

ORIGINAL ARTICLES

Where children sit in motor vehicles: a comparison of selected European and American cities

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Abstract

Objectives—To ascertain whether there are differences in child seating location between selected cities in the US and continental Europe, and if differences exist, to ascertain what factors predict them.

Setting—Boston and New Orleans, which have no laws regarding child seating location, and Paris, Frankfurt, and Brussels, which for approximately 20 years have had laws requiring children under the ages of 10 or 12 to sit in the rear.

Methods—Observations were made in the first quarter of 1997 at several locations in or near each city. The vehicle seating capacity, total number of occupants, the seating location of adults and children, and driver shoulder belt use were recorded for each vehicle with at least one child. The predictors of a vehicle having a child in the front were estimated using logistic regression.

Results—Data on 5501 children riding in 3778 vehicles were collected. Adjusting for differences in vehicle seating capacity, occupant mix, and driver shoulder belt use, vehicles in the European cities are significantly less likely to have a child in the front seat than vehicles in the American cities.

Conclusions—Cities with no history of laws prohibiting children from sitting in the front, vehicles with low seating capacity, vehicles with no adult (other than the driver) or many child passengers, and unbelted drivers were associated with a higher likelihood of children riding in the front seat. It is feasible for a society to insist, through custom and/or law, that children sit in the back seat.

(*Injury Prevention* 1998;4:98-102)

Keywords: motor vehicle; seating position

The adverse impact of passenger-side airbags on children^{1,2} has renewed the interest of safety professionals in where children sit when traveling in motor vehicles. For example, in the summer of 1997, the National Transportation Safety Board recommended that each state in

the US amend its child passenger safety law to compel children under the age of 13 to ride in the rear seat if a rear seat is available.³ The state of Rhode Island recently became the first to move in this direction, passing legislation requiring all children less than 6 years old to ride in the rear seat unless no rear seat is available.⁴ Several other states (for example, Connecticut, Delaware, Illinois, Massachusetts, New Jersey, New York, Pennsylvania, and Tennessee) are now considering similar legislation.⁵

It has been well accepted for decades that the rear seat is safer than the front seat for both children and adults.⁶⁻¹⁶ In the mid-1970s, well before the recent concern about airbags, several countries in continental Europe (including Germany, Belgium, and France) passed legislation requiring children to ride in the rear seat (table 1).¹⁷⁻¹⁹ The law in France covered children under 10 years of age, while the laws in Germany and Belgium covered children less than 12 years old. However, a 1992 guideline from the European Union which advocates restraint use in the front and rear seats (rather than a rear seating requirement) has induced some countries to amend their laws. Currently, most European countries (including Belgium, France, and Germany) allow properly restrained children in the front seat.²⁰ For example, since 1992, France allows children to ride in the front seat as long as they use a child restraint or a properly fitted shoulder belt.

Despite this legislative activity, surprisingly little is known about precisely how often American or European children sit in the front of motor vehicles. In the annual US 19 city survey conducted from 1983 to 1991, the National Highway Traffic Safety Administration (NHTSA) observed child restraint use and seating location at shopping centers and intersections.²¹ According to these data, more than one third of children in the US traveled in the front seat. The frequency of this behavior varied by the age of the child and tended to decrease during the 1980s. Hence, the reported proportion of children riding in the front seats decreased over time, from 65 to 50% among infants (children less than 1 year old); 35 to 20% among toddlers (children 1 to 3 years

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old); and 45 to 35% among subteens (children 4 to 11 years old). The 19 city survey was terminated in 1991 and replaced by state level surveys of restraint use, but NHTSA does not currently expect states to report information on where children sit.

More recently, NHTSA conducted the National Occupant Protection Use Survey (NOPUS).²² A component of this survey, the Controlled Intersection Study, collected information on where children sit in vehicles. In the latest survey, 67.9% of the 666 children up to 4 years old were in the front (when these observations are weighted according to the sampling strategy, this figure drops to 51.3%).²³ Recently, an analysis of the National Accident Sampling System data from 1988 to 1995 showed that 39% of all passengers less than 12 years old were seated in the front seat when crashes occurred.²⁴ Despite interviews with numerous European officials, we were unable to obtain data on where European children sit in vehicles.

Thus, the goal of this study was to obtain recent information on where children sit when traveling in motor vehicles. Our primary aim was to investigate potential differences in the seating behavior of children associated with the existence (or past existence) of laws regarding child seating position. We also evaluated whether other factors, such as the size of the vehicle, the mix of children and adults traveling in the same vehicle, and adult's shoulder belt use had any association with child seating location.

Methods

We conducted a cross sectional observational study. Roadside observation of vehicles was employed to determine where children sit in five conveniently selected cities in four different countries: Frankfurt (Germany), Brussels (Belgium), Paris (France), Boston (Massachusetts, USA), and New Orleans (Louisiana, USA). Only passenger vehicles transporting at least one child were included in the study. Vehicles

included passenger cars, minivans, and light trucks. Children were defined as passengers likely to be less than 13 years old, as indicated by their appearance and height (head below the top of the head restraint in the front right seat).

Trained observers recorded their observations using a standardized instrument during the daytime or early evening hours of the following dates in 1997: January 17–20 (Frankfurt), January 21–24 (Brussels), January 24–26 (Paris), January 22–March 30 (Boston), and March 21–23 (New Orleans). Locations were selected for convenience, and included intersections near public and private schools, churches, movie theaters, parks, downtown crossings, and freeways. The exact street locations where data were collected are available from the authors upon request.

The vehicle seating capacity, total number of occupants, and shoulder belt use by the driver and front right passenger were recorded for each vehicle. We also recorded whether each seating position within the vehicle was occupied, whether the occupant was an adult or a child, whether there was a child being transported on the lap of another passenger, and the type of child restraint device employed.

The difficulty of obtaining accurate measures of safety belt use for rear seat occupants (for example, the lap belt in a rear seating position is not easily seen) prevented us from recording these data. Moreover, it is only recently that shoulder belts have become common in rear seats. Studies aiming to evaluate lap belt use or appropriateness of child restraints typically require the observer to have access to the interior of the car.

One concern with using observational data is that interobserver variation may exist. Thus, we conducted a reliability study on a subsample of vehicles. Kappa (κ) statistics were calculated for each variable recorded.²⁵ Any variable whose reliability value was less than substantial (that is, $\kappa \leq 0.6$) was not used for the analysis.

Two measurements were used to describe child seating behavior across cities: the

Table 1 Summary of past and present child passenger safety laws: seating position and restraint requirements

Country	City	Years	Age limit (years)	Allowed in front seat?	Restraint use required in rear seat?
Germany	Frankfurt	1975–88	<12	No*	No
		1988–93	<12	Yes. Restrained*	No
		1994–	<12 and <150 cm	Yes. Restrained	Yes†
Belgium	Brussels	1975–96	<12	No	No
		1996–	≤ 12	Yes. Restrained‡	Yes§
France	Paris	1975–91	<10	No	No
		1992–	≤ 10	Yes. Restrained‡	Yes†
USA	Boston, MA	<1997	<12	Yes¶	Yes†
		April 1997–	No age limit	Yes . Restrained	Yes
	New Orleans, LA	1984–96	≤ 5	Yes. Restrained	Yes**
		1996–	>5	Yes. Restrained	No
			<13	Yes. Restrained	Yes**

Notes: By restrained all countries (except where indicated) mean: if child <3, child restraint; if child 3–12, booster or seat belt; if >12, seat belt.

*Except if there are no rear seats or all rear seats are occupied with other children.

†Except if number of passengers exceeds number of seats; riding in taxis; passengers with a handicap or medical exception.

‡Except if no rear seat is available, all rear seats are occupied by children or rear seats are unusable.

§Except if number of passenger exceeds the number of seats.

¶Type of restraint was not specified, but seat belts were sufficient for all ages. Seat belts or child restraints acceptable for children <6.

|| Except if the child rides in a vehicle manufactured before 1966 or the child is unable to use a child restraint.

**If the number of children in the vehicle is greater than the number of seat belts or restraining systems available, the unrestrained children must sit in the rear.

proportion of all observed children who were in the front (the most commonly reported measurement in the literature), and the proportion of all observed vehicles that had at least one child in the front. As the number of children in each vehicle rises (that is, as a result of larger families or car pooling arrangements), the proportion of all children riding in the front necessarily decreases. The proportion of vehicles that had at least one child in the front (our preferred measurement) reflects better the decision faced by each driver: to seat or not to seat a child in the front.

A descriptive analysis of the data was performed. Then, four separate logistic regression models were used to evaluate the crude associations between vehicle capacity, occupant mix, drivers shoulder belt use, and location (that is, city) and the probability of a vehicle carrying at least one child in the front. Last, a multiple logistic regression model was used to assess whether differences in child seating behavior were confounded by vehicle seating capacity, occupant mix, driver shoulder belt use, and location.²⁶

Results

To evaluate the interrater agreement, two observers recorded data on the same 128 vehicles. The agreement about whether the passenger in the front right seat (if any) was an adult or a child, the item of most interest for this study, was 0.89 (almost perfect). κ Statistics for the total number of seats, total number of passengers, and the age of passengers were above 0.85 (almost perfect) for each of these items. Lower agreement was found for the driver's shoulder belt use (0.67, substantial), the front seat adult passenger shoulder belt use (0.57, moderate), and the type of child restraint used (0.55, moderate).

In the full study, information was recorded on 3778 vehicles with a total of 5501 children. By city, the number of observed vehicles ranged from 646 in Frankfurt to 935 in Paris; the number of observed children ranged from 892 in Frankfurt to 1120 in New Orleans (table 2).

Most vehicles in each city had four to six seating positions. Between 0 and 5% of the vehicles had no rear seats (for example, pick ups and small sport cars); the proportion of vehicles with seven or more seating positions ranged from 6 to 10% (table 2).

The number of occupants observed in each vehicle ranged from two (that is, the driver and one child) to nine. Overall, 40% of the vehicles had three occupants, 33% had two occupants, 18% had four occupants, 6% had five occupants, and the remaining 2% had six or more occupants (data not shown). The occupant mix (that is, whether the passengers were: only one child, only two children, only three children, only three or more children, or one or more adults and any number of children) per car was similar among the five cities, with the exception of Brussels where vehicles were less likely to have adult passengers (table 2).

Shoulder belt use among observed drivers varied considerably among cities. The proportions were highest in Frankfurt (85%) and lowest in Brussels (52%). The proportion in Paris was 75% and in Boston and New Orleans 58% (table 2).

The proportions of children seated in the front were 9% in Paris, 10% in Frankfurt, 22% in Brussels, 25% in Boston, and 27% in New Orleans (table 2). The proportions of vehicles with at least one child in the front seat ranged from a low of 14% in Frankfurt and Paris to a high of 38% in New Orleans (table 2).

To determine whether front seat occupancy by children was associated with the lack of an available rear seat, we evaluated rear seat availability for the vehicles observed with a child in the front. Among these vehicles, 96% (Paris and Brussels), 88% (Frankfurt and Boston), and 80% (New Orleans) had an unused seat available in the rear (computed from table 2).

The univariate logistic regression models revealed statistically significant relationships between the probability of a child riding in the front and city, seating capacity, occupant mix, and driver shoulder belt use (table 3). Vehicles with no rear seat are more likely to have a child in the front, as are vehicles driven by

Table 2 Child seating patterns, vehicle size, occupant mix, and driver shoulder belt use by city; values are number (%)

	Frankfurt	Brussels	Paris	Boston	New Orleans	Total
Children	892	996	1372	1121	1120	5501
Children in the front	89 (10)	123 (22)	219 (9)	280 (25)	302 (27)	1013
Vehicles	646	671	935	783	743	3778
Vehicles with at least one child in the front	90 (14)	212 (32)	129 (14)	272 (35)	283 (38)	986
Vehicles with more children than rear seats						
And a child in the front	11 (2)	8 (1)	7 (1)	32 (4)	57 (8)	115
And no child in the front	0 (<1)	4 (<1)	1 (<1)	4 (1)	4 (1)	13
Seats per vehicle						
2-3	2 (<1)	4 (<1)	5 (1)	25 (3)	37 (5)	73
4-6	608 (94)	630 (94)	841 (90)	715 (91)	645 (87)	3439
7+	36 (6)	37 (6)	89 (10)	43 (5)	61 (8)	266
Occupant mix						
1 adult + 1 child	153 (24)	309 (46)	251 (27)	292 (37)	250 (34)	1255
1 adult + 2 children	45 (7)	150 (2)	96 (10)	83 (11)	95 (13)	469
1 adult + 3 children	14 (2)	37 (6)	15 (2)	18 (2)	25 (3)	109
1 adult + 4 or more children	14 (2)	8 (1)	3 (<1)	6 (1)	19(3)	50
2 or more adults + 1 or more children	420 (65)	167 (25)	570 (61)	384 (49)	354 (48)	1895
Driver shoulder belt use						
Belted	551 (85)	350 (52)	703 (75)	456 (58)	432 (58)	2492
Unbelted	70 (11)	299 (45)	179 (19)	284 (36)	284 (38)	1116
Unknown	25 (4)	22 (3)	53 (6)	43 (5)	27 (4)	170

Table 3 Probability of at least one child in the front seat: crude and adjusted odds ratio (OR) and 95% confidence interval (95% CI)

	Crude		Adjusted	
	OR	95% CI	OR	95% CI
City				
Frankfurt	0.3	0.2 to 0.4	0.4	0.3 to 0.5
Brussels	0.9	0.7 to 1.1	0.5	0.4 to 0.6
Paris	0.3	0.2 to 0.4	0.3	0.3 to 0.5
Boston	1.0	—	1.0	—
New Orleans	1.2	0.9 to 1.4	1.1	0.8 to 1.4
Seats per vehicle				
2-3	216.0	30 to ∞	406.0	54 to ∞
4-6	1.0	—	1.0	—
7+	0.8	0.6 to 1.0	0.6	0.4 to 0.9
Occupant mix				
1 adult + 1 child	1.0	—	1.0	—
1 adult + 2 children	0.7	0.6 to 0.9	0.7	0.6 to 0.9
1 adult + 3 children	1.8	1.2 to 2.7	2.0	1.3 to 3.1
1 adult + 4 or more children	4.5	2.2 to 9.1	5.3	2.5 to 11.1
2 or more adults + 1 or more children	0.1	0.1 to 0.1	0.1	0 to 0.1
Driver seat belt use				
Belted	0.5	0.4 to 0.6	0.7	0.6 to 0.8
Unbelted	1.0	—	1	—
Unknown	0.3	0.2 to 0.5	0.5	0.3 to 0.8

unrestrained drivers. The use of the front seat by children is related to both the number of children in the vehicle and the presence of adult passengers. Children are least likely to sit in the front when the occupant mix includes an adult passenger, since the adult tends to occupy the front right seating position.

The multiple logistic regression confirmed the statistically significant impact of vehicle seating capacity, occupant mix, and driver seat belt use, and increased the impact of location. After controlling for all other variables, the three European cities were half as likely to have children riding in the front of vehicles (table 3).

Discussion

A significant difference exists in child seating behavior. After controlling for vehicle seating capacity, occupant mix, and driver shoulder belt use, there was a statistically significant difference in the probability of a vehicle having a child in the front between the three European and the two American cities. Vehicles in the selected European cities were 50% to 70% less likely to carry children in the front seats.

The cross sectional comparison of cities reported here provides insight into differences regarding child seating behavior. However, we have no baseline data prior to the enactment of child seating laws in the selected European countries in the mid-1970s. Whether the differences we have observed are attributable to the legal requirements that once existed in these European countries or to norms that gave rise to those legal requirements in the mid-1970s is not clear. None the less, the data reported here suggest that child seating laws may have an influence on the seating behaviors of children and that the effects of these laws may last even after the laws preventing children from riding in the front were revoked.

These conclusions are tentative because of several limitations. The selection of cities and sites for data collection was based primarily on convenience. Nevertheless, our results for the American cities are similar to those previously reported in the literature. Representative ob-

servational surveys conducted in the past reported between 20% and 50% of children riding in the front seats²¹ and 58% (± 3.8) driver shoulder belt use.²⁷ The higher proportion of children riding in the front of the American vehicles reported in the latest NOPUS survey is probably due to the small sample size recorded in that study, and the fact that that study was not designed to characterize child seating locations.²³ Observational surveys of adult shoulder belt use among front seat occupants traveling in urban areas reported proportions of 85% in Germany, 71% in France, and 41% in Belgium.²⁸ The similarity of our results to these other surveys supports the representativeness of our sample.

Implications for prevention

Given the rapid introduction of passenger airbags into vehicle fleets around the world, it is especially important that children be urged or required to sit in the rear seat. Our results show that there are different social norms for where children sit in motor vehicles. The data reported in our paper suggest that child seating laws may have had a substantial influence on these norms.

In our opinion, rear seating should be a new element of comprehensive child passenger safety laws which also require age and weight appropriate restraint use. The ideal law would apply to all vehicles (even vehicles for hire), be easy to enforce, and include significant fines and penalty points that increase car insurance rates.

Some have suggested that it may be more cost effective to enforce existing child restraint use laws than to add seating requirements to existing laws.⁵ We disagree. Child seating laws will enhance the cost effectiveness of existing laws because police will find it easier to observe where a child is seated than discern whether restraints are used properly. Once a vehicle is stopped, police can then make a precise determination about whether restraints are being used properly among all child occupants in the vehicle.

The authors thank Kim Clemente and Chun Hui Chang for their assistance in the data collection and data entry processes. Toben Nelson, Dana Sussman, Kimberly Thompson, and two anonymous reviewers provided helpful comments on a previous version of this manuscript.

This study was supported by the Harvard Center for Risk Analysis, Harvard School of Public Health, Boston, Massachusetts, USA.

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Home alone death?

Investigators were considering a possible Hollywood connection in the death of a 10 year old boy after he was hung from a coat hook in the washroom of his school in a small Ontario town. The popular comedy movie *Home Alone* shows a boy hanged on a coat hook by thieves; parents in the area also noted that a recent television commercial contains a similar act, but neither depiction portrays any resulting injury. The Ontario boy died a week after he was found. He never regained consciousness, and his parents instructed that life support systems be removed. Police kept the school closed for two weeks to gather evidence (Canadian Press/Toronto *Globe and Mail*, February 1998).

Deadly game

To play "blackout", you just slip your head into the cloth towel in the dispenser in the school washroom, and spin around until you feel lightheaded. Many schools have spoiled the fun by removing the towel dispensers, but some remain, particularly in private schools. An 11 year old boy in Vancouver died in November, three days after he was found unconscious in the school washroom, hanging from the towel dispenser. He is the fourth young boy to die in this way since 1990. In reporting his death, the Toronto *Globe and Mail* quoted one child development specialist who repeated the warning that preadolescent boys cannot be expected to fully comprehend the danger they face from such a game. Instead, the temptation should be removed (*Globe and Mail*, November 1997).

"Walking school bus" arrives in Canada

Vancouver parents have begun to recognize a growing big city dilemma about child pedestrian safety: if parents drive their children to school in the belief that walking is hazardous, are they creating a bigger danger by building traffic jams around schools? A recent study of commuter habits in the Vancouver area found that every day almost half of the region's elementary schoolchildren are being driven to and from school. Parents in the area culled community ideas from around the world to address their local problem. One such idea is the *walking school bus*, developed in Australia, in which a parent "driver" walks through a neighbourhood, picking up children at designated stops and times. They then walk to school in an escorted group. More information is available at www.slonet.org/canderso/de_walk.html (Toronto *Globe and Mail*, 2 March 1998).