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LESSONS TO BE LEARNED

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16. Abstract

This study compared road safety and related factors in the U.S. with those in Sweden, the United Kingdom, and the Netherlands, in order to identify actions most likely to produce casualty reductions in the U.S. The reviewed topics were basic country statistics, road fatalities and various fatality rates, national road-safety strategies, and selected road-safety issues. The main differences concerned structural and cultural factors (such as vehicle distance driven), and procedural factors (such as road-safety strategies and targets, alcohol-impaired driving, exceeding speed limits, and use of seat belts).

The main recommendations for improving road safety in the U.S. are as follows: (1) lower states' BAC limits to 0.5 g/l and introduce effective random breath testing, (2) reexamine the current speed-limit policies and improve speed enforcement, (3) implement primary seat-belt-wearing laws in each state that would cover both front and rear occupants, and reward vehicle manufacturers for installation of advanced seat-belt reminders, (4) reconsider road-safety target setting so that the focus is on reducing fatalities and not on reducing fatality rate per distance driven, and (5) consider new strategies to reduce vehicle distance driven.

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Contents

Introduction

Despite recent major improvements in road safety in the U.S. (Sivak and Schoettle, 2011), the current safety level is far below the level of the best-performing countries (OECD/ITF, 2012). Therefore, it should be instructive to compare factors affecting road safety in the U.S. and the best-performing countries. This type of benchmarking can be beneficial as it can reveal differences at several relevant levels (Wegman and Oppe, 2010): (1) structure and culture, (2) safety measures and programs, (3) safety performance indicators, and (4) number of fatalities and injured persons. A comparison of the U.S. with countries that do not substantially differ in terms of economic situation, motorization, etc. will yield the most valuable information.

Recently, several comparisons of this type have been carried out in Europe under the SUNflower umbrella. These studies started with a comparison of road-safety developments in **S**weden, the **U**nited Kingdom and the **N**etherlands (the SUN countries), which are among the best-performing countries in the world in terms of road safety (Koornstra, Lynam, Nilsson, Noordzij, Pettersson, Wegman, and Wouters, 2002). That study determined the underlying elements in the road-safety policies and programs of the countries, and it investigated factors that make them particularly effective. The results showed that the targeted road-safety policy areas were rather similar, but the policies that were implemented differed. This implies that there is no single approach to achieving first-class road-safety results.

The present study was designed to compare road safety and related factors in the U.S. with those in Sweden, the United Kingdom (U.K.), and the Netherlands, in order to identify actions most likely to produce casualty reductions in the U.S.

Approach

To compare road safety in the U.S. and the SUN countries, the following topics were examined by country: (1) background statistics, (2) road fatalities and main fatality rates, (3) national road-safety strategies, and (4) five selected road-safety issues.

The primary measures for international road-safety comparisons are road fatalities and/or injuries per population, because they are the most appropriate measures to show the total harm resulting from road crashes (Sivak and Tsimhoni, 2008; Nilsson, 2004; Sivak, 1996). Such measures are compatible with the measures used in the public-health domain (Sivak, 1996), such as mortality per population from illnesses and other causes (WHO, 2012).

Other measures include fatality rates per distance driven, per registered vehicle, per licensed driver, and per trip. They have relevance in road-safety activities and each of them has proper areas of application (Sivak, 1996). However, none of them can measure the total harm, as a rate per population can.

The study was limited to fatal crashes and fatalities, because there are no major differences in the countries of interest in the definitions of road fatalities (IRTAD, 2012). In contrast, the definitions of injured persons by country vary too much to make reliable comparisons. In addition, it is well known that crashes involving nonfatal injuries are underreported (e.g., Elvik, Høye, Vaa, and Sørensen, 2009). To avoid problems with short-term and random variations in crash statistics, data for five recent years (2006-2010) were used, whenever available.

Crash and exposure information was retrieved from international sources such as the IRTAD database (IRTAD, 2012) and publications of international organizations (e.g., OECD/ITF, WHO), if available. This approach aimed to avoid differences in the reporting systems of the countries that could be responsible for some of the obtained findings. Additional information was collected from national sources.

In some cases, data were not available for the U.K. (Great Britain and Northern Ireland), but for Great Britain only. However, this does not make any substantial difference because road fatalities in Great Britain in 2006 through 2010 constituted about 96% of all road fatalities in the U.K. (IRTAD, 2012).

The final topics to be covered in this report are based on our earlier study (Sivak, Luoma, Flannagan, Bingham, Eby, and Shope, 2007), which examined five factors that are important to road safety in the U.S. The factors included were alcohol-impaired driving, exceeding posted speed limits, not wearing seat belts, visibility problems in nighttime driving, and young driver problems. These factors will be discussed in terms of driver behavior, crashes, and countermeasures.

Background statistics

Table 1 lists selected background statistics by country. The main difference between the U.S. and the SUN countries is the size of the U.S., which is larger in terms of both population and land area. Consequently, the variability of factors related to driving and traffic crashes in the U.S. is larger than in the SUN countries. In addition, it is likely that there is much more long-distance travel in the U.S in comparison with the SUN countries.

In terms of population density, the U.S. is within the range of the SUN countries. Population in the U.S. is somewhat younger and wealthier than in the SUN countries.

Table 1
Selected background statistics by country.

Background statistics	U.S.	Sweden	U.K.	Netherlands
Population, thousand (2010)[1]	310,384	9.380	62,036	16,613
Area, thousand km^2 (2010) [1]	9,629.1	450.3	255.4	37.4
Population density, inhabitants per km^2 (2010) [1]	32.2	20.8	255.4	444.7
Population age composition (2010)[2]				
≤14 years	20%	17%	17%	18%
15-64 years	67%	65%	66%	67%
≥65 years	13%	18%	17%	15%
Gross domestic product per capita (PPP), US$ (2010)[3]	46,805	39,479	35,692	42,230

[1] UN (2012)
[2] IRTAD (2012)
[3] UNECE (2012)

Road fatalities and main fatality indices

Main statistics and fatality rates

This section presents the number of road fatalities and selected fatality rates for the four countries of interest. Table 2 shows the number of fatalities, population, motor vehicles, and vehicle distance driven by country. The data indicate that recently there has been a decreasing trend of road fatalities in every country. Fatality rates based on the data in Table 2 are presented in Table 3.

Table 2
Number of fatalities, population, motor vehicles (excluding mopeds), and vehicle distance driven by country (IRTAD, 2012).

Measure	Year	U.S.	Sweden	U.K.	Nether-lands	*SUN total*
Fatalities	2006	42,708	445	3,298	730	*4,473*
	2007	41,259	471	3,059	709	*4,239*
	2008	37,423	397	2,645	677	*3,719*
	2009	33,883	358	2,337	644	*3,339*
	2010	32,885	266	1,905	537	*2,708*
	Average	*37,632*	*387*	*2,649*	*659*	*3,696*
Population (10^3)	2006-2010[1]	303,965	9,188	61,408	16,436	*87,032*
Vehicles (10^3)	2006-2010[1]	256,944	5,351	34,850	9,045	*49,246*
Vehicle distance driven (10^6 km)	2009	4,758,450	81,444	516,007	126,966	*724,417*
Vehicle distance driven per person	2009	15,511	8,799	8,345	7,701	*8,272*

[1] Average for the given years

Table 3 shows that every rate is substantially lower for the SUN countries than for the U.S. (on average 66% lower per population, 49% lower per motor vehicles, and 35% lower per vehicle distance driven).

Table 3
Fatality rate per population, number of motor vehicles (excluding mopeds), and vehicle distance driven by country (2006-2010).

Fatality rate	U.S.	Sweden	U.K.	Netherlands	*SUN average*
Per million people	123.8	42.2	43.1	40.1	*42.5*
Per million motor vehicles	146.5	72.4	76.0	72.9	*75.0*
Per billion km driven[1]	7.1	4.4	4.5	5.1	*4.6*

[1] 2009

In-depth comparison of road fatality rates in the U.S. and the U.K.

Table 4 shows more detailed comparisons between the U.S. and the U.K. based on fatality and distance-driven information by road type. The underlying logic of this analysis is to examine main sources for the differences in road safety between the two countries (Peltola, Luoma, and Salenius, in preparation).

The upper section of the table shows the original statistics. These statistics were used to compute the derived statistics presented in the lower section of the table. The first row of the derived-statistics section lists the number of road fatalities in the U.S. by road type if the overall fatality rate were the same as in the U.K. In the next row, fatality decrease in the U.S. by road type is presented if the fatality rate were the same as in the U.K. In the final four rows, this decrease is partitioned into the effects of the following four factors: (1) different distance driven per licensed driver, (2) different fatality rate per distance driven by road category, (3) different licensure rate, and (4) different distribution of the usage of different road categories. This analysis assumes that, other things being equal, the magnitude of each effect is directly proportional to the change of a given factor. This is a simplifying assumption, because these types of effects generally exhibit some elasticity (see e.g., Fridstøm, 1999). In addition, it is likely that there are interactions between these four factors, but the analysis does not take them into account. Nevertheless, the analysis provides general estimates of the effects of various factors.

Table 4
Road fatalities and related measures in the U.S. and the U.K. in 2009 (upper section; IRTAD, 2012), and road fatalities in the U.S. if overall fatality rate per population were the same as in the U.K., partitioned into four factors (lower section).

Measure	Country	Limited-access highways	Rural roads	Urban roads and streets	Total
Fatalities[1]	U.S.	4,122	17,264	12,497	33,883
	U.K.	132	1,423	782	2,337
Distance driven, billion km	U.S.	1,154	1,191	2,414	4,758
	U.K.	101	224	191	516
Population, million inhabitants	U.S.				306.8
	U.K.				61.8
Licensed driver (millions)[2]	U.S.				209.6
	U.K.				35.8
Fatality rate per billion km driven	U.S.				110.5
	U.K.				37.8
Distance driven (km) per thousand licensed drivers	U.S.	5.5	5.7	11.5	22.7
	U.K.	2.8	6.3	5.4	14.4
Distance driven (km) per thousand people	U.S.	3.8	3.9	7.9	15.5
	U.K.	1.6	3.6	3.1	8.3
Fatalities in the U.S. if the overall fatality rate per population were the same as in the U.K.		655	7,060	3,880	11,595
Fatality decrease in the U.S. if the fatality rate per population were the same as in the U.K. (sum of the entries in the next four lines)[3]		-3,467	-10,204	-8,617	-22,288
Effects of the lower overall distance driven per licensed driver[4]		-1,502	-6,290	-4,553	-12,345
Effects of the lower fatality rates per distance driven by road category[5]		-1,406	-5,213	-1,416	-8,035
Effects of the lower licensure rate[6]		-403	-1,686	-1,220	-3,309
Effects of the proportionally different usage of different road types[7]		-157	2,985	-1,427	1,400

[1] In the U.S., 233 fatalities with unknown location were distributed among the three categories in proportion to the known frequencies.
[2] Licensed drivers in the U.K. are estimated from licensed drivers in Great Britain (i.e., proportionally the same license rate in the U.K. as in Great Britain).
[3] First line subtracted from the preceding line.
[4] Ratio of the U.K. and U.S. distances driven per licensed driver, minus 1, times the fatalities in the U.S. for a particular road category.
[5] Ratio of the U.K. and U.S. fatality rates per distance driven for a particular road category, minus 1, times the fatalities in the U.S, times the ratio of the U.K. and U.S. distances driven per capita.
[6] Ratio of the U.K. and U.S. populations, minus the ratio of the U.K. and U.S. licensed drivers, times the fatalities in the U.S., times the ratio of the U.K. and U.S. distances driven.
[7] Proportion of the distance driven for a road category out of the total distance driven in the U.K., minus that in the U.S., times the distance driven in the U.S., times the fatality rate per distance driven for this road category in the U.K., times the ratio of the distances driven per capita in the U.K. and the U.S.

The results show that the greater distance driven per licensed driver in the U.S. is the main factor affecting the difference in road safety between the two countries: The effect of distance driven (additional 12,345 fatalities) is higher than the total effect of all other factors combined. The effect of the lower fatality rate per distance driven (additional 8,035 fatalities) is substantial as well (and especially so on rural roads). The lower licensure rate has an effect as well (additional 3,309 fatalities), but licensure rate is not relevant to the goal of this study. Finally, the results show that the different usage pattern of the road network is more beneficial in the U.S. than in the U.K. This is the case because U.S. drivers use proportionally more limited-access highways, which are safer per distance driven than other road types. The difference between the U.S. and U.K. usage patterns is responsible for 1,400 *fewer* fatalities in the U.S.

Road fatalities by road-user group

In the U.S. and Sweden, there are proportionally more fatalities of occupants of light-duty vehicles than in other countries, while the proportions of motorized two-wheeler and pedestrian fatalities are highest in the U.K. The proportion of bicyclist fatalities is highest in the Netherlands. These differences are most likely due to differences in exposure by mode in the respective countries.

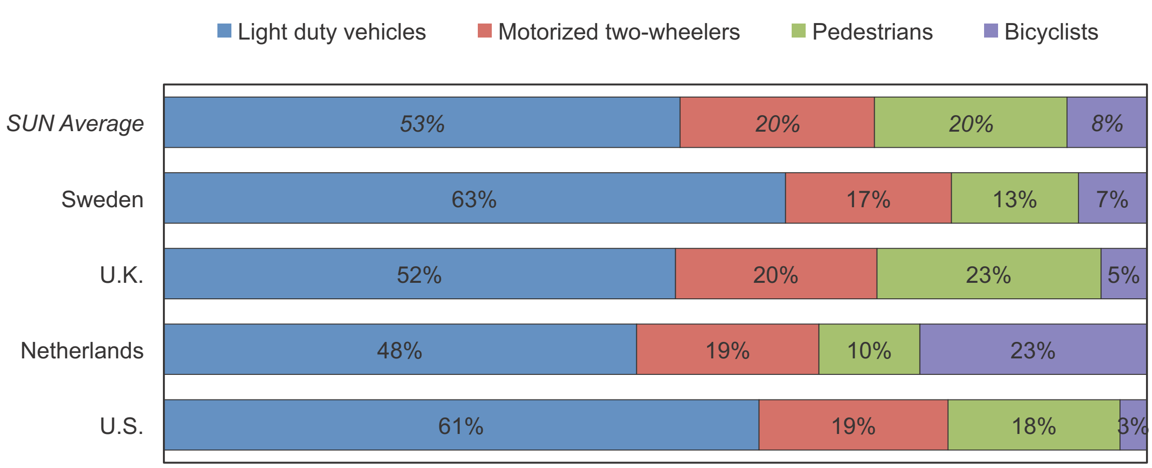

Figure 1. Road fatalities for main road-user groups in 2006-2009 (IRTAD, 2012; NHTSA, 2012). Light-duty vehicles include passenger cars and light trucks. (The European categorization includes no light trucks; it was assumed that they are included in the category of passenger cars.)

Road fatalities by gender and age group

The proportion of female fatalities is highest in the U.S. (30%), followed by the Netherlands (27%), Sweden (26%), and the U.K. (25%) (IRTAD, 2012). Figure 2 shows road fatalities by age group for males and females in each of the four countries in 2006 through 2010. For younger age groups, there are no substantial differences between the U.S. and the SUN countries. However, the proportion of road fatalities of older road users is lower in the U.S. than in the SUN countries, while the opposite is the case for middle-aged fatalities. This pattern is especially evident for females.

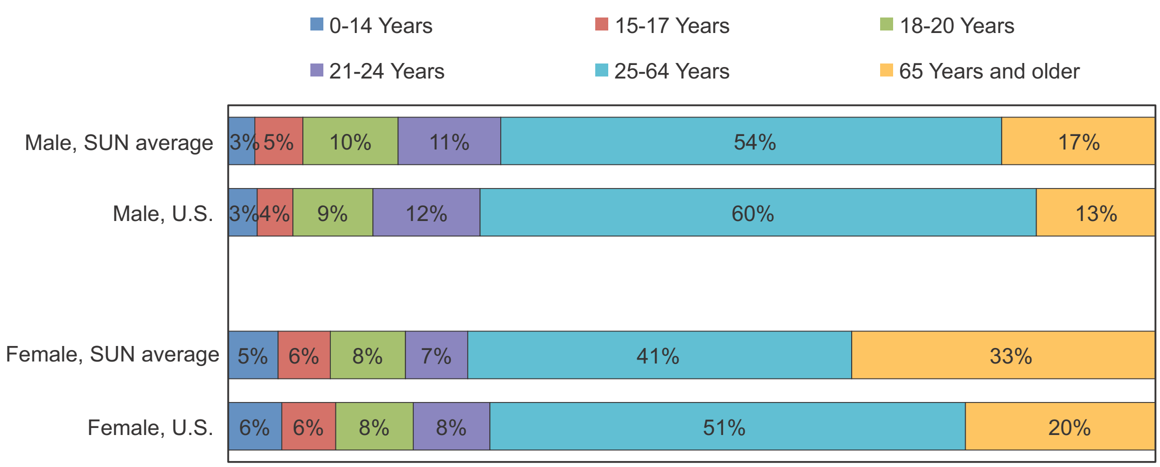

Figure 2. Proportion of road fatalities by age for males and females (IRTAD, 2012).

Road fatalities by weather conditions

Road fatalities by weather conditions in 2009 are shown in Figure 3. Weather conditions during fatal crashes in the U.S do not appear to differ greatly from those in the SUN countries. Specifically, 80-90% of fatalities in each country result from crashes that occur in dry/normal conditions. Winter conditions are most frequent in Sweden, while rainy conditions are most frequent in the U.K. The weather-condition distribution in the U.S. is most similar to that in the Netherlands.

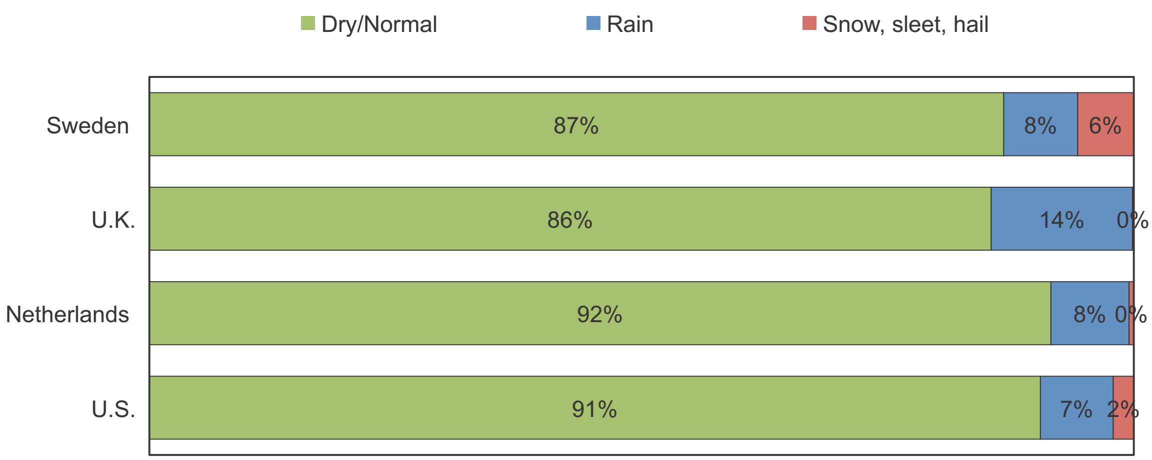

Figure 3. Road fatalities by weather conditions (other/unknown not included) and country in 2009 (NHTSA, 2011; Trafikanalys, 2012; Department for Transport, 2012; SWOV, 2012).

National road-safety strategies

United States

Based on the current strategies and initiatives (OECD/ITF, 2012), the U.S. Department of Transportation (USDOT) focuses on the most detrimental road-safety issues, such as alcohol-impaired driving fatalities (32% of traffic fatalities; WHO, 2009), and motorcycle fatalities (14% of traffic fatalities; OECD/ITF, 2012). In addition, the fatality-rate goal for 2012 is 1.05 fatalities per 100 million vehicle-miles (as compared to the actual rate for 2010 of 1.10).

There are four fatality submeasures concerning passenger vehicles, non-occupants, motorcycle riders, and large truck/bus-related fatalities (OECD/ITF, 2012). "The new approach raises the four fatality submeasures from agency-specific goals to departmental metrics to highlight the overall commitment by USDOT and the three surface transport agencies (NHTSA, FHWA, and FMCSA) that directly support the respective submeasures and the overall fatality rate goal" (OECD/ITF, 2012, p. 329).

Sweden

Swedish road-safety management is based on *Vision Zero*, a safe system approach where no one should be at risk of being fatally or severely injured while using road transportation (Dacota, 2012). Vision Zero is based on four principles: (1) ethics of the human life, (2) shared responsibility of authorities and road users, (3) safety from a human-centered approach, and (4) change by cooperation of all stakeholders.

Sweden no longer has a road-safety plan in a traditional sense. However, a management-by-objective approach has been adopted to achieve interim targets. This approach is based on the recent ISO standard on road-traffic safety-management systems (ISO, 2012). Several agencies and stakeholders are involved in the activities, representing transportation authorities, municipalities, the police, insurance industry, car industry, etc.

The current Swedish interim target for fatalities is a 50% reduction between 2007 and 2020. A corresponding target for serious injuries is a 25% reduction. Additional objectives have been identified in terms of performance factors or indicators. Priority topics include speed compliance, sober drivers, fatigued drivers, seat-belt use, bicycle helmet use, safe vehicles, safe roads, rescue, care and rehabilitation, and valuation of road safety.

United Kingdom

There are two separate road-safety strategies in the U.K. (Dacota, 2012): (1) Strategic Framework for Road Safety for Great Britain, which was accepted in 2011, and (2) Road Safety Strategy to 2020 for Northern Ireland, which was accepted in 2010.

There are no road-safety targets in Great Britain. Instead, the following forecasted scenarios are used: (1) for 2020, *Fatalities Scenario with no new measures* resulting in a fatality reduction of 37%, (2) for 2030, *Fatalities Scenario with new measures* resulting in a fatality reduction of 57% from 2020, and (3), for 2030, *Key Safety Indicator Scenario with new measures* resulting in a fatality reduction of 70% from 2020. Northern Ireland has road-safety targets, including a fatality reduction of 60% for 2020 in comparison with the average for 2004 through 2008.

Great Britain's current approach focuses on the following areas: making it easier for drivers to do the right thing; better education for children and novice drivers; remedial education after mistakes and minor offences; tougher enforcement for deliberate dangerous driving; cost-benefit analyses, including assessment of impact on business; more local community decision making and information; and an effort to make better tools for road-safety professionals.

Northern Ireland has defined the following challenges: improving safety on rural roads; protecting young drivers and motorcyclists; reducing inappropriate road-user behavior; and increasing knowledge about road-safety problems.

Netherlands

The Dutch road-safety strategy is primarily based on a safe-system approach called *Sustainable Safety* (Dacota, 2012). The five principles of this approach are (1) functionality of roads, (2) homogeneity of masses and/or speed and direction, (3) predictability of road course and road-user behavior by a recognizable road design, (4) forgiveness of the environment and of road users, and (5) state of awareness by the road users.

The current road-safety targets for 2020 include a maximum of 580 fatalities and 10,600 serious injuries. The fatality figure refers to the actual number of fatalities (640 in 2010), as it has been shown that the official statistics in the Netherlands underestimate the number of the actual road fatalities (OECD/ITF, 2012).

Priority topics include the general/overall approach (integral approach, cooperation, and Sustainable Safety), vulnerable road users, novice drivers, mopeds and motorcycles, impaired driving, speeding, alcohol and drugs, 50 and 80 km/h roads, vans and trucks, and single-vehicle crashes (Dacota, 2012).

Five selected road-safety issues

In this section, five selected road-safety issues will be examined in detail. The issues included are alcohol-impaired driving, exceeding speed limits, not wearing seat belts, nighttime driving, and young drivers (Sivak et al., 2007).

Alcohol-impaired driving

Alcohol-impaired driving has been one of the most severe and long-lasting problems of road safety throughout the world. The extent of alcohol consumption is typically the first proxy for estimating the problem of alcohol-impaired driving. The data from WHO (2012) for 2003-2005 show that average alcohol consumption (in liters of pure alcohol) per capita for persons 15 years of age or older was highest in the U.K. (13.4), followed by Sweden (10.3), the Netherlands (10.1), and the U.S. (9.4). These results suggest that alcohol consumption is slightly lower in the U.S. than in the SUN countries.

Table 5 shows the general legal BAC limits in the U.S. and the SUN countries. The highest limit is in the U.S. and U.K. (0.8 g/l), followed by the Netherlands (0.5 g/l) and Sweden (0.2 g/l). Given that the risk of a crash at 0.8 g/l is about twice that at 0.5 g/l (Compton, Blomberg, Moskowitz, Burns, Peck, and Fiorentino, 2002), lowering the limit in the U.S. would result in some safety benefits. Specifically, Elvik et al. (2009) estimated that such a lowering reduces alcohol-related fatal crashes by 2%.

Table 5
General BAC limit(s) (g/l) by country (OECD/ITF, 2012).

U.S.	Sweden	U.K.	Netherlands
0.8 (0.2 for drivers < 21 years; 0.4 for professional drivers)	0.2	0.8	0.5 (0.0 for drivers < 20 years and repeat offenders since 2011 [earlier 0.3])

The prevalence of driving under the influence of alcohol on weekend nights is currently estimated to be 3% in the U.S. (OECD/ITF, 2012) and 2.4% in the Netherlands (SWOV, 2011). No corresponding information is available for Sweden or the U.K.

Overall, assessments of the proportion of alcohol-related crashes lack reliable information. This is the case because not all road users involved in crashes are tested for alcohol (e.g., Dacota, 2012). Thus, alcohol-related crashes are usually underreported. With that caveat and different legal limits in mind, country reports collected by WHO (2009) indicate that the proportion of road fatalities attributable to alcohol was 32% for the U.S., 25% for the Netherlands, 20% for Sweden, and 17% for the U.K.

Random breath testing means that the police are allowed to test drivers' breath without having any suspicion. Random breath testing is generally recognized as one of the most effective countermeasures against alcohol-impaired driving (SUPREME, 2010). Random breath testing is implemented in the Netherlands and Sweden, but not in the U.K. and the U.S.

The results of face-to-face interviews of European drivers show that the proportion of drivers who have encountered (any sort of) alcohol checks over the previous three years was 41% in Sweden, 37% in the Netherlands, and 9% in the U.K. (Sardi and Evers, 2004). Consequently, drivers' subjective risk of being caught is relative high in the Netherlands and in Sweden but not in the U.K. Furthermore, it has been found in the Netherlands that each doubling of the number of random breath tests since 1986 was associated with a 25% decrease in drink-driving offenses (SUPREME, 2010). Between 1985 and 2005, the proportion of drink-driving offenders decreased by two thirds. In Sweden, the proportion of injury crashes involving drunk drivers was reduced from 14% to 9% after the introduction of random breath testing in the 1970s (SUPREME, 2010).

Alcohol ignition interlock is a relatively new countermeasure to reduce alcohol-impaired driving. The device utilizes breath-alcohol sensors to confirm that a driver's BAC is below a specified limit before the vehicle can be started. These devices are currently used in certain conditions in the U.S. and the SUN countries. Specifically, more than a half of all U.S. states require alcohol offenders to install interlocks on their vehicles (IIHS, 2012b). The device is used during a license suspension and/or for specified time periods before relicensing. In Sweden, alcohol ignition interlocks are used for repeat offenders (European Commission, 2012a). In addition, in Sweden more than 5,000 company cars and all 800 vehicles of driving schools are currently equipped with alcohol interlocks. In the Netherlands, an alcohol-interlock program for serious alcohol offenders was introduced in 2011 (SWOV, 2011). No information was available for the U.K. Recently, the U.S. National Transportation Safety Board recommended ignition interlocks for all first-time offenders (NTSB, 2012).

Exceeding speed limits

Many countries provide information about the frequency of speeding-related crashes. However, that information is not very relevant, because speed is a contributing factor in all crashes. Therefore, we focus here on speed limits, drivers exceeding the limit, and automatic speed enforcement.

Table 6 lists the posted speed limits for passenger vehicles by road type and country. The maximum speed limit is highest in the U.S. for all road types (for motorways about the same as in the Netherlands). This difference is likely to be important, because the highest limit is likely used most frequently.

Table 6
Posted speed limits (km/h) for passenger vehicles. Frequently used limits are listed, with less frequent limits in parentheses (OECD/ECMT, 2006).

Road type	U.S.	Sweden[1]	U.K.	Netherlands
Motorways (limited-access highways)	104-120 (88-113)[2]	90-110 (70-90)	113	120 (100)
Main highways	88-113	90 (70-110)	97	100
Rural roads	88-113	70 (90)	97	80 (60)
Urban arterial roads	48-88	50-70	48 (64)	50-70
Urban local and collector streets	40-56	30-50	48 (32)	50 (30)

[1] Sweden applies lower speed limits in wintertime than the limits listed. The wintertime limits generally fall within the lower range listed (European Commission, 2012b).
[2] In urban areas.

Special speed limits for heavy vehicles are used in the SUN countries, but only in 10 states in the U.S. (OECD/ECMT, 2006). Speed limiters are compulsory for heavy vehicles in the SUN countries (European Commission, 2012b), but not in the U.S.

The proportion of light-duty vehicles/passenger cars exceeding the posted limit by road type and country is given in Table 7. (The U.S. data is limited to 30 out of the 50 states, and the frequency of monitoring in the U.S. is generally less than in the SUN countries.) The results show that the U.S. percentages are among the highest for each road type. The most substantial difference exists on urban local and collector streets where 74% of U.S. drivers exceed the posted speed limits in comparison with 22% in the U.K. and 45% in the Netherlands.

Table 7
Percentage of passenger vehicles exceeding the posted limit (OECD/ECMT, 2006).

Road type	U.S.[1]	Sweden	U.K.	Netherlands
Motorways	41-66	68	20-57	40-45
Main highways	52-66	59	10	20
Rural roads	47	59	10	45
Urban arterial roads	73	N/A	8	50-73
Urban local and collector streets	74	N/A	22	45

[1] 30 states

Automated speed enforcement (ASE) is a system designed to automatically detect vehicles violating speed limits. These types of systems include fixed and mobile speed cameras as well as section control (which measures the average speed over a road section). ASE has been used around the world, and positive effects on speed behavior and safety have been reported overall (e.g., Thomas, Srinivasan, Decina, and Staplin, 2008). One of the main advantages of automated speed enforcement is that it substantially strengthens speed enforcement. In the U.S., speed cameras are used only in 13 states and the District of Columbia (IIHS, 2012a). Many programs in the U.S. are restricted to school and constructions zones, residential areas, only when a law-enforcement officer is present, etc. In contrast, all SUN countries apply automatic speed control widely (Kallberg and Törnqvist, 2011). For example, the number of fixed speed cameras was estimated at about 1,100 in Sweden, 3,500 in the U.K., and 1,600 in the Netherlands (Kallberg and Törnqvist, 2011).

Intelligent speed adaptation (ISA) is an in-car technology that warns the driver about speeding, discourages the driver from speeding, or prevents the driver from exceeding the speed limit. Each SUN country has run several ISA trials (ETSC, 2006). Recently, ISA was included as part of the European New Car Assessment Program (Euro NCAP, 2012). There has not yet been any ISA trial in the U.S. (FOT-Net Wiki, 2012).

Use of seat belts

The single most effective technology for reducing injury severity in a motor-vehicle crash is the seat belt (Sivak et al., 2007). In the SUN countries, the use of seat belts is mandatory for both front and rear occupants of passenger vehicles. In the U.S., there is a mandatory seat-belt law in every state except New Hampshire (IIHS, 2012c). However, the laws cover rear occupants in only 26 states and the District of Columbia. In addition, primary laws (i.e., police may stop vehicles solely for belt-law violations) exist in only 32 out of the 50 states.

In the U.S., the seat-belt usage rates are lower for both sets of seats than in the SUN countries (Table 8). In addition, the use of seat belts in the U.S. is higher in the states with primary belt law (87%) than in the states with secondary belt laws (76%) (OECD/ITF, 2012). The differences between the U.S. and the SUN countries, shown in Table 8, are substantial, especially because non-users are also more likely to get involved in crashes (Turbell, Andersson, Kullgren, Larsson, Lundell, Lövsund, Nilsson, and Tingvall, 1997). For example, 51% of fatally injured passenger-vehicle occupants in the U.S. in 2010 were unrestrained, although the mean proportion of unbelted drivers and passengers was from 15% to 26% (OECD/ITF, 2012). Overall, safety benefits obtained from a given percentage increase in seat-belt usage are greatest at the highest percentage levels of usage (Turbell et al., 1997).

Table 8
Use of seat belts by country (OECD/ITF, 2012).

<table>
<tr><th>Condition</th><th>U.S.</th><th>Sweden</th><th>U.K.</th><th>Netherlands</th></tr>
<tr><td>Front, driver</td><td rowspan="2">85%</td><td>97%</td><td rowspan="2">96%</td><td>97%</td></tr>
<tr><td>Front, passenger</td><td>96%</td><td></td></tr>
<tr><td>Rear, adults</td><td rowspan="2">74%</td><td>81%</td><td rowspan="2">90%</td><td rowspan="2">82%</td></tr>
<tr><td>Rear, children</td><td>95%</td></tr>
</table>

Euro NCAP (2012) assessment program scores advanced seat-belt reminder systems separately for front and rear occupants. A Swedish study showed that this type of reminder substantially improves belt use (Turbell et al., 1997).

Nighttime driving

Driving at night is substantially riskier than during the day (Owens and Sivak, 1996; Sullivan and Flannagan, 2002). Overall, this applies to all countries, but there are differences in exposure to nighttime driving, frequency of vulnerable road users at night, etc.

Table 9 shows road fatalities by light conditions in the four countries of interest. The main result of this comparison is that the overall proportion of nighttime fatalities is highest in the U.S.

Table 9
Percentage of road fatalities by light conditions (other/unknown not included)
(NHTSA, 2011; Trafikanalys, 2012; Department for Transport, 2012; SWOV, 2012).

Light condition	U.S.	Sweden	U.K.	Netherlands
Daylight	49.0	58.3	58.1	79.8
Dark but lighted	17.3	12.4	23.3	0.4
Dark	29.7	21.9	18.5	14.7
Dawn and dusk	4.0	7.4	N/A	5.0

Young drivers

It is a universal finding that young drivers have above average rates of fatal crashes. In most U.S. states, a license to drive unsupervised requires a driver to be at least age 16 (IIHS, 2012d). The corresponding minimum age (for passenger cars/light duty vehicles) is 18 in Sweden and the Netherlands, and 17 in the U.K. (Dacota, 2012). Because of these differences in licensure age, fatality rates of two age groups (15-17 years old and 18-20 years old) were examined. Specifically, the proportions of road fatalities of these age groups (out of the total number of road fatalities) were compared with the proportions of persons in the same age groups by country (Figure 4). If the road users in a given age group are disproportionately likely to be fatally injured in road crashes, the points would fall above the diagonal lines in Figure 4.

There were two main findings: (1) road fatalities are substantially overrepresented for the 18 to 20 year olds, but only slightly so for the 15 to 17 year olds, and (2) the problem with young drivers is not more severe in the U.S. than in the SUN countries.

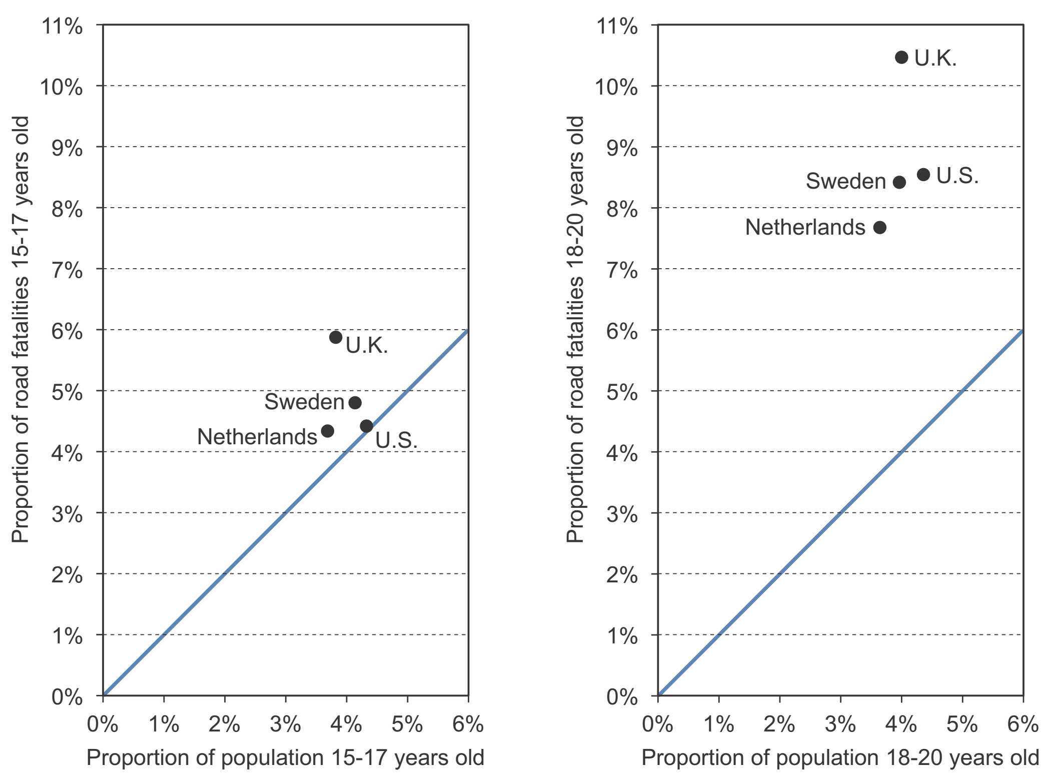

Figure 4. The proportion of road fatalities of 15-17 years old persons (left panel) and 18-20 years old persons (right panel) compared with the proportion of the same age group in the population by country, 2006-2010 (IRTAD, 2012).

Discussion

The information in Table 3 showed that the fatality rate per population in the U.S. is about 3 times the rate in the SUN countries; the corresponding multiples for the fatality rates per vehicle and per distance driven are about 2 and 1.5, respectively. The present analysis indicates that there are three sets of underlying factors that are responsible for these differences: structural, cultural, and procedural. This distinction is of importance because structural and cultural factors are much less amenable to change than procedural factors.

Structural and cultural factors

The U.S. is a much larger country than any of the SUN countries. Furthermore, land use and urban planning differ substantially between the U.S. and Europe. Most U.S. cities were designed in such a way that transportation depends heavily on personal vehicles. Primarily as a consequence of these two factors, the average annual distance driven per capita in the U.S. is about 2 times the distance in the SUN countries. Furthermore, a more detailed comparison of the U.S. and the U.K. indicated that the greater distance driven in the U.S. is responsible for 12,345 additional fatalities (out of 22,288); the higher fatality rate per distance driven in the U.S. is responsible for an additional 8,035 fatalities. In contrast, the different usage pattern of the road network is more beneficial in the U.S. than in the U.K. (1,400 fewer fatalities), because U.S. drivers use proportionally more limited-access highways, which are safer per distance driven than other road types.

These findings imply that fatality rate per distance driven in the U.S. would have to be substantially (66%) lower than it is now to achieve the safety level of the SUN countries in terms of fatalities per population. Another alternative for achieving the same goal would involve reducing the vehicle distance driven by improving urban planning, encouraging people to use more public transportation, telecommuting, etc. This would be beneficial from the environmental point of view as well (Luoma and Sivak, 2011).

The SUN countries are independent countries that can design and implement their own road-safety strategies (although they are member states of the European Union). On the other hand, the U.S. consists of individual states, and the power of the federal government is more limited. A potentially important cultural difference is that Americans might be less willing to accept restricting legislation and enforcement to improve road safety (e.g., Sivak, 2006; Evans, 2004) than Europeans (Quimby and Sardi, 2004).

Procedural factors

Procedural factors are important because they have the greatest potential of being modifiable in a relatively short time. The present analysis has identified four procedural factors that have likely contributed greatly to the better safety record of the SUN countries as compared with the U.S.

Alcohol-impaired driving. The proportion of road fatalities attributable to alcohol is likely lower in the SUN countries. The BAC limit in Sweden and the Netherlands (but not in the U.K.) is lower than is generally the case in the U.S. Sweden and the Netherlands apply random breath testing.

Speed. In the SUN countries speed limits by road type tend to be lower, special speed limits for heavy vehicles are used without exception, speed limiters for heavy vehicles are compulsory, speed cameras are used widely, and the proportion of vehicles that exceed speed limits tends to be smaller.

Use of seat belts. Usage rates in the SUN countries are higher for both front and rear occupants. Seat belts are compulsory and the law covers both front and rear seats. Primary law is the prevailing practice.

Road-safety strategy and target setting. The underlying logic of the road-safety strategies in the SUN countries differs substantially from that in the U.S. In the SUN countries, the emphasis is on the total number of fatalities (and injuries), and thus on fatality (and injury) rates per population. In contrast, the U.S. focus is on fatality rates per distance driven.

Methodological considerations

International road-safety comparisons would benefit greatly from data on distance driven. The comparisons of fatalities with no exposure information are frequently inconclusive, because potential explanations of differences include both crash risk and exposure. This was the case also in this study in comparing fatalities by road-user groups, gender, age, weather, etc. The more detailed comparison of the U.S. and U.K. with exposure and fatality data by road type demonstrated that international comparisons with such data could provide much more useful insights about country-wide differences. The overall exposure data are important, but exposure information by road-user group, road and weather conditions, etc. would greatly improve road-safety research.

This study was limited to fatalities, because the definitions of injured persons by country vary too much to make reliable comparisons. Standardized information on traffic injuries—and crash severity in general—would substantially benefit international comparisons.

Availability of both exposure data and crash-severity data would provide new opportunities to examine road safety in terms of three relevant dimensions—exposure, crash risk, and consequences (Sivak and Tsimhoni, 2008; Nilsson, 2004).

Recommendations

The implementation of effective new countermeasures in the U.S. requires raising the awareness of the general public and of the decision makers concerning the much higher safety level in the best-performing countries and of the effectiveness of various countermeasures that have been implemented elsewhere. The countermeasures to be recommended would lead to only limited restrictions on driver behavior or privacy, but would likely result in substantial benefits in terms of human life saved, suffering avoided, and expenses avoided.

Based on the present analysis, the following is a list of key recommendations for improving road safety in the U.S.

- Lower states' BAC limits to 0.5 g/l, introduce efficient random breath testing with widespread utilization in all states, and encourage the use of alcohol ignition interlocks.
- Reexamine the current speed limit policies (especially in urban areas), implement special speed limits and compulsory speed limiters for heavy vehicles, and improve speed enforcement by a wide-scale implementation of speed cameras and/or intelligent speed adaptation.
- Implement in each state primary seat-belt-wearing laws that would cover both front and rear occupants. In addition, reward OEMs for installation of advanced seat-belt reminders.
- Reconsider road-safety target setting so that the goal is given in terms of the number of reduced fatalities, with supplementary goals in terms of serious injuries and other safety indicators.
- Consider new strategies to reduce distances driven (e.g., urban planning, encouragement of people to use more public transportation, telecommuting, etc.).

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