

# The Epidemiology of Case Fatality Rates for Suicide in the Northeast

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See editorial, p. 731.

**Study objective:** We examine how method-specific case fatality rates for suicide differ by age and sex.

**Methods:** Seven northeastern states provided mortality and hospital discharge data (1996 to 2000). Suicide acts were divided into 8 categories according to the method used. For each method, the fraction of acts resulting in death (the method-specific case fatality rate) was calculated. Only suicide acts that resulted in hospitalization or death were included.

**Results:** Overall, 13% of all suicide acts proved lethal (23% for males compared with 5% for females; 7% for people aged 15 to 24 years compared with 34% for individuals aged  $\geq 65$  years). Poisoning with drugs accounted for 74% of acts but only 14% of fatalities; firearms and hanging accounted for only 10% of acts but 67% of fatalities. Firearms were the most lethal means (91% resulted in death), followed by drowning (84%) and hanging (82%). For every means, method-specific case fatality rates were higher for male victims and older individuals. Age and sex were associated with overall case fatality rates primarily because of their association with the distribution of methods chosen.

**Conclusion:** Our findings are based on suicide acts that result in hospitalization or death and therefore underestimate the actual incidence of suicide acts and overestimate case fatality rates. Nevertheless, we find that age and sex influence overall case fatality rates primarily through their association with methods used, rather than because of variation in method-specific case fatality rates.

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## INTRODUCTION

Most studies of suicide acts have relied on self-reported behavior,<sup>1-3</sup> focused on limited groups,<sup>1-5</sup> or restricted analyses to a small number of the methods used.<sup>6</sup> As a result, few studies have reported how the method chosen in a suicide act influences the likelihood of death.<sup>7-9</sup> The earliest report to describe variation by method in the lethality of suicide acts (ie, the method-specific case fatality rate) found that suicide acts in Allegheny County, PA, between 1966 and 1970 were most likely to prove fatal if

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**Editor's Capsule Summary****What is already known on this topic**

Most studies of suicide acts are limited as a result of their focus on self-reported behavior, group size, or small number of suicide methods used.

**What question this study addressed**

Using mortality and hospital admission data from 7 states, specific case fatality rates for suicide attempted by different methods were calculated and compared for differences by age and sex.

**What this study adds to our knowledge**

Of 8 categories of methods (ie, firearms, hanging, jumping, poisoning by drugs, cutting, drowning, poisoning by gas, and other), firearms were the most lethal means (91% lethal), followed by drowning (84%) and hanging (82%), compared with 2% for drug ingestion. For every method of suicide attempt, case fatality rates were higher for males and older individuals.

**How this might change clinical practice**

Age and sex influence the proportion of suicide acts that prove lethal primarily because they are related to which methods are chosen. Further study is needed to better understand how age and sex influence this choice.

the act was made with a firearm (case fatality rate 92%, ie, 92% of acts were lethal), by hanging (case fatality rate 78%), or by poisoning with carbon monoxide (case fatality rate 67%). Methods least likely to prove fatal included cutting (case fatality rate 4%) or poisoning with drugs (case fatality rate 11%). Case fatality rates reported in subsequent studies were also highest for suicide acts involving firearms, hanging, and carbon monoxide poisoning and lowest for acts by cutting and poisoning with drugs.<sup>8,9</sup> Others noted that the body part affected can also affect the case fatality rate, at least for firearm-related acts,<sup>10</sup> and that compared with male individuals and older individuals, female individuals and younger individuals make up a disproportionate number of all suicide acts but are less likely to use highly lethal methods.<sup>8,9</sup> Little else is known about the extent to which overall and method-specific case fatality rates are modified by individual or ecologic factors previously established to be associated with an increased risk of suicide.<sup>11-16</sup>

The objective of this study is to examine how method-specific case fatality rates for suicide differ by age and sex. The present study extends previous work by using more recent data and by describing the extent to which sex- and age-based differences in overall case fatality rates are attributable to differences in the distribution of the methods chosen.

**METHODS**

We use customary nomenclature when referring to suicidal actions, as recommended by O'Carroll et al.<sup>17</sup> We refer to any self-inflicted injury, whether fatal or nonfatal, as a "suicide act"; when the act results in death, we label the act a suicide, and when the outcome is nonfatal, we label the act an attempted suicide. The case fatality rate for a particular method is defined as the number of suicides with that method divided by the number of suicide acts with that method (ie, case fatality rate = deaths/[deaths + nonfatal hospitalized attempts]).

To be included in this study, a suicide act had to meet at least 1 of 2 criteria: death or admission to a medical hospital. For deaths from 1996 to 1998, the first listed *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* external cause of injury codes were used (codes E950.0 to E959.9)<sup>18</sup>; for deaths in 1999 and 2000, *International Classification of Diseases, 10th Revision* external cause of injury codes were used (codes X60 to X84).<sup>19</sup> ICD-9-CM E-codes were used for the hospital discharge data for all years (codes E950.0 to E959.9).<sup>18</sup>

Seven northeastern states provided complete mortality files, and electronic hospital discharge data for acute care general medical hospital admissions assigned an injury code (800 to 999). Hospital discharge files contain data from acute care facilities but not from Veterans Administration hospitals or from psychiatric hospitals. All acute care general medical hospitals in each state were represented in our data set. We could not independently confirm the completeness of data sent by each hospital.

One state, Rhode Island, provided mortality and hospital discharge data for each of the 5 years (1996 to 2000; 60 months). Connecticut, New Hampshire, and Vermont provided corresponding mortality and hospital discharge data for 4 complete years (1996 to 1999); Massachusetts and New Jersey for 3 complete years (1996 to 1998); and Maine for 2 complete years (1998 to 1999). Suicide is never coded as a cause of death for children younger than 5 years; accordingly, this age group is omitted from analyses. Evaluations using data from 1998 and 1999 (years for which all states provided data) produced method-specific case fatality rates similar to those using all available data from 1996 to 2000. Results using all 25 state-years of available data from 1996 to 2000 are presented unless otherwise noted.

The method used in a suicide act was grouped into 8 categories: suicide and self-inflicted injury by (1) poisoning with solid or liquid substances (E950.0 to E950.9; X60 to X66, X68, X69); (2) poisoning with gases and vapors (E951.0, E951.1, E951.8, E952.0, E952.1, E952.8, E952.9; X67); (3) hanging, strangulation, and suffocation (E953.0; E953.1; E953.8; E953.9; X70); (4) submersion (drowning; E954; X71); (5) firearms (E955.0 to E955.4; X72 to X74); (6) cutting and piercing instrument (E956; X78); (7) jumping from high places (E957.0 to E957.2, E957.9; X80); and (8) other (E958.0 to E958.8; X75, X76, X77, X79, X81, X82, X83) and unspecified (E958.9; X84) means. Some people who attempt suicide make more than 1 attempt.<sup>4,20,21</sup> We estimate the number of suicide acts rather than the number of individuals who attempted or completed suicides.

Demographic data were obtained from the US Census Bureau's American Fact Finder Web site.<sup>22</sup> Rates of suicide acts per 100,000 were calculated using sex- and age-specific population figures corresponding to state-years for which counts of suicide acts were available. A suicide act was counted as attributable to the group of 7 states when the act was made by a resident of 1 of these 7 states (and was attributed to a particular state when the act was made by a resident of the state in question). Population data came from the Centers for Disease Control and Prevention's Wide-ranging Online Data for Epidemiologic Research database.<sup>23</sup>

To avoid double counting, we excluded suicide acts that resulted in death in the hospital because we assumed these deaths were captured in the corresponding mortality files. In addition, we excluded patients transferring from another hospital because this too could lead to double counting of the same attempt. Maine was unable to provide hospital transfer data. To obtain case fatality rates for Maine, we assumed that the hospital transfer rate in Maine was the average of the transfer rates in the other states (4.5% of all admissions E-coded as a suicide act). The resulting pooled data included 39,025 nonfatal suicide attempts and 5,806 suicides.

We report the percentage of injury hospitalizations with E-codes using the Injury Surveillance Workgroup definition<sup>24</sup>: the percentage of injury hospitalizations with E-codes = [(number of records with principal diagnosis of ICD-9-CM 800 to 994, 995.5, and 995.80 to 995.85, excluding ICD-9-CM 909.3 and 909.5, that have a valid E-code other than E849, E967, E869.4, E870 to 879, or E930 to 949)/(number of records with

principal diagnosis of ICD-9-CM 800 to 994, 995.5, and 995.80 to 995.85, excluding ICD-9-CM 909.3 and 909.5)] × 100.

Descriptive analyses were performed using Stata software (Stata Corporation, College Station, TX).

## RESULTS

Overall, 96% of all hospitalizations with an injury-related principal diagnosis were E-coded (97% for Massachusetts and New Hampshire; 96% for Connecticut, New Jersey, and Rhode Island; 89% for Maine; and 86% for Vermont). Overall (and for each state), less than 1% of all known suicide deaths and less than 2% of all known suicide attempts had E-codes that were nonspecific for the method used (not shown).

We identified 44,831 suicide acts across our 7 states, 5,806 (13%) of which proved fatal (Table). The distribution of methods used in fatal acts differed markedly from the methods used in nonfatal acts.

Male victims accounted for 79% (4,579/5,806) of all suicides and 44% (19,660/44,831) of all suicide acts (Table). People younger than 25 years accounted for 13% (751/5,806) of all fatalities and 25% (11,020/44,831) of all acts. Adults aged 25 to 64 years accounted for approximately 70% of suicides and suicide acts. Fatal suicide acts were predominantly acts with firearms or by hanging or suffocation, accounting for 38% (2,227/5,806) and 29% (1,712/5,806) of all fatalities, respectively. In aggregate, 94% of attempted suicides (36,510/39,025) and 84% of all suicide acts (37,465/44,831) involved poisoning by drugs or cutting or piercing.

Compared with male individuals, female individuals were 20% more likely to engage in suicidal acts and 50% more likely to make nonfatal attempts; 5% of all suicide acts by female individuals proved fatal versus 23% of all acts by male individuals (Table). With respect to age, the suicide attempt rate showed an inverted "U" distribution, with rates peaking in the 15- to 24-year-old group and lowest in the youngest and the oldest age groups. The rate of fatal acts was lowest for younger people and then leveled out after age 25; case fatality rates increased steadily with age.

The proportion of suicidal acts that proved fatal varied by method (Table). Methods that most frequently proved lethal were firearms (case fatality rate 91%), drowning (case fatality rate 84%), hanging (case fatality rate 82%), and poisoning with gases (case fatality rate

64%). Methods least frequently resulting in death were poisoning (case fatality rate 2%) and cutting or piercing (case fatality rate 3%).

Twenty percent of suicide acts by men involved firearms or hanging compared with 3% of all acts by women (Figure 1). Ninety-three percent of suicide acts by women were poisoning, cutting, or piercing compared with 71% of acts by men. Older individuals were more likely to choose firearms and hanging than were younger individuals (Figure 2).

Method-specific case fatality rates were consistently higher for male and older individuals than for female and younger individuals (Figures 1 and 2). Sex- and age-related disparities in method-specific case fatality rates did not, however, account for a large proportion of the pronounced sex- and age-related disparities in the proportion of all suicide acts that result in death (ie, differences in the overall case fatality rate for male individuals versus female individuals and for older versus younger people). For example, the overall (ie, all methods combined) case fatality rate for male individuals is 23% (Table); if the method-specific case fatality rates for female individuals is applied to the distribution of methods used by male individuals (ie, firearms still represent 11% of all acts, but the case fatality rate for firearms is now 85% rather than 91%), the overall case fatality rate decreases, but only from 23% to 20%. Simi-

larly, if the method-specific case fatality rates for adults 65 years and older is applied to the distribution of method choice used by people aged 15 to 24 years, the overall case fatality rate increases from 7% (the overall case fatality rate for 15- to 24-year-olds) to 14% but would still fall short of the overall case fatality observed for those aged 65 years and older (34%).

States in our study contribute data for different years (1996 to 2000). To address the possibility that combining data for different years from different states introduced bias in our estimates, we conducted a sensitivity analysis using only 1998 and 1999 data (the 2 years for which all states provided data). Method-specific case fatality rates using only 1998 and 1999 data produced results similar to those obtained using all available data (1996 to 2000). For example, using only 1998 and 1999 data, poisoning and firearms constitute 75% and 4% of suicide acts overall and have case fatality rates of 2% and 91%, respectively. Using all years of available data, poisoning and firearms constitute 74% and 5% of suicide acts overall and have case fatality rates of 2% and 91%, respectively. Both data sets also reveal that method-specific case fatality rates are, for every method used, higher for male individuals compared with female individuals and for older compared with younger individuals. We present results using all available data (1996 to 2000) to increase the precision of our estimates.

**Table.** *Suicides, suicide attempts, and case fatality rates in the Northeast by sex, age, and method.*

Characteristic	Suicides (N=5,806), No. (%)	Suicides per 100,000	Hospitalized Suicide Attempts (Nonfatal) (N=39,025)	Suicide Attempts, Nonfatal per 100,000	Total Suicide Acts per 100,000	Percentage of All Suicide Acts	Case Fatality Rate, %
<b>Sex</b>							
Male	4,579 (79)	13.5	15,081	44.4	57.9	44	23
Female	1,227 (21)	3.4	23,944	66.2	69.6	56	5
<b>Age, y</b>							
5-14	49 (<1)	0.5	1,173	12.1	12.6	3	4
15-24	702 (12)	8.2	9,096	106.8	115.0	22	7
25-44	2,417 (42)	10.7	20,240	89.4	100.0	51	11
45-64	1,612 (28)	10.8	6,440	43.1	53.9	18	20
≥65	1,026 (18)	10.5	2,034	20.9	31.4	7	34
<b>Method</b>							
Gun	2,227 (38)	3.2	226	0.3	3.5	5	91
Hanging	1,712 (29)	2.4	365	0.5	3.0	5	82
Jump	145 (2)	0.2	288	0.4	0.6	<1	34
Poisoning by drugs	814 (14)	1.2	32,454	46.3	47.4	74	2
Cut/pierce	141 (2)	0.2	4,056	5.8	6.0	9	3
Drowning	112 (2)	0.2	22	0.0	0.2	<1	84
Poisoning by gas	444 (8)	0.6	255	0.4	1.0	2	64
Other	211 (4)	0.3	1,360	1.9	2.2	4	13

DISCUSSION

Consistent with select population and self-report studies<sup>1-6,25</sup> and with previous studies that reported case fatality rates,<sup>8,9</sup> we find that suicide acts are most frequent among women and young adults. The rate of suicide acts in our study is considerably lower than rates reported by studies using self-report data<sup>1,3</sup> but similar to rates reported in studies that use hospital discharge data.<sup>4,5,8,9</sup>

Method-specific case fatality rates in our study are similar to those previously reported.<sup>8-10</sup> In our study, as in previous work,<sup>8-10</sup> firearms not only have the highest case fatality rate but also account for more deaths than any other means. In contrast, the most commonly used method—poisoning by drugs—is the method with the lowest case fatality rate and the method least likely to result in death. Morgues in the Northeast appear to be filled with suicides by firearms and hangings; hospitals, by suicide attempters using drugs or sharp instruments.

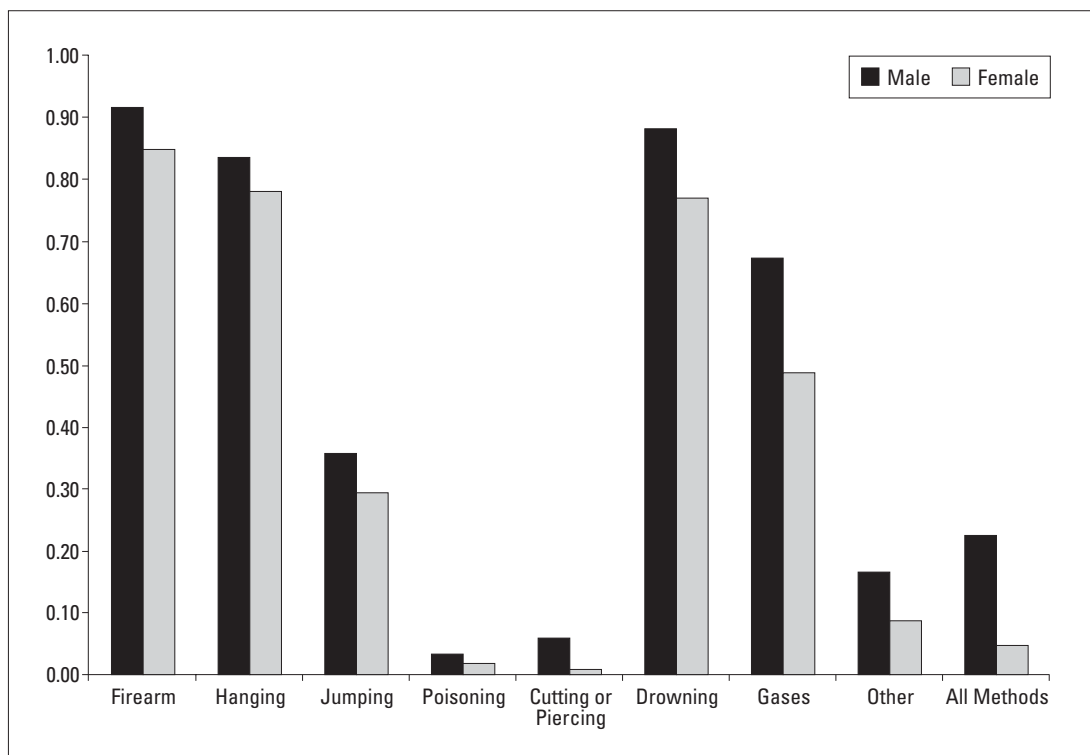
The proportion of all suicide acts that resulted in death in our study (case fatality rate 13%) is lower than in previous studies (16% and 22%).<sup>8,9</sup> This discrepancy may reflect the fact that suicide acts in our study were less likely to be firearm related (38% of all suicides in our study involved firearms versus 54%<sup>8</sup> and 47%<sup>9</sup> in

previous reports). This discrepancy could also be due to unmeasured factors such as differences between studies in thresholds for hospitalization, training and qualifications of coroners and medical examiners,<sup>26</sup> use of postmortem examinations in determining cause of death, and coding guidelines.

For every method, we found that a suicide act was more likely to result in death when made by a male individual or by an older individual. This finding largely agrees with results from the only previous study to explore modifiers of method-specific case fatality rates,<sup>9</sup> the only difference being that we found variation by age and sex across all methods, whereas Shenassa et al<sup>9</sup> found no such age-related variation in case fatality rate by firearms- or sex-related variation in case fatality rate by firearms or hanging or suffocation. The underlying message from both studies is, nevertheless, similar: firearms and hanging or suffocation are very likely to result in death, irrespective of the age or sex of the individual. Indeed, the relative variation we observed in method-specific case fatality rates across both sex and age was smallest for firearms and hanging.

We found that the overall case fatality rate for men (and older individuals) is far higher than that for women (and younger individuals), not so much because of differences in method-specific case fatality

**Figure 1.**  
Suicide case fatality rates by sex.



rates by sex and age, but rather because of differences in the methods chosen. Unfortunately, our data do not allow us to identify whether or to what extent potential sex- and age-related factors, such as seriousness of intent, symbolic valance, impulsiveness, and familiarity with or availability of particular means (eg, firearms), influenced the choice of methods.

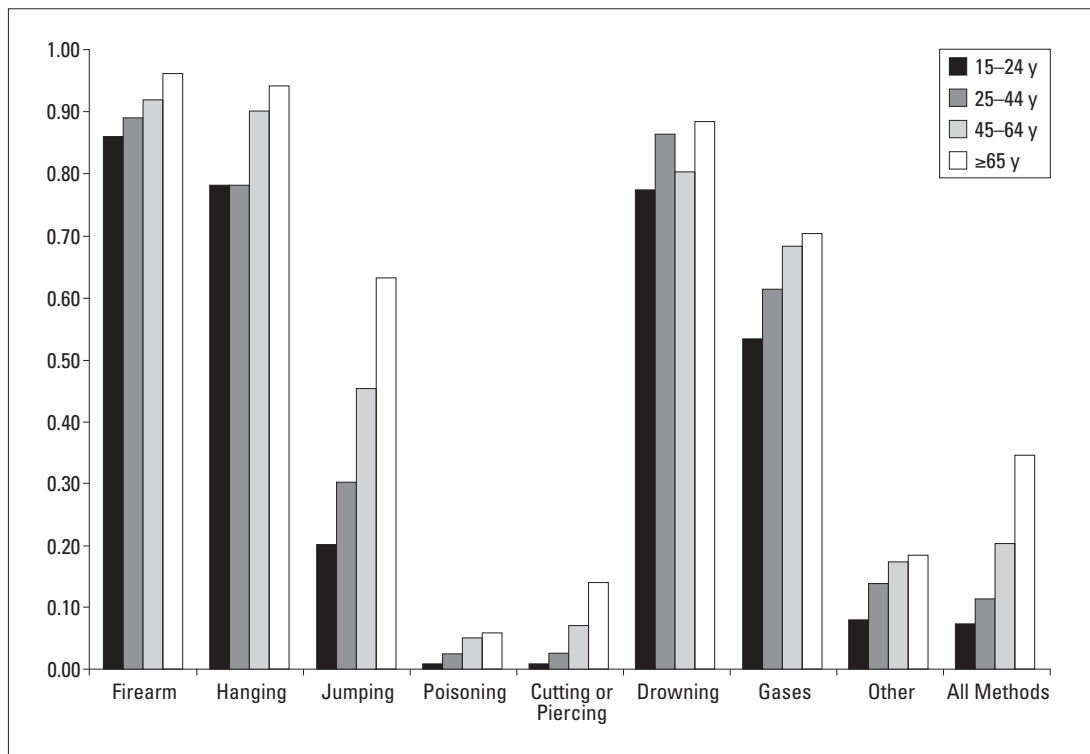
Our results underestimate the number of suicide acts. Our data did not include attempts that led to hospitalization in veteran or psychiatric institutions or that failed to result in hospitalization, even if the individual received medical attention in an emergency department (ED), a clinic, or a physician's office. The number of suicide attempts that do not result in hospitalization may be large. For example, a national study using ED and hospital discharge data found that approximately 48% of individuals with self-inflicted injuries were treated in and released from EDs<sup>27</sup>; in the late 1960s in Allegheny County, PA, 28% of suicide attempts were not medically treated (or treatment was unknown)<sup>7</sup>; in a study of college students in Nevada, only 9 of the 18 students who reported receiving some form of medical attention for a suicide attempt were admitted to a medical hospital<sup>28</sup>; and in Belgium, 28% of suicide attempts reported by general practitioners did not involve a referral to a higher level of care.<sup>29</sup>

Our study may also inaccurately measure suicide attempt rates for hospitalized patients if some suicide acts are misclassified as unintentional injuries or as injuries of undetermined intent. Misclassifications of suicide in this manner might, at least in part, be motivated by reluctance to impose stigma or by concerns about forfeiting a patient's insurance benefits.<sup>8,30</sup> In our study, 4% of injury-related hospitalizations were missing E-codes, an indeterminate number of which might have been suicide attempts.

A related source of potential bias comes from injury-related hospital discharges for which the mechanism of injury was identified (eg, poisoning, firearm) but that were coded "undetermined for intent" (ie, undetermined whether intent was unintentional, suicide, or assault; ICD-9-CM E-codes 980 to 989). Fortunately, fewer than 2% of all injury-related hospital discharges with an identified mechanism of injury were coded "undetermined for intent." Even if all injuries so coded were actually suicide attempts, our overall case fatality rate would decrease from 13% to only 11% (not shown).

Because people who engage in suicide acts that result in serious injury are more likely to be hospitalized than those who engage in suicide acts that result in minor or no injury, we suspect we missed few attempts with firearms and many more with other methods, such as at-

**Figure 2.**  
Suicide case fatality rate by age.



tempts with pills. Consequently, the actual difference between the firearm case fatality rate and the case fatality rate for other methods may be even greater than reported.

Another concern is the possibility that the propensity with which individuals making similar attempts seek and receive medical care may differ by sociodemographic characteristics, geographic area, or method used. It is possible, for example, that more affluent, urban residents with higher levels of education are more likely to be hospitalized than others. Unfortunately, we do not have data to help assess whether these or other differences exist or the extent to which such differences bias our case fatality estimates.

Finally, the 7 states we analyzed do not represent the United States either demographically or geographically. For example, residents of the Northeast, compared with residents of other regions, tend to have relatively low rates of divorce or separation, high rates of attaining graduate and professional degrees, and low rates of household firearm ownership.<sup>31,32</sup> Consequently, our findings should not be used to extrapolate to national estimates of suicide acts.

In summary, our estimates of method-specific case fatality rates are based on suicide acts that result in death or hospitalization and therefore underestimate the actual incidence of suicide acts and overestimate case fatality rates. Despite the limitations, our findings that age and sex influence the proportion of suicide acts that prove lethal primarily by influencing the distribution of methods chosen—rather than because of age- or sex-related differences in method-specific case fatality rates—underscore the need to better understand how factors related to age and sex (eg, seriousness of intent, the availability of highly lethal means) influence the choice of method used in the first place.

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