

I have addressed 3 questions: (1) Do the conclusions derived from data through 2002 persist? (2) Are claims that the 3 comparison countries were not “special” validated by other countries? (3) Are even stronger conclusions now validated with even more clarity and confidence?

METHODS

I applied a better analysis method to compare US safety performance through 2011 with performance in 25 countries. My approach differs from that in many previous international comparisons^{30–32} in that I have introduced a new measure that uses only fatality data. This keeps the analysis largely assumption-free and also free from uncertainties in computing rates using additional data sets. For example, estimates of distance of travel are unavailable or unreliable for most countries.

The New Measure

The new measure is grounded on a characteristic of the evolution of fatalities in motorized countries. In the early days of motorization few traffic fatalities occurred because there were few vehicles. As motorization increased rapidly, so did the number of traffic deaths. In time the number of deaths declined in response to such factors as improved traffic law and the population maturing with respect to motorized traffic.²¹ Fatalities in some years accordingly reached a maximum number, F_{Max} . We can therefore define

$$(1) \text{ Fatalities in year Y relative to max} = 100 \times \frac{\text{Fatalities in year Y}}{F_{\text{Max}}}$$

Advantages of using the measure in Equation 1 include the following:

- It depends only on fatalities. It requires no other data sets or comparison year, such as 1979.
- It is dimensionless. In the physical sciences, measures that are dimensionless are sought because of their many advantages. Even the simplest rate used in fatality analysis, a simple count of fatalities, has the dimension fatalities per unit of time (or T^{-1}), where the time unit is generally (but not

necessarily) 1 year. Likewise, it is effective in analyzing national or smaller regional trends.

- Because factors appear equally in numerator and denominator, it does not depend strongly on broad differences (e.g., high population density vs low population density, predominantly rural vs urban, wide-spread vs limited public transportation) or on the definition of fatality. If a jurisdiction's data are systematically biased, this will also not affect results provided the bias remains unchanged. This may not be true if data reporting is improved or if data are distorted to provide false indications of safety improvements.
- It is effective in comparing countries that are at different stages of motorization. For example, some countries that increased fatalities after 1979 subsequently achieved reductions greater than those of the United States.

Materials

My study is predicated on fatalities available in the International Road Traffic Accident Database (IRTAD)^{32,33} augmented with additional most recent IRTAD data.³⁴ Using this 1 source can help other researchers replicate or later update this study. The safety data are derived mainly from police reports. The most reliable safety information is for fatalities, although this is still often less reliable than it might seem. Most jurisdictions define a fatality as death within 30 days of the crash as a result of the crash. Police may not consistently follow up crashes to record later outcomes. Another problem is that the government entities responsible for reducing traffic deaths are often the same ones collecting and analyzing data. This may produce biases.³⁵ With these caveats, I take the IRTAD data as reflecting the actual number of traffic deaths.

IRTAD provides data for 35 jurisdictions, including the United Kingdom, Great Britain, and Northern Ireland. Data for 2011 are as follows: for the United Kingdom, 1960 fatalities; for Great Britain, 1901; and for Northern Ireland, 59. Because the United Kingdom consists of Great Britain and Northern Ireland, at most 1 of these can be included. It might be preferable to use United Kingdom data because they are for the entire nation and sample sizes

are a few percentage points larger. However, to provide better comparisons with earlier analyses, and nearly all previous British safety studies, I used data for Great Britain. Additionally, estimates of vehicle travel³⁶ apply only to Great Britain.

I included data for Germany but not for East Germany and West Germany. I excluded 5 additional countries: Slovenia (141 fatalities in 2011), Luxemburg (33), and Iceland (12) because of too few data, and Slovakia and Turkey because of too many missing values.

Data for the remaining 26 countries in selected years are presented in Table 1. Data for all years from the mid-1960s are available as supplemental material to the online version of this article at <http://www.ajph.org>. I computed all points plotted in the figures from the supplemental material. The main results can be computed from the selection in Table 1.

The Netherlands' Special Case Data

The Netherlands data shown in Table 1 and the supplementary data (available at <http://www.ajph.org>) are in 2 series. From 1996 onward a revised procedure estimated “true” values rather than the long-established police reports that the Ministry of Transport provides. The true estimates augmented the police report totals with cause of death and coroners' records.³⁷ Some crashes reported as found body or alcohol offense were classified later as traffic crashes.³⁸ Police underreporting was highest for crashes involving older road users (injuries more severe than the crash scene suggested), crashes in which people died later, single-vehicle crashes, and crashes not involving motor vehicles. The data include fatalities from crashes between bicycles, between bicycles and pedestrians, and single bicycle crashes.³⁹ US data include only crashes involving motorized vehicles.²

For all years 1996 through 2012, the true value was at least 6.0% higher than was the police value. Larger discrepancies of 15.0% to 21.0% occurred in recent years, possibly reflecting reduced effort on the part of police to follow up on injuries because they knew others were doing this. The true value was, on average, 7.4% higher than was the police value. Accordingly, the data in Table 1 for years before 1966 are the police-reported data

TABLE 1—Number of Traffic Fatalities by Year in 26 Countries

Country	2011, No.	2010, No.	2009, No.	2008, No.	2007, No.	2006, No.	2005, No.	2004, No.	2003, No.	2002, No.	1979, No.	Max, No.	Year of Max ^a
United States	32 367	32 885	33 833	37 423	41 259	42 708	43 510	42 836	42 884	43 005	51 093	54 589	1972
Great Britain	1901	1850	2222	2538	2946	3172	3201	3221	3508	3431	6352	7985	1966
Canada	2025	2227	2230	2419	2761	2884	2898	2731	2779	2921	5863	6706	1973
Australia	1275	1352	1488	1442	1603	1602	1627	1583	1621	1715	3508	3798	1970
Austria	523	552	633	679	691	730	768	878	931	956	2186	3027	1972
Belgium	858	840	944	944	1071	1069	1089	1162	1213	1353	2326	3101	1972
Czech Republic	773	802	901	1076	1222	1063	1286	1382	1447	1431	1377	1988	1971
Denmark	220	255	303	406	406	306	331	369	432	463	730	1213	1971
Finland	292	272	279	344	380	336	379	375	379	415	650	1156	1972
France	3963	3992	4273	4275	4620	4709	5318	5593	6058	7655	13 603	18 113	1972
Germany	4009	3648	4152	4477	4949	5091	5361	5842	6613	6842	15 558	21 332	1970
Greece	1114	1258	1456	1553	1612	1657	1658	1670	1605	1634	1483	2411	1995
Hungary	638	740	822	996	1232	1303	1278	1296	1326	1429	1750	2432	1990
Ireland	186	212	238	279	338	365	396	374	335	376	614	640	1972
Israel	341	352	314	412	382	405	437	467	445	515	555	702	1974
Italy	3860	4090	4237	4725	5131	5669	5818	6122	6563	6980	8983	11 964	1972
Japan	5507	5806	5772	6023	6639	7272	7931	8492	8877	9575	11 006	21 795	1970
Korea	5229	5505	5838	5870	6166	6327	6376	6563	7212	7222	6907	15 443	1991
Netherlands	661	640	720	750	791	811	817	881	1088	1066	2123	3506	1972
New Zealand	284	375	384	365	421	393	405	436	461	404	554	843	1973
Norway	168	208	212	255	233	242	223	258	282	312	437	560	1970
Poland	4189	3908	4572	5437	5583	5243	5444	5712	5640	5827	5793	7901	1991
Portugal	891	937	929	974	1071	1066	1372	1423	1701	1843	2741	3356	1975
Spain	2060	2478	2714	3100	3823	4104	4442	4741	5399	5347	6752	9344	1989
Sweden	319	266	358	397	471	445	440	480	529	532	926	1313	1966
Switzerland	320	327	349	357	384	370	409	510	546	513	1230	1720	1972

Note. Earlier studies used only the first 4 listed countries and compared 2002 to 1979 fatalities. Values reported for 2002 differ by inconsequential amounts from the preliminary values reported in 2004.
^aFor the United States, the maximum number of annual fatalities (54 589) was recorded in 1972.

increased by 7.4%. This is the approach IRTAD uses.¹³

The results from the Equation 1 analysis were not materially different if I used the original police-reported data or if I used percentages other than 7.4 (including zero) to correct the pre-1996 fatalities.

I did not revise the data for any other country in a similar way. The revision of the Netherlands data reflects a commitment in the Netherlands to continual traffic safety improvement. The Netherlands Institute for Road Safety Research Web site provides further evidence of this.⁴⁰ The Dutch government supports the Netherlands Institute for Road Safety Research, but it is an independent scientific institute that provides solicited and unsolicited science-based advice to the

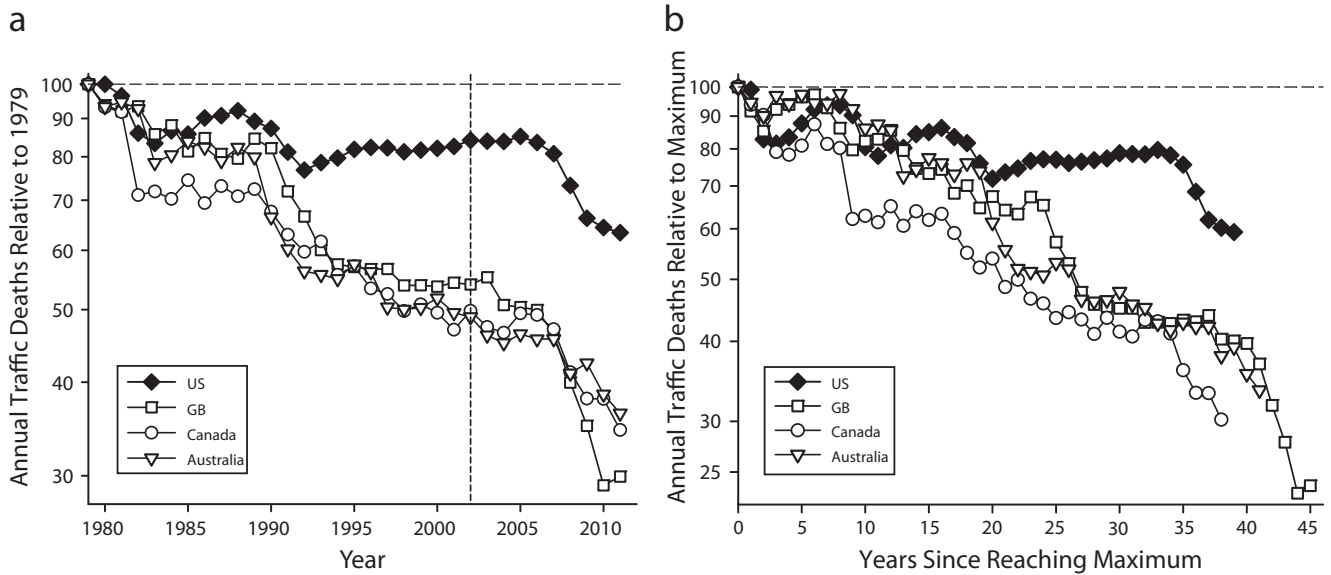
government. The United States lacks any remotely comparable organization.

The Netherlands achieves one of the best safety records in the world while still allowing road users' freedoms that are often taken away in the United States. Although bicyclists are about one third of fatalities, bicyclists are not required to wear helmets because evidence indicates this would reduce bicycling, a healthy, convenient, economic, and environmentally friendly mode of transportation. Speed limits on motorways are 130 kilometers per hour (80.8 miles per hour). Higher speed increases risk sharply,¹⁴ but when the base risk is very low, increasing it by a factor produces a risk that is still acceptable. Where risks are high, speeds are far lower than are those in the United States.

RESULTS

From 1979 to 2002 fatalities in the United States declined by 16% (from 51 093 in 1979 to 43 005 in 2002; Table 1). Taken in isolation this might look like impressive progress. Indeed, US officials hailed it as showing that their policies were highly successful. However, when the US 16% reduction is compared with the average reduction of 49% computed from Table 1 for the 3 comparison countries, an entirely different conclusion is unavoidable.

Figure 1a provides no evidence that after 2002 the large difference between the United States and the comparison countries was cancelled. On the contrary, the United States barely kept parallel with Canada and Australia but fell even further behind Great Britain.



Note. The portion 1979–2002 (delineated by vertical line in part a) reproduces a figure published in 2004 when the most recent data were for 2002. The plot for each country in part b has a different number of points because each attained its maximum number in a different year, as follows: United States, 1972; Great Britain, 1966; Canada, 1973; and Australia, 1970. All graphs use logarithmic scales. Source. Data were obtained from the International Road Traffic and Accident Database.

FIGURE 1—Two ways to compare traffic fatality changes in the United States (US) to those in 3 comparison countries, Great Britain (GB), Canada, and Australia, (a) relative to 1979 value and (b) relative to the maximum number reached.

Figure 1b shows the evolution of fatalities in the United States and the 3 comparison countries since each attained its maximum number (Equation 1). Plots have different numbers of points because each country achieved its maximum in a different year (listed in the last column in Table 1).

Figure 2a shows the United States and the 3 comparison countries compared with a number of other countries that achieved larger reductions than did the 3 comparison countries. Japan, Sweden, and other countries are not plotted because their data largely overlap with those of Great Britain, the original comparison country that attained the largest fatality reductions.

Clearly, the original 3 comparison countries were not uniquely successful. If I had chosen other countries, the measured difference between them and the United States would have been even larger.

Figure 2b, which includes all the graphs in Figure 2a, shows data for all 26 countries. In this representation the individual countries are not always distinct. The striking feature is the way the United States stands out from all the others—fatalities in each of the other 25 countries dropped further from their highs than occurred in the United States.

Other Measures

I augmented my analysis with an examination of 2 traditional measures of traffic safety¹ in different countries.

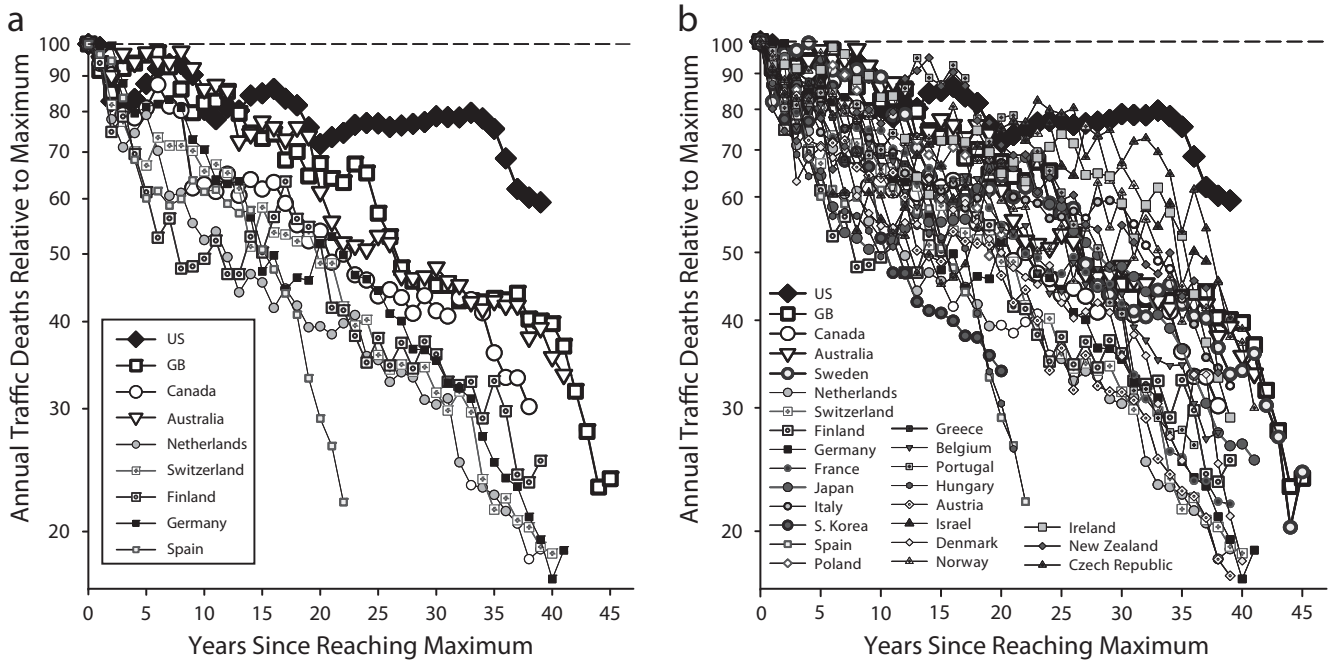
Driver fatalities per 1000 registered vehicles are presented in Figure 3a. All governments collect the number of registered vehicles to tax vehicles; this number is available in IRTAD data.¹¹ In the 1970s the number of US deaths per 1000 registered vehicles was lower than was the number for each of the other 25 countries. US traffic was often heralded at the time as the safest in the world.⁴¹

By 2011 the United States had dropped from number 1 in safety to number 19 (out of 26). The 18 countries that had fewer deaths per 1000 vehicles than did the United States by 2011 were Australia, Austria, Canada, Denmark, Finland, France, Germany, Great Britain, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, and Switzerland. Each of these countries had higher rates in 1970. Because rates in other countries are continuing to decline faster than is the US rate, it seems likely that the United States will fall to lower ranking than its present number 19.

Traffic fatalities per billion kilometers of vehicle travel are presented in Figure 3b. The

distance traveled by all vehicles in a nation can be determined only if a measurement program is established and provided ongoing support. The most reliable data are from Great Britain, which has a long-time commitment to estimating total travel in Great Britain. Britain currently obtains estimates based mainly on around 10 000 manual counts, by which trained enumerators count traffic by vehicle type over a 12-hour period.⁴² Estimates of total travel in the United States are on the basis of estimates from the individual states. There is no published information on how states make such estimates.

The US rate in 1970 was 29.64 deaths per billion kilometers of travel. By 2011 it dropped to 6.83 per billion kilometers (or 1.10 deaths per 100 000 000 miles¹⁹). This is a 77.0% decline. From 1970 to 2011 the rate for Great Britain declined from 34.89 to 3.30 deaths per billion kilometers, an 88.9% decline. Note that the Great Britain rate was substantially higher than was the US rate in 1970 but substantially lower in 2011. If the US rate had declined by the same 88.9% as that of Great Britain, the US rate would have dropped to 3.02 deaths per billion kilometers, and US fatalities would have been 15 661 instead of the 32 367 observed.



Note. Fatalities in each of the other countries declined further than did those in the United States. All graphs use logarithmic scales.
 Source. Data were obtained from the International Road Traffic and Accident Database.

FIGURE 2—Traffic fatality declines since reaching maximum values in (a) selection of countries that had larger fatality declines than did Great Britain (GB), Canada, and Australia, and (b) United States (US) compared with all 25 other countries.

The Equation 1 estimate for Great Britain from the data in Table 1 is 12 996 US fatalities in 2011. A greater increase in travel in the United States than the increase in Great Britain could explain a portion (17.0%) of the Equation 1 effect. A parallel calculation for the deaths per 1000 registered vehicles variable gave 12 898 fatalities, very close to the Equation 1 estimate.

Everyone driving an additional 1000 kilometers on low-risk interstate highways¹ would kill additional people but lower the number of deaths per billion kilometers. More generally, extra miles driven are safer than is the average of previous miles driven. This brings into question the value of deaths per billion kilometers as a good public health metric.

Of the 26 countries I studied, 19 had some sort of estimate for distance of travel in the IRTAD data, not always through the most recent years.³² In the 1970s no country had a lower rate than did the United States. By 2011 the United States had dropped from best in the world to rank number 13 out of 19, in which the comparison was for the most recent year of available data. The 12 countries with

rates lower than that of the United States are Australia, Canada, Denmark, Finland, Germany, Great Britain, Ireland, Israel, the Netherlands, Norway, Sweden, and Switzerland.

Numerical Example of United States vs The Netherlands

Applying Equation 1 to examine the latest fatalities relative to maximum fatalities and using only the data in Table 1, fatality reductions in the United States can be compared with reductions in any 1 of the other 25 countries. I compared fatality declines in the United States and in the Netherlands. The United States and the Netherlands both experienced their maximum number of fatalities in 1972 (last columns in Table 1), so results can be interpreted as either progress since 1972 or progress since reaching their maximum number of fatalities.

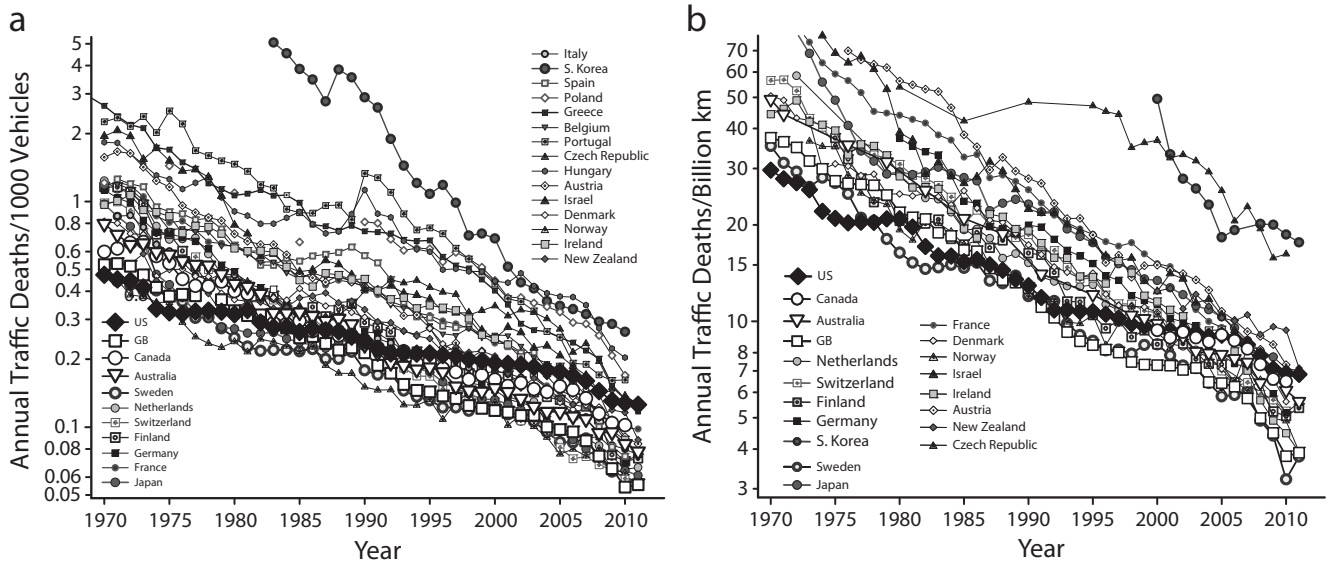
In the 39 years from 1972 to 2011, US fatalities declined from 54 589 to 32 367—a 40.7% decline. In the same period, fatalities in the Netherlands declined from 3506 to 661—an 81.1% decline. If US fatalities had declined by 81.1%, US fatalities in 2011 would have

been 10 292 and not the 32 367 observed. In other words, because the United States failed to match the decline in the Netherlands, an additional 22 075 deaths occurred on US roads.

I compared each of the 25 other countries with the United States in the same way. Each of them declined from their all-time highs by more than the US decline. If the United States had matched the average decline for all 25 countries, there would have been 16 330 fewer deaths in the United States in 2011. In addition to the Netherlands, 6 other countries (Austria, Denmark, France, Germany, Spain, and Switzerland) produced the result that if the United States had matched their declines since reaching their maximum values, US fatalities in 2011 would have been more than 20 000 fewer than actually occurred. Instead of 32 000 fatalities, the United States would have experienced fewer than 11 000.

DISCUSSION

The conclusions as determined by data through 2002 persist, the earlier comparison countries were not particularly special, and the



Note. Part a shows that in the early 1970s each of the 25 other countries had a higher rate than did the United States (US). The US has dropped from number 1 in safety to number 19 out of 26. The 18 countries that now have fewer deaths per 1000 vehicles than the United States are Australia, Austria, Canada, Denmark, Finland, France, Germany, Great Britain (GB), Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, and Switzerland. Part b shows that in the early 1970s each of the other 18 countries providing data had a higher rate than did the US. The US has dropped from number 1 to number 13 out of 19. The 12 countries with rates now lower than the US are Australia, Canada, Denmark, Finland, Germany, GB, Ireland, Israel, the Netherlands, Norway, Sweden, and Switzerland. All graphs use logarithmic scales.

Source. Data were obtained from the International Road Traffic and Accident Database.

FIGURE 3—Two traditional ways to compare traffic safety in different countries by (a) number of deaths per 1000 registered vehicles, and (b) fatalities for same travel distance.

conclusions, now supported with enormously more data, are even more firmly established.

All the fatality rates examined declined in the United States over the past 4 decades. However, they declined more rapidly in each of the other 25 countries, in most cases far more rapidly. In terms of declines after reaching a maximum number of fatalities, the United States is a unique outlier. All 25 other countries declined further and faster.

The differences found are of such enormous magnitude as to be largely unaffected by explanations in terms of confounding factors, which in any event are mainly rendered moot by the Equation 1 measure and additionally by the other measures in Figure 3.

The United States was the safest country in the world in the 1970s. By 2011 the United States dropped from number 1 to number 19 in terms of traffic fatalities per registered vehicle and to number 13 (out of 19 countries providing data) in terms of traffic fatalities for the same travel distance.

The failure of the United States in traffic safety is of near incomprehensible magnitude. By simply

matching the road safety changes in a number of other unremarkable countries, the United States could prevent 20 000 traffic deaths per year.

US safety policy continues to be a public health catastrophe. If the United States could only match the far from perfect safety performance of a number of other countries, 20 000 fewer Americans would be killed annually and almost a million injuries prevented. An explanation of why this happens is given in an editorial⁴³ in this issue.

As a US citizen and member of the US National Academy of Engineering, it pains me to come to these conclusions. However, the data speak for themselves, and the conclusions are inescapable. They apply only to road safety; the United States is the world leader in other safety areas, such as air travel. ■

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Human Participant Protection

No protocol approval was necessary because data were obtained from secondary sources.

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