Effects of Enforcement on Seat Belt Use in Hawaii

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Hawaii leads the nation in seat belt use compliance. The use rate for front-seat occupants of passenger vehicles in daylight exceeds 80 percent. After the results of observational studies on seat belt use conducted in Hawaii are described, the relationship between enforcement levels and seat belt use is explored. Some of the relevant literature and some of the different approaches to explaining driver behavior are reviewed, and a statistical model relating levels of enforcement and rates of seat belt use for the city and county of Honolulu is presented and discussed. A variation of the regression model that uses cumulative citations standardized by the estimated number of drivers in the county is shown to explain more than half of the monthly variation in seat belt use. Enforcement is shown to be an important factor in Hawaii's success with its mandatory seat belt law, but other factors such as public education (though difficult to quantify) are examined. Finally, the relevance of these findings to other states is discussed.

Since the passage of its mandatory belt use law in 1985, Hawaii has consistently led the nation in seat belt use compliance. The most recent observational studies show that front-seat occupant daylight use of passenger restraints in Hawaii exceeds 80 percent (*1*). In the state's largest city, Honolulu, the use rate is 85.2 percent, approximately twice the average use rate (42.3 percent) in most U.S. cities (*2*). Further evidence of Hawaii's lead in seat belt use compliance comes from the federal government's Fatal Accident Reporting System (FARS), which showed that Hawaii had the highest restraint use of all states for drivers and passengers involved in fatal accidents (*3*).

After a description of Hawaii's environment and some patterns in belt use before and after the enactment of the Hawaii law, an effort is made to explain the success of the Hawaii law. In particular, the relationship between enforcement and compliance is examined. A statistical model relating levels of enforcement and compliance is presented and discussed. The relevance of Hawaii's experience to other states is also discussed.

BACKGROUND

Created by volcanic activity that began some 30 million years ago, the Hawaiian archipelago comprises seven inhabited islands and numerous uninhabited smaller islands, atolls, and shoals. The state is organized into four counties: Honolulu, Hawaii, Maui, and Kauai. With a resident population of just more than 1 million, Hawaii is the 39th largest state in the nation. But in terms of land area, it is the fourth smallest. Its 4,100 mi of roadway is the least amount of roadway of all 50 states. It is also last in the nation in terms of drivers per 1,000 people of driving age (*4*).

The major economic activity in Hawaii is tourism. More than 6 million visitors come to Hawaii each year. The trade and services sector accounts for more than 50 percent of the state's total employment. Defense activities also figure heavily in the Hawaiian economy. Approximately 134,000 members of the armed forces and their dependents are stationed in Hawaii. Although less dominant than it was a quarter-century ago, agriculture is still an important part of the state's economy. Major agricultural products include sugar, pineapples, flowers, macadamia nuts, and coffee.

Changes in land use and settlement patterns (the shift from agricultural to urban uses, increased densities, and continued growth in population and automobile use) are reflected in the increase in traffic accidents. In 1967 there were only 11,529 accidents in Hawaii. By 1987 the total number of accidents in the state grew to 23,618; in those accidents, 138 persons were killed and approximately 12,000 were injured.

Hawaii's Mandatory Seat Belt Use Law

During summer 1985, Hawaii became the 10th state in the nation to enact a mandatory seat belt law. The Hawaii law—Hawaii Revised Statutes (H.R.S.) 291-11.6—took effect December 16, 1985, after a 45-day warning period. The law was written to cover only front-seat occupants of motor vehicles because most people killed in crashes are front-seat passengers (between 1979 and 1984, 88 percent of motor-vehicle crash fatalities were front-seat passengers). Legislators also believed that a law covering rear-seat passengers would be difficult to enforce and more intrusive. Hingson (*5*) has noted that intrusiveness of seat belt laws has been a major reason for public opposition. In addition, Hawaii legislators amended the law regulating insurance rates (H.R.S. 294-13) and required all insurance companies to provide a 10 percent reduction in premium charges for all policy holders with vehicles equipped with seat belt assemblies. Unlike many other states with seat belt laws, the Hawaii law gave police the power of primary enforcement, under which police have the authority to stop and issue citations to any motorists not in compliance with the law. Under secondary enforcement, police can issue belt use citations only if the vehicle has been stopped for another traffic violation. The fine for violating the seat belt law was $15. Legislators argued for setting the fine at less than $25 in order to avoid supporting the federal rule that would have made it unnecessary for automobile manufactur-

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ers to provide automatic passive restraints if two-thirds of the U.S. population resided in states that had passed seat belt laws meeting certain federal requirements, including the $25 fine (*6*, p. 889).

In the context of other traffic safety initiatives enacted in Hawaii, it is not surprising that Hawaii was one of the first states to adopt a seat belt law and one of the few to grant police the power of primary enforcement. Williams and Lund (*7*) report that 8 other states (New York, Texas, North Carolina, Connecticut, New Mexico, Iowa, Minnesota, and Oregon) have primary enforcement laws and 25 states have secondary enforcement laws. Besides its seat belt law, Hawaii also has a mandatory child restraint law. It was enacted in 1983 and carries a $100 fine for first-time violators. In 1986 the state raised the minimum age for alcohol purchase from 18 to 21. In addition, the police departments routinely use sobriety checkpoints as a way to curb drunk driving. Other initiatives under consideration by the legislature include adopting administrative revocation of licenses of drunk drivers, banning passengers in the cargo area of pickup trucks, and restoring the mandatory helmet use law for motorcyclists. At present, there is little, if any, interest in raising the state's maximum speed limit above 55 mph.

Compliance with Hawaii's Mandatory Seat Belt Law

Soon after the law was enacted, the Motor Vehicle Safety Office of the State Department of Transportation contracted with the University of Hawaii's Department of Urban and Regional Planning to develop a system for monitoring, recording, and reporting on seat belt use in Hawaii. The university developed a procedure using observers at 118 fixed locations throughout the state. Each observer was trained and tested to ensure a high degree of consistency. The sites were chosen to ensure that major population centers and travel corridors and a variety of settings (urban, rural, suburban, commercial, etc.) were covered. A microcomputer-based data base management system for inputting, editing, and compiling the data was developed. Analysis of the data was conducted on the University of Hawaii's IBM 3081 mainframe computer, using the SPSSx statistical package.

Since 1985 a total of 393,021 persons have been observed during 11 separate periods. The earliest observations were conducted in November 1985, before the law took effect, and the most recent were completed in January 1990.

Over the period 1985 to 1990, total statewide seat belt use increased from 33 percent 1 month before the law took effect to higher than 80 percent in January 1990 (Figure 1). Belt use increased immediately after the law took effect to more than 72.6 percent in January 1986. The use rate dropped during the first year of the law to 66.7 percent in July 1986 and even further to 66.1 percent by January 1987. Hawaii experienced a continuing decrease in belt use through October 1987, when the lowest use rate (63.5 percent) was recorded. By January 1988, however, compliance began to increase and has climbed steadily ever since. By June 1989 seat belt use in Hawaii had surpassed even the high levels set immediately after the law took effect. This has surprised some observers who thought that the high levels of compliance achieved just after the law was implemented would be difficult to surpass. Hawaii's high

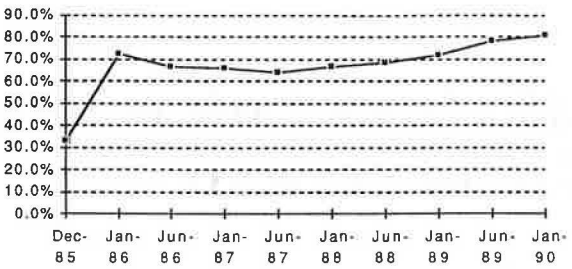

FIGURE 1 Seat belt use rate for Hawaii, 1985–1990.

and increasing rate of compliance with its mandatory seat belt law means that the state has not only passed all other states in the United States, but has begun to approach the high levels of compliance (80 to 90 percent) reported in many European countries (*8*, p. 89).

Hawaii's initial rate of compliance, 73 percent, was one of the highest levels of compliance achieved in the United States, according to a survey of states conducted in 1987 (*9*, p. 2). Only two states (North Carolina and Maryland) have ever reported use rates higher than Hawaii's. The reported increase in belt use in Hawaii immediately after the law took effect was 40 percentage points, but the actual increase attributable to the law may have been much greater. Surveys conducted in 1983 revealed a use rate of approximately 17 percent (Hawaii Department of Transportation, unpublished data).

Hawaii is unique in that there are relatively few governmental jurisdictions. There are only four counties and no other units of local government. Use rates for the four county jurisdictions and the state as a whole are contained in Table 1. Honolulu has maintained an average use rate much higher than 70 percent during the entire period in which the seat belt law has been in effect. The neighboring island counties have all had use rates lower than Honolulu's both before and after the law took effect. In general, use rates have been much more unstable in the neighboring island counties. During the period after the law took effect, Hawaii's use rate has ranged between 55.4 and 78.9 percent; Maui's, between 43.5 and 77.3 percent; and Kauai's, between 64.8 and 73.5 percent.

The most recent observations (January 1990) show that belt use in Hawaii varies not only by county but also by position in the vehicle, posted speed limit, urban versus rural location,

TABLE 1 SEAT BELT USE RATE: PERCENTAGE BY COUNTY

Date	Honolulu	Hawaii	Maui	Kauai	State
12/85[a]	37.4	26.0	26.0	28.8	33.0
1/86	76.5	64.0	67.3	70.7	72.6
6/86	71.9	59.6	57.7	64.9	66.7
1/87	68.9	63.2	54.8	65.6	66.1
6/87	70.7	59.3	44.5	66.8	63.8
10/87	70.6	55.4	43.5	65.0	63.5
1/88	71.2	69.9	50.1	64.8	66.5
6/88	72.8	65.6	59.3	68.5	68.5
1/89	72.5	77.0	64.6	69.3	71.5
6/89	81.9	73.6	74.0	68.9	78.3
1/90	82.3	78.9	77.3	73.5	80.5

[a]Represents the pre-law observations.

and time of day. The use rate for drivers was 82.6 percent, but the use rate for front-seat passengers was much lower—75.0 percent. Belt use among both drivers and passengers increased with the posted speed limit. The highest use rates (86.1 percent for drivers, 78.6 percent for outboard passengers) were observed on roadways in which the posted speed limits were 50 mph or greater. The highest use rates in the state occurred in the most urbanized areas. For example, the use rate in Honolulu's primary urban center was 85.2 percent; in the rural areas of the island, use rates ranged between 69.6 percent (Waianae) and 79.2 percent (Waialua). Similarly, on each of the three other islands where observations were taken, the highest use rates occurred in the urbanized areas (Kihei and Wailuku on Maui, North Hilo on Hawaii, and Koloa and Lihue on Kauai). The highest use rates also occurred during the morning, from 8:00 to 10:00.

EXPLAINING THE SUCCESS OF HAWAII'S SEAT BELT LAW

Interest in explaining seat belt use is not new. Fhaner and Hane, for example, have reviewed the studies conducted before the enactment of mandatory seat belt use laws in the United States (*10*). There are, therefore, several hypotheses that might explain Hawaii's high and continuing rate of compliance with its mandatory seat belt law. For example, the decision to use a seat belt might be modeled as a benefit-cost problem. Graham (*11*) has estimated that the benefits of using seat belts range between 3 to 25 cents per trip, which should be compared with the costs (time, inconvenience, discomfort, etc.) of using seat belts. By adding the costs of a fine—the dollar amount as well as the additional costs and aggravation associated with receiving a citation—one could argue that passage of Hawaii's mandatory seat belt law changed the economic incentives such that the perceived benefits of seat belt use outweighed its costs. This perspective presumes rational behavior on the part of motorists and their passengers. The reality may be that people are incapable of making such benefit-cost comparisons, particularly when such small probabilities may be involved. Slovic et al. have argued that behavior is more likely to be influenced by the probability of the hazard than the magnitude of its consequences (*12*). Traffic safety specialists, let alone motorists, vary widely in terms of the perceived effectiveness of seat belts in reducing fatalities and injuries as well as in assigning a probability to the likelihood of an accident's occurrence. The problem is compounded by the phenomenon, observed by Svenson and others, that most drivers may regard themselves as more skillful and less risky than average (*13*). Another view of the problem suggests that the failure to use seat belts results primarily from a failure to make use of seat belts a habit rather than any "distrust of seat belts or any very deep-seated systems of attitudes and beliefs" (*14*). The question as to how habits are formed opens some larger psychological questions that may involve the influence of personality types, such as introversion-extroversion (*15*), or certain driver and vehicle characteristics that Evans and Wasielewski (*16*) have related to risky driving practices. Also, there are various theories and counterarguments involving the "danger compensation" principle or "Peltzman effect"—whereby it has been argued that drivers compelled by law to use seat belts or other safety measures increase their risk-taking behaviors and unsafe driving practices. The presence of many different theoretical perspectives complicates the explanation of Hawaii's success with its mandatory seat belt law.

Enforcement and Compliance

What is apparent from Hawaii's experience is that there has been a radical change in behavior in comparison with past levels of belt use in the state and in terms of Hawaii's overall level of compliance vis-à-vis other states in the United States. What explains the high and lasting levels of compliance in Hawaii? One might examine the relationship between levels of compliance and enforcement. Compared with some of the strategies used to increase seat belt compliance (public education, media campaigns, public service announcements, etc.), enforcement is a visible and measurable intervention. The numbers of traffic citations for seat belt law violations are compiled monthly by state and local governments.

One might hypothesize that seat belt use in Hawaii is a function of enforcement levels. In terms of the relationship between seat belt enforcement and compliance, one study has found that belt use in primary enforcement states is at least 13 percent higher than it is in secondary enforcement states (*9*, p. 16). Two other studies—Evans and Graham (*17*) and Wagenaar et al. (*18*)—have found a reduction in traffic fatalities that is higher among those states with primary enforcement than those with secondary enforcement. However, the work by Shinar and McKnight suggests that the major determinant in compliance behavior is "not necessarily what the police do, but rather, how it is perceived by the road users" (*19*, p. 386). It is interesting to note that Shinar and McKnight identify two variables associated with the perceived risk of apprehension: threat (degree to which the driver sees visible enforcement units as a threat of apprehension) and density (the number of enforcement units per mile of driver travel).

Because Hawaii is an island state with a limited amount of roadway, it is not unreasonable to expect that the threat of apprehension and the density of police units would be greater in Hawaii than elsewhere. The geography in Hawaii makes it relatively easy to establish a strong police presence. Hawaii is composed of volcanic mountain ranges that dominate the interior of each island, so most development has concentrated in the low-lying coastal areas. Narrow transportation corridors have evolved that connect the major nodes and population centers. As a result, it is easy not only to monitor motor vehicle movements, but also to set up enforcement strategies covering a large proportion of the driver population. Anyone who has lived on an island for any extended period of time understands the notion that the threat of apprehension in Hawaii is greater than it is elsewhere. Moreover, because Hawaii's system of government is highly centralized, it is easier to mandate policies regarding belt use, training, and enforcement. Enforcement of the seat belt law in Hawaii has been strong, consistent, and more uniform than in other places that have multiple, overlapping jurisdictions. In addition, a strong public information program has helped to increase public perception of the risks associated with nonuse.

Testing the Hypothesis

To test the relationship between seat belt use and enforcement, data on seat belt citations and observed belt use rates in Honolulu were compiled each month. More than 70 percent of the state's population lives in Honolulu. Selecting one county eliminates some of the differences between counties that may exist in terms of enforcement practices. Table 2 contains a summary of seat belt citations issued in Honolulu from 1985 through 1989. The number of annual citations has grown steadily, from 12,347 in 1986 to more than 18,500 in 1989. In the city and county of Honolulu alone, 64,900 citations have been issued since the seat belt law took effect.

Two data sets were pooled. The observational data on belt use were collected by the University of Hawaii; the data on seat belt citations were collected by the Honolulu Police Department and furnished to the Hawaii Department of Transportation. Information about numbers of licensed drivers was obtained from the Honolulu Department of Data Systems.

Several steps were taken to transform these different data elements into usable variables. Citation data were available monthly, but data on seat belt use were available only biannually (January and June). A smoothing technique (running averages) was used to estimate the monthly use rates between the observation periods. A similar technique was used to transform the annual data regarding motor vehicle licences into monthly totals. In this manner, a monthly time series for licensed drivers, seat belt citations, and seat belt use rates was derived. Summary descriptive statistics are provided in Table 3.

Two approaches were taken. The first approach (Equation 1) viewed the potential relationship between enforcement and compliance on a month-to-month basis. Several regression models were developed. Of the models tested, the one (Equation 2) with greatest explanatory power (R^2-value) used the number of belted drivers as the dependent variable (Y) and a ratio of the drivers to citations issued as the independent or explanatory variable (X). The number of belted drivers was derived by applying the observed use rates to the total number of estimated drivers. The ratio of drivers to citations was determined by dividing the number of drivers by the number of citations issued each month. This figure increases during those months in which few citations are issued and decreases during those months in which many citations are issued. The resulting equation can be expressed as

$$Y = 367{,}441.5 - 63.24X \quad (-5.06) \qquad (1)$$

$$R^2 = .348, \ F\text{-statistic} = 25.5$$

with t-statistic values in parentheses. The t-statistic value is significant at the .05 level, as is the F-statistic. With an R^2-value of .348, more than one-third of the total variation in belt use is explained by the single citation variable. It is also important to note that the sign of the regression coefficient is negative, as expected. The citation variable is expressed as ratio of drivers to citations, so that as the number of citations increases, the value of this variable decreases. This suggests that, for Honolulu, enforcement has had a significant influence on observed belt use.

The second approach attempted to account for the cumulative effects of enforcements on compliance. Under this approach, the dependent variable (Y) remains the same as before, but the independent term (X) is the cumulative number of monthly citations divided by the monthly number of drivers. The assumption here is that with each passing month, a larger and larger proportion of the driving population in violation of the seat belt law has been cited. The equation can be expressed as follows:

$$Y = 288859.4 + 598535.4X \quad (7.18) \qquad (2)$$

$$R^2 = .518, \ F\text{-statistic} = 51.59$$

In this formulation, the R^2 is higher, explaining more than half of the total variation in monthly belt use. In addition, the t-statistic on the citation term is highly significant. These results suggest that the relationship between enforcement and compliance is best viewed in a cumulative manner. Although the month-to-month approach can explain approximately one-third of total variation, the cumulative model performs substantially better.

The technique relies upon a number of important assumptions. First, in constructing the monthly time series, the variation over the 6-month intervals is assumed to be small enough that the averaging technique provides a good approximation of use rates for individual months. Similar assumptions regarding the smoothing of licensing data are also implicit in this analysis. Second, it has been assumed that standardizing citations by dividing them into the approximated monthly totals of licensed drivers gives a reasonable approximation of the enforcement effort. Although using an exposure variable such as total front-seat occupants on the road for a given month would have been a better way to standardize this variable, such data are not readily available. The third major assumption in this analysis involves the use of a simple linear

TABLE 2 SEAT BELT CITATIONS, CITY AND COUNTY OF HONOLULU

Date	Total Annual Citations
December 1985	210
December 1986	12,347
December 1987	15,182
December 1988	18,661
December 1989	18,500
Total	64,900

TABLE 3 SUMMARY STATISTICS, MONTHLY TIME SERIES DATA (DECEMBER 1985–JANUARY 1990)

Variable	Mean	Standard Deviation	Range
Belt use (%)	73	6.5	37.4–82.3
Citations	1,319	631.3	210–2,840
Drivers	460,794	9,954.2	441,278–479,140
Belted drivers	337,948	34,584.2	165,039–394,332
Cumulative citations	30,498	19,801	210–65,950[a]

[a] Includes January 1990.

regression model. Several other curvilinear regressions of transformed variables were tested, but none provided greater explanatory power than the one presented. The model explains almost half of the total variation in monthly belt use, but it is important to recognize inherent deficiences with a pooled, cross-sectional analysis such as the one presented. One basic problem is that, though all the data come from Honolulu and cover roughly the same time period, the observations are not pure time-series data. For example, the same members of the sample of automobile occupants may or may not have been observed over the 4-year period. Similarly, the citation data do not distinguish between first-time and repeat offenders. These are important aspects of the analysis that need to be controlled in a strict time-series study of the relationship between enforcement of and compliance with the mandatory use law.

Nonetheless, the results suggest that enforcement has been an important factor in encouraging seat belt usage in Honolulu. Several federal grants have been used to pay for seat belt enforcement, but the responsibility for maintaining enforcement levels still rests with each local government. Although enforcing the seat belt law is expensive, the results suggest that enforcement levels should be maintained or perhaps increased to ensure growing compliance with the mandatory restraint law.

The model also fails to account for saturation effects or potential differences between the resilient nonuser of seat belts and one who changes behavior after being cited. Further research is needed, and plans to examine more closely the background and demographic characteristics of those who have received seat belt citations are under way. Of special interest are studies on rates of repeated offenses, tourists versus residents, and relationships between violations of the seat belt law and violations of other traffic safety laws.

Other Factors Related to Hawaii's High Rate of Compliance

Whereas the cumulative model was able to predict approximately half of the variation in belt use in Hawaii, it is clear that there are other factors related to Hawaii's high rate of compliance. Public education about the benefits of seat belt use might have played a part in Hawaii's success. Such efforts are difficult to evaluate, but it is important to note that Hawaii's campaign to increase seat belt use involved broad sectors of the community. Besides the Hawaii Coalition for Safety Belt Use, several other state and local groups were formed to share information and promote traffic safety. A "Saved-by-the-Belt" Club was formed; newsletters, bumper stickers, buttons, grocery bags, key chains, posters, and brochures with printed messages about seat belt use were developed and distributed. The national organization Traffic Safety Now spent an estimated $350,000 over 4 years. In addition to funding a newsletter sent to more than 700 people, funds were used to produce local radio and television spots promoting seat belt use. Activities were also undertaken by health educators, police officials, and others—such as car rental agencies and airlines that provided information and reminders to tourists. A public relations firm was hired to coordinate such activities as interviews with key public officials and production of press kits for local media. A combination of paid and nonpaid advertising was used. The public relations firm worked out an arrangement in which local stations ran one free public service announcement for each paid broadcast. Several hundred roadway signs proclaiming "Buckle up, it's the law" were placed at strategic locations throughout the state.

The observation data collected by the University of Hawaii have proved to be an integral part of the public education campaigns in Hawaii. The biannual data were distributed to local police departments and used by health educators in targeting areas for increased activity. Because the data were collected by the university on a scheduled basis, the information served to promote some competition between various communities and local agencies around the state. In addition, the results of the observational studies were reported by news media and incorporated into public service announcements.

RELEVANCE OF HAWAII'S EXPERIENCE TO OTHER STATES

Although the voluntary adoption of passive restraints and airbags by automobile manufacturers may eventually eliminate much of the need for studies on seat belt use, the data and results on seat belt compliance from Hawaii are interesting for several reasons. First, Hawaii has achieved extraordinarily high rates of compliance with its seat belt use law. Just 1 month before the law took effect, belt use was approximately 37 percent; it has more than doubled during the past 4 years. The actual increase or change in behavior may have been much greater, because earlier surveys in Hawaii reported use rates of only 17 percent.

The second point is that seat belt use in Hawaii—though it dropped during the initial period in which the law was implemented—has continued to increase steadily since October 1987 to the point that it has even surpassed the initial high levels set immediately after the law took effect. Use rates in Hawaii are high and are continuing to grow.

A third point is that there does appear to be a relationship between enforcement levels and seat belt use, particularly when accounting for the cumulative number of citations issued for seat belt law violations. More than half of the monthly variation in belt use could be explained by the cumulative number of seat belt citations. Enforcement has been an important factor in Hawaii, but the effects of public education and public service announcements, though difficult to measure, should not be overlooked. A challenge to traffic safety researchers may be to develop an appropriate evaluation technique for measuring the impact of these efforts. In Hawaii, the fact that the seat belt law was able to generate such broad involvement is evidence of community support and acceptance of the law.

Hawaii provides an ideal setting for the testing of hypotheses regarding driver behavior. In addition to being a nearly closed system because of its location in the middle of the Pacific Ocean, Hawaii has only four units of local government, which correspond to the major islands, so many of the problems associated with multiple or overlapping jurisdictions do not exist. Both Hawaii's law and the programs (enforcement and public education) that have evolved here

should be scrutinized by other states in search of greater success in implementing mandatory seat belt use laws.

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Publication of this paper sponsored by Committee on Traffic Law Enforcement.