationally representative estimates. Each HCUP-NIS record contains patient-level utilization and resource-use information included in a typical discharge abstract. Records that indicated a live discharge and an injury diagnosis in any of the first three diagnosis fields were counted in this analysis.

Mechanism and intent classifications for some types of injuries were limited. For example, the intent of injury could be discerned from E codes (external cause: mechanism and intent) in only 83% of cases identified as hospitalized injuries in the HCUP-NIS data. For cases where no E code was present, E codes were imputed based on the distribution of E-coded cases with the same primary diagnosis, age group and gender. Using this approach, E codes were able to be assigned to all but 0.33% of cases.

The incidence of injuries treated in the emergency department was estimated from the 2001 National Electronic Injury Surveillance System–All Injury Program, NEISS-AIP. (Note: The first complete year of NEISS data collection is 2001.) NEISS-AIP collects detailed injury data from emergency departments at 66 hospitals and includes weights for generating nationally representative estimates.

Except for fatalities, the incidence estimates are weighted sample data and uncertain. For example, the unweighted hospitalized nonfatal case counts from the HCUP-NIS data are 29,060 assaults and 40,006 suicide acts. The associated standard errors are 5% and 2.5% of the weighted means.

To compute incidence rates, population counts from the 1999 MEPS were used. The 276.4 million estimate of the civilian non-institutionalized resident population from MEPS is slightly lower than the Census Bureau's broader estimate of 279.0 million total U.S. residents in 1999. Although a mix of data from 1999 through 2001 were used in this analysis, it was assumed that the incidence of injuries did not differ over this period and injuries were reported as if for a single year, 2000.

Medical Costs

All medical costs are presented in 2000 U.S. dollars. To inflate unit cost estimates (provided in the results section of the paper) to current-year dollars, the authors used the medical care component of the Consumer Price Index.[1]

For fatalities, medical costs were computed separately for five places of death identified in the 2000 National Vital Statistics System (NVSS) data: death on scene/at home, death on arrival to the hospital, death at the emergency department, death at the hospital after inpatient admission, and death at a nursing home. Depending on place of death, the medical costs incurred might include coroner/medical examiner (C/ME), medical transport, emergency department, inpatient hospital, or nursing home.

All fatalities were assigned C/ME costs of $530.[2] Deaths on arrival to the hospital, in the emergency department, or after admission also received the cost of one-way transport ($212), which was based on average ambulance transport costs for injury victims found in the 1999 Medicare 5% sample. For deaths on arrival or in the emergency department, average costs for injury fatalities in the emergency department computed from 363 injury deaths in 1997 Nebraska, New Hampshire, and South Carolina emergency department discharge data were added. (These are the only states from which data with charges and discharge destination were readily available.) For deaths in the hospital, the costs for an inpatient admission that resulted in a fatality using the HCUP-NIS file for those who died in the hospital were added to the transport and C/ME costs. To all inpatient facility estimates from HCUP-NIS, estimates were first multiplied by cost-to-charge ratios provided by the Agency for Healthcare Research and Quality (AHRQ), and then costs for nonfacility services such as professional services used while in the hospital, yet not included in the admissions billing (e.g., surgeon, anesthesia, physical therapy) were added.

These nonfacility medical costs were based on Medstat's 1996 and 1997 MarketScan Commercial Claims and Encounters Database. This database contains an inpatient hospital admissions file with records summarizing each hospital admission, including total payments, facility payments, and detailed diagnosis data. The mean ratio of total hospital costs to facilities costs were calculated for each injury category. The ratios of total costs to facilities costs ranged from 1.03 to 1.39, with an overall average of 1.26. The HCUP-NIS cost estimate for each admission was multiplied by the corresponding ratio to estimate total inpatient costs for each injury admission contained in the HCUP-NIS database. For deaths in a nursing home, to the transport and C/ME costs, the authors added (1) the HCUP-NIS/MarketScan cost for an acute care hospitalization with live discharge for those with the same injury diagnosis, plus (2) the average cost of nursing home care computed from the 1999 National Nursing Home Survey.

MEPS data were used to quantify medical costs for nonhospitalized injuries. For hospitalized injuries, because of the small sample size of admitted injuries in MEPS, the authors primarily relied on other data sources. HCUP-NIS data and

the Agency for Healthcare Research and Quality cost-to-charge ratios were used to compute inpatient facility costs. Using the approach described above for deaths in the hospital, Medstat's MarketScan data were then used to quantify nonfacility costs incurred during an inpatient admission.

Most injuries that require a hospitalization will also require additional treatment after discharge. To develop estimates of short- to medium-term medical costs for injuries requiring an inpatient admission, total inpatient costs derived from the HCUP-NIS/MarketScan data were multiplied by the ratio of all costs during the first 18 months of injury, on average, to the total inpatient costs for that kind of injury. These ratios were derived from 1996 to 1999 Medical Expenditure Panel Survey (MEPS) data. Because analyses were limited to injuries with at least 12 months of follow-up, and because the MEPS data include costs for up to 24 months, the sample captured injuries with an average of 18 months post-injury treatment. The MEPS indicates that the ratio of total costs to inpatient costs is roughly 1.35, and ranges between 1.02 and 2.13, depending on the type of injury.

Rice et al.[3] estimated long-term medical costs from those accrued over the first 6 months using multipliers derived from longitudinal 1979–1988 Detailed Claim Information (DCI) data on 463,174 worker compensation claims. The DCI file was unique and nothing similar has subsequently become available. Noting that out-year costs are not inconsequential for some injuries, and for lack of a better alternative, ratios computed from the DCI expenditure patterns were used to adjust the 0- to 18-month cost estimates to arrive at estimates of total medical costs (including beyond 18 months) associated with injuries. This method implicitly assumes that while treatment costs vary over time, the ratio of 18-month costs to total lifetime costs has remained constant between the time the DCI data were reported and 2000. The DCI ratios indicate that 77% of the costs for admitted cases and 88% of the costs for non-admitted cases occur in months 0 to 18. These ratios suggest average multipliers of 1.30 and 1.14 to estimate total medical costs for admitted and non-admitted cases, respectively.

Productivity Losses

All productivity loss estimates are presented in 2000 U.S. dollars. To inflate unit productivity loss estimates (provided in the Results section of the paper) to current year dollars, the authors used indexes in the annual *Economic Report of the President.*[4]

Temporary or short-term work loss for nonfatal injuries was quantified using the approach presented by Lawrence et al.[5] These authors combined the probability of an injury that resulted in lost workdays from 1987 to 1996 National Health Interview Survey (NHIS) data with the mean workdays lost (conditional on having missed at least 1 day) per injury estimated from the 1993 Annual Survey of Occupational Injury and Illness reported by the Bureau of Labor and Statistics (BLS). Averaged across all injuries, estimated temporary work loss was 11.1 days per injury. Although the BLS data are old and limited to injuries that occur on the job, a separate analysis of MEPS data (based on a much smaller sample) found similar estimates. This suggests that the BLS-NHIS work-loss estimates can credibly be applied to estimate work loss associated with non–work-related injuries. MEPS data also indicate that the duration of work loss was five times greater for admitted cases. Using the BLS-NHIS estimates, incidence data by place of treatment, and this ratio, work loss durations for injuries were computed separately for admitted and non-admitted cases for each age category, gender, and mechanism.

To apply a monetary value to temporary work loss, estimated work-loss days were multiplied by the average daily wage and fringe benefit costs stratified by age group and gender from the Current Population Survey. The authors assumed that household work was lost on 90% of days that wage work was lost. Using this ratio and the value of household work reported by Haddix et al.,[6] a value for household work lost was imputed.

To compute productivity loss due to permanent or long-term disability, permanent total disability and permanent partial disability were considered separately. For permanent total disability, the present value of age- and gender-specific lifetime earnings and household production (reported by Haddix et al.[6]) was multiplied by the probability of permanent disability for each type of injury. For permanent partial disability, the earnings estimate was multiplied by the probability of permanent partial disability and an additional factor that identified the percentage of disability that resulted from that type of injury. Results were summed to compute the net productivity loss associated with permanent disability, including total and partial disability.

The probabilities of permanent and partial disability and the percent disabled (by body part and nature of injury) were reported by Lawrence et al.[5] They used pooled multistate worker compensation data from the 1979–1988 Detailed Claims Information (DCI) database of the National Council on Compensation Insurance (NCCI) to estimate these probabilities. Application of these estimates to this analysis assumes that these probabilities are the same for injuries that do and do not occur on the job and that they have not changed significantly over time. Averaged across all injuries, the estimated percentage of lifetime productivity potential lost due to injury was 0.26% per injury. The DCI probabilities were used, stratified by age, gender, and mechanism, with the understanding that more recent data, if available, would have been preferable.

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