Published in final edited form as:
Ann Am Acad Pol Soc Sci. 2002 March 1; 580(1): 172–200.

An International Comparison of Adolescent and Young Adult Mortality

PATRICK HEUVELINE
Patrick Heuveline's research interests center on population dynamics and family change. His current research includes a comparative project on the increasing complexity of childhood family experiences across industrialized countries and the impact of these experiences on child well being. Other projects in the developing world focus on how populations,and families in particular, cope with demographic crises. One current project looks at the demographic “recovery” in Cambodia after the Khmers Rouges. Another project under development will study the impact of the HIV epidemic on the reproductive regimes of high-prevalence populations in Eastern Africa.

Abstract

This paper analyzes mortality rates for 3 of the main causes of deaths between the ages of 15 and 34 (motor vehicle injuries, homicide, and suicide) from 1950 to 1996, and across 26 countries. Average sex ratios and age patterns and the trends in age- and sex-standardized mortality rates are analyzed for each cause. Overall, youth violent mortality levels have been remarkably stable since the 1950s. As mortality due to other causes has receded, the contribution of these three causes has increased from 25 to 40 percent between the 1950s and the mid-1970s, and has remained above 40 percent since. Last, a principal component analysis is performed to summarize the variance in age-, sex-, and cause-specific rates over time and across countries. This summary representation of international differences displays regional clusters and emphasizes the “outlying” position of the United States among industrialized nations.

In his 1991 presidential address to the Population Association of America, Ronald Rindfuss brought attention to the high “demographic density” of the young adult years (there defined as ages eighteen to thirty). Marriage, fertility, migration, school leaving, and unemployment rates are all highest during these years, which attests “that major decisions and role changes in most areas of life are occurring during a relatively short, overlapping period” (Rindfuss 1991, 498). On the contrary, mortality rates are relatively low, rising only slightly from their minimum during childhood and being still much lower than later in life. In 1995, in the United States, the probability of surviving from age fifteen to age thirty-five was estimated to be 97.7 percent (Anderson, Kochanek, and Murphy 1997). The risk of death may not appear to constitute, on average, a salient aspect of the transition from adolescence to adulthood. Should an issue on the transition from adolescence to adulthood even have an article on mortality during these years? Or differently stated, Can we learn anything about this transition from mortality data?

One of the primary reasons for studying adolescents’ and young adults’ deaths in public policy circles is their unusual balance of higher than average societal costs and apparently more preventable causes. When productivity losses are added to direct medical care, the societal cost of early deaths rises compared to more frequent deaths at later ages. Deaths between age fifteen and thirty-five also exhibit a distinct set of causes. Again for the United States in 1995, the top four causes of death at those ages were, in decreasing order, accidents and adverse effects, homicide and legal intervention, HIV infection, and suicide. Together,

these four categories represented 70 percent of deaths in this age group compared to 8 percent of all-age deaths. While their overall mortality is low, adolescents and young adults contribute significantly to the societal costs of injury and violence, estimated in the United States at more than $224 billion per year (U.S. Department of Health and Human Services 2000).

That the bulk of adolescent and young adult mortality can be traced to fatal behavior, whether intentional or not, whether one's own or others' behavior, is also of interest to the social scientist. Because of this unique cause-of-death pattern, the social dimension of mortality is probably more transparent in this than in any other age group. Moreover, even if deaths remain fortunately rare, mortality levels are likely to be positively associated with the prevalence of other behaviors of sociological interest, often referred to as "problem behaviors," that are more common but also more difficult to assess. Mortality during these years is perhaps just as revealing of the "major decisions and role changes" taking place during these years as the peaks in fertility, migration, marriage, school leaving, and unemployment rates.

In this article, I review international trends in four major causes of death for adolescents and young adults (defined here as between the ages of fifteen and thirty-five): self-inflicted injuries, injuries intentionally inflicted by others, motor vehicle injuries (the main type of fatal injury at those ages), and HIV infection. I describe the age- and sex-pattern of mortality for each cause, draw temporal and international comparisons, and discuss to what extent these can be taken as markers of the difficulties associated with the transition from adolescence to adulthood.

THE DATA

Most of the data reviewed in this article are readily available from the World Health Organization (WHO) Mortality Database.[1] The database contains information on cause of death originally supplied by countries that have universal registration of deaths in conjunction with a high level of certification of cause of death. The first year of data is 1950, but the number of countries for which data are available gradually increases over time as more countries contribute to the database. The most recent year with data also varies by country. The most recent year is 1996, but for a significant number of countries, the reporting lag is one or a few years longer. Overall, approximately fifty to sixty countries report to WHO regularly, with national time series varying both in range and degree of completeness. In general, there are fairly complete time series for industrialized countries, notably countries in North America and Europe, Australia, New Zealand, and Japan.

For most analyses in this article, I retained all countries that reported at least thirty-five years of usable data on cause-specific mortality between 1950 and 1996. The purpose of this restriction was to allow more meaningful time series analysis. Countries that contributed fewer years to the WHO Mortality Database typically reported only in more recent years, and these countries are potentially different from those having provided data for a longer period. Temporal comparisons could have been biased by the increasing heterogeneity of the countries in the database over time had such restrictions not been imposed.

The selected countries are shown in Table 1 with their year of available and complete data.[2] As expected, the majority of countries (eighteen) are in Europe. Japan, Australia, New

[1]The short description of the database provided here comes from the database Web page (http://www.who.int/whosis/mort/index.html), where a more comprehensive description can be found.

[2]Two relatively small countries (Mauritius, and Trinidad and Tobago) were not included although they would have met these data requirements.

Zealand, Canada, and the United States, but also Chile, Mexico, and Venezuela complete the list for a total of twenty-six countries. The cutoff of thirty-five years is arbitrary but was eventually selected as a threshold below which the number of available years for additional countries drops rapidly. Raising the bar to forty years would have excluded four countries (Greece and Mexico at thirty-six years, Venezuela at thirty-eight years, and Belgium at thirty-nine years), while lowering it to thirty years would have added only one (Uruguay at thirty-one years).

For the purposes of the analyses below, each entry in the database corresponds to a given country in a given year (1,128 observations) and consists of the number of deaths and death rates by sex, age group, and cause of death. Between the ages of fifteen and thirty-five, age is reported in five-year age groups. The cause of death is coded using a three-character International Classification of Diseases (ICD) code, internally developed and maintained by WHO. The ICD has been revised ten times since its first formulation in the nineteenth century. The database was established after the sixth revision (ICD-6) of 1948. ICD-7 was published in 1955, ICD-8 in 1965, ICD-9 in 1975, and ICD-10 in 1992. Countries did not necessarily all adopt a new revision in the year it appeared, so the switch from one revision to the next is generally staggered.

The degree to which equivalent causes may be tracked from one revision to the next depends on the stability of a label, or for labels that change, it depends on the extent to which the causes subsumed in a label can be distinguished and identified in subsequent revisions. Table 2 shows the categories used in the different classifications to track trends in three causes of death discussed below: suicide, homicide, and motor vehicle injuries. Fortunately, those appear as fairly stable categories across classifications, and tracking these deaths over time is fairly straightforward. Even if mortality data are subject to relatively less variability in definition than most social data, misclassification is a potential issue here. In particular, countries vary in their certification procedures for homicide or suicide (Brooke 1974) and social values toward the latter. International differences in recorded rates might reflect differential reluctance or inefficiency in recording death from specific causes. To provide some data checks (discussed below), I included the “undetermined intent” and “other (than motor vehicle–related) unintentional injury” categories in the database (also shown in Table 2).

Finally, more general concerns about data quality are, as always, in order. The countries described here are believed to have complete death registration systems, and baring serious flaws in the chain of reporting to WHO, these data should be accurate. There was one cause of death though for which data were suspected to be potentially incomplete, namely HIV infection. Countries differ as regards their efforts to identify and report deaths from HIV-related causes. Time trends in reported HIV-related death may reveal more the process of gradual recognition of HIV/AIDS than the actual progression of the epidemic. The analysis of the HIV infection was based instead on the Joint United Nations Programme on HIV/AIDS (UNAIDS) estimates of the cumulative number of HIV-related deaths and adult HIV seroprevalence in each country as of the end of 1997 (UNAIDS 1998).

Because of the different nature of the data, HIV/AIDS data are discussed in a distinct section toward the end of the article. These data are then compared with mortality data from the above-discussed causes. Since the analysis including HIV data is de facto limited to 1980 and thereafter, additional countries could be considered for this part of the analysis only, that is, countries that did not meet the earlier data requirements but had acceptable data for nearly all years after 1980. Of particular interest were countries of eastern Europe because of the economic and social transformations that occurred in the past decade. Among those, only the Czech Republic and Hungary are included in the first analyses, but the satisfactory

quality of their post-1980 data allowed the addition of Bulgaria, Poland, the Russian Federation, and Ukraine[3] in the later analyses.

THE SEX AND AGE STRUCTURE OF ADOLESCENT AND YOUNG ADULT MORTALITY

Sex ratios of mortality by cause

The most salient feature of mortality in those ages is perhaps the high sex ratio of mortality from suicide, homicide, and motor vehicle injuries. The average mortality sex ratio between ages fifteen and thirty-five is 2.7 for suicide, 4.2 for motor vehicle injuries, and 4.7 for homicide (see Table 3). The average mortality sex ratio for all other causes of deaths (after subtracting these three major causes) is 1.6, leading to an all-causes mortality sex ratio of 2.1. For each of the three causes, the average sex ratio increases to a plateau between ages twenty and thirty, after which it declines slightly, whereas the ratio is nearly constant over age for other causes of death. The distinct pattern of these three behavior-related causes of death is perhaps one of the clearest indications of the social dimension of gender differences. It also suggests that individuals' risk behavior is most gendered during their twenties.

The sex ratios of mortality from behavior-related causes could perhaps be expected to have declined over time with increased female enrollment in higher education institutions or labor force participation. I thus examined these sex ratios over time for the different causes of death. Changes seemed fairly linear over time and are summarized in Table 3 by comparing average ratios for the decade 1955 to 1964 with the most recent decade, 1985 to 1994. The most dramatic change has been indeed the declining sex ratio of mortality from motor vehicle injuries, from 6.5 to 4.1 between ages twenty and thirty. Meanwhile, the sex ratios of mortality from suicide were going in the opposite direction. While between 1955 and 1964, suicide sex ratios averaged between 1.6 and 2.2 across the four five-year age groups, they reached between 3.5 and 4.3 in the most recent decade.[4] Homicide trends are mixed: sex ratios increased between ages fifteen and twenty-five but declined between ages twenty-five and thirty-five.

Overall, sex ratios changed in different directions for each of the three causes of death and did not uniformly decline. In fact, for all causes combined, average mortality sex ratios have increased slightly over time between ages fifteen and thirty-five. Interestingly, the ratios seem to be converging to the extent that the sex ratios that were highest between 1955 and 1964 (motor vehicle injuries and homicide after age twenty-five) declined thereafter, while the other ratios increased. For example, in the earlier decade, the sex ratios between ages twenty-five and thirty ranged from 2.2 for suicide to 6.4 for motor vehicle injuries. In the more recent decade, the sex ratios in the same age group ranged from 3.9 for suicide and motor vehicle injuries to 5.1 for homicide.

Across countries, sex ratios are fairly similar for suicide mortality rates, ranging from 1.8 in Japan and 2.0 in the Netherlands to 4.0 in Chile, 4.1 in Ireland, 4.2 in Norway, and 4.4 in Finland (averages across all available years). No clear regional basis could be detected for these variations. For motor vehicle injuries, sex ratios are lower in the United States (3.6)

[3]Other countries could have been included based on their post-1980 data availability, such as the Baltic Republics or non-European countries. We limited our selection to the larger eastern European countries among which Romania could not be included due to data limitations.

[4]Pampel (1998), analyzing trends in eighteen industrialized nations (1953 to 1992), found that trends in suicide sex ratio were not linear but that sex differentials narrowed and then increased on the period. For the age groups considered here (the "young," ages fifteen to thirty-five), however, he reported that the "differentials bottom out early for the young; around 1960, male suicide rates begin to rise faster than female suicide rates" (p. 753). The trend analysis is consistent with ours, while the absolute levels vary because of different sets of countries.

and Canada (3.8) and were highest in southern Europe (Portugal: 8.1, Italy: 6.4), Japan (6.9), eastern Europe (Hungary: 6.8, the Czech Republic: 6.5), and Latin America (Chile: 6.7, Venezuela: 6.5, and Mexico: 5.9). But regional patterns are most clear for sex ratios of homicide rates. The sex ratios are by far the highest in Latin America (Mexico: 13.1, Venezuela: 11.3, and Chile: 10.2). The only other countries with ratios above four are in southern Europe (Italy: 4.4, Portugal: 4.1, and Spain: 4.0), whereas the ratios are lowest in Denmark (1.0) and Switzerland (1.0). As will be discussed in a section below, the countries with low ratios are also countries with low mortality from homicide, and the low ratios reflect low male mortality from homicide rather than high female mortality.

Age pattern of mortality by cause

The different age patterns by cause are shown in Table 4. For suicide and homicide, mortality is much lower before twenty, especially for males,whose average mortality rates from suicide and homicide roughly double after age twenty. For suicide, average mortality rates continue to increase slightly beyond age twenty and then remain about constant between ages twenty-five and thirty-five. For homicide, the plateau is between ages twenty and thirty, and then average mortality rates begin to decrease. The age pattern for motor vehicle injuries is quite different. For males, the average rates increase after age fifteen to peak in the twenty to twenty-four age group and decline rapidly thereafter, whereas the average rates for females are already highest in the fifteen to nineteen age group. These three age patterns are also quite distinct from most other causes of death whose mortality rates increase at all ages.

The sex and age pattern in Table 4 reflects average rates across years and countries but not necessarily a uniform pattern. Further analyses suggest, however, that the pattern is fairly robust. This is illustrated in Table 5, which tabulates across all observations (country-year), the sex and age group in which mortality rates are highest for different causes of death.

For suicide, mortality rates are highest for males ages thirty to thirty-four in nearly half of the observations, the other half being divided evenly between males ages twenty to twenty-four and males ages twenty-five to twenty-nine. I further investigated whether these age-pattern variations corresponded to different periods. Preston (1984) reported that the age gradient after age twenty-five had become less pronounced in recent years in the United States, and a similar increase of young adult rates relative to older adults has been observed in other countries (Ruzicka 1995). This observation does not apply, however, to most countries in the database. On the contrary, both male and female average mortality rates from suicide peaked in the twenty to twenty-four age group between 1955 and 1964, whereas they increased with age between 1985 and 1994 (results not shown). In absolute terms, female rates strongly declined at all ages between 1955 and 1964 and between 1985 and 1994, however, whereas male rates increased except for the twenty to twenty-four age group.

Variations in mortality from suicide exhibit a geographical rather than a temporal pattern. Most countries contributing to an early peak are non-European countries. While for European countries, the average male mortality rates from suicide increase with age (from 15.3 per 100,000 between ages twenty and twenty-five to 19.4 between ages thirty and thirty-five), average rates for other countries decrease from the younger to the older age group (from 21.9 to 19.7 per 100,000). The different age gradient of young adult mortality from suicide may be related to a more gradual transition to adulthood in Europe, which is suggested by later median ages for home leaving, first union, or first birth.

Variations in the age pattern are larger for homicide. As shown in Table 5, males ages twenty-five to twenty-nine constitute the peak sex and age group for homicide in about 30

percent of country-year observations, whereas the mortality rates from homicide are highest for males ages thirty to thirty-four in another 30 percent of the cases. Rates peak with younger males in about 20 percent of the observations but also with females (any of the four age groups) in nearly 14 percent of the cases. The variability of the peak sex- and age-specific rates can be explained in part by fairly low rates, typically on the order of 1 to 3 per 100,000, in all countries except Latin American countries and the United States.

These variations are also due to a visible shift in the male age pattern of homicide mortality. While on average, both male and female rates increased by about 75 percent between the 1955 to 1964 and the 1985 to 1994 decades, female rates increased similarly across all age groups. On the contrary, average male rates increased by about 50 percent after age twenty-five, while rates doubled between the ages of twenty and twenty-five and nearly tripled between the ages of fifteen and twenty (results not shown). Between 1955 and 1964, the average male age pattern exhibits a steep slope from 4.2 per 100,000 between ages fifteen and twenty to a peak at 10.7 per 100,000 between twenty-five and thirty. But between 1985 and 1994, the age slope was reduced to an increase from 11.4 to 16.7 per 100,000 across these two age groups, with the peak shifting earlier to ages twenty to twenty-five (18.1 per 100,000).

Finally, Table 5 shows a relative concentration of peak ages for mortality from motor vehicle injuries. The rates are highest for males ages twenty to twenty-five in nearly two-thirds of the observations, the rest being spread to adjacent male age groups. Latin American countries, Portugal, and Spain often exhibit a late peak. Japan and Nordic countries (Norway, Sweden, and Finland) often exhibit an early peak. Over time, as suggested by trends in sex ratios, average age-specific rates have increased for females in each age group, while they have declined for males except for the fifteen to nineteen age group.

To conclude this section, the average sex and age mortality patterns shown in Table 4 appear fairly robust over time and across countries. To be sure, there are some important deviations such as the decrease in the sex ratio of mortality from motor vehicle injuries, the shift in peak mortality from homicide toward younger ages, or the higher sex ratio of mortality from these two causes in Latin American and south European countries. But overall, Tables 3 through 5 also suggest some important common features across most years and countries, such as high sex ratios for each of the three causes, peak homicide mortality between ages twenty and thirty, and peak mortality from motor vehicle injuries between ages twenty and twenty-five. Because of these marked sex and age patterns of mortality, the rest of the article addresses temporal and international differences in mortality levels by comparing sex- and age-standardized mortality rates for each cause. The sex and age distribution used as the standard is the average distribution in the population of the database and is also shown in Table 4.

TRENDS IN LEVELS OF ADOLESCENT AND YOUNG ADULT MORTALITY

For each five-year interval between 1955 and 1994, average standardized mortality rates from each cause are reported in Table 6. To check whether the average trend represents a uniform experience across countries, Table 7 displays the period in which each national time series reaches its maximum and minimum values for each cause of death.

The clearest trend is for mortality rates from motor vehicle injury. The average rates increased rapidly between 1955 and 1964 to reach a maximum between 1965 and 1974 and then declined in the 1980s and 1990s (see Table 6). This trend is fairly uniform across countries since all countries reached their lowest rate either before 1961 or after 1992, while twenty countries out of twenty-six reached their peak year between 1968 and 1978 (see Table 7). Some countries have only recently succeeded in reducing mortality from motor

vehicle injury, but with the exception of Greece, recent mortality rates fell significantly below their period peak. Seven countries (Canada, the United States, the Czech Republic, Sweden, Switzerland, the United Kingdom, and Australia) even reached their lowest mortality rates in the 1990s.

A quite different trend is visible for mortality from homicide. Average standardized rates first went up, remained at a plateau during the 1970s and early 1980s, then increased again. Overall, average rates nearly doubled between the late 1950s and the early 1990s. Although not quite as uniform as for motor vehicle injuries, the trend in average rates is applicable to a majority of countries. Every country but one enjoyed its lowest rate before 1977, half of them in the 1950s. Japan is unique for reaching its highest rate in 1955, as well as for reaching its lowest mortality rate in 1995, whereas half the countries reached their highest rate in one of their last ten years of data. The plateau in the average rate is due in part to the fact that some countries did experience an increase in homicide mortality in the 1970s but did not in the 1990s. Their mortality rate thus peaked in the mid- to late 1970s (Canada, Austria, Finland, Portugal, and the United Kingdom).

The trend for suicide is more difficult to characterize. The average standardized rate appeared to decrease in the 1960s, increase in the 1970s, and then decrease in the 1980s and 1990s. There is, however, a lot of variability in country-specific trends. Eighteen countries reach their highest mortality rates after 1982, in a period of average rate decline. But eight countries also reached their lowest mortality rates after 1987: besides Japan, Venezuela, and Portugal, there are five countries in northern and central Europe (the Czech Republic, Hungary, Austria, Germany, and Denmark). By contrast, Canada, the United States, Australia, New Zealand, and six countries in northern and western Europe (France, Belgium, the Netherlands, the United Kingdom, Norway, and Sweden) had their lowest rate in the 1950s.

Again, the mortality trends from these three causes are different from one another but also quite distinct from the other causes of death between ages fifteen and thirty-five. Overall mortality has declined almost linearly since 1950, and the upswings in mortality from motor vehicle injuries, suicide, or homicide only reduced the pace of the decline in one period or another. Between the late 1950s and the early 1990s, average standardized mortality rates from all causes combined declined by a third. Meanwhile, the sum of the mortality rates from the three causes reviewed above—driven by the pre-dominant mortality from motor vehicle injury—increased through the mid-1970s and only slightly decreased thereafter. Overall, the average standardized mortality rate for three causes combined increased by 9 percent, while the corresponding rate for the other causes of death declined by 48 percent. As a result, the contribution of these three causes of death to overall mortality between ages fifteen and thirty-five has risen from 26 percent in the late 1950s to 43 percent from the late 1970s on (see Table 6). When AIDS-related mortality is incorporated (see section below), the increasing contribution over time of behavior-related mortality during the transition to adulthood is even more striking.

INTERNATIONAL VARIATIONS IN LEVELS OF ADOLESCENT AND YOUNG ADULT MORTALITY

As in the previous section, international comparisons in mortality levels are drawn from standardized rates to control for differences in the sex and age distribution. In addition, the preceding section has demonstrated some important time trends. To avoid bias due to missing values in early or late years, international comparisons are based on the forty-year average between 1955 and 1994. As shown in Table 1, most countries have data for each year between 1955 and 1994 except Greece (1955 to 1960 missing or incomplete), Mexico

(missing 1955 to 1957, 1977, and 1984), Venezuela (missing 1984 and 1991), Belgium (1993 and 1994 not yet available), Spain (missing 1970), and Italy (1994 not yet available).

The average standardized mortality rates for each cause and country are presented in Table 8 (in ascending order of mortality from the three causes combined). The list of countries at the top of the table is somewhat disparate, including southern European countries (Spain, Greece, and Italy), northern European countries (the United Kingdom, Ireland, Norway, and the Netherlands), and Chile. These countries form a heterogeneous group in part because they rank near the top for different causes of death. Southern European countries and Ireland have relatively low mortality rates from suicide, whereas northern European countries and Chile have relatively low mortality rates from motor vehicle injuries.

With the exception of Austria, countries at the bottom of the table are predominantly non-European (Canada, the United States, Australia, New Zealand, Mexico, and Venezuela). For all countries but Mexico, the high combined rate is largely due to high mortality rates from motor vehicle injury, which is the most frequent cause of death of the three included here. High mortality rates from homicide explain the low position of Mexico and, combined with motor vehicle injuries, the bottom positions of the United States and Venezuela. The surprising position of Austria—its combined rate is 20 percent higher than that of Germany, the closest other European country—results from a combination of high mortality from both motor vehicle injuries and suicide.

As often observed and challenged, Catholic countries have the lowest mortality rates from suicide: seven of them (Mexico, Spain, Italy, Portugal, Ireland, Venezuela, and Chile) are here among the ten countries with the lowest rates. Whether this corresponds to lower mortality from suicide or to some lower propensity to report this mortality in the appropriate category remains a contested issue (e.g., Simpson 1998; van Poppel and Day 1996, 1998). In an attempt to detect such inappropriate reporting, I included in the database death rates from causes with undetermined intent and from other unintentional injuries (non–motor vehicle related), two likely candidates for concealed deaths from suicides. Analyses of these two sets of mortality rates do reveal a negative correlation, across sex and age groups, between mortality rates from suicide and both undetermined causes and other unintentional injuries, which is consistent with the suspicion of suicide misreporting in these two sets of causes. The correlation was almost entirely due, however, to the three Latin American countries. When compared to the other industrialized countries, European Catholic countries (Ireland, Italy, Spain, and Portugal) do not exhibit any significantly different mortality rates from undetermined causes and from other unintentional injuries. Their average mortality rates from the former are actually lower, while their average mortality rates from the latter are higher than those of other European countries but lower than those of the United States and Canada (none of the differences' being significant).

The three Latin American countries do exhibit much higher mortality rates from these two sets of causes. Not having any non-Catholic developing countries in the database, the hypothesis of a Catholic bias cannot be tested. Without inferring any such bias, higher mortality rates from other unintentional injuries are plausible, however, while higher mortality rates from undetermined causes could result from genuine (i.e., nonintentional) differences in death certification procedures. In any event, Latin American mortality rates from suicide should be considered with caution and probably not be interpreted at this stage. But low mortality rates from suicide in European Catholic countries seem to reflect a real difference in the incidence of fatal suicide rather than a statistical artifact. In any event, one finds at the other end of the range of mortality rates from suicide central European countries (Hungary, Austria, Switzerland, and the Czech Republic), northern European countries (Finland, Sweden, and Denmark), and Japan.

The distribution of mortality rates from homicide is much more skewed. At the lower end, Japan and fifteen European countries have average standardized rates ranging from 0.81 and 1.51 per 100,000 (see Table 8). The rates are higher in three European countries (Italy, Hungary, and Finland) and four non-European countries (Canada, Australia, New Zealand, and Chile). Finally, three American countries (the United States, Venezuela, and Mexico) clearly stand out for their mortality rates from homicide, five, seven, and eleven times higher, respectively, than the highest rate in a European country (Finland).

Motor vehicle injuries contribute most to mortality between ages fifteen and thirty-five (except in Mexico), but the international variations are smaller than for mortality rates from suicide (in relative terms) and from homicide (both in relative and absolute terms). Countries with low average rates of mortality from motor vehicle injuries form a disparate group. Except for Spain, European countries are mostly from northern Europe (the United Kingdom, Ireland, the Netherlands, Denmark, Norway, Sweden, and Finland) or from central Europe (the Czech Republic and Hungary), while outside Europe, Japan, Chile, and Mexico also have low average rates. This disparate group seems to be composed of two distinct sets of countries. In the first one, including countries such as Spain, Hungary, and Mexico, rates used to be low but have been increasing in more recent years, perhaps reflecting the trend in motor vehicle density. On the contrary, in other countries such as Sweden, the Netherlands, and the United Kingdom, mortality rates from motor vehicle injuries are declining from high levels in the early 1970s, probably due in part to changes in regulations and safety devices. At the high end of mortality rates, Austria is the only European country, joining Canada, the United States, Australia, New Zealand, and Venezuela. Except for the last two, non-European countries seem to be closing the gap, however, after having led the increasing mortality trend in the late 1960s and early 1970s.

HIV/AIDS MORTALITY

The above database and analytical strategy is not appropriate for the study of HIV/AIDS mortality. Data quality is in general lower for AIDS-related mortality. Because the eventual death of an HIV-infected person results from some additional, opportunistic infection, the certification of death from AIDS-related causes is complex. Although there have been guidelines in classifying causes of deaths as AIDS-related, some international variation likely remains in the certification process. These differences are amplified by the stigma often still attached to the virus, which may lead to avoiding classifying a death as AIDS related, much more than is now the case for suicide, for example.

A second important difference from the standpoint of this study lies in the lag between the incidence of HIV infection and death from AIDS-related causes. Until recently, the median duration from HIV infection to AIDS was about ten years, while the median survival with AIDS was about two years, but recent medical developments have considerably improved the survival of HIV-infected people. The reason to include AIDS-related mortality in this analysis is not simply the sheer mortality impact between ages fifteen and thirty-five, even though in several industrialized countries AIDS-related mortality is ranking among the top causes of death in this age group. The reason is rather that many HIV infections are acquired in this age group so that irrespective of the exact age at death, a premature death can be related to behavior in the age group of interest here. The argument could actually be extended to several other problem behaviors, such as abuse of alcohol, cigarette smoking, or illicit drug consumption, which may result in later life mortality but are often developed in adolescence or early adulthood (see Eisner 2002 [this issue]). The argument remains most convincing for HIV/AIDS, however, since mortality in the young to middle adult years is low on average so that most HIV infection would end with a premature death from causes directly related to the infection.

HIV incidence in this age group is thus more relevant to this study than is AIDS-related mortality. Unfortunately, data on HIV incidence (new infections) over time is not routinely available for a large number of countries. Recorded trends are often distorted by the fact that they capture the dynamics of the epidemic as well as progress made in tracking and testing HIV-positive people. As a result, the most reliable time series are reconstructed from estimates of the number of currently infected persons and back-calculation of the time of infection (Brookmeyer and Gail 1994).

In this section, I use data from UNAIDS, which regularly estimates the number of HIV-infected persons alive and the cumulative number of deaths from AIDS-related causes for every country in the world. The most recent data at this writing refer to the end of 1997 and are shown in the second two columns of Table 9. The data are not as detailed as the mortality data discussed in previous sections,nor perhaps as one could obtain from national statistical offices from a few of the countries. These estimates have the advantage of originating from a single source, however, and are thus more likely to be comparable across countries.

The estimates of HIV-positive persons are provided for adults and infants, and only the number of HIV-positive adults is reported in Table 9, adults being defined here as between the ages of fifteen and fifty. The numbers of deaths from AIDS-related causes are not available separately for infants and adults. In the countries considered here, however, high sex ratios of HIV infections (typically four males per female), low birth rates, and mother-to-child transmission rates on the order of one in four all contribute to a relatively small number of infant deaths among AIDS-related deaths. The sum of (1) the number of HIV-positive adults alive and (2) the cumulative number of deaths from AIDS-related causes should hence provide a fair approximation of the total number of adult HIV infection since the onset of the epidemic. On one hand, the total is slightly inflated by the inclusion of child deaths. On the other hand, the total does not include HIV-infected adults who might have died of causes unrelated to their infection.

The next column in Table 9 presents the ratio of the cumulative number of adult HIV infections to the size of the adult population, as of the end of 1997. The term “ratio” is used to emphasize that this quantity does not directly relate occurrences to exposure as opposed to the mortality rates used in previous sections. Yet, in the last two columns of Table 9, I attempted to present adult HIV-infection data and other mortality data in comparable metrics. The adult HIV-infection figure is an annualized ratio; that is, the above ratio divided by eighteen—the number of years between an estimate of the onset of the epidemic (end of the 1970s) and the end of 1997—and expressed in per 100,000 as mortality rates. The denominator is then a crude measure of exposure to HIV infection in the adult population since 1980. On one hand, the annualized ratio uses eighteen times the 1997 adult population instead of person-years of exposure in the adult population between 1980 and 1997, introducing an overestimation bias likely to be small since population growth is slow in most of these countries. On the other hand, the adult (fifteen to fifty) HIV-infection rate likely underestimates the corresponding rate for people ages fifteen to thirty-five.

On balance, the annualized ratio should be reasonably comparable to the HIV-infection rate between ages fifteen and thirty-five, an expectation supported by additional data from the United States. According to UNAIDS data, by the end of 1997, there had been about 1.23 million people infected by the virus in the United States, that is, nearly 70,000 per year between 1980 and 1997. Typically, age at the time of infection is unknown but can be assessed backward from age at the time of death. In 1995, 30,754 out of 43,115 death from AIDS-related causes occurred between the ages of twenty-five and forty-five (Anderson, Kochanek, and Murphy 1997). If we assume a uniform duration from infection to death of

ten years, the proportion of all HIV infections that occurred between ages fifteen and thirty-five is about 70 percent. These approximations lead to an estimate of about 49,000 HIV infections between the ages of fifteen and thirty-five between 1980 and 1997, which compares with an estimate from the mortality database of 47,396 deaths from suicide, homicide, and motor vehicle injuries in the United States, on average, between 1980 and 1995. The comparison suggests that in the United States, the average HIV ratio should be about as high as the average mortality rates from the three causes combined. The annualized ratio for the United States is actually 20 percent lower than the three-cause mortality rate (48.29 per 100,00 versus 59.59 per 100,000). For the United States, the annualized ratio appears to be a conservative estimate of average HIV-infection rates since 1980 between ages fifteen and thirty-five but to be reasonably comparable to the average standardized mortality rates.

In Table 9, the annualized ratio is compared with an average standardized mortality rate for the three causes combined (suicide, homicide, and motor vehicle injuries) and computed only for available data after 1980. As mentioned in the Data section above, the restriction of the analysis to those years allows the inclusion of four countries in addition to those presented in Table 1: Bulgaria, Poland, the Russian Federation, and Ukraine. For the three causes of death analyzed so far combined, the post-1980 rate for Bulgaria is low, close in that respect to the Czech Republic, while the rate for Poland is near the average and slightly lower than the rate for Hungary. The rates are quite high for the two countries from the former Soviet Union, Ukraine, and the Russian Federation. The latter has the highest post-1980 average rate for the three causes combined across the thirty countries included here, and recent data are even more worrisome. The average standardized rates increased for each cause between the 1980s and the early 1990s (1990 to 1995): from 25.9 to 32.3 per 100,000 for suicide (+25 percent), from 22.1 to 32.3 per 100,000 for motor vehicle injuries (+46 percent), and from 13.8 to 29.7 per 100,000 for homicide (+115 percent).

The annualized HIV ratio suggests a high incidence of HIV infection relative to mortality rates from the three causes combined in a number of countries. Besides in the United States, the HIV ratio approaches the three-cause mortality rate in Italy, Switzerland, France, Mexico, and Venezuela; it even surpasses it in Portugal and, foremost, in Spain. Countries in Table 9 were reordered based on the sum of the HIV ratio and mortality rate from the three causes combined. If the HIV ratio was exactly equivalent to the sex- and age-standardized rates, that sum would measure the average sex- and age-standardized rates of HIV infection and death from suicide, homicide, and motor vehicle injuries combined between ages fifteen and thirty-five from 1980 on.

The top third of Table 9 is dominated by northern European countries (the United Kingdom, Ireland, the Netherlands, Norway, and Sweden) but also includes Japan, Bulgaria, the Czech Republic, and Chile. To the extent that we can relate differences in behavior-related mor tality to well-being, the presence of these three very different countries seems to indicate that adolescent and young adult well-being can be improved under very different socioeconomic and cultural conditions. This is confirmed by the bottom position of the United States, just below Ukraine, the Russian Federation, Mexico, and Venezuela. As opposed to Table 8, the bottom third of Table 9 now includes southwestern European countries. When the risk of HIV infection is added, Portugal, Spain, France, and Switzerland now fall below non-European countries such as Australia, New Zealand, and Canada.

INTERNATIONAL DIFFERENCES AND UNDERLYING CAUSES

In the introduction, I underscored that adolescent and young adult mortality was dominated by causes of death related to behavior, whether one's own or not, and whether intentionally

fatal or not. To suggest that mortality rates from such causes do reveal something about the transition to adulthood is to assume implicitly that such mortality can be related to some underlying social dimensions. The tables above clearly exhibit marked international differences, but they force comparisons to a monodimensional scale. An alternative way to explore the international differences without preimposing the number of dimensions is to perform a principal components analysis. Each observation in the mortality database (i.e., a country in a given year) is a point in a thirty-two-dimension space, composed of both four age groups for each sex and, for each ageand-sex group, mortality rates from four causes: suicide, homicide, motor vehicle injuries, and other unintentional injuries.[5]

Results shown in the appendix (the first six components only), confirm that there are some strongly invariant elements in age-, sex-, and cause-specific mortality. The thirty-two-dimension space can be reduced to five principal dimensions that account for 95 percent of the database variance. The first component, accounting for 35 percent of the variance, essentially separates suicide rates at all ages and for both sexes from other mortality rates. Mortality from motor vehicle injuries exhibits for each sex a clear age gradient along that component with rates at younger ages closer to mortality rates from suicide and rates at older ages closer to mortality rates from homicide and other unintentional injuries. As young drivers are more frequently involved in motor vehicle accidents, this age effect may reflect a decrease with age of the proportion of motor vehicle fatalities in which the victim was actually driving. Mortality rates at younger ages may then be more closely related to their own behavior (as in the case of suicide), whereas at older ages these rates are more dependent on other drivers' behavior (as in the case of homicide). The first dimension thus seems to capture a distinction between intentional, self-inflicted injuries and unintentional injuries or injuries inflicted by others.

The second dimension appears to represent a weighed sum of the three risk profiles (suicide, homicide, and motor vehicle injuries), as the corresponding mortality rates are separated from other unintentional, arguably more genuinely "accidental" injuries. The second dimension explains another 24 percent of the total variance in youth mortality. The main deviation in age- and sex-group loadings on the second dimension concerns sex differences in mortality rates from homicide. Male rates appear relatively less associated with that dimension than do female rates, and male homicide rates appear closer to mortality rates from unintentional injuries especially at older ages. Although we know that most homicides stem from encounters between a criminal and a victim who know each other, this result may reflect the higher proportion of homicide by strangers that may affect males in high-crime areas.

The next two principal components isolate specific causes of death, motor vehicle injuries and homicide, explaining, respectively, 19 percent and 12 percent of the variance. The fifth component appears to discriminate mostly along gender lines, with male suicide rates being associated with female mortality rates from homicide and motor vehicle injuries at all ages. It is possible that this reflects a higher proportion of female victims of male criminals and female passengers of male drivers. In any event, the fifth component only accounts for 4 percent of the total variance, and subsequent components are even less important.

The principal components analysis allows for parsimonious descriptions of the trends and international patterns in mortality by sex, age, and cause of death. Figure 1 summarizes changes over time on the two principal dimensions. The two principal axes have been

[5]Mortality rates from HIV are not available for each observation (i.e., country-year), so to obtain more robust estimated factors, the assessment was conducted on mortality data with suicide, homicide, motor vehicle injuries, and other unintentional injuries. The fourth cause is added to help the interpretation of the principal factors.

rotated,and the vertical axis is the second dimension, an aggregate of violent mortality levels, with positive values representing lower mortality. The vertical axis is labeled “control” because variations along this dimension can be thought of as resulting from the various degree of control exerted over potentially harmful behaviors. The horizontal axis, which essentially discriminates between suicide (on the right) and other causes of violent mortality (on the left), is labeled “motivation” because the victim's intentions best discriminate suicide from the other causes of death under consideration. Missing values for Mexico characterize the five years on the right side of the graph (1955, 1956, 1957, 1977, and 1984) because the high homicide rates for Mexico contribute to pull the international average to the left in years Mexican data are available.

Starting in the 1960s, change occurs mostly along the vertical dimension, with a marked decline from 1965 to 1972 and annual average values remaining near their lowest for the rest of the 1970s. The trend is reversed after 1980, and from 1992 on, average values are back to their 1966 level but remain below those of the first decade (1955 to 1965). This analysis is consistent, of course, with the descriptions provided in the sections above and, in particular, with data summarized in Table 6, which suggest that the sum of the three standardized cause-specific mortality rates had increased up to the mid-1970s and declined thereafter. The principal component analysis exhibits, however, a much more coherent average trend than could be detected above.

This representation of past trends does not conform to the common perception of a continued worsening of the social conditions faced by adolescents and young adults. In particular, its timing is inconsistent with the popular argument about increased social disorganization attributed to the recent family changes that have taken place in nearly all the industrialized countries studied here. It is true, however, that the data used in this section do not incorporate the impact of the HIV/AIDS epidemic, which should largely moderate any positive interpretation of the post-1980 trend. With this important reservation, the trend is more consistent with the relative cohort size argument (Easterlin 1980; Ryder 1974), according to which members of a larger cohort experience stiffer competition to access more strained resources. The “worse” years range from 1970 to 1981, years during which the baby boomers entered the fifteen- to thirty-five-year-old age group.[6]

The same representation can be used to summarize international variations (see Figure 2). The most important variations are along the horizontal axis, with the extreme position of Mexico and very high (negative) values for the United States and Venezuela. Japan and northern European countries (Denmark, Sweden, the Netherlands, Norway, and the United Kingdom) are at the other tail of the distribution, but compared with the three American countries above, all other countries seem fairly clustered on the second axis. Noting that the position of Mexico and Venezuela might be rendered more extreme by the suspected underreporting of suicide makes the position of the United States all the more unusual.

On the vertical dimension, low behavior-related mortality countries include Chile, some southern European countries (Spain, Italy, and Greece), and northern European countries (Ireland, the United Kingdom, Norway, and the Netherlands). The United States is again a clear outlier at the other end of this axis, but other non-European English-speaking countries (Australia, New Zealand, and Canada) are also on the negative side. The closest European countries from this group are central European countries (Austria, Germany, Hungary, and Switzerland) and Finland.

[6]Results supporting the relative cohort size argument are also reported in a study of persons committing homicide in the United States between 1960 and 1995 (O'Brien, Stockard, and Isaacson 1999).

Unfortunately, this analytical strategy could not be extended to HIV/AIDS data because there are only thirty observations (countries) as opposed to more than one thousand (country-years) in the above data set. Although a different analytical approach was used, the above results are fairly consistent with those presented in a one-dimensional format in Table 8, and I would suggest that a principal components analysis that integrates international variation in HIV infections would also extend and support the results from Table 9. If that leap is valid, countries with high rates of HIV infection, such as the United States, Portugal, Venezuela, Spain, and to a lesser extent, Mexico, France, Switzerland, and Italy should appear lower on the vertical axis. Similarly, Ukraine and the Russian Federation would be expected to be closer to the United States and Venezuela than other European countries.

As a summary of the mortality data between ages fifteen and thirty-five, Figure 2 seems to support the notion that international differences in adolescent and young adult mortality relate to underlying structural differences. First, two of the three less industrialized countries, Mexico and Venezuela, stand out most clearly from the other countries. Then, non-European countries are located at the core of a cluster of European countries. English-speaking non-European countries, Australia, New Zealand, Canada, and foremost, the United States, stand at the low end of one dimension, while Chile stands at the other end of that distribution and Japan stands at the end of the other dimension (opposite Mexico). All European countries are clustered within these extremes, and intra-European differences are more limited. Nevertheless, southern countries (Spain, Greece, and Italy) are closest to Chile, Nordic countries (Denmark and Sweden) are closest to Japan, and central countries (Austria, Germany, Switzerland, and Hungary) are closest to the English-speaking non-European countries. In sum, these clustering patterns provide encouraging prospects for the further investigation of the specific structural factors explaining international variations in adolescent and young adult mortality.

Acknowledgments

This research was supported in part by a start-up fund allocated by the Population Research Center from its National Institutes of Health grant. The comments and encouragement of Frank F. Furstenberg Jr. from the outset of this project are gratefully acknowledged. I would also like to thank Gail Slap and other participants of the Transition from Adolescence to Early Adulthood Workshop, where this article was first presented, for helpful comments and suggestions. Chi-Young Koh provided skillful assistance during the subsequent revisions.

APPENDIX

APPENDIX

RESULTS FROM PRINCIPAL COMPONENTS ANALYSIS (FIRST SIX FACTORS): MORTALITY RATES

	Principal Component					
	1	2	3	4	5	6
Suicide						
Males						
15-19	–0.1809	0.6042	0.5979	0.0047	–0.0455	–0.1409
20-24	–0.2323	0.6066	0.6816	0.0161	–0.0251	–0.0698
25-29	–0.2945	0.5815	0.6685	0.0057	–0.1363	–0.2352
30-34	–0.3149	0.5235	0.5795	0.0045	–0.1933	–0.3502
Females						
15-19	–0.0486	0.3461	0.6664	0.1205	0.4186	0.1545

	Principal Component					
	1	**2**	**3**	**4**	**5**	**6**
20-24	–0.2301	0.3828	0.6832	0.0857	0.3111	0.3222
25-29	–0.3472	0.5129	0.6214	0.0661	0.1131	0.2104
30-34	–0.4013	0.5257	0.5369	0.0527	–0.0271	0.0446
Homicide						
Males						
15-19	0.7824	0.1360	–0.0049	–0.5122	0.1566	–0.0327
20-24	0.8360	0.0943	0.0249	–0.4756	0.1706	–0.0117
25-29	0.8372	0.0508	0.0535	–0.4682	0.1399	0.0015
30-34	0.8253	0.0280	0.0666	–0.4675	0.1056	0.0051
Females						
15-19	0.5896	0.3529	0.0532	–0.4442	–0.0634	0.0382
20-24	0.6025	0.4423	0.0583	–0.4381	–0.0955	0.0732
25-29	0.6028	0.4414	0.0513	–0.4343	–0.1512	0.0294
30-34	0.5869	0.4247	0.1012	–0.4480	–0.1750	–0.0117
Motor vehicle injury						
Males						
15-19	–0.0671	0.7296	–0.4255	0.2220	–0.0819	0.1517
20-24	0.1280	0.7077	–0.4781	0.3637	0.1301	–0.0033
25-29	0.3694	0.5523	–0.4494	0.3474	0.3759	–0.1853
30-34	0.4366	0.4615	–0.3977	0.3209	0.4296	–0.2225
Females						
15-19	–0.0517	0.7605	–0.3759	0.1008	–0.3160	0.1969
20-24	0.0668	0.7347	–0.4780	0.1798	–0.2045	0.1125
25-29	0.2079	0.6892	–0.4819	0.1587	–0.0838	0.0017
30-34	0.2617	0.6777	–0.4361	0.1808	–0.0434	–0.0407
Other unintentional injury						
Males						
15-19	0.7851	–0.0999	0.1677	0.4010	0.1007	–0.0228
20-24	0.7816	–0.1516	0.2857	0.4534	–0.0131	0.0058
25-29	0.7843	–0.1905	0.3400	0.3958	–0.0933	–0.0402
30-34	0.7539	–0.1776	0.3769	0.3611	–0.1523	–0.1094
Females						
15-19	0.7476	–0.1424	0.2254	0.4014	–0.0503	0.0786
20-24	0.7510	–0.1770	0.2222	0.3828	–0.1146	0.1179
25-29	0.7664	–0.1620	0.2362	0.3485	–0.1659	0.0723
30-34	0.7366	–0.1280	0.2308	0.2818	–0.1737	0.0239

Factor	**Eigenvalue**	**Difference**	**Proportion**	**Cumulative**
1	9.85125	3.17560	0.3547	0.3547
2	6.67565	1.32011	0.2404	0.5951
3	5.35554	1.95374	0.1929	0.7880
4	3.40180	2.29099	0.1225	0.9105

Factor	Eigenvalue	Difference	Proportion	Cumulative
5	1.11081	0.52528	0.0400	0.9505
6	0.58553	0.17001	0.0211	0.9716

References

Anderson, Robert N.; Kochanek, Kenneth D.; Murphy, Sherry. Report of final mortality statistics, 1995. National Center for Health Statistics; Hyattsville, MD: 1997.

Brooke, Eileen M., editor. Suicide and attempted suicide. World Health Organization; Geneva, Switzerland: 1974.

Brookmeyer, Ron; Gail, Mitchell H. AIDS epidemiology: A quantitative approach. Oxford University Press; New York: 1994.

Easterlin, Richard A. Birth and fortune: The impact of numbers on personal welfare. Basic Books; New York: 1980.

Eisner, Manuel. Crime, problem drinking, and drug use: Patterns of problem behavior in cross-national perspective. Annals of the American Academy of Political and Social Science. 2002; 580:201–225.

Joint United Nations Programme on HIV/AIDS (UNAIDS). Report on the global HIV/AIDS epidemic. World Health Organization; Geneva, Switzerland: 1998.

O'Brien, Robert M.; Stockard, Jean; Isaacson, Lynne. The enduring effects of cohort characteristics on age-specific homicide rates, 1960-1995. American Journal of Sociology. 1999; 104:1061–95.

Pampel, Fred C. National context, social change, and sex differences in suicide rates. American Sociological Review. 1998; 63:744–58.

Preston, Samuel H. Children and the elderly: Divergent paths for Amer ica's dependents. Demography. 1984; 21:435–57. [PubMed: 6394374]

Rindfuss, Ronald R. The young adult years: Diversity, structural change, and fertility. Demography. 1991; 28:493–512. [PubMed: 1769399]

Ruzicka, Lado T. Suicide mortality in developed countries. In Adult mortality in developed countries: From description to explanation. In: Lopez, Alan D.; Caselli, Graziella; Valkonen, Tapani, editors. Clarendon; Oxford, UK: 1995. p. 83-110.

Ryder, Norman B. Youth: Transition to adulthood report of the Panel on Youth to the President's Science Advisory Committee. University of Chicago Press; Chicago: 1974.

Simpson, Miles. Suicide and religion: Did Durkheim commit the ecological fallacy, or did van Poppel and Day combine apples and oranges? American Sociological Review. 1998; 63:893–94.

U.S. Department of Health and Human Services. Healthy people 2010. U.S. Department of Health and Human Services; Washington, DC: 2000.

van Poppel, Franz; Day, Lincoln H. A test of Durkheim’s theory of suicide—Without committing the “ecological fallacy.”. American Review of Sociology. 1996; 61:500–507.

van Poppel, Franz; Day, Lincoln H. Reply to Simpson. American Review of Sociology. 1998; 63:896–99.

World Health Organization (WHO). International classification of diseases. Vol. 1. World Health Organization; Geneva, Switzerland: 1957. Rev. ed.

World Health Organization (WHO). World health statistics annual. World Health Organization; Geneva, Switzerland: 1996.

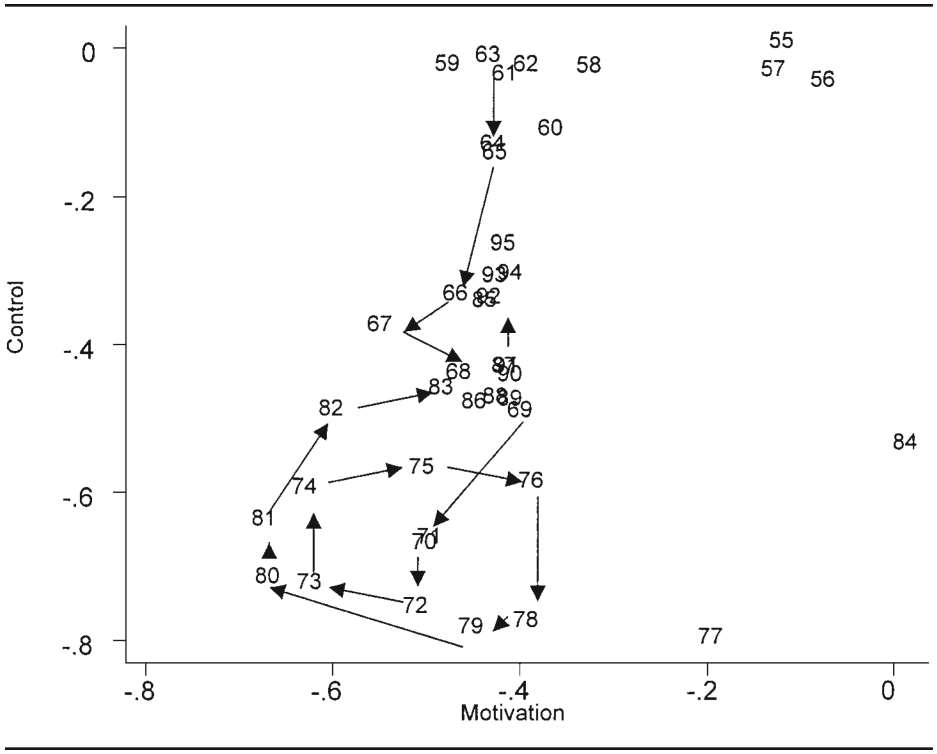

FIGURE 1.
SUMMARY TRENDS IN ADOLESCENT AND YOUNG ADULT MORTALITY

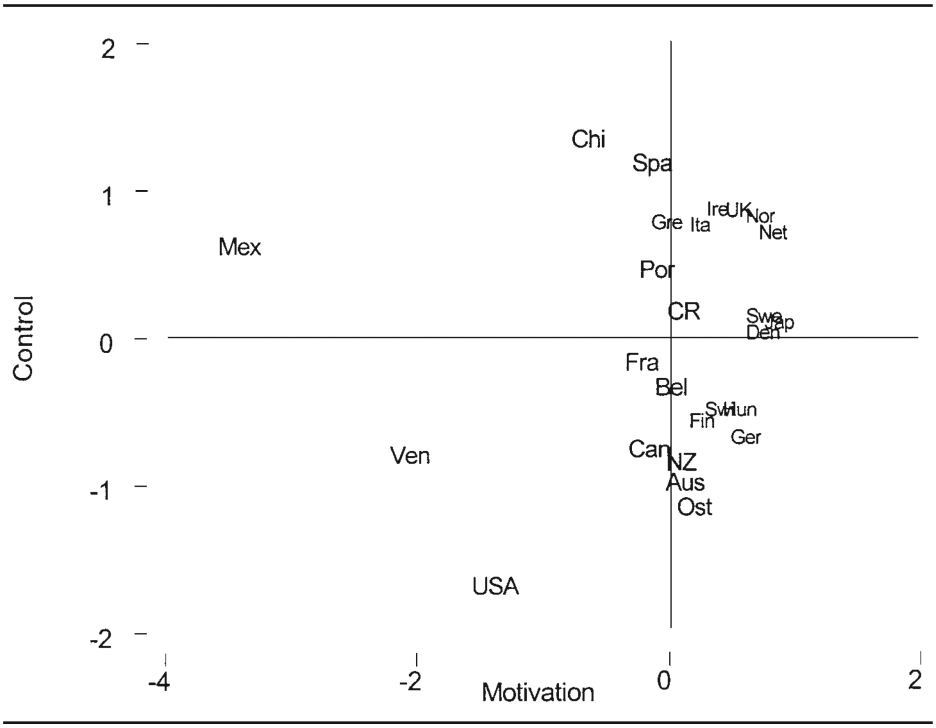

FIGURE 2.
INTERNATIONAL VARIATIONS IN ADOLESCENT AND YOUNG ADULT MORTALITY
NOTE: Chi = Chile; Spa = Spain; Ire = Ireland; UK = United Kingdom; Gre = Greece; Ita = Italy; Nor = Norway; Net = Netherlands; Mex = Mexico; Por = Portugal; CR = Czech Republic; Swe = Sweden; Jap = Japan; Den = Denmark; Fra = France; Bel = Belgium; Swi = Switzerland; Hun = Hungary; Fin = Finland; Ven = Venezuela; Ger = Germany; Can = Canada; NZ = New Zealand; Aus = Australia; Ost = Austria; USA = United States.

TABLE 1

LIST OF COUNTRIES INCLUDED IN THE ANALYSIS WITH AVAILABLE YEARS OF DATA

Region and Country	First Year	Last Year	Years with Full Data	Missing or Incomplete Data
Asia (1)				
Japan	1950	1996	47	
Europe (18)				
Austria	1955	1996	42	
Belgium	1954	1992	39	
Czech Republic[a]	1953	1996	44	
Denmark	1951	1996	46	
Finland	1952	1995	44	
France	1950	1994	45	
Germany[b]	1952	1996	45	
Greece	1956	1996	36	1956-1960
Hungary	1955	1996	42	
Ireland	1950	1994	45	
Italy	1951	1993	43	
Netherlands	1950	1995	46	
Norway	1951	1995	45	
Portugal	1955	1996	42	
Spain	1951	1995	44	1970
Sweden	1951	1995	45	
Switzerland	1951	1994	44	
United Kingdom	1950	1996	47	
Latin America (3)				
Chile	1955	1994	40	
Mexico	1958	1995	36	1977, 1984
Venezuela	1955	1994	38	1984, 1991
North America (2)				
Canada	1950	1995	46	
United States	1950	1995	46	
Oceania (2)				
Australia	1950	1995	46	
New Zealand	1950	1994	45	
Total: Twenty-six countries			1,128	

[a]The series for the Czech Republic consist of data reported as Czechoslovakia until 1991 and data reported as the Czech Republic thereafter.

[b]The series for Germany consist of data reported as West Germany until 1990 and data reported as Germany thereafter.

TABLE 2

CAUSES OF DEATH: INTERNATIONAL CLASSIFICATION OF DISEASES (ICD)

	ICD-6 and ICD-7	ICD-8	ICD-9	ICD-10
All causes	B000 or A000	B000 or A000	B00	AAA
Motor vehicle injuries[a]	A138	A138	B471	CAR (car occupant death in traffic accident) BUS (occupant—bus—death in traffic accident) MCY (motorcycle rider death in traffic accident) RWT (all railway-related accident deaths) PED (pedestrian death in traffic accident involving a motor vehicle) PCY (pedal cyclist death in traffic accident involving motor vehicle) TEE (three-wheeled motor vehicle occupant death in traffic accident) VAN (occupant—pick-up truck or van—death in traffic accident) HTV (occupant—heavy transport vehicle—death in traffic accident) OFT (death in other land transport motor vehicle traffic accident)
Other unintentional injuries	A140 (accidental poisoning) A141 (accidental falls) A142 (accident caused by machinery) A143 (accident caused by fire and explosion of combustible material) A144 (accident by hot substance, corrosive liquid, steam, radiation) A145 (accident caused by firearm) A146 (accidental drowning and submersion) A147 (all other accidental causes)	A140 (accidental poisoning) A141 (accidental falls) A142 (injuries caused by fires) A143 (accidental drowning and submersion) A144 (accident caused by firearm missiles) A145 (injuries mainly of industrial types) A146 (all other injuries)	B48 (accidental poisoning) B49 (misadventures during medical care, abnormal reactions, etc.) B50 (accidental falls) B51 (injuries caused by fire and flames) B52 (other injuries: includes A142 in ICD-7; A143 and A144 in ICD-8) B53 (drugs, medicaments causing adverse effects)	ADR (accidental drowning and submersion) AEX (accidental exposure to untabulated causes) ABL (accidental contact with a blunt object) ASH (accidental contact with a sharp object) AFD (accidental firearm discharge) APO (accidental poisoning by noxious substance) AFI (accidental exposure to smoke, fire, and flames) AEL (accidental exposure to electric current) AHO (accidental contact with heat and hot substances) AXP (accidental explosions) AHS (accidental hanging, strangulation, and suffocation) AFA (accidental falls) AGA (accidental exposure to gases and vapors, etc.) AEU (accidental exposure to other specified and unspecified factors)
Suicide (and self-inflicted injury)	A148	A147	B54	SPO (suicide by self-poisoning) SDR (by drowning and submersion) SGS (by hanging, strangulation, and suffocation) SFD (by firearm discharge) SHO (by explosive material; smoke, fire, and flames; etc.) SSH (with a sharp object) SLM (by jumping or lying before a moving object) SMV (by crashing of motor vehicle) SUU (by other specified or unspecified means) SBL (with a blunt object) SGA (by self-poisoning by exposure to gases and vapors, etc.) SFA (by jumping)
Homicide (and injury purposely inflicted by other persons)[b]	A149 (includes death by legal intervention such as by police or execution)	A148 (includes legal intervention such as by police or execution)	B55 (death by legal intervention is excluded)	HFD (by firearm discharge) HHO (by explosive material; smoke, fire, and flames; etc.) HSH (by sharp object) HLM (by pushing or placing the victim before moving object) HFA (by pushing from high place) HDR (by drowning and submersion) HMV (by crashing of motor vehicle)

Ann Am Acad Pol Soc Sci. Author manuscript; available in PMC 2014 February 28.

	ICD-6 and ICD-7	ICD-8	ICD-9	ICD-10
				HGA (by gases and vapors) HPO (by noxious substances) HBS (by bodily force, including sexual assault death) HHS (by hanging, strangulation, and suffocation) HBL (by blunt object) HNA (by neglect and abandonment and other maltreatment) HOU (by other specified or unspecified means)
Undetermined intent (whether accidental or purposely inflicted)	No category	A149	B561	UPO (poisoning, exposure to noxious substances, undetermined intent) UGA (exposure to other gases and vapors, undetermined intent) UHS (hanging, strangulation, and suffocation; undetermined intent) UDR (drowning and submersion, undetermined intent) UFD (firearm discharge, undetermined intent) UHO (exposure to explosive material, etc.; undetermined intent) USH (contact with a sharp object, undetermined intent) UBL (contact with a blunt object, undetermined intent) UFA (falling, jumping, or pushing from a high place; undetermined intent) ULM (falling, lying, or running before or into moving object; undetermined intent) UMV (crashing of motor vehicle, undetermined intent) UUU (other specified or unspecified event, undetermined intent)

SOURCES: World Health Organization (WHO), Division of Epidemiological Surveillance and Health Situation and Trend Assessment, WHO Mortality Database (http://www.who.int/whosis/mort/index.html); and WHO (1957).

NOTE: Classification in ICD-10 is drastically different from classification in previous revisions in that ICD-10 has much detailed classification of “method of death” in each cause. Each cause of death is uniquely entered in three alphabetical characters. Selection and grouping was made according to the “ICD-10 Tabulation List Items Selected or Grouped for Publication of Causes of Death” available in *World Health Statistics Annual* (1996).

[a] Motor vehicle injuries are defined as “any accident (except collision with aircraft) involving a motor vehicle, or happening to a person while entering or leaving a motor vehicle.” Motor vehicles are defined as “any mechanically or electrically powered device, not operated on rails, upon which or by which any person or property may be transported or drawn upon a land highway,” such as automobile, bus, construction machinery, farm machinery, fire engine, motorcycle, motorized bicycle, tractor, trolley, truck, or van.

[b] In ICD-10, “homicide” excludes legal intervention.

Ann Am Acad Pol Soc Sci. Author manuscript; available in PMC 2014 February 28.

TABLE 3

AVERAGE MALE TO FEMALE SEX RATIO, BY CAUSE OF DEATH

	Age Group				
	15-34	**15-19**	**20-24**	**25-29**	**30-34**
All years combined					
All causes	2.1	2.2	2.4	2.0	1.8
Suicide	2.7	2.4	2.8	2.8	2.7
Homicide	4.7	4.1	5.0	5.0	4.7
Motor vehicle injury	4.2	3.3	4.8	4.7	4.4
All other causes	1.6	1.7	1.7	1.5	1.5
1955 to 1964					
All causes	1.7	1.9	1.9	1.6	1.5
Suicide	2.0	1.6	1.9	2.2	2.2
Homicide	4.9	3.6	5.1	5.4	4.9
Motor vehicle injury	5.4	3.9	6.5	6.4	5.6
All other causes	1.3	1.6	1.4	1.3	1.2
1985 to 1994					
All causes	2.7	2.6	3.0	2.7	2.4
Suicide	3.8	3.5	4.3	3.9	3.5
Homicide	5.2	5.4	5.9	5.1	4.7
Motor vehicle injury	3.7	3.0	4.1	4.0	3.8
All other causes	2.1	2.0	2.1	2.1	2.1

TABLE 4

AVERAGE SEX AND AGE PATTERNS, ALL COUNTRIES AND YEARS

	Age Group				
	15-34	**15-19**	**20-24**	**25-29**	**30-34**
Male mortality rates (per 100,000)					
All causes	157.68	117.59	163.75	166.23	188.34
Suicide	16.68	9.15	19.03	19.79	19.52
Homicide	11.44	7.16	13.51	13.58	11.82
Motor vehicle injury	37.65	39.33	48.92	34.01	27.13
Female mortality rates (per 100,000)					
All causes	76.36	53.80	69.65	81.73	103.19
Suicide	6.19	3.84	6.85	6.98	7.25
Homicide	2.41	1.74	2.68	2.72	2.53
Motor vehicle injury	8.96	11.82	10.28	7.17	6.22
Population distribution (in percentages)					
Males	50.3	13.5	12.8	12.3	11.6
Females	49.7	13.0	12.7	12.3	11.7
Both sexes	100.0	26.5	25.5	24.6	23.3

TABLE 5

DISTRIBUTION OF PEAK SEX- AND AGE-SPECIFIC MORTALITY, ACROSS ALL COUNTRIES AND YEARS (IN PERCENTAGES)

Cause of death	Females, any age group	Males, 15-19	Males, 20-24	Males, 25-29	Males, 30-34
All causes	0.3	0.2	18.9	3.5	77.1
Suicide	0.3	0.1	26.2	26.1	47.4
Homicide	13.8	1.9	21.4	32.9	30.0
Motor vehicle injury	0.0	20.7	63.7	10.4	5.2

NOTE: *N* = 1,228 observations (1,233 for all causes combined).

TABLE 6

MORTALITY TRENDS BY CAUSE, 1955 TO 1994 (STANDARDIZED RATES PER 100,000)

Time Period	Suicide	Homicide	Motor Vehicle Injury	All Causes	Share of the Three Causes (%)
1955-1959	13.00	4.50	20.51	145.02	26.2
1960-1964	10.92	5.85	22.73	133.56	29.6
1965-1969	9.95	5.93	26.86	126.95	33.7
1970-1974	11.03	7.54	28.23	124.69	37.5
1975-1979	12.23	7.33	26.53	110.36	41.8
1980-1984	11.99	7.72	24.80	102.09	43.6
1985-1989	11.44	8.45	22.40	97.31	43.5
1990-1994	10.83	9.93	20.63	96.83	42.7

TABLE 7

PEAK AND TROUGH YEARS IN MORTALITY TIME SERIES, BY CAUSE (NUMBER OF COUNTRY PER PERIOD)

	Country-Year of Data	Suicide		Homicide		Motor Vehicle Injury	
Period		Trough	Peak	Trough	Peak	Trough	Peak
1950-1955	102	8	1	7	1	15	0
1956-1960	123	2	1	6	2	3	0
1961-1965	130	2	1	4	1	1	1
1966-1970	129	3	2	4	2	0	6
1971-1975	130	3	0	1	3	0	11
1976-1980	129	0	3	3	2	0	3
1981-1985	128	0	7	0	3	0	1
1986-1990	130	1	6	0	3	0	3
1991-1996	121	7	5	1	9	7	1

TABLE 8

AVERAGE STANDARDIZED MORTALITY RATES, BY COUNTRY AND BY CAUSE, 1955 TO 1994 (RATES PER 100,000)

	Suicide		Homicide		Motor Vehicle Injury		
Country	**Rate**	**Rank**	**Rate**	**Rank**	**Rate**	**Rank**	**Three Causes Combined (Rate)**
Spain	3.66	3	0.81	1	17.46	9	21.93
Chile	8.01	10	4.52	23	10.33	1	22.86
United Kingdom	6.72	8	1.19	8	15.77	5	23.68
Norway	10.47	11	0.95	3	13.18	2	24.6
Netherlands	6.6	7	0.95	3	17.13	8	24.68
Ireland	6.48	6	0.93	2	17.71	12	25.12
Greece	3.13	2	1.12	7	21.2	14	25.45
Italy	4.21	4	2.01	18	21.35	15	27.57
Sweden	15.02	20	1.22	10	15.17	4	31.41
Japan	18.26	22	1.2	9	13.94	3	33.4
Portugal	6.17	5	1.51	16	25.77	17	33.45
Denmark	14.93	19	1.02	5	18.03	13	33.98
Czech Republic	16.44	21	1.42	15	17.54	10	35.4
France	11.77	13	1.32	13	27.61	18	40.7
Belgium	10.86	12	1.26	11	28.74	19	40.86
Switzerland	18.88	24	1.04	6	22.48	16	42.4
Hungary	24.21	26	2.44	20	15.94	6	42.59
Finland	23.91	25	2.88	22	17	7	43.79
Germany	14.82	18	1.31	12	29.08	20	45.21
Canada	13.81	17	2.65	21	29.91	21	46.37
New Zealand	12.26	15	1.94	17	33.49	24	47.69
Australia	13.19	16	2.28	19	33.35	23	48.82
Mexico	3.07	1	30.85	26	17.59	11	51.51
Austria	18.65	23	1.41	14	34.43	25	54.49
United States	12.22	14	14.06	24	33.11	22	59.39
Venezuela	7.83	9	19.39	25	35.03	26	62.25

TABLE 9

CUMULATIVE HIV/AIDS STATISTICS, BY COUNTRY, END OF 1997

Country	HIV-Infected Adults	Total AIDS Deaths	Adult HIV-Incidence Ratio (per Thousand)	Annualized Incidence Ratio (per 100,000)	Average Mortality Rates from Three Causes Since 1980
Japan	6,800	1,700	0.14	0.76	25.36
Bulgaria	300	0	0.07	0.40	28.13
United Kingdom	25,000	13,000	1.35	7.48	22.12
Czech Republic	2,000	200	0.41	2.28	27.52
Chile	15,000	2,900	2.31	12.83	20.53
Sweden	3,000	990	0.97	5.37	28.56
Norway	1,300	500	0.83	4.60	29.59
Netherlands	14,000	4,700	2.28	12.69	22.37
Ireland	1,700	360	1.11	6.17	30.47
Poland	12,000	490	0.61	3.39	35.00
Greece	7,500	1,300	1.69	9.36	32.05
Germany	35,000	13,000	1.17	6.50	35.94
Denmark	3,100	1,800	1.88	10.45	32.53
Finland	500	210	0.28	1.54	44.09
Hungary	2,000	200	0.43	2.40	46.46
Italy	90,000	31,000	4.18	23.23	27.74
Australia	11,000	6,000	1.78	9.87	43.91
Belgium	7,200	1,700	1.75	9.71	46.37
Austria	7,500	1,500	2.14	11.90	49.4
Canada	43,000	11,000	3.39	18.84	42.64
New Zealand	1,300	530	0.97	5.40	56.11
Spain	120,000	33,000	7.32	40.68	28.18
Switzerland	12,000	5,100	4.59	25.52	43.45
France	110,000	35,000	4.94	27.45	43.39
Ukraine	110,000	240	4.33	24.05	47.95
Russian Federation	40,000	190	0.52	2.88	74.52
Mexico	180,000	91,000	5.42	30.13	52.79
Portugal	35,000	3,900	7.79	43.28	41.83
Venezuela	81,000	6,600	7.38	41.00	64.16
United States	810,000	410,000	8.69	48.29	59.29

SOURCE: Joint United Nations Programme on HIV/AIDS (1998).