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Adolescent and Young Adult Mortality by Cause: Age, Gender, and Country, 1955 to 1994

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Abstract

Purpose—To compare mortality rates from motor vehicle accidents (MVA), homicide, and suicide across countries, age groups, and time.

Methods—The World Health Organization Mortality Database was used to construct age- and gender-specific rates in 26 countries for individuals aged 15 to 34 years during the period 1955 to 1994. The rates were adjusted for differences among countries in the age-and-gender distributions of their populations. Cause-specific rates were compared by country, 4-year age groups, 8-year time blocks, and male/female ratios.

Results—The proportion of deaths in 15–34-year-olds owing to MVA, homicide, and suicide increased from 26% to 43% over the 40-year study period. Mortality rates differ by country more than time block, peak at ages 15–29 years, and are higher in males than females. Compared to the United States, 24 countries had lower homicide rates and 23 had lower MVA-death rates.

Conclusions—Despite declining rates of death from other causes, the rates of adolescent and young adult death from MVA, homicide, and suicide remain high in countries throughout the world. The proportion of deaths attributable to these causes increased steadily during the latter half of the 20th century. Fatal risk behaviors begin to increase during adolescence but do not peak until age 30 years, suggesting that the target population for prevention extends well beyond the teenage years.

Keywords

Adolescent; Homicide; Injury; Motor vehicle accidents; Suicide; Young adult; Gender differences

The words "injury," "homicide," and "suicide" have been linked in the adolescent health literature since the 1980s when their contribution to the rising youth mortality rate in the United States was recognized. Adolescent mortality from all causes declined during the 1990s, yet these three causes continue to account for 75% of deaths among individuals aged 15–19 years [1]. Although commonly summed as risk behaviors resulting in death, the rates of fatal unintentional injury (i.e., accident), homicide, and suicide have followed different trajectories over time. In the United States between 1979 and 1998, 15–19-year-old deaths owing to accidents declined 45.5%, although deaths owing to homicide and suicide

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increased 9.7% and 3.6%, respectively [1,2]. It is unclear if other developed countries experienced similar cause-specific trends in youth mortality during this same time period.

No published study, to our knowledge, has jointly examined variations in age- and gender-standardized rates of fatal accident, homicide, and suicide across countries and time. The importance of such analyses to the prioritization of public health issues and the formulation of government policy is exemplified by several studies of youth morbidity. For example, the 1985 cross-national comparison of adolescent pregnancy rates by the Alan Guttmacher Institute revealed that the scope of the problem was far greater in the United States than in any other industrialized nation. The findings focused federal and community attention in the United States on the design, implementation, and evaluation of prevention strategies targeting teens [3]. The Monitoring the Future Project, a national survey of substance use by U.S. high-school students administered annually since 1975, has demonstrated the importance of both data disaggregation in the calculation of substance use rates and trend analyses in the identification of factors predicting future use [4].

Cross-national and time trend analyses of youth death owing to injury, homicide, and suicide have been hampered by reporting bias and failure to recognize that the relative size of a population subgroup may affect individual health and behavior within that subgroup. Analyses that do not adjust crude mortality rates for population age-and-gender proportions cannot conclude that between-country differences or within-country changes over time reflect more than the underlying demographic characteristics of the populations studied [5]. Conversely, variations in adjusted population rates suggest differences in large-scale social or environmental factors that are associated with mortality. Recognizing that variation in these adjusted rates exists and proceeding next to the identification of contextual factors associated with this variation may help guide the development of effective public health strategies for the prevention of youth mortality.

The objective of this study was to explore age-and-gender-adjusted rates of fatal motor vehicle accident (MVA), homicide, and suicide among individuals aged 15–34 years living in 26 countries from 1955 to 1996. The decision to focus on MVA rather than all unintentional injury is supported by evidence that it will rank third by the year 2020 in global disease burden measured as premature deaths and disability-adjusted life-years [6,7]. The decision to include age groups beyond adolescence is supported by the known concentration of MVA and violence in young adult males[8–10].

Materials and Methods

Data Set

The analyses for this study used the Mortality Database of the World Health Organization (WHO) [11] which consists of annual mortality data from countries with universal death registration and high rates of cause-of-death certification. The first and latest years for which data are available are 1950 and 1996, respectively.

Participation in the Database in any given year depended on a country's ability to collect and willingness to share the required information. Because of a 2 or more year lag in reporting for many countries, the number of countries with available data declined during the last 2 years (1995–1996) of the Database. Countries that reported early, continuously, and without delay tended to have more stable sociopolitical structures than did countries that missed reporting years. Because factors that influence reporting may also influence mortality, this introduces a potential selection bias when analyzing mortality trends over time. In an effort to limit the effect of this bias, we excluded the earliest (1950–1954) and latest (1995–1996) years of reporting, as well as countries with 5 or more years of missing data within the

1995–1994 window. The study sample therefore includes the 26 countries with at least 35 years of data during the 40-year time span. According to the United Nations, all except the three Latin American countries are defined as “more developed regions of the world” (MDR) [12]. For the purpose of these analyses, the time span was divided into eight increments of 4 years each (i.e., 1955–1959, 1960–1964, etc).

The cause of death is coded in the Database according to the Revision of the International Classification of Diseases (ICD) [13] that was in use at the time of data collection (Revisions 6 through 9). The causes of death analyzed in this study were MVA, suicide, homicide, and the sum of all causes. The description for MVA remained stable between ICD Revisions 6 and 9, but the number code changed from A138 in Revisions 6–8 to B471 in Revision 9. The description for suicide remained stable, but its number code changed from A148 in Revisions 6 and 7, to A147 in Revision 8, to B54 in Revision 9. Both description and number code for homicide changed between revisions. In Revisions 6–8, the description included “death by legal intervention such as by police or execution,” and the code changed from A149 in Revision 6 and 7 to A148 in Revision 8. In Revision 9, death by legal intervention was excluded, and the number code changed to B55 [13].

Although the selected countries are those with the most reliable national death registration systems, countries and cultures may vary in their reporting and classification of some causes of death. This variability is most likely to be seen for suicide because of religious differences across countries, and the most likely category for misclassification is “accident of undetermined intent.” [14] This category therefore was included in the analysis as an indirect estimate of differential reporting of suicidal deaths.

Data Analysis

The WHO Database lists the absolute mortality rates of each country by year, age group, ICD code, and gender. The listed rates do not adjust for differences among countries or changes across time in the relative population proportions by age and gender. To correct for a possible association between subgroup size and mortality, the absolute rates were standardized by applying a common set of weights anchored to the average age and gender distributions across the 26 countries and 40 years of analysis [15]. The country-specific rates and rankings in this study therefore may differ from those listed in the WHO Database.

The standardized country rates were used to calculate average rates across time periods, age groups, genders, and causes. Because economic prosperity may be associated with rates of MVA, homicide and suicide, some of the analyses are restricted to the 23 countries classified as MDRs. These descriptive statistics include the following: (a) rates of death from MVA, homicide, suicide, and all other causes for each country averaged across both genders and the eight time periods; (b) rates of death from MVA, homicide, suicide, and all other causes for each age group stratified by gender and averaged across the 26 countries and eight time periods; (c) male/female ratios of the rates of death from MVA, homicide, suicide, and all other causes for each age group averaged across the 26 countries and eight time periods; and (d) rates of death from MVA, homicide, suicide, and all other causes for each time period averaged across both genders, the four age groups, and the 26 countries. Within each cause-of-death category, the calculations are rank-ordered from lowest (rank of 1) to highest on a scale of “26” for countries, “4” for age groups, and “8” for age groups stratified by gender, and “8” for time periods.

Results

Mortality by Cause and Country

Figure 1 shows the range of national rates of death from MVA, homicide, suicide, and the three causes combined, averaged across age groups, gender, and time periods. The countries with the lowest and highest rates among the 26 countries in the study sample and the 23 MDR countries are noted on the bar graphs. Between the lowest and highest country rates, there is a 3-fold difference for MVA, a 38-fold difference for homicide, an 8-fold difference for suicide, and a 3-fold difference for the three causes combined. The U.S. MVA mortality rate is 24th among all 26 countries and 22nd among the 23 MDR countries, surpassed only by Austria. The U.S. homicide rate is 24th among all 26 countries, and highest among the 23 MDR countries. The U.S. suicide rate is 14th among all 26 countries and 11th among the 23 MDR countries.

Of the 26 countries, only the three Latin American countries had lower rankings for suicide than fatal accidents of undetermined intent, suggesting under-reporting of deaths owing to suicide. When each country's rates of MVA, homicide, and suicide were summed, Spain ranked lowest and Venezuela highest among the 26 countries and the United States ranked highest among the 23 MDR countries.

Mortality by Cause, Age, and Gender

Table 1 shows the rates of death from MVA, homicide, suicide, other causes, and all causes by age group and gender averaged across countries and time. All-cause mortality is higher for males than females in each age group, and both the male and female rates increase steadily with age. The rates of death owing to MVA, homicide and suicide also are higher for males than females in each age group, but neither the male or female rates increase steadily with age. Deaths from MVA peak at 20–24 years for males and at 15–19 years for females. Deaths from homicide peak at 25–29 years for both males and females. Deaths from suicide peak at 25–29 years for males and at 30–34 years for females. The total proportion of deaths owing to the three causes is highest for males aged 20–24 years (49.7%) and lowest for females aged 30–34 years (15.5%). Among males and females aged 15–19 years, the three causes account for 47.3% and 32.3% of deaths, respectively. The likelihood of death from MVA, homicide, or suicide is higher for a 15–19-year-old male than is the likelihood of death from any cause for a 30–34-year-old female.

Male/Female Mortality by Cause and Age

Table 2 shows the male/female ratios of the rates of death from MVA, homicide, suicide, and all other causes for each age group, averaged across time and countries. The ratios are lowest in the 15–19-year-old group for MVA, homicide, and suicide. However, even within this age group, the likelihood of death for males compared to females is 2-fold for MVA, 4-fold for homicide, and 3-fold for suicide. In contrast, the male/female ratios for deaths from all other causes are lower and nearly constant across the four age groups (1.49–1.70).

Mortality by Cause and Time

Table 3 shows the rates of death from MVA, homicide, suicide, and all other causes for each time period, averaged across age and countries. All-cause mortality declined steadily from the 1950's to the 1990's owing to a 50% decline in causes other than MVA, homicide, or suicide. Deaths owing to these three causes increased 24% from the 1950's to the 1970's and then decreased 12% from the 1970's to the 1990's, resulting in a net increase over the 40 years of 12%. The percentage of all deaths of individuals aged 15 to 34 years therefore increased from 26.2% in the 1950's to 42.7% in the 1990's.

Death rates from MVA, homicide, and suicide follow different trends over the 40 years. The MVA rate was lowest in the 1950's and 1990's, the homicide rate increased steadily from the 1950's to the 1990's, and the suicide rate was sporadic until the 1970's when it began a stepwise decline.

Discussion

This study demonstrates that the average country rate of death from MVA, homicide, and suicide combined peaks at age 15–24 years. Disaggregation of the data reveals far greater differences in cause-specific rates by gender than by age, time, or country. For each of the three causes, death rates for males exceed those for females across the 15–34-year-old age window and the gender gap does not begin to narrow until age 25–30 years.

The strengths of the current study include the following: (a) a wide array of developed countries; (b) a sampling strategy designed to limit bias in the reporting of death rates; (c) disaggregation of the data to allow calculation of rates specific for cause, country, age, gender, and time; (d) rate adjustment for population differences in age and gender proportions; and (e) incorporation of an analysis to test the reliability of the reported suicide rates. The study confirms that disaggregated and adjusted mortality rates vary considerably across countries and over time. The next steps are to identify the mechanisms underlying the variation, to predict increasing mortality before it occurs, and to respond with prompt and effective intervention strategies.

An important limitation of the current study is its inablility to explore the reasons underlying differences in country-specific mortality rates or to identify predictors of a change in rate. The WHO Database used in the study does not include the contextual data about individual countries or specific time periods required for such analyses. Future cross-national and time trend studies of adolescent and young adult mortality should seek or collect data that will facilitate the identification of social and environmental correlates of premature death.

We conclude that: (a) fatal risk behaviors begin to increase during adolescence but do not peak until ages 25–30 years; (b) the increasing proportion of deaths caused by MVA, homicide, and suicide during the latter half of the 20th century is neither limited to the United States, nor explained by changing age and gender distributions over time; (c) the United States ranks low compared with other countries on mortality from MVA and homicide; and (d) the low ranking is not due to a difference between the United States and other countries in the proportion of its population that is adolescent, young adult, or male.

These findings suggest that the target age range for the prevention of MVA, homicide, and suicide should be 15–30 years. Cross-national studies designed to elucidate population-level factors associated with adolescent and young adult death from these causes may help guide the development of prevention strategies that will save individual lives.

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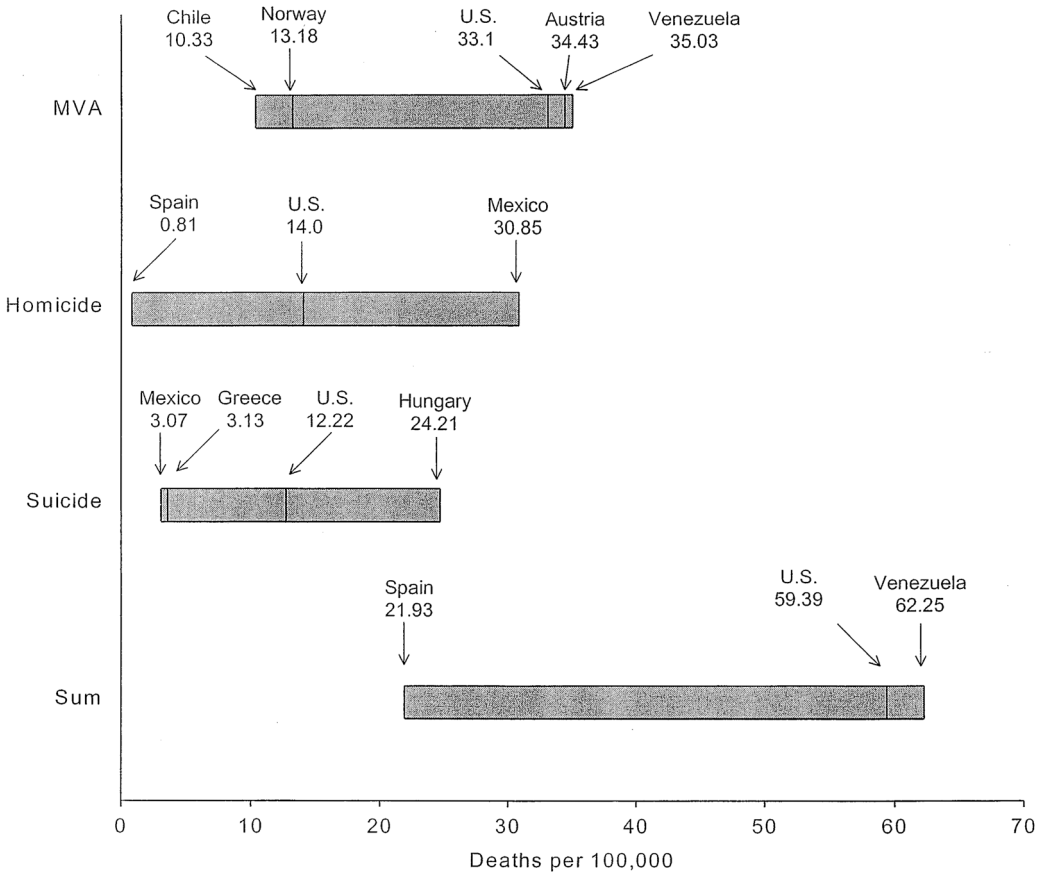

Figure 1.

Country-Specific Rates of Death per 100,000 Individuals 15–34 Years of Age from 1955–1994. Rates are Adjusted for Population Age-and-Gender -Distributions and Stratified by Cause of Death. Rates are Shown for United States, First-Ranked Country, and Last-Ranked Country Among the 26 Countries in the Study and Among the 23 MDR Countries. (MVA = motor vehicle accident).

Table 1

Gender-and-Age-Specific Rates of Death per 100,000 Individuals in 26 Countries From 1955–1994[a]

		Cause of Death				
Gender	**Age (yrs)**	**MVA**	**Homicide**	**Suicide**	**Other**	**All**
Males	15–19	39.33 (7)	7.16 (5)	9.15 (5)	62.0 (3)	117.59 (5)
	20–24	48.92 (8)	13.51 (7)	19.03 (6)	82.3 (5)	163.75 (6)
	25–29	34.01 (6)	13.58 (8)	19.79 (8)	98.9 (7)	166.23 (7)
	30–34	27.13 (5)	11.82 (6)	19.52 (7)	129.9 (8)	188.34 (8)
Females	15–19	11.82 (4)	1.74 (1)	3.84 (1)	36.4 (1)	53.80 (1)
	20–24	10.28 (3)	2.68 (3)	6.85 (2)	49.8 (2)	69.65 (2)
	25–29	7.17 (2)	2.72 (4)	6.98 (3)	64.9 (4)	81.73 (3)
	30–34	6.22 (1)	2.53 (2)	7.25 (4)	87.2 (6)	103.19 (4)

[a]Rates are adjusted for population age-and-sex-distributions and stratified by cause of death. Number in parentheses is the gender-age group ranking from lowest (1) to highest (8) for the given cause of death.

Table 2

Age-Specific Male/Female Mortality Ratios in 26 Countries from 1955–1994[a]

	Cause of Death				
Ages (yrs)	**MVA**	**Homicide**	**Suicide**	**Other**	**All**
15–19	2.38 (1)	4.11 (1)	3.33 (1)	1.70 (4)	2.19 (3)
20–24	2.78 (3)	5.04 (4)	4.76 (4)	1.65 (3)	2.35 (4)
25–29	2.84 (4)	4.99 (3)	4.74 (3)	1.52 (2)	2.03 (2)
30–34	2.69 (2)	4.67 (2)	4.36 (2)	1.49 (1)	1.83 (1)

[a]Rates are adjusted for population age-and-gender-distributions and stratified by cause of death. Number in parentheses is the age group ranking from lowest (1) to highest (4) for the given cause of death.

Table 3

Time-Specific Rates of Death per 100,000 Individuals Aged 15–34 Years in 26 Countries[a]

	Cause of Death				
Time	**MVA**	**Homicide**	**Suicide**	**Other**	**All**
1955–1959	20.51 (1)	4.50 (1)	13.00 (8)	107.01 (8)	145.02 (8)
1960–1964	22.73 (4)	5.85 (2)	10.92 (3)	94.06 (7)	133.56 (7)
1965–1969	26.86 (7)	5.93 (3)	9.95 (1)	84.21 (6)	126.95 (6)
1970–1974	28.23 (8)	7.54 (5)	11.03 (4)	77.89 (5)	124.69 (5)
1975–1979	26.53 (6)	7.33 (4)	12.23 (7)	64.27 (4)	110.36 (4)
1980–1984	24.80 (5)	7.72 (6)	11.99 (6)	57.58 (3)	102.09 (3)
1985–1989	22.40 (3)	8.45 (7)	11.44 (5)	55.02 (1)	97.31 (2)
1990–1994	20.63 (2)	9.93 (8)	10.83 (2)	55.44 (2)	96.83 (1)

[a]Rates are adjusted for population age-and-gender-distributions and stratified by cause of death. Number in parentheses is the time period ranking from lowest (1) to highest (8) for the given cause of death.