

# **SURVEY OF SAFETY BELT AND MOTORCYCLE HELMET USAGE IN TENNESSEE**

FISCAL YEAR 2006 FINAL REPORT



Prepared by:



**The University of Tennessee  
Center for Transportation Research**

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# **SURVEY OF SAFETY BELT AND MOTORCYCLE HELMET USAGE IN TENNESSEE**

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**MATTHEW A. CATE**

The University of Tennessee Center for Transportation Research conducts a statewide survey once each year during which both safety belt and motorcycle helmet use data are gathered simultaneously. The sample design, data collection techniques, and estimation procedures for the surveys were developed in accordance with the National Highway Traffic Safety Administration's (NHTSA's) "Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use," published in the June 29, 1992, Federal Register with the guideline revisions agreed upon at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta. Detailed information on the sample design (including site selection), survey conduct (including data collection), and statistical procedures for estimation can be found in the April 2005 report "Documentation of Tennessee Observational Surveys of Safety Belt and Motorcycle Helmet Use" and are summarized below.

### **Survey Design**

A multi-stage area probability sampling approach is used in the survey. In the first stage, an appropriate number of primary sampling units are randomly selected. The primary sampling unit for the Tennessee survey is the "county" and 16 counties were selected for inclusion in the survey.

In the second stage, sampling of individual route segments in each of the counties is performed. All route segments in a county with an average daily traffic (ADT) of 500 or more make-up the "target" population and are identified from the Tennessee Roadway Information Management System (TRIMS) files. The qualifying route segments from each of the survey counties are stratified into six groupings using TRIMS functional classification data. For a given county, segments are randomly chosen from each of these six strata. The number of segments chosen from each stratum is proportional to the county's estimated annual vehicle miles of travel (VMT) in each stratum. The proportional allocation of the segments across the various roadway groupings assures that the final sample is representative of the urban and rural mix in the county, as well as the mix of roadway functional types.

As per NHTSA guidelines and to achieve the required level of precision, a total of 440 roadway segments comprise the target sample. This number is based on NHTSA guidelines for "second stage sample size." Forty percent of these sample sites (176 sites) are allocated to the state's 4 largest counties, with each of these counties receiving one-fourth of this total number, or 44 sites. The remaining 60 percent (264 sites) are evenly divided among the 12 smaller counties in the survey, i.e., 22 sample sites per county.

An observational site is a homogeneous segment of roadway, generally ranging in length from 0.5 to 5 miles. A typical segment is approximately 1 mile in length.

Observers record the belt use/nonuse of occupants of "qualifying" vehicles in the travel direction of record for a period of 40 minutes. Data are collected during all daylight hours, generally from 8:00am to 6:00pm, and on all days of the week. For the purpose of the Tennessee surveys, "qualifying" vehicles include all passenger cars, pick-up trucks, vans, and sport utility vehicles that are not exempted from the Tennessee seatbelt law. Exempted vehicles are: mail carriers; vehicles registered for "farm use," and vehicles operated by persons with medical exemptions.

Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, is counted for the motorcycle helmet use survey. The helmet use/nonuse of both motorcycle drivers and any passengers is recorded.

After the raw data have been used to determine observed percentages of belt and helmet use, "adjusted" percentages, weighted by each site's final probability of selection, are computed and reported. These weighted percentages then are combined to yield statewide estimates of safety belt and motorcycle helmet use. Estimates of one standard error are calculated for the estimated statewide usage rates, and these statistics are used to construct a 95 percent confidence interval for the belt use estimate and helmet use estimate, respectively. A complete description of the methods used in this survey of seatbelt usage may be seen in Appendix 1.

### **2006 Tennessee Seatbelt Survey Results**

In 2006 the highway safety community has continued several important vehicle occupant protection initiatives. The Tennessee Governor's Highway Safety Office has partnered with the National Highway Traffic Safety Administration, the Tennessee Department of Safety, local law enforcement agencies, and numerous other public and private entities in order to increase seatbelt usage across the state of Tennessee. Chief among these initiatives is the sixth consecutive year of the Click It or Ticket initiative. This high visibility education and enforcement campaign, combined with the 2004 enactment of a statewide primary enforcement seatbelt law, has produced an increase in Tennessee's observed seatbelt usage rate in every year since its implementation in 2001. Other safety campaigns such as Booze It and Lose It, Buckle Up in Your Truck, and 100 Days of Summer Heat have also contributed to continuing progress in safety belt usage.

For 2006, the final statistically-adjusted statewide seatbelt usage rate is 78.57%. By comparison, the final usage rate for 2005 was 74.42%. Within this year's results, many historical trends continue. Despite significant gains in recent years, pickup trucks continue to have the lowest usage rate of any vehicle type. For 2006, pickup trucks occupants were observed to have a seatbelt usage rate of 69.37%, up from 62.60% in 2005. The next lowest rate by vehicle type was 80.00% for vans. Cars and sport utility vehicles returned usage rates of 82.09% and 81.97%, respectively. Unadjusted seatbelt

usage estimates for each category of vehicle by county are shown in Table 1. Table 2 shows the final adjusted usage rates by vehicle type and county, as well as the final statewide usage rate of 78.57% ( $\pm 1.71\%$ ) for all vehicle types. The statewide motorcycle helmet usage in 2006 was 99.55% ( $\pm 0.54\%$ ). Table 3 shows the motorcycle helmet usage by county. To further illustrate the recent progress brought about in increasing seatbelt usage across the state of Tennessee by both the Click-It-Or-Ticket campaign and passage of a primary seatbelt enforcement law, Table 4 shows annual usage rates for all vehicles, passenger cars, pickup trucks, vans, and sport utility vehicles.

**Table 1: Final Summary of 2006 Tennessee Safety Belt Use  
Statewide Observational Survey Results**

July 31, 2006

		RAW DATA									
		Passenger Cars		Pickups		Vans		Sports Utilities		All Vehicles	
County	No. of Sites	Total Occupants		Total Occupants		Total Occupants		Total Occupants		Total Occupants	
		Observed	% Belt Use	Observed	% Belt Use	Observed	% Belt Use	Observed	% Belt Use	Observed	% Belt Use
Davidson	44	7,072	87.50%	3,155	73.53%	1,629	78.08%	3,175	86.33%	15,031	83.30%
Hamilton	43	4,353	84.36%	2,549	70.22%	1,207	84.92%	2,110	83.18%	10,219	80.65%
Knox	44	4,189	80.19%	2,187	67.49%	1,008	80.95%	1,917	81.06%	9,301	77.46%
Shelby	44	5,538	85.79%	2,416	75.29%	1,143	80.31%	2,473	86.01%	11,570	83.10%
Anderson	22	704	69.03%	388	61.34%	161	67.70%	391	67.77%	1,644	66.79%
Bradley	21	1,455	82.75%	859	64.38%	354	75.99%	554	77.26%	3,222	76.16%
Gibson	22	1,053	76.07%	888	64.64%	271	71.22%	497	74.65%	2,709	71.58%
Greene	20	685	77.37%	327	80.12%	169	81.07%	409	81.17%	1,590	79.31%
Hawkins	22	467	80.30%	254	75.98%	112	91.96%	277	85.56%	1,110	81.80%
Madison	22	2,256	77.48%	1,258	66.53%	509	78.19%	938	79.74%	4,961	75.21%
Obion	22	1,113	75.83%	872	63.76%	260	76.15%	474	82.28%	2,719	73.12%
Putnam	22	1,476	84.69%	938	70.79%	285	88.07%	622	84.57%	3,321	81.03%
Rutherford	20	1,155	85.54%	623	73.84%	258	86.05%	549	87.80%	2,585	83.25%
Sullivan	22	940	75.64%	574	70.56%	261	79.69%	579	80.31%	2,354	76.00%
Sumner	22	1,430	83.36%	967	70.42%	321	81.31%	742	85.58%	3,460	80.03%
Williamson	21	1,884	82.48%	1,105	66.61%	553	84.09%	1,007	81.93%	4,549	78.70%
Statewide Totals	433	35,770	82.90%	19,360	70.06%	8,501	80.52%	16,714	83.05%	80,345	79.59%

**Table 2: Final Summary of 2006 Tennessee Safety Belt Use  
Statewide Observational Survey Results**

July 31, 2006

		<b>ADJUSTED DATA</b>									
County	No. of Sites	Passenger Cars		Pickups		Vans		Sports Utilities		All Vehicles	
		Total Adjusted Occupants Observed <sup>a</sup>	% Belt Use (Weighted Data) <sup>b</sup>	Total Adjusted Occupants Observed <sup>a</sup>	% Belt Use (Weighted Data) <sup>b</sup>	Total Adjusted Occupants Observed <sup>a</sup>	% Belt Use (Weighted Data) <sup>b</sup>	Total Adjusted Occupants Observed <sup>a</sup>	% Belt Use (Weighted Data) <sup>b</sup>	Total Adjusted Occupants Observed <sup>a</sup>	% Belt Use (Weighted Data) <sup>b</sup>
Davidson	44	31,151	87.87%	13,399	73.49%	6,972	78.29%	13,727	86.48%	65,249	83.62%
Hamilton	43	19,236	84.17%	11,626	69.89%	5,866	85.03%	9,647	81.99%	46,375	80.25%
Knox	44	15,256	80.18%	8,040	68.63%	3,888	80.59%	7,348	81.50%	34,532	77.77%
Shelby	44	27,742	86.06%	11,800	75.76%	5,701	80.56%	12,264	85.65%	57,507	83.31%
Anderson	22	2,226	69.33%	1,218	62.89%	502	69.02%	1,258	67.67%	5,204	67.41%
Bradley	21	3,573	95.22%	2,096	61.18%	876	76.25%	1,360	74.60%	8,775	76.46%
Gibson	22	2,594	77.24%	2,096	64.77%	670	70.86%	1,218	74.44%	6,578	72.05%
Greene	20	1,508	76.90%	708	80.34%	368	82.10%	904	79.17%	3,488	78.73%
Hawkins	22	1,300	78.52%	692	75.90%	318	92.62%	760	85.47%	3,070	81.14%
Madison	22	7,406	78.00%	4,218	67.15%	1,714	79.23%	3,138	80.58%	16,476	75.83%
Obion	22	3,514	76.52%	2,852	63.72%	858	76.23%	1,570	82.44%	8,794	73.36%
Putnam	22	4,186	84.37%	2,728	69.88%	890	86.67%	1,902	84.94%	9,706	80.60%
Rutherford	20	4,992	84.75%	2,670	71.53%	1,202	84.77%	2,572	86.65%	11,436	82.34%
Sullivan	22	3,014	74.82%	1,868	70.36%	848	78.98%	1,868	79.42%	7,598	75.33%
Sumner	22	3,394	84.33%	2,316	70.95%	798	80.77%	1,754	86.68%	8,262	80.88%
Williamson	21	7,325	83.86%	3,708	68.93%	2,218	84.78%	3,765	82.81%	17,016	80.48%
<b>Statewide Totals</b>	<b>433</b>	<b>138,417</b>	<b>82.09%</b>	<b>72,035</b>	<b>69.37%</b>	<b>33,689</b>	<b>80.00%</b>	<b>65,055</b>	<b>81.97%</b>	<b>310,066</b>	<b>78.57%</b>
<b>95% Confidence Interval</b>			<b>(± 2.05%)</b>		<b>(± 1.81%)</b>		<b>(± 2.08%)</b>		<b>(± 2.13%)</b>		<b>(± 1.71%)</b>

<sup>a</sup> Total occupants observed adjusted based on the number of lanes per section.

<sup>b</sup> County Estimates Weighted to reflect distribution of roadway type within county; statewide estimate also weighted based on proportional populations of surveyed counties.

**Table 3: Final Summary of 2006 Tennessee Motorcycle Helmet Use  
Statewide Observational Survey Results  
July 31, 2006**

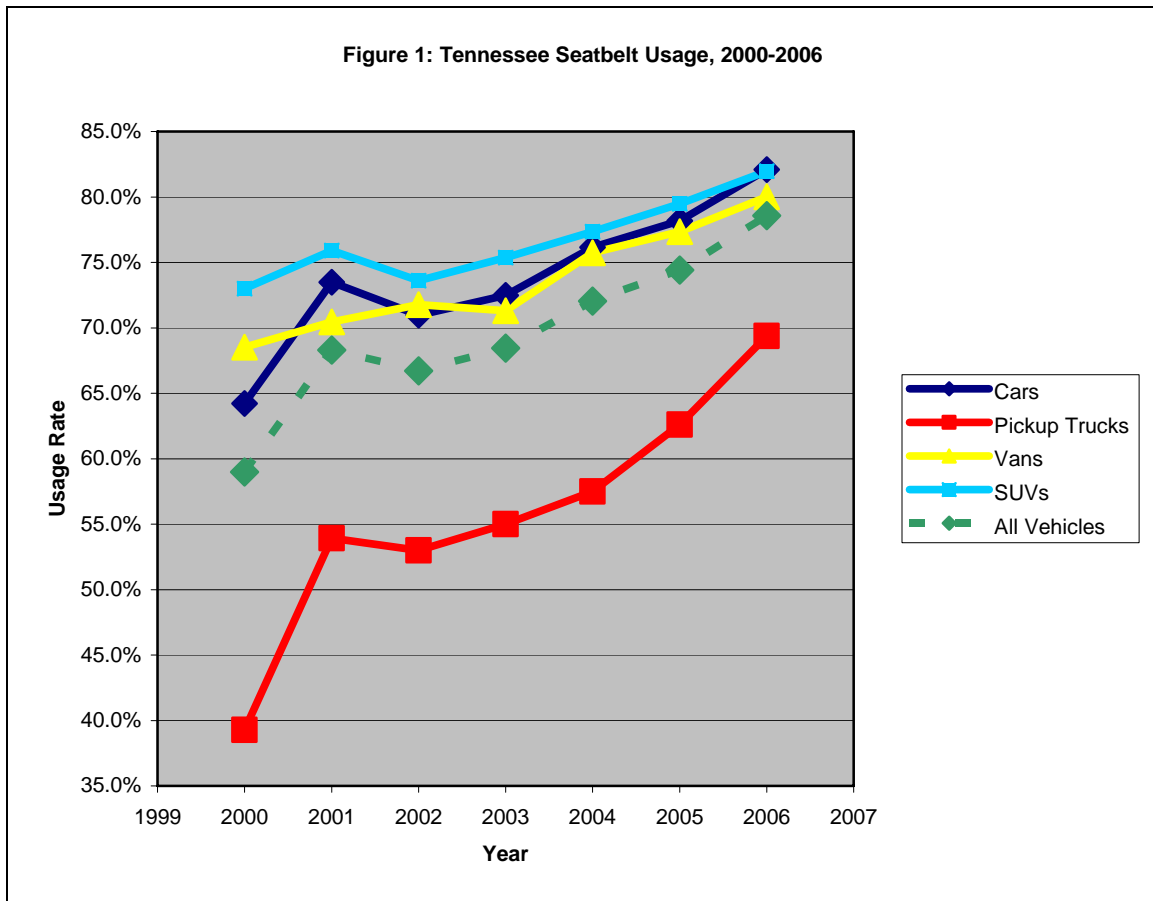
County	No. of Sites	Total Occupants Observed	% Helmet Use (Raw Data)	% Helmet Use (Weighted Data) <sup>a</sup>
Davidson	44	106	100.00%	100.00%
Hamilton	43	107	100.00%	100.00%
Knox	44	105	100.00%	100.00%
Shelby	44	65	98.46%	98.56%
Anderson	22	23	100.00%	100.00%
Gibson	22	13	100.00%	100.00%
Bradley	21	45	100.00%	100.00%
Greene	20	26	96.15%	97.14%
Hawkins	22	16	100.00%	100.00%
Putnam	22	28	100.00%	100.00%
Madison	22	51	98.04%	98.12%
Rutherford	20	25	100.00%	100.00%
Sullivan	22	21	100.00%	100.00%
Obion	22	34	100.00%	100.00%
Sumner	22	19	100.00%	100.00%
Williamson	21	26	100.00%	100.00%
<b>Statewide Totals</b>	<b>433</b>	<b>710</b>	<b>99.58%</b>	<b>99.55%</b> <b>(± 0.54%)<sup>b</sup></b>

<sup>a</sup> County Estimates Weighted to reflect distribution of roadway type within county; statewide estimate also weighted based on proportional populations of surveyed counties.

<sup>b</sup> 95 percent confidence interval

**Table 4:** Tennessee Seatbelt Usage, 2000-2006

Survey Year	Passenger Cars	Pickup Trucks	Vans	Sport Utility Vehicles	All Vehicles
2000	64.2%	39.3%	68.5%	73.0%	59.0%
2001	73.5%	53.9%	70.4%	75.9%	68.3%
2002	71.0%	53.0%	71.8%	73.6%	66.7%
2003	72.5%	55.0%	71.3%	75.4%	68.4%
2004	76.1%	57.5%	75.7%	77.3%	72.0%
2005	78.2%	62.6%	77.3%	79.5%	74.4%
2006	82.09%	69.37%	80.00%	81.97%	78.57%



**Figure 1:** Tennessee Seatbelt Usage, 2000-2006

## **Appendix 1: Survey Methodology**

**DOCUMENTATION OF TENNESSEE  
OBSERVATIONAL SURVEYS OF  
SAFETY BELT AND MOTORCYCLE HELMET USE**

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April 18, 2005

## **Executive Summary**

University of Tennessee Transportation Center conducts a statewide survey once each year in late summer, at which time both safety belt and motorcycle helmet use data are gathered simultaneously. The sample design, data collection techniques, and estimation procedures for the surveys were developed in accordance with NHTSA “Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use,” published in the June 29, 1992 Federal Register with the guideline revisions agreed upon at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta.

A multi-stage area probability sampling approach is used in the survey. In the first stage, an appropriate number of primary sampling units is randomly selected. The primary sampling unit for the Tennessee survey is the “county” and 16 counties were selected for inclusion in the survey.

In the second stage, sampling of individual route segments in each of the counties is performed. All route segments in a county with an ADT of 500 or more make-up the “target” population and are identified from the TRIMS files. The qualifying route segments from each of the survey counties are stratified into 6 groupings using TRIMS functional classification data. For a given county, segments are randomly chosen from each of these six strata. The number of segments chosen from each stratum is proportional to the county’s estimated annual VMT in each stratum. The proportional allocation of the segments across the various roadway groupings assures that the final sample is representative of the urban and rural mix in the county, as well as the mix of roadway functional types.

As per NHTSA guidelines and to achieve the required level of precision, a total of 440 roadway segments comprise the sample. This number is based on NHTSA guidelines for “second stage sample size.” Forty percent of these sample sites (176 sites) are allocated to the state’s 4 largest counties, with each of these counties receiving one-fourth (44) of this total number, or 44

sites. The remaining 60 percent (264 sites) are evenly divided among the 12 smaller counties in the survey, i.e., 22 sample sites per county.

An observational site is a homogeneous segment of roadway, generally ranging in length from 0.5 to 5 miles. A typical segment is approximately 1 mile in length. Observers record the belt use/nonuse of occupants of “qualifying” vehicles in the travel direction of record for period of 40 minutes. Data are collected during all daylight hours, generally from 8:00am to 6:00pm, and on all days of the week. For the purpose of the Tennessee surveys, “qualifying” vehicles include all passenger automobiles (passenger cars, pick-up trucks, vans, and sport utility vehicles) which are not exempted from the Tennessee law. Exempted vehicles are: mail carriers; vehicles registered for “farm use,” and vehicles operated by persons with medical exemptions.

Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, is counted for the motorcycle helmet use survey. The helmet use/nonuse of both motorcycle drivers and any passengers is recorded.

After the raw data has been used to determine observed percentages of belt use and helmet, “adjusted” percentages, weighted by each site’s final probability of selection, are computed and reported. These weighted percentages then are combined to yield statewide estimates of safety belt and motorcycle helmet use. Estimates of one standard error are calculated for the estimated statewide usage rates, and these statistics are used to construct a 95 percent confidence interval for the belt use estimate and helmet use estimate, respectively.

## **Introduction**

Following is a detailed description of the methodology employed in the State of Tennessee observational surveys of safety belt and motorcycle helmet use. The sample design, data collection techniques, and estimation procedures for the surveys were developed in accordance with NHTSA “Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use,” published in the June 29, 1992 Federal Register with the guideline revisions agreed upon at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta. Under the Tennessee plan, a statewide survey is conducted once each year in the summer, at which time both safety belt and motorcycle helmet use data are gathered simultaneously. This annual survey is designed, and is currently administered, analyzed and documented by the University of Tennessee Center for Transportation Research. The primary contact person at the Center is Mr. Matthew Cate (865/974-5255).

The sampling procedures described herein utilize data from the Tennessee Roadway Information Management System compiled by the Tennessee Department of Transportation (TDOT), and from the Tennessee Statistical Abstract published annually by the University of Tennessee Center for Business and Economic Research. The TRIMS files include estimates of Average Daily Traffic (ADT) and Vehicle Miles of Travel by road class and county. The Tennessee Statistical Abstract presents population data by county as well as county road mileage by functional roadway classification.

The TRIMS files also provide a ‘population’ of observational sites for the surveys. TRIMS contains data on the entire 84,000-mile road system in Tennessee, including Interstate Highways and Expressways, Principal and Minor Arterials, Major and Minor Collectors, and Local Roads. As part of these data, each roadway is broken down into several “control-sections,” which vary from less than a mile to a few miles in length. These route segments tend to be homogeneous with regard to traffic volumes, land use, function, speeds, etc. Segment beginning

and ending termini, functional classification, location of intersecting roadways and an ADT estimate are recorded in the TRIMS files for each control-section.

## **Sample Design**

A multi-stage area probability sampling approach is used in the survey. In the first stage, an appropriate number of primary sampling units is randomly selected. The primary sampling unit for the Tennessee survey is the “county.” Tennessee has a total of 95 counties; however, the least populated counties which collectively comprise approximately 15 percent of the State’s population are excluded from the sampling process. (County population is the measure of sampling unit size for the purpose of defining the initial set of sampling units to be considered.) Table 1 shows a listing of Tennessee’s 95 counties ranked using current Census data from least to most populated. The 47 counties which have been included in the sampling population as per the above criterion are identified in Table 1, as well as the 48 least populated counties which have been excluded from the sampling population.

From the sampling population, a sample of 16 counties is selected. The number of counties (16) in the survey sample is based on the fact that Tennessee has a total of 47 counties in its sampling unit population. Applying NHTSA guidelines to this number of sampling units, 16 is an appropriate number to achieve the desired level of accuracy in belt use estimation. The 16 county sample is chosen using a two-step procedure. First, the 4 largest counties (Shelby, Davidson, Knox and Hamilton) comprising approximately 40 percent of the state’s population are automatically placed into the 16 county sample. Then, 12 additional counties are selected from the remaining 43 county population to complete the survey sample, with probability for selection proportional to the population of the county. “Population weighting” is used together with random number generation to select the 12 smaller counties into the 16-county sample; the selection is done with replacement.

**Table 1: 2000 Census Population**

<b>County</b>	<b>Population</b>	<b>% Total</b>	<b>Cumulative % Total</b>
Pickett	4,945	0.1%	0.1%
Van Buren	5,508	0.1%	0.2%
Moore	5,740	0.1%	0.3%
Hancock	6,786	0.1%	0.4%
Trousdale	7,259	0.1%	0.5%
Perry	7,631	0.1%	0.7%
Lake	7,954	0.1%	0.8%
Clay	7,976	0.1%	0.9%
Houston	8,088	0.1%	1.1%
Jackson	10,984	0.2%	1.3%
Meigs	11,086	0.2%	1.5%
Lewis	11,367	0.2%	1.7%
Sequatchie	11,370	0.2%	1.9%
Decatur	11,731	0.2%	2.1%
Bledsoe	12,367	0.2%	2.3%
Stewart	12,370	0.2%	2.5%
Cannon	12,826	0.2%	2.7%
Grundy	14,332	0.3%	3.0%
Crockett	14,532	0.3%	3.2%
Chester	15,540	0.3%	3.5%
Polk	16,050	0.3%	3.8%
Benton	16,537	0.3%	4.1%
Fentress	16,625	0.3%	4.4%
Wayne	16,842	0.3%	4.7%
DeKalb	17,423	0.3%	5.0%
Johnson	17,499	0.3%	5.3%
Unicoi	17,667	0.3%	5.6%
Smith	17,712	0.3%	5.9%
Union	17,808	0.3%	6.2%
Humphreys	17,929	0.3%	6.5%
Morgan	19,757	0.3%	6.9%
Haywood	19,797	0.3%	7.2%
Overton	20,118	0.4%	7.6%
Macon	20,386	0.4%	8.0%
Grainger	20,659	0.4%	8.3%
Scott	21,127	0.4%	8.7%
Hickman	22,295	0.4%	9.1%
White	23,102	0.4%	9.5%
McNairy	24,653	0.4%	9.9%
Henderson	25,522	0.4%	10.4%
Hardin	25,578	0.4%	10.8%
Marshall	26,767	0.5%	11.3%
Lauderdale	27,101	0.5%	11.8%
Marion	27,776	0.5%	12.3%
Hardeman	28,105	0.5%	12.7%
Rhea	28,400	0.5%	13.2%
Fayette	28,806	0.5%	13.8%
Giles	29,447	0.5%	14.3%

**Table 1 Continued: 2000 Census Population**

<b>County</b>	<b>Population</b>	<b>% Total</b>	<b>Cumulative % Total</b>
Carroll	29,475	0.5%	14.8%
Claiborne	29,862	0.5%	15.3%
Henry	31,115	0.5%	15.9%
Lincoln	31,340	0.6%	16.4%
Obion	32,450	0.6%	17.0%
Cocke	33,565	0.6%	17.6%
Weakley	34,895	0.6%	18.2%
Cheatham	35,912	0.6%	18.8%
Dyer	37,279	0.7%	19.5%
Bedford	37,586	0.7%	20.1%
Warren	38,276	0.7%	20.8%
Monroe	38,961	0.7%	21.5%
Loudon	39,086	0.7%	22.2%
Franklin	39,270	0.7%	22.9%
Campbell	39,854	0.7%	23.6%
Lawrence	39,926	0.7%	24.3%
Dickson	43,156	0.8%	25.0%
Jefferson	44,294	0.8%	25.8%
Cumberland	46,802	0.8%	26.6%
Coffee	48,014	0.8%	27.5%
Gibson	48,152	0.8%	28.3%
McMinn	49,015	0.9%	29.2%
Tipton	51,271	0.9%	30.1%
Roane	51,910	0.9%	31.0%
Hawkins	53,563	0.9%	31.9%
Robertson	54,433	1.0%	32.9%
Carter	56,742	1.0%	33.9%
Hamblen	58,128	1.0%	34.9%
Putnam	62,315	1.1%	36.0%
Greene	62,909	1.1%	37.1%
Maury	69,498	1.2%	38.3%
Sevier	71,170	1.3%	39.6%
Anderson	71,330	1.3%	40.8%
Bradley	87,965	1.5%	42.4%
Wilson	88,809	1.6%	43.9%
Madison	91,837	1.6%	45.6%
Blount	105,823	1.9%	47.4%
Washington	107,198	1.9%	49.3%
Williamson	126,638	2.2%	51.5%
Sumner	130,449	2.3%	53.8%
Montgomery	134,768	2.4%	56.2%
Sullivan	153,048	2.7%	58.9%
Rutherford	182,023	3.2%	62.1%
Hamilton	307,896	5.4%	67.5%
Knox	382,032	6.7%	74.2%
Davidson	569,891	10.0%	84.2%
Shelby	897,472	15.8%	100.0%
Tennessee	5,689,283		

Once the 16 survey counties have been chosen, second stage sampling of individual route segments in each of the counties is performed. The qualifying route segments comprising the sampling population are identified from the TRIMS files. All route segments in a county with an ADT of 500 vehicles per day (vpd) or more make-up the route segment population. (In the interest of efficiency and cost, very low volume segments with daily traffic volumes less than 500 vpd have been excluded from consideration.) The qualifying route segments from the 16 counties collectively constitute the set of observational sites from which the survey sites are then selected. The qualifying route segments from the 47 counties collectively constitute the “target population” of observational sites.

The qualifying route segments from each of the survey counties are stratified into the following 6 groupings using TRIMS functional classification data:

1. Urban Interstate, Freeway or Expressway;
2. Rural Interstate;
3. Urban Other Principal or Minor Arterial;
4. Rural Other Principal or Minor Arterial;
5. Urban Major or Minor Collector/Local; and,
6. Rural Major or Minor Collector/Local.

For a given county, segments are randomly chosen from each of these six strata. The number of segments chosen from each stratum is proportional to the county’s estimated annual VMT in each stratum. The proportional allocation of the segments across the various roadway groupings assures that the final sample is representative of the urban and rural mix in the county, as well as the mix of roadway functional types.

As per NHTSA guidelines and to achieve the required level of precision, a total of 440 roadway segments comprise the sample. This number is based on NHTSA guidelines for “second stage sample size.” Forty percent of these sample sites (176 sites) are allocated to the state’s 4 largest counties, with each of these counties receiving one-fourth (44) of this total number, or 44 sites. The remaining 60 percent (264 sites) are evenly divided among the 12 smaller counties in the survey, i.e., 22 sample sites per county. In addition, one alternate site per county per roadway classification will be identified. (This represents an additional 96 sites which can be used as

substitute sites in the event that a primary site is unusable, e.g. it is closed for roadwork.) The sample sites within each stratum are selected with replacement.

## **Data Collection**

An observational site is a homogeneous segment of roadway, generally ranging in length from 0.5 to 5 miles. A typical segment is approximately 1 mile in length. (The longer segments tend to be in rural areas where there are few intersections and/or driveways.) At each observational site, a direction of travel is randomly selected (by the equivalent of a coin toss) to be the travel direction of record. Proceeding in this direction from the beginning point of the segment, the observer is instructed to position himself or herself at the first intersection, (preferably the first controlled intersection) within the segment.

The observer finds a safe spot to stand just beyond the edge of the roadway at or very near the intersection. From this vantage point the observer records the belt use/nonuse of occupants of “qualifying” vehicles in the travel direction of record. If there are multiple lanes in the travel direction of record, only vehicles traveling in the outermost lane are sampled. In the rare event that traffic is too heavy to count every vehicle in the survey lane, observers are instructed to count every second or third vehicle, whichever is appropriate.

For the purpose of the Tennessee surveys, “qualifying” vehicles include all passenger vehicles (passenger cars, pick-up trucks, vans, and sport utility vehicles) which are not exempted from the Tennessee law. Exempted vehicles are: mail carriers; vehicles registered for “farm use,” and vehicles operated by persons with medical exemptions. It will be possible through visual observation to identify and not survey vehicles in the first two exempted categories (mail carriers and registered farm vehicles). Vehicles in the third category (driver physically unable to wear belt) will not be recognizable, and therefore these vehicles will be included in the survey sample. (The numbers of such vehicles is very small and their inclusion in the sample is expected to be insignificant.)

The shoulder belt use/nonuse of all front seat, outboard occupants of “qualifying” vehicles is recorded, including children. Children four years of age and younger are counted, and

if they are wearing a shoulder belt or are restrained in a proper child restraint device, they are counted as “belted.”

Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, is counted for the motorcycle helmet use survey. The helmet use and nonuse of both motorcycle drivers and any passengers are recorded.

The observation period at each site is 40 minutes. Observation periods are scheduled to begin at the following times: 8:00am; 9:00am; 10:00am; 11:00am; 12:00 noon; 1:00pm; 2:00pm; 3:00pm; 4:00pm; and 5:00pm. Actual observation time periods will begin at these times, or as close as practical to these times, i.e., as soon the observer can get positioned at the site. Observers are instructed to commence counting with the first vehicle which arrives at the site after the time period begins, and to cease counting at the precise end of the 40-minute time period.

Data are collected during all daylight hours, generally from 8:00am to 6:00pm, and on all days of the week. In assigning observation time periods to individual sites, the sites are first clustered according to travel time proximity. Those sites within a reasonable driving distance, i.e., approximately 25 minutes, are grouped together. A cluster is then randomly assigned to a day or days of the week. Then, the sites within the cluster are randomly assigned to the consecutive observation time periods within that day or days.

If an observation site cannot be surveyed because of construction activities, safety concerns, or some other legitimate reason, the site is abandoned. The observer is instructed to travel to the next assigned site and resume the survey at the appropriate time. Then, after all the sites within the cluster are completed, the observer travels to a pre-selected alternate site (with the same characteristics as the abandoned site), and he/she surveys this site beginning in the next available time period. As noted previously, alternate sites are selected during the initial sampling process.

The surveys will continue during mild inclement weather. In the event of severe inclement weather, the surveys are discontinued until such time as the weather eases. Then, the surveys are resumed according to the original schedule. After the remaining sites in a cluster have been surveyed, the observer returns to the missed site(s), and he/she surveys the site(s) beginning in the next consecutive time period.

## Estimation

Based on the data collected, appropriate statistical computations are performed to estimate the percentage of seatbelt and helmet use for each county and for the state as whole. After the raw data have been used to determine observed percentages of belt use and helmet, “adjusted” percentages, weighted by each site’s final probability of selection, are computed and reported. These weighted percentages then are combined to yield statewide estimates of safety belt and motorcycle helmet use. Estimates of one standard error are calculated for the estimated statewide usage rates, and these statistics are used to construct a 95 percent confidence interval for the belt use estimate and helmet use estimate, respectively.

### Site Dependent Adjustments

For each site in the survey, the number of belted and un-belted passengers observed for each class of vehicles are counted. In addition, the observed number of helmeted and non-helmeted motorcycle riders are recorded. Because data are collected only on the outermost lane for seatbelt use, the observed seatbelt use data are adjusted to reflect the number of lanes at each site. Consequently, for each site, the number of belted,  $B_{jlcks}$ , and un-belted,  $U_{jlcks}$ , passengers is given by:

$$B_{jlcks} = n \times b_{jlcks} \text{ and}$$

$$U_{jlcks} = n \times u_{jlcks}$$

Where s = the site identifier

k = roadway functional class

c = county identifier

l = identifies the county level (described later in the section on statewide weighting)

j = the vehicle type (i.e. passenger car, pick-up truck, van/mini-van or sport utility)

b = number of observed belted passengers

u = number of observed un-belted passengers

n = number of lanes in the outbound direction

Since data for helmet use are collected for all lanes of travel on all approaches, an adjustment for the number of lanes at a site is not applied to helmet use data.

The next step is to weight the observed belt and helmet use counts proportional to the number of roadway segments within a county.

### County Wide Weighting

*County wide weighting is conducted for each vehicle type observed. Because the procedures for each type of vehicle are exactly the same and for purposes of simplification, the remainder of this discussion will illustrate the procedure for weighting passenger cars.*

For each county, the roadway segments can be classified into 6 functional categories:

1. Urban Interstate, Freeway or Expressway;
2. Rural Interstate;
3. Urban Other Principal or Minor Arterial;
4. Rural Other Principal or Minor Arterial;
5. Urban Major or Minor Collector/Local; and,
6. Rural Major or Minor Collector/Local.

Belt use data are collected for a sample of roadway segments within a county. To estimate the county wide use, the observed data are weighted to reflect the probability of being included in the survey. Consequently for a given county, the average number of observed belted,  $\bar{B}_{jlc}$ , and total users,  $\bar{T}_{jlc}$ , is given by:

$$\bar{B}_{jlc} = \frac{\sum_{l=1}^S B_{jlcs}}{S} \text{ and}$$

$$\bar{T}_{jlc} = \frac{\sum_{s=1}^S T_{jlcs}}{S} = \frac{\sum_{s=1}^S B_{jlcs} + U_{jlcs}}{S}$$

Where S = the number of sites in a given class

s = the site identifier

k = roadway functional class

c = county identifier

l = identifies the county level (described later in the section on statewide weighting)

j = the vehicle type (i.e. passenger car, pick-up truck, van/mini-van or sport utility)

B = number of observed belted passengers adjusted for the number of lanes

U = number of observed un-belted passengers adjusted for the number of lanes

The usage for the entire county is calculated by multiplying the average number of observed belted,  $\bar{B}_{jlc k}$ , and total users,  $\bar{T}_{jlc k}$ , by the number of segments in a given class for a given county,  $m_{ck}$ :

$$\hat{B}_{jlc} = \sum_{k=1}^6 m_{ck} \times \bar{B}_{jlc k} \text{ and}$$

$$\hat{T}_{jlc} = \sum_{k=1}^6 m_{ck} \times \bar{T}_{jlc k}$$

Thus if we had the following distribution of roadway segments:

Class	Number in	
	County	Sample
1	5	5
2	44	6
3	25	1
4	0	0
5	26	8
6	78	2

Then for class 2,

$$\bar{B}_{jlc2} = \frac{B_{jlc21} + B_{jlc22} + B_{jlc23} + B_{jlc24} + B_{jlc25} + B_{jlc26}}{6}$$

and for the county,

$$\hat{B}_{jlc} = 5 \times \bar{B}_{jlc1} + 44 \times \bar{B}_{jlc2} + 25 \times \bar{B}_{jlc3} + 0 \times \bar{B}_{jlc4} + 26 \times \bar{B}_{jlc5} + 78 \times \bar{B}_{jlc6}$$

With the estimation of  $\hat{B}_{jlc}$  and  $\hat{T}_{jlc}$ , the weighted seatbelt usage for a particular vehicle type in a given county is defined as:

$$\hat{X}_{jlc} = \frac{\hat{B}_{jlc}}{\hat{T}_{jlc}}$$

Given county wide estimates of seatbelt use, statewide estimates are calculated based on the probability of the county being selected for the survey.

### State Wide Weighting

The probability of a county being selected for inclusion in the survey is based on 2000 census population. The 4 most populated counties are automatically included and 12 more counties are selected from the remaining counties (43) which account for 85% of the state of Tennessee's population. Therefore, two strata of counties can be created – Level 1 for the 4 most populated counties and Level 2 for the remaining 43. Level 1 has only four counties and all four

counties are surveyed so the entire population is known. Consequently, the population mean and variance are known. Meanwhile, for Level 2 only a sample of counties is used so the population statistics are estimated with the sample statistics.

**Level 1 Counties**

Shelby  
Davidson  
Knox  
Hamilton

**Level 2 Counties**

Anderson	Coffee	Henry	Montgomery	Tipton
Bedford	Cumberland	Jefferson	Obion	Warren
Blount	Dickson	Lawrence	Putnam	Washington
Bradley	Dyer	Lincoln	Roane	Weakley
Campbell	Franklin	Loudon	Robertson	Williamson
Carter	Gibson	Madison	Rutherford	Wilson
Cheatham	Greene	Maury	Sevier	
Claiborne	Hamblen	McMinn	Sullivan	
Cocke	Hawkins	Monroe	Sumner	

Given seatbelt use estimates for the level 1 and 2 counties, a statewide usage rate can be estimated for a given vehicle type, j. For the level 1, the estimates of belt use are given by:

$$\hat{B}_{j1} = \hat{B}_{j11} + \hat{B}_{j12} + \hat{B}_{j13} + \hat{B}_{j14} \text{ and}$$

$$\hat{T}_{j1} = \hat{T}_{j11} + \hat{T}_{j12} + \hat{T}_{j13} + \hat{T}_{j14}.$$

However, only 12 Level 2 counties are included in the survey, so county wide estimates are adjusted to approximate the Level 2 wide usage:

$$\hat{B}_{j2} = \sum_{c=1}^{12} \frac{\hat{B}_{j2c}}{z_c 12} \text{ and}$$

$$\hat{T}_{j2} = \sum_{c=1}^{12} \frac{\hat{T}_{j2c}}{z_c 12}$$

where  $z_c \equiv$  probability of being chosen , or

$$z_c = \frac{\text{population}_c}{\sum_{c=1}^{c=43} \text{population}_c}$$

Thus the statewide usage is estimated by the sum of the usage in the level 1 and 2 counties, or

$$\hat{B}_j = \hat{B}_{j1} + \hat{B}_{j2} \text{ and}$$

$$\hat{T}_j = \hat{T}_{j1} + \hat{T}_{j2} \text{ so that}$$

$$\hat{X}_j = \frac{\hat{B}_j}{\hat{T}_j}$$

### Variance of Statewide Estimates

The variance for the statewide estimate of belt usage is given by:

$$\begin{aligned}\sigma_{\hat{X}_j}^2 &= \sigma_{\frac{\hat{B}_j}{\hat{T}_j}}^2 \\ &= \sigma_{\frac{\hat{B}_{j1} + \hat{B}_{j2}}{\hat{T}_{j1} + \hat{T}_{j2}}}^2 \\ &= \frac{1}{(\hat{T}_{j1} + \hat{T}_{j2})^2} \left\{ \sigma_{\hat{B}_{j1}}^2 + \sigma_{\hat{B}_{j2}}^2 + \left( \frac{\hat{B}_{j1} + \hat{B}_{j2}}{\hat{T}_{j1} + \hat{T}_{j2}} \right)^2 (\sigma_{\hat{T}_{j1}}^2 + \sigma_{\hat{T}_{j2}}^2) - 2 \frac{\hat{B}_{j1} + \hat{B}_{j2}}{\hat{T}_{j1} + \hat{T}_{j2}} (\sigma_{\hat{B}_{j1}, \hat{T}_{j1}}^2 + \sigma_{\hat{B}_{j2}, \hat{T}_{j2}}^2) \right\} \\ &= \frac{1}{\hat{T}_j^2} \left\{ \sigma_{\hat{B}_{j1}}^2 + \sigma_{\hat{B}_{j2}}^2 + \hat{X}_j^2 (\sigma_{\hat{T}_{j1}}^2 + \sigma_{\hat{T}_{j2}}^2) - 2 \hat{X}_j (\sigma_{\hat{B}_{j1}, \hat{T}_{j1}}^2 + \sigma_{\hat{B}_{j2}, \hat{T}_{j2}}^2) \right\}\end{aligned}$$

The variance of the belted passengers and total passengers for Levels 1 and 2 are given by:

$$\begin{aligned}\sigma_{\hat{B}_{j1}}^2 &= \frac{\sum_{c=1}^4 \left( \hat{B}_{j1c} - \frac{\hat{B}_{j1}}{4} \right)^2}{4(4-1)} \quad \text{and} \quad \sigma_{\hat{B}_{j2}}^2 = \frac{\sum_{c=1}^{12} \left( \frac{\hat{B}_{j2c}}{z_c} - \hat{B}_{j2} \right)^2}{12(12-1)} \\ \sigma_{\hat{T}_{j1}}^2 &= \frac{\sum_{c=1}^4 \left( \hat{T}_{j1c} - \frac{\hat{T}_{j1}}{4} \right)^2}{4(4-1)} \quad \text{and} \quad \sigma_{\hat{T}_{j2}}^2 = \frac{\sum_{c=1}^{12} \left( \frac{\hat{T}_{j2c}}{z_c} - \hat{T}_{j2} \right)^2}{12(12-1)}\end{aligned}$$

meanwhile the covariances are given by

$$\begin{aligned}\sigma_{\hat{B}_{j1}, \hat{T}_{j1}}^2 &= \frac{\sum_{c=1}^4 \left( \hat{B}_{j1c} - \frac{\hat{B}_{j1}}{4} \right) \left( \hat{T}_{j1c} - \frac{\hat{T}_{j1}}{4} \right)}{4(4-1)} \quad \text{and} \\ \sigma_{\hat{B}_{j2}, \hat{T}_{j2}}^2 &= \frac{\sum_{c=1}^{12} \left( \frac{\hat{B}_{j2c}}{z_c} - \hat{B}_{j2} \right) \left( \frac{\hat{T}_{j2c}}{z_c} - \hat{T}_{j2} \right)}{12(12-1)}\end{aligned}$$

### Confidence intervals

With estimates of the statewide safety belt usage and its variance, the 95% confidence interval is given by

$$C.I. = \hat{X}_j \mp 1.96 \sqrt{\sigma_{\hat{X}_j}^2}$$