South Carolina
Statewide Survey of Safety Belt Use:
June 2009

Produced for the South Carolina Department of Public Safety

Prepared by
Department of Statistics
University of South Carolina
Columbia, SC 29208
Phone: 777-7800
Fax: 777-4048
statlab@stat.sc.edu

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I. Executive Summary

June 2009

81.5% of South Carolina drivers and passengers used shoulder style safety belts in June 2009; this is a historical high for the state since 1991. In June 2008, this percent was 79.0, which was also a record high. Hence 2009 represents the first year the statewide estimate has exceeded 80%.

Women continue to be more likely than men to use safety belts (87.8% to 77.1%); passengers are marginally more likely than drivers to use safety belts (82.1% to 81.3%); and rural occupants are less likely to use safety belts than urban occupants (79.5% to 82.3%). White occupants had a higher rate of use than non-white occupants (84.7% to 74.1%), while car occupants were more likely to wear safety belts than truck occupants (84.3% to 75.0%).

There were 353 observed motorcyclists of which 157 or 50.1% were wearing a helmet; this is a decrease from the rate in April 2009, which was 67.1%. Based on the small sample sizes, there is often little consistency from year to year in motorcycle helmet use.

The 3 counties in our study with the highest rates of safety belt use in June 2009 are Lexington (91.6%), Horry (86.9%), and Cherokee (86.8%). The 3 counties in our study with the lowest rates of safety belt use in June 2009 are Richland (77.3%), Georgetown (76.5%) and Bamberg (75.2%).

II. Introduction

In an attempt to improve the use of safety belts across the United States, President George H. W. Bush established a national goal of 70% use to be met by each state. Those states which could attain this level of safety belt use would be eligible for extra highway department funds from the Federal Government. At roughly the same time that the President was setting these national goals, the state of South Carolina enacted a law requiring all front seat passengers and the driver of all automobiles and trucks to use seat belts. In December 2005, South Carolina passed a new safety belt law, which changed failure to wear a safety belt from a secondary offense to a primary offense, punishable by a $25 fine. According to the National Highway Traffic Safety Administration, recent national and regional goals involve increasing safety belt use to 85% by 2009.

Subsequent to the effort to improve the rate of safety belt use, the Safety Office of the South Carolina Department of Highways and Public Transportation (now the office of Highway Safety of the South Carolina Department of Public Safety) began a concentrated effort at public education coupled with a series of surveys to determine the rate of use across the state. These surveys were conducted in May 1991, January 1992 and September 1992, by the Statistical Laboratory (Stat Lab) at the University of South Carolina, which revealed safety belt use rates around 55% statewide. Four other such surveys were conducted in October 1993, October 1994, September 1995 and October 1996 by the Stat Lab under the auspices of the Department of Public Safety (DPS). The surveys recommenced in 1998 and 1999. Since 2000, surveys both preceding and following a campaign intervention have been conducted to both monitor safety belt usage and judge the campaign's effectiveness.

III. Methodology

Sampling

In the conduct of the safety belt survey, a total of 16 counties are selected, based upon sample size requirements published by the National Highway Traffic Safety Administration (NHTSA). The state is divided into 3 geographic regions, the upper state, the midlands and the coastal area, each with approximately equal values for the average daily traffic intensity. Within the geographic areas, each county is designated as either urban or rural; urban counties being those in which more than 50% of the residents live in urban areas, according to the state demographer. The result is 6 strata: urban upstate, rural upstate, urban midlands, rural midlands, urban coastal and rural coastal. The proportion of the 16 counties allocated to each of the strata is determined by taking the average daily traffic intensity for that stratum and dividing it by the sum of all 6 strata averages. This proportion is then applied to the 16 counties to obtain the number of counties selected from each stratum.

Within strata, counties are randomly selected with probability of selection proportional to size (pps). In this case, the value used to weight the county is the average daily traffic intensity. Within each county, 4 census tracts are selected again with pps, using the average daily traffic intensity in the tract as the weight. Finally, within each census tract, 3 sites are selected pps with average daily traffic intensity serving as the weight.

The number of tracts and sites selected is determined by logistics and funding. It was decided that given the available resources, 12 locations in each county was a reasonable number to sample. In

order to use time most efficiently, the researchers decided to use census tracts as a sampling unit within counties (per the NHTSA recommendations) so that the matched sites would not be too far apart.

The assignment of counties to each of the two counting groups, and the order in which counties are visited, is arbitrary if not random. The order in which tracts within a county were visited was arbitrary, as was the assignment of counters to intersections within a tract.

The road and side of the road to be observed was determined prior to entry into the field, based upon the location of the state traffic counting marker. Observers were instructed to count vehicles only on the side of the road that had been selected.

Site Requirements and Observer Safety

In accordance with the NHTSA Guidelines, several requirements were used to ensure the safety of observers and the adequacy of sites for observation of vehicles. These requirements included: 1) some form of traffic control device such as a stop sign or a traffic light, 2) a sidewalk or other safe vantage point for observers to stand out of the way of traffic but retain a good view of passing vehicles, 3) areas where crime does not appear to be a major problem. In the event that a selected site did not meet these criteria, the team leader was required to make an on-site change before any data were collected. The procedure for making such a change required the leader to locate the closest intersection to the original location which met the criteria described above. Such changes were noted and adjustments in the list of sites were made.

In order to ensure the safety of observers, several precautions were taken. As described above, sites were selected in such a way as to keep staff safely removed from the flow of traffic while retaining a good view of the passing vehicles. In addition, observers were given orange safety vests, and the team leader drove between sites during the hour-long observations to ensure that the observers were

safe and having no problems. During periods of inclement weather, which precluded observation, observers were instructed to find temporary shelter until the team leader could arrive and pick them up in a car. At each site, the team leader and the observer agreed upon such a sheltered site before the observation period began.

Observational Technique

The methodology for making observations was very similar to that used in past surveys. Each site was staffed by one observer for a one-hour period. The observers had a clipboard with several data collection sheets. They were instructed to observe every vehicle which they saw, and indicate on the form the type of vehicle (car/truck), position of the person (driver/passenger), the gender of the person (male/female), the ethnicity of the person (white/other) and whether or not the individual was using a shoulder harness style safety belt. At the end of the observation period, survey forms from each site were stapled together, labeled with the county name and intersection, and put into a folder labeled with the county name.

At the predetermined start time, observers were told to count every vehicle in the two lanes closest to them in the case of 4-lane roads, and in the closest lane in the case of 2-lane roads. During periods of heavy traffic, observers counted the next vehicle that passed after they recorded the previous vehicle. In other words, after the observer recorded information for a car and looked back up he/she would record data for the first car to pass. This methodology was designed to reduce the possibility of observer bias in counting by eliminating the instance where individuals using safety belts in heavy traffic were preferentially counted. Vehicles eligible for inclusion in the study were all automobiles and trucks, including those licensed in South Carolina as well as those from out of state. Within vehicles, the driver and front-seat outboard passenger were included.

Since 2006, we were instructed to count whether motorcycle riders wore helmets. Due to the low response rate and the non-statistical nature of this portion of the survey, only raw counts are recorded.

IV. Results

Counties selected for sampling appear in Table 1.

Table 1
Selected Counties with June Monitoring Dates

County	Strata	Date
Abbeville	Upper Rural	6/11
Bamberg	Lower Rural	6/9
Beaufort	Lower Urban	6/11
Cherokee	Upper Rural	6/3
Chesterfield	Mid Rural	6/6
Edgefield	Mid Rural	6/10
Florence	Mid Urban	6/4
Georgetown	Lower Rural	6/12
Greenville	Upper Urban	6/10
Horry	Lower Urban	6/8
Laurens	Upper Rural	6/2
Lexington	Mid Urban	6/12
Marlboro	Mid Rural	6/9
Richland	Mid Urban	6/8
Spartanburg	Upper Urban	6/5
Union	Upper Rural	6/13

The total number of observations recorded across the state was 40,120 in June 2009. The percent of vehicle occupants in the state of South Carolina using safety belts in June 2009 is estimated to be 81.5 (SE=.0048%). The 95% confidence interval is (81.47%, 81.49%).

The percentages of vehicle occupants within each county wearing a safety belt appear in Table 2 below. These percentages are taken from an intermediate step in computing the statewide rate, and should be interpreted cautiously. Note that there are no consistent patterns in the differences in these raw percentages for the 6 counties sampled in both the pre-survey and the post-survey. Most counties had slight declines or slight increases in use, while Beaufort County's percentage fell by 7.6%.

Table 2
Percentage of Occupants Using Safety Belts
By County

County	April 2009	June 2009
Abbeville	77.8	80.8
Bamberg		75.2
Beaufort	86.6	79.0
Cherokee		86.8
Chesterfield		84.3
Edgefield		84.8
Florence		83.1
Georgetown	78.7	76.5
Greenville	82.4	83.0
Horry		86.9
Laurens		85.0
Lexington		91.6
Marlboro	85.2	83.9
Richland	76.5	77.3
Spartanburg		82.6
Union		80.9

The percentages of males and females, drivers and passengers, and urban and rural occupants using safety belts appear in Tables 3 and 4. Classifications using vehicle type appear in Table 5. Table 6 contains classification by gender and race.

Table 3*
Percentage Safety Belt Use By Demographic Category

	12/02	6/03	12/03	6/04	6/05	6/06	6/07	6/08	6/09
Male	61.3	66.8	60.6	64.2	62.2	67.6	68.4	74.2	77.1
Female	73.6	80.1	74.0	75.4	78.7	79.3	84.5	85.8	87.8
Driver	66.5	73.2	65.7	66.7	70.3	73.0	74.6	79.1	81.3
Passenger	66.9	70.8	70.5	64.5	66.5	70.8	74.0	78.2	82.1
Urban	68.4	73.0	67.7	66.5	68.0	73.5	75.2	80.3	82.3
Rural	62.9	67.6	53.2	63.6	73.5	70.1	73.0	76.0	79.5
White	70.9	76.0	71.7	69.5	74.1	76.4	77.8	82.4	84.7
Non-white	56.8	64.3	56.3	56.7	58.0	63.8	67.2	70.9	74.1
Cars		76.4	69.8	69.2	72.3	75.7	77.7	81.1	84.3
Trucks		60.4	53.9	52.5	60.8	63.8	67.8	73.3	75.0
Overall	66.3	72.7	66.8	65.7	69.7	72.5	74.5	79.0	81.5

Table 4*
Percentage Safety Belt Use By Demographic Combinations

	12/02	6/03	12/03	6/04	6/05	6/06	6/07	6/08	6/09
Rural Driver	62.9	67.0	53.3	62.9	72.8	70.4	72.1	76.3	79.8
Urban Driver	68.2	74.2	63.9	68.2	69.3	74.0	75.7	80.2	81.9
Rural Passenger	62.7	69.3	47.8	61.2	74.8	69.1	76.8	75.3	78.1
Urban Passenger	68.9	68.0	67.5	65.9	63.2	71.5	72.9	79.5	83.7
Rural Male	57.4	61.5	45.3	60.9	66.1	64.3	65.9	70.4	76.5
Urban Male	63	68.4	57.0	65.5	60.6	68.9	69.4	75.8	77.3
Rural Female	71.2	75.1	75.1	71.1	82.1	78.4	83.7	84.8	84.3
Urban Female	74.7	78.9	78.9	77.2	77.3	79.7	84.9	86.2	89.3
Male Driver	62	66.7	55.5	60.3	64.1	68.6	69.1	75.1	77.7
Male Passenger	56.6	63.4	56.5	48.7	52.6	62.4	64.4	69.0	73.6
Female Driver	73.6	74.8	65.5	75.0	79.3	79.9	84.7	85.7	87.2
Female Passenger	73.7	74.8	66.8	76.4	76.2	77.5	83.8	86.1	89.2

*****For rates prior to 2002, please refer to the December 2000, June 2002, and June 2008 Stat Lab reports.

Table 5
Percentage Safety Belt Use by Vehicle Type*

	6/03	12/03	6/04	6/05	6/06	6/07	6/08	6/09
Car Urban	76.4	68.0	69.8	70.6	76.2	78.4	82.2	85.0
Truck Urban	60.3	60.3	52.9	60.4	65.6	67.7	74.7	75.1
Car Rural	71.6	56.8	67.5	76.5	74.5	75.9	78.4	82.5
Truck Rural	56.2	56.2	51.6	61.7	59.4	68.0	70.0	74.8
Car Male	69.4	59.3	63.4	64.8	71.6	70.9	76.0	79.9
Car Female	81.5	70.0	74.0	78.5	79.6	84.9	85.6	88.3
Truck Male	54.3	43.4	50.0	57.4	61.3	64.9	71.4	72.9
Truck Female	64.1	51.1	69.2	81.9	75.6	82.7	86.9	88.6
Car Driver	75.5	62.9	69.1	69.1	74.0	75.8	78.8	82.1
Truck Driver	57.0	57.0	53.7	65.2	72.7	73.1	77.0	79.2

*Vehicle Type first recorded in June 2003

Table 6
Percentage Safety Belt Use by Gender and Race**

	6/06	6/06	6/07	6/08	6/09
Female White	81.9	83.1	88.2	79.9	83.5
Female Non-White	68.1	71.8	75.9	83.4	85.2
Male White	66.4	71.7	71.4	66.6	74.0
Male Non-White	51.7	57.4	60.5	72.7	74.1

**Classification first introduced in April 2006.

V. Conclusions

On a county-by-county basis, raw counts of safety belt use fell in 3 of the counties, and increased in the remaining 3 counties between the April 2009 pre-intervention survey and June 2009 survey. County-by-county differences should be viewed with caution, since the survey was not specifically designed to capture these comparisons. For this reason, only raw percentages are presented.

The overall safety belt use has been over 70% for six years in a row and has reached historical highs the past two years, finally breaking 80% this year. In general, the patterns of use that have been observed in past years continued to be in evidence in June 2009, though some of the gaps typically observed for demographic groups have narrowed this past year. Females still had a much higher use rate than males, and non-white occupants continue to be much less likely than white occupants to use safety belts. The patterns for drivers and passengers have been much less conclusive, though passengers were somewhat more likely to use safety belts than were drivers in June 2009. Safety belt use in urban counties continues to be modestly higher than in rural counties, while safety belt use in trucks remains low.

VI. Notes

All equations for calculating estimates of compliance and the variance for these estimates were developed by John Grego, Department of Statistics, University of South Carolina, 1995; substantive revisions were made by John Grego and Cerissa Newdigate in 2003. See Appendix for details.

VII. References

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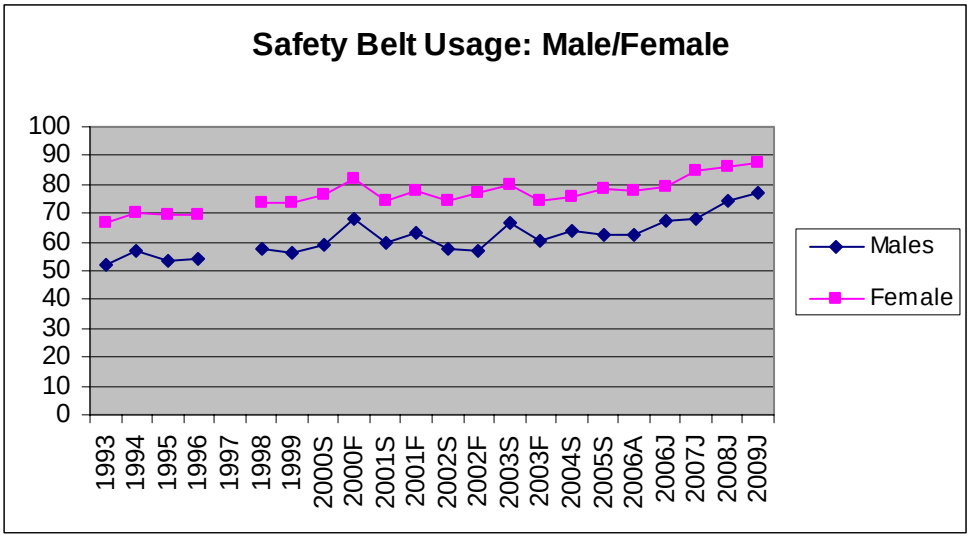
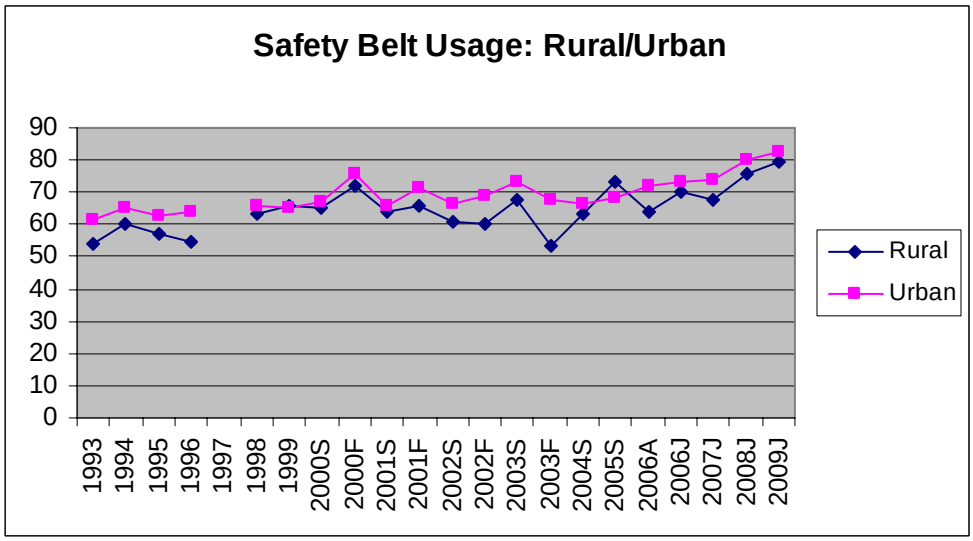
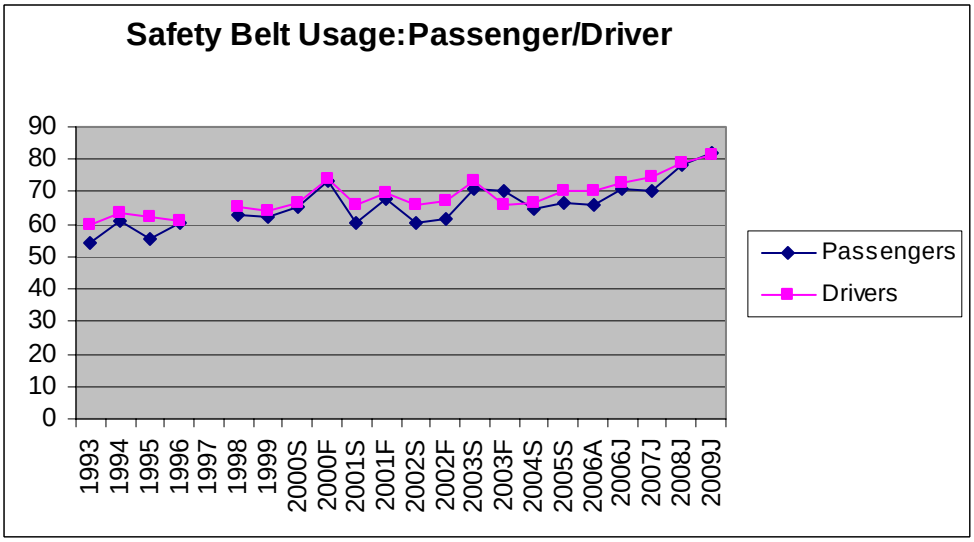
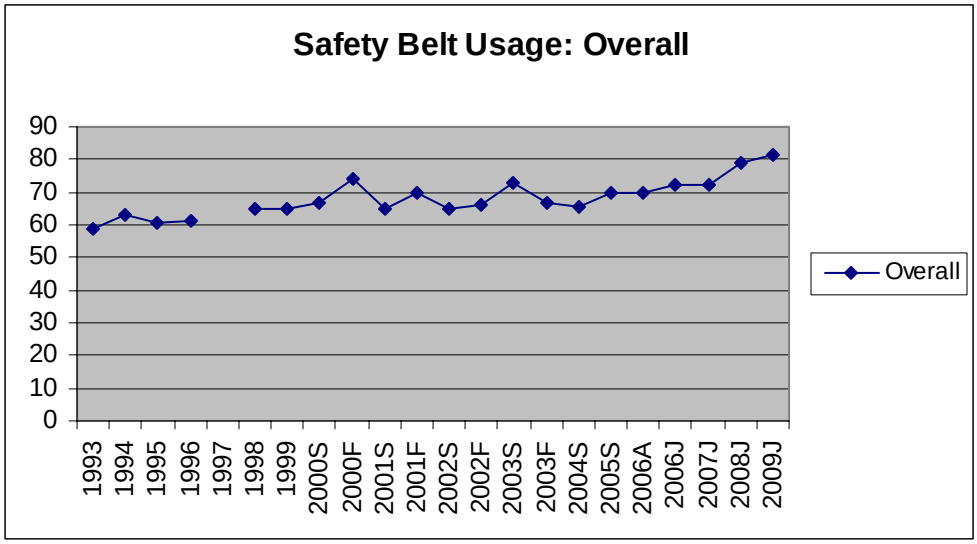
VIII. Figures








Safety Belt Usage: Overall
90
80
70
60
50
40
30
20
10
0
1993
1994
1995
1996
1997
1998
1999
2000S
2000F
2001S
2001F
2002S
2002F
2003S
2003F
2004S
2005S
2006A
2006J
2007J
2008J
2009J
Overall

IX. Appendix

The calculation of the estimate of safety belt use and the accompanying variance estimate was changed between 1996 and 1998. The revised method for calculation introduced the use of weights to account for the fact that sampling at a given site does not usually represent a true cluster sample, because not all vehicles that pass the observation point can be counted. This additional weight, representing the ratio of the number of cars that would be expected to pass a site in an hour to the number actually counted in an hour, was used at the site level to account for the sampling discrepancy. Based upon work conducted by the Stat Lab, it appears that in most cases the new method results in a modest increase in the estimated rate of safety belt use. While we believe that the new approach yields a more accurate estimate of actual use, changes in estimated rates from 1996 to 1998 must be read in light of this new method.

In 2003, a revised method for estimating safety belt variances was introduced; the method uses Taylor-series linearization of a ratio estimator in the same way that SUDAAN computes standard errors for sampling estimates. The method for computing the estimates themselves, though greatly simplified in implementation, remains the same. The new variance estimates are actually simpler than the previous estimates, but are not prone to the same problems experienced with the previous variance estimators. These earlier estimators, while unbiased, often led to negative variance estimates at the tract and county level that had to be set to 0 to proceed. Formulas for the new method appear below; formulas for the old method are retained in the next section of the appendix.

New Method

Strata-level estimates of seatbelt compliance will be computed using the following formula:

$$p_s = \frac{\sum_{i,j,k} \frac{w_{sijk}}{\pi_{sijk}} B_{sijk}}{\sum_{i,j,k} \frac{w_{sijk}}{\pi_{sijk}} O_{sijk}}$$

where s, i, j, and k are stratum, county, tract and intersection indices; w_{sijk} is the inverse of the probability of detecting a subject at intersection k in tract j in county i in stratum s (usually computed as the ratio of observed subjects vs. expected subjects); B_{sijk} and O_{sijk} are the number of buckled participants and observed participants at intersection k in tract j in county i in stratum s; and π_{sijk} is the probability of intersection k in tract j in county i in stratum s being included in the multistage sample. This formula is applicable for demographic subgroups based on gender, race, seat position (driver/passenger), county type (rural/urban), region (upstate, midstate, lower state), vehicle type, or any cross-classification of these variables.

A variance estimate for p_s can then be computed as

$$\hat{V}(p_s) = \frac{1}{O_s^2}\left[\frac{1}{n_s - 1}\sum_i (B_{si} - p_s O_{si})^2\right], \text{ where}$$

$$O_s = \sum_{i,j,k} \frac{w_{sijk} O_{sijk}}{\pi_{sijk}}, \; O_{si} = \sum_{j,k} \frac{w_{sijk} O_{sijk}}{\pi_{sijk}}, \; B_{si} = \sum_{j,k} \frac{w_{sijk} B_{sijk}}{\pi_{sijk}}.$$

Overall statewide percentages and variance estimates are then computed using the typical formula for stratified samples (see next section).

Previous Method

Below is a complete description of the method used to estimate safety belt use at the state level. Similar estimates will be calculated separately for men and women, urban and rural vehicles, and passengers and drivers. These estimates will take the following form at the census tract level:

$$B_t=\Sigma(w_i a_i)/\pi_i$$

$$O_t=\Sigma(w_i m_i)/\pi_i$$

where:

B_t=Weighted estimate of tract total wearing safety belts
O_t=Weighted estimate of tract total number of occupants
a_i=Total number of observed occupants wearing safety belts at intersection i
m_i=Total number of observed occupants at intersection i
w_i=Ratio of number of vehicles expected to pass site in 1 hour to number actually passing the site in 1 hour
π_i=Probability that the intersection would be one of three selected

At the county level, the proportions take the following form:

$$B_c=\Sigma\, B_t\, /\pi_t$$
$$O_c=\Sigma O_t/\pi_t$$
$$p_c= B_c/\, O_c$$

where:

B_c=Weighted estimate of county total wearing safety belts
O_c=Weighted estimate of county total number of occupants
π_t=Probability that the tract would be one of four selected
p_c=Estimated proportion county wearing safety belts

At the urban/rural strata level, the proportions take the following form:

$$B_s=\Sigma B_c/\pi_c$$
$$O_s=\Sigma O_c/\pi_c$$
$$p_s= B_s/ O_s$$

where:

p_s=Estimated strata Proportion wearing safety belts
B_s=Weighted estimate of strata total wearing safety belts
O_s=Weighted estimate of strata total number of occupants
π_c=Probability that the county would be selected

The strata estimates are then combined using the following equation to obtain a statewide estimate of safety belt use.

$$(1/ADT)[\ \Sigma ADT_s p_s]$$

where:

ADT=Sum of Average Daily Traffic count across s stratums
ADT_s=Average Daily Traffic count for strata s
p_s=Estimated strata proportion wearing safety belts

A conservative estimate of the variance of these proportions at the strata level is of the form:

$$\hat{\sigma}^2 = \frac{1}{x^2}\left[\sum\sum\left(\frac{\pi_i\pi_j - \pi_{ij}}{\pi_{ij}}\right)\left(\frac{d_i'}{\pi_i} - \frac{d_j'}{\pi_j}\right)^2 + \sum\left(\frac{N_i^2(1-f_{2i})s_i^2}{n_i\pi_i}\right)\right]$$

where

$x = \frac{O_c}{\pi_i}$

O_c = Number of occupants observed

π_i = Probability that county i would be sampled

π_{ij} = Probability that counties i and j would be sampled together

$d_i' = B_c - \hat{p}_c O_c$

B_c = Number of occupants observed wearing safety belts

$\hat{p}_c$ = Estimated proportion in county wearing safety belts

N_i = Total number of census tracts in the county

$\mathrm{n_i}$ = Number of census tracts selected from the county; 4 in this case

$f_{2i} = \frac{\mathrm{n_i}}{N_i}$

s_i^2 = Variance of census tract i

The variance for the statewide estimate takes the form:

$$\hat{\sigma}^2 = \frac{1}{N^2}\sum N_s^2\left(\frac{N_s - n_s}{N_s}\right)\left(\frac{\hat{V}(p_s)}{n_s}\right)$$

where

N_s = Total number of counties in strata s

n_s = Number of counties selected in strata s

$\hat{V}(p_s)$ = Sample variance for strata s

N = Total number of counties in South Carolina, 46

Estimates are calculated for each subgroup of interest, including males/females, drivers/passengers and urban/rural, in addition to state and county level across all groups.