FINAL REPORT

SAFETY BELT AND MOTORCYCLE HELMET USE IN VIRGINIA: THE DECEMBER 2003 UPDATE

Jami L. Kennedy
Research Associate

Cheryl W. Lynn
Senior Research Scientist

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the
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EXECUTIVE SUMMARY

This survey was conducted at the request of the Virginia Department of Motor Vehicles solely to track the effectiveness of programmatic efforts carried out in the fall to increase safety belt usage. The December 2003 survey marks the second consecutive year of both winter and summer surveys. The official Virginia safety belt use survey is conducted in early summer each year, and the 2003 Virginia data are reported to the National Highway Traffic Safety Administration (NHTSA) in another report.[1]

The Virginia Transportation Research Council has been collecting safety belt use data in Virginia since 1974. The initial surveys (1974 through 1977 and 1983 through 1986) covered only the four major metropolitan areas of the state (Northern Virginia, Tidewater, Richmond, and Roanoke). From 1987 through 1992, data were also collected in nine communities with a population under 15,000. In 1991 and 1992, data were collected in four communities with a population between 50,000 and 100,000. Beginning in 1992, the data gathering methodology was changed to a statistically valid probability-sampling plan in accordance with federal guidelines. Prior to initiation of the 2003 survey, 20 new sites were added to enhance statistical power. This gave Virginia a total of 140 sites to be surveyed. Also in 2003, population figures were reexamined based on new census data.[2]

This report describes the methodology used for site selection and data collection and adds the results of the December 2003 survey to those conducted previously. It should be noted that the dates for the 2002 and 2003 summer surveys differed from those of previous surveys. From 1992 through 2001, surveys began the last Thursday in May and ended the second week in July. In 2002, at the request of NHTSA, the summer survey was begun the fourth week of April. In 2003, the summer survey was conducted starting Monday, June 1, and concluding on Sunday, June 21, with the intent to carry out future summer surveys using this time frame.

In December 2002, at the request of the Virginia Department of Motor Vehicles, a second statewide safety belt observational survey was conducted. Both the December 2002 and the December 2003 surveys began and ended the first three weeks of December with rescheduling of "rained out" sites during the fourth week. Since the winter survey was carried out during a time period when days were very short and during which daylight saving time was not in effect, some of the later sites could not be surveyed because of darkness. New times were randomly selected for these sites during daylight hours.

The results showed that Virginia's December 2003 safety belt use rate was 73.1 percent and its motorcycle helmet use rate was 100 percent (Figure ES-1). (In the 12 previous surveys, virtually all of the motorcycle drivers and passengers observed were using a helmet.) For passenger car drivers and right-front passengers observed in the 11 most recent years of the study, use rates varied from a low of 67.1 percent in 1997 to a high of 74.6 percent in the summer 2003. The December 2003 use rate of 73.1 percent represents an increase from the December 2002 use rate of 71.1 percent and a decrease from the 74.6 percent use rate in the summer 2003. It should be noted that because of the change in survey dates, modification of times necessitated during the winter survey, addition of new sites, and reexamined population

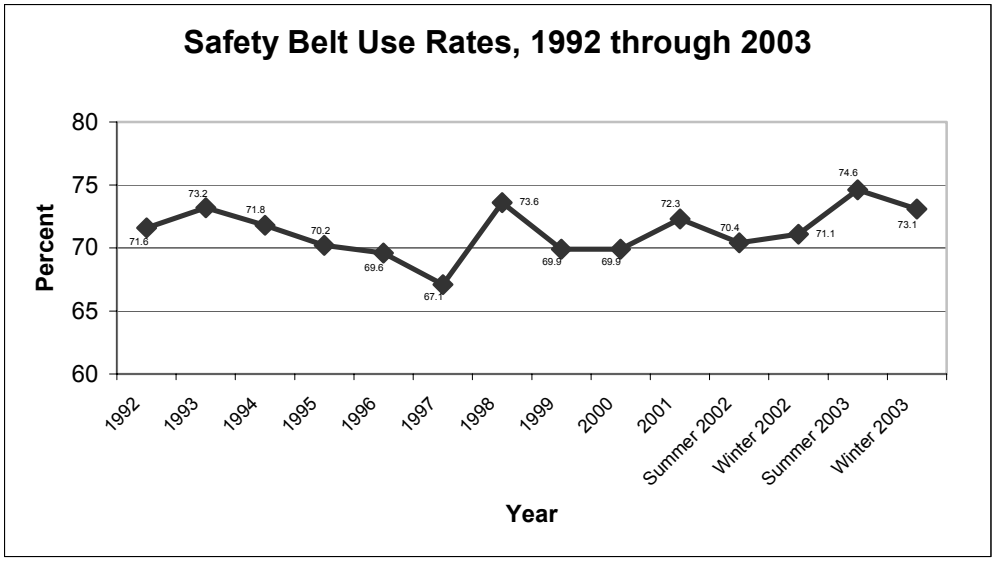

Figure ES-1. Trends in Safety Belt Use

figures, longitudinal comparisons between use rates in 2002 and 2003 and use rates in other years should be interpreted with caution. Any differences between annual use rates might be attributable to seasonal differences in travel patterns and restraint/helmet use rather than solely to changes in driver and occupant behavior.

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INTRODUCTION

Virginia has monitored safety belt use data for almost 30 years. In the last 11 years, since the onset of a federally approved survey design, the use rate has hovered between 67 and 74 percent, despite significant efforts aimed at increasing usage on the statewide and local level, and despite a mandatory belt use law. Research has shown safety belts can reduce the risk of death of front seat occupants of passenger motor vehicles by 45 percent and decrease the risk of serious injury for front seat occupants of passenger motor vehicles by 50 percent.[3] In addition, inpatient hospital care costs for an unbelted crash victim are 55 percent higher than those for a crash victim wearing a safety belt.[4]

On January 23, 1997, President Clinton directed the U.S. Secretary of Transportation to develop a plan to increase safety belt use in the United States. On April 16, 1997, a plan was presented to the president that established a goal of 85 percent use by the year 2000 and 90 percent use by 2005. As part of the Transportation Equity Act for the 21st Century, Section 157 of Title 23 was added, which established a new safety belt incentive grant program for allocating funds to the states. The final rule concerning grant allocation became effective May 29, 2001. Under this statute, funds are to be allocated to states whose seat belt use rate exceeds either the national average seat belt use rate or the state's highest-achieved seat belt use rate during particular years. Allocations are based on savings in medical costs to the federal government resulting from these seat belt use rates.[5]

On April 14, 2000, the National Highway Traffic Safety Administration (NHTSA) published the final rule concerning methodological requirements for state seat belt surveys. Under this statute, in order to be considered for incentive grant funds under Section 157, states must meet particular criteria to ensure that the survey measurements are "accurate and representative."[6]

This ruling incorporated in large part many of the earlier survey requirements of its predecessor document.[7] For instance, the final rule continued the requirement that surveys have a probability-based design; that only direct observational data be used to demonstrate compliance; that the relative error of the seat belt use estimate not exceed 5 percent; that counties or other primary sampling units totaling at least 85 percent of the state's population be eligible

for inclusion in the sample; that all daylight hours for all days of the week be eligible for selection; and that the sample design, data collection, and estimation procedures be well documented. The sample design must also include predetermined protocols for (1) determining sample size; (2) selecting sites; (3) selecting alternate sites when necessary; (4) determining which route, lane, and direction of traffic flow are to be observed; (5) collecting the observational data; and (6) beginning and concluding an observation period.

In addition to these established protocols, the modified ruling imposed or clarified other requirements to ensure consistency with statutory provisions of Section 157. The revised requirements mandated that determination of safety belt use rate:

- be based on "passenger motor vehicles," defined as cars, pickup trucks, vans, minivans, and sport utility vehicles
- include observations of both drivers and front seat outboard passengers
- exclude child restraint devices from the survey observation requirement
- be based on measurements of seat belt use taken completely within the calendar year for which the seat belt use rate is reported
- include both in-state and out-of-state vehicles.

The methods and procedures that qualified Virginia for incentive fund consideration from 1992 through 2003 were used in all 11 official summer surveys as well as the two internal-use-only winter surveys. This report summarizes the results of the most recent winter survey.

PURPOSE AND SCOPE

The purpose of this project was to conduct a survey of safety belt and motorcycle helmet use in Virginia in accordance with NHTSA's criteria as a means to track the effectiveness of the fall statewide campaign of education and enforcement efforts to increase safety belt usage.

This report describes the methodology used for site selection and data collection and adds the results of the December 2003 survey to those of previous surveys. In 2003, 20 new sites were added to enhance statistical power. This gave Virginia a total of 140 sites to be surveyed. Beginning with the 2003 summer survey, population figures were reexamined based on updated census data. In the last several years, the dates for the safety belt surveys varied, although the day of the week and time of day remained the same. From 1992 through 2001, surveys began the last Thursday in May and ended the second week in July. In 2002, at the request of NHTSA, the summer survey was begun the fourth week of April. In 2003, the summer survey was conducted starting Monday, June 1, and concluding Sunday, June 21, with the intent to carry out future summer surveys using this time frame.

In December 2002, at the request of the Virginia Department of Motor Vehicles, a second statewide safety belt observational survey was conducted. The December 2003 survey marks the second consecutive year of this project. Both the December 2002 and the December 2003 surveys were conducted during the first three weeks of December, with rescheduling of "rained

out" sites during the fourth week. Since the winter survey occurred during a time period when days were very short and during which daylight saving time was not in effect, some of the later sites could not be surveyed because of darkness. As suggested by the NHTSA statistical staff, new times for these later sites were randomly selected during daylight hours. Thus, because of the change in survey dates, modification of times necessitated during the winter survey, addition of new sites, and reexamined population figures, longitudinal comparisons between use rates in 2002 and 2003 and use rates in other years should be interpreted with caution. Any differences between annual use rates might be attributable to seasonal differences in travel patterns and restraint/helmet use rather than solely to changes in driver and occupant behavior.

METHODS

This survey method includes five tasks: (1) defining the population from which the sample was drawn, (2) determining the number of survey sites, (3) developing the sampling plan (4) developing procedures and collecting data, and (5) determining how estimates would be weighted to approximate statewide figures.

Population

According to federal guidelines, local jurisdictions that made up less than 15 percent of the state's total population could be removed from the study population. In Virginia, determining which localities made up 15 percent of the population was difficult. In most states, a city is a part of the surrounding county. In Virginia, although towns are considered to be a part of the surrounding county, the 41 independent cities are not. To accommodate this arrangement of political jurisdictions, both counties and independent cities were considered in establishing the sampling population.

Beginning with the 2003 summer survey, population figures were reexamined based on new census data. Table 1 shows the 136 counties and independent cities in Virginia ranked by population. According to 2000 census figures, Virginia's total population was about 7.1 million. However, most of the population is located in the four population centers: Northern Virginia, Tidewater, Richmond, and Roanoke. There is a great disparity between the populations of rural and urban areas. For instance, the least populated county, Highland, had fewer than 2,600 residents, and the least populated city, Norton, had fewer than 4,000. Twenty-two of the 136 political jurisdictions had a population less than 10,000, and another 39 had a population between 10,000 and 20,000. About 45 percent of the jurisdictions had fewer than 20,000 residents and accounted for 10.2 percent of the state's total population. On the other hand, 14 jurisdictions had a population of more than 100,000 and accounted for more than 53 percent of the total population of the state. Because of this disparity in population, the 75 least populated jurisdictions (the shaded portion of Table 1) made up just fewer than 15 percent of the state's population; thus, they were excluded from sampling. All other locations in the state were equally eligible for inclusion in the sample.

Table 1
POPULATION BY POLITICAL JURISDICTION
December 2003

Jurisdiction	Jurisdiction Population	Cumulative Population	Cumulative Percent	Jurisdiction	Jurisdiction Population	Cumulative Population	Cumulative Percent
Highland County	2,536	2,536	0.04	Winchester	23,585	924,370	13.06
Norton City	3,904	6,440	0.09	Lee County	23,589	947,959	13.39
Clifton Forge	4,289	10,729	0.15	Staunton	23,853	971,812	13.73
Bath County	5,048	15,777	0.22	Dinwiddie County	24,533	996,345	14.08
Craig County	5,091	20,868	0.29	Salem	24,747	1,021,092	14.43
Emporia	5,665	26,533	0.37	Louisa County	25,627	1,046,719	14.79
Bedford	6,299	32,832	0.46	Orange County	25,881	1,072,600	15.15
Covington	6,303	39,135	0.55	Buchanan County	26,978	1,099,578	15.53
Buena Vista	6,349	45,484	0.64	Wythe County	27,599	1,127,177	15.92
King and Queen County	6,630	52,114	0.74	Carroll County	29,245	1,156,422	16.34
Surry County	6,829	58,943	0.83	Isle of Wight County	29,728	1,186,150	16.76
Galax	6,837	65,780	0.93	Russell County	30,308	1,216,458	17.19
Lexington	6,867	72,647	1.03	Botetourt County	30,496	1,246,955	17.62
Bland	6,871	79,518	1.12	Warren County	31,584	1,278,538	18.06
Charles City County	6,926	86,444	1.22	Amherst County	31,894	1,310,432	18.51
Rappahannock County	6,983	93,427	1.32	Mecklenburg County	32,280	1,342,812	18.97
Franklin	8,346	101,773	1.44	Prince George County	33,047	1,375,859	19.44
Richmond County	8,809	110,582	1.56	Smyth County	33,081	1,408,940	19.90
Cumberland County	9,017	119,599	1.69	Petersburg	33,740	1,442,680	20.38
Mathews County	9,207	128,806	1.82	Culpeper County	34,262	1,476,942	20.87
Middlesex County	9,932	138,738	1.96	Gloucester	34,780	1,511,722	21.36
Essex County	9,989	148,727	2.10	Shenandoah County	35,075	1,546,797	21.85
Manassas Park	10,290	159,017	2.25	Pulaski County	35,127	1,581,924	22.35
Falls Church	10,377	169,394	2.39	Manassas	35,135	1,617,059	22.84
Amelia County	11,400	180,794	2.55	Halifax County	37,355	1,654,414	23.37
Greenville County	11,560	192,354	2.72	Accomack County	38,305	1,692,719	23.91
Poquoson	11,566	203,920	2.88	Wise County	40,123	1,732,842	24.48
Lancaster County	11,567	215,487	3.04	Harrisonburg	40,468	1,773,310	25.05
Williamsburg	11,998	227,485	3.21	Tazewell County	44,598	1,817,908	25.68
Northumberland County	12,259	239,744	3.39	Charlottesville	45,049	1,862,957	26.32
Charlotte County	12,472	252,216	3.56	Franklin County	47,286	1,910,243	26.99
Sussex County	12,504	264,720	3.74	James City County	48,102	1,948,345	27.67
Madison County	12,520	277,240	3.92	Danville	48,411	2,006,756	28.35
Clark County	12,652	289,892	4.10	Campbell County	51,078	2,057,834	29.07
Allegany County	12,926	302,818	4.28	Washington County	51,103	2,108,937	29.79
Northampton County	13,093	315,911	4.46	Fauquier County	55,139	2,164,076	30.57
King William County	13,146	329,057	4.65	York County	56,297	2,220,373	31.37
Lunenburg County	13,146	329,057	4.83	Henry County	57.930	2,278,303	32.19
New Kent County	13,462	355,655	5.02	Frederick County	59,209	2,337,512	33.02
Appomattox County	13,705	369,370	5.22	Bedford County	60,371	2,397,883	33.88
Floyd County	13,874	383,244	5.41	Pittsylvania County	61,745	2,459,628	34.75
Nelson County	14,445	397,689	5.62	Suffolk	63,677	2,523,305	35.65
Greene County	15,244	412,933	5.83	Lynchburg	65,269	2,588,574	36.57
Martinsville	15,416	428,349	6.05	Augusta County	65,615	2,654,189	37.50
Buckingham County	15,623	443,972	6.27	Rockingham County	67,725	2,721,914	38.45
Nottoway County	15,725	459,697	6.49	Albemarle County	79,236	2,801,150	39.57
Radford	15,859	475,556	6.72	Montgomery County	83,629	2,884,779	40.75
Dickenson County	16,395	491,951	6.95	Roanoke	85,778	2,970,557	41.97
Giles County	16,657	508,608	7.19	Hanover	86,320	3,056,877	43.19
Westmoreland County	16,718	525,326	7.42	Spotsylvania County	90,395	3,147,272	44.46
King George County	16,803	542,129	7.66	Stafford County	92,446	3,239,718	45.77
Goochland County	16,863	558,992	7.90	Roanoke	94,911	3,334,629	47.11
Colonial Heights	16,897	575,889	8.14	Portsmouth	100,565	3,435,194	48.53
Bristol	17,367	593,256	8.38	Alexandria	128,283	3,563,477	50.34
Southampton County	17,482	610,738	8.63	Hampton	146,437	3,709,914	52.41
Grayson County	17,917	628,655	8.88	Loudoun County	169,599	3,879,513	54.81
Brunswick County	18,419	647,074	9.14	Newport News	180,150	4,059,663	57.35
Fredericksburg	19,279	666,353	9.41	Arlington County	189,453	4,249,116	60.03
Patrick County	19,407	685,760	9.69	Richmond	197,790	4,446,906	62.82
Waynesboro	19,520	705,280	9.96	Chesapeake	199,184	4,646,090	65.64
Prince Edward County	19,720	725,000	10.24	Norfolk	234,403	4,880,493	68.95
Fluvanna County	20,047	745,047	10.53	Chesterfield County	259,903	5,140,396	72.62
Rockbridge County	20,808	765,855	10.82	Henrico County	262,300	5,402,696	76.33
Fairfax	21,498	787,353	11.12	Prince William County	280,813	5,683,509	80.29
Caroline County	22,121	809,474	11.44	Virginia Beach	425,257	6,108,766	86.30
Hopewell	22,354	831,828	11.75	Fairfax County	969,749	7,078,515	100.00
Powhatan County	22,377	854,205	12.07				
Page County	23,177	877,382	12.40				
Scott County	23,403	900,785	12.73	Total Population	7,078,515		

Number of Survey Sites

Starting in 1993, NHTSA required Virginia to use 120 sites to be allocated to urban and rural areas based on population. In 2003, 20 new sites were added to enhance statistical power. This gave Virginia a total of 140 sites to be surveyed.

Sampling Plan

Sites to be surveyed were selected using the standard map of Virginia issued by the Virginia Department of Transportation (VDOT) drawn to a scale of 1 inch equals 13 miles. The researchers removed counties that accounted for less than 15 percent of the total population of the state based on the 2000 census data. They then placed a transparent grid with sections 1/4 by 1/4 inch (sixteen 1/4-inch grids per square inch) over the prepared state map. Each 1/4-inch grid box contained an area of approximately 10.5 square miles. This procedure produced a system of 160 sections across the horizontal axis and 72 sections down the vertical axis. However, because Virginia is not perfectly rectangular, some sections fell outside the geographical area or were wholly within excluded areas and were not included in the population.

Each valid grid box containing at least one intersection in an included part of Virginia was numbered. Random numbers had been generated to select the original 120 sites and were also generated to select the additional 20 sites from the 2,780 grid boxes, without replacement, from which specific intersections were selected.

To respond to a concern expressed by NHTSA that a purely statewide random sample of 140 sites would over-represent the non-urban areas of Virginia, the originally proposed procedures were changed. The selection of sites was based on the proportion of the population in the urban and rural areas of the state. Excluding the lowest 15 percent of the population, the urban areas had about 68 percent of the remaining population and the rural areas had about 32 percent. Of the 140 total sites, 85 were randomly selected from the four metropolitan areas and 55 were randomly selected from the remainder of the state.

After grid boxes were randomly selected, the box location was transferred to a more detailed map (VDOT county maps or ADC map books for more urban areas).[8-12] One 1/4-inch grid section on the state map represented a section approximately 2 by 2 inches on the VDOT county map (see Figure 1).

Each intersection in a selected grid box was numbered, left to right and bottom to top. A random number was generated to select the specific intersection to be used. Two alternate sites were also selected randomly. For each primary and alternate site, random numbers were used to select the route and direction of travel to be sampled, as well as whether traffic entering or exiting the selected intersection would be observed. Examples of urban and rural site selection maps appear in Figures 2 and 3.

Staff of the Virginia Transportation Research Council visited and evaluated each site to determine whether data could be safely and adequately collected. The safety of the observer was

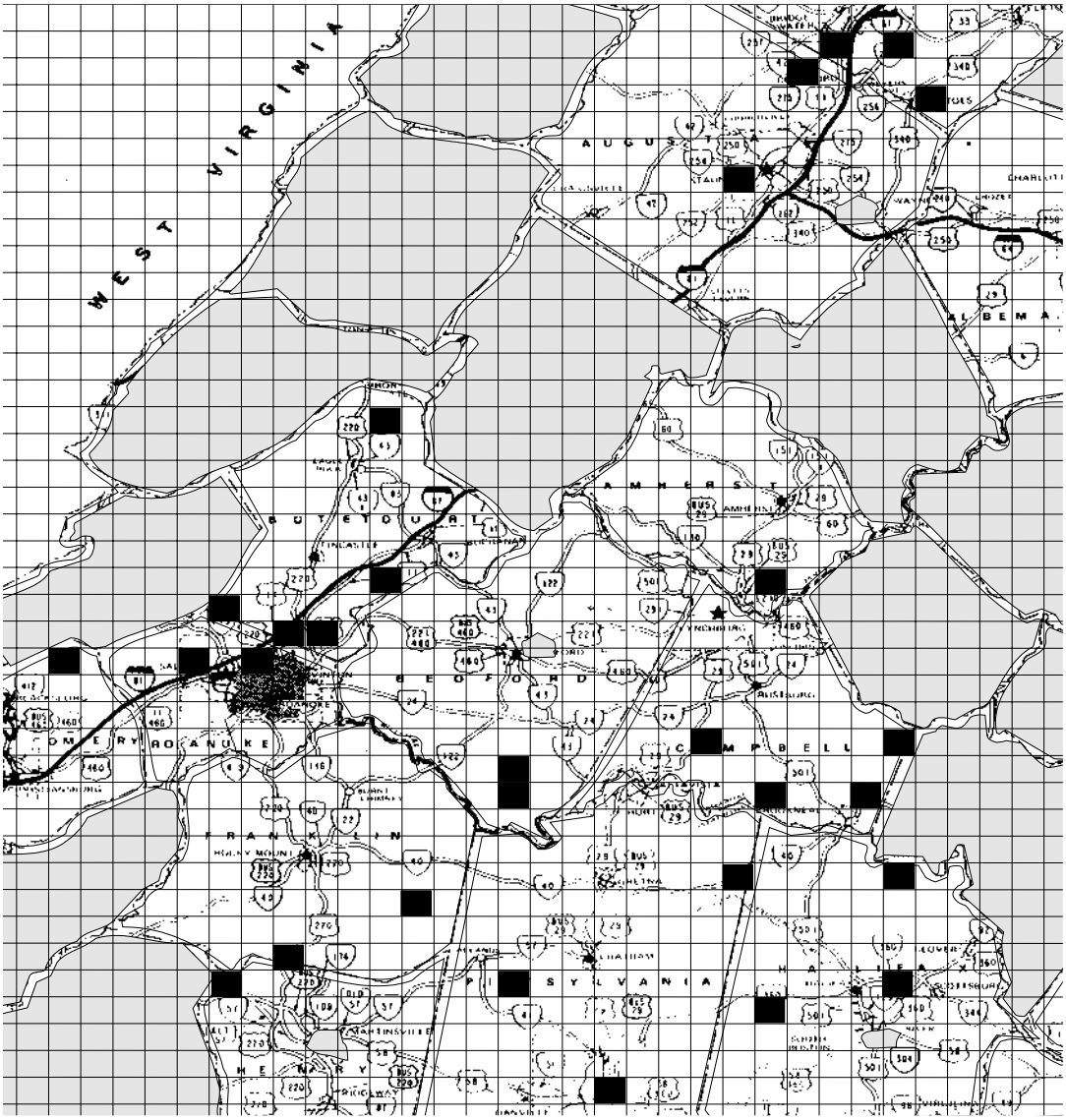

Figure 1. Sample Section of State Map Showing Grid Boxes

Figure 2. Detail of Urban Grid Showing Intersection Choices. Copyright ADC The Map People. USED WITH PERMISSION.

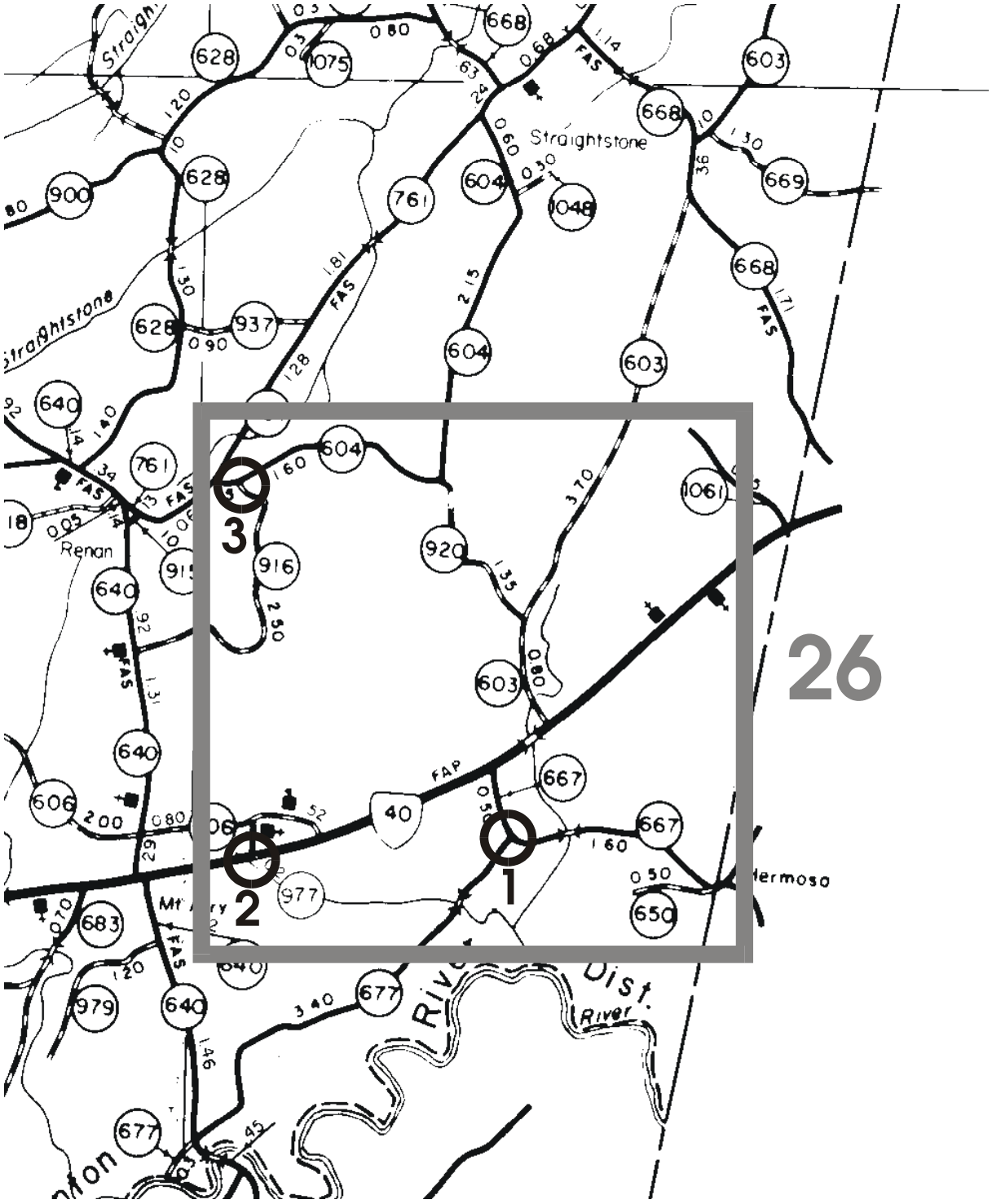

Figure 3. Detail of Rural Grid Showing Intersection Choices

the primary criterion for evaluating each site, followed by the ability to observe traffic. If an intersection was found to be inadequate, attempts were made to find an adequate observation point downstream if traffic exiting the intersection was to be observed and upstream if entering traffic was to be observed. The adequacy of the observation point was determined by locating a

point before the next intersection that ensured the exact same traffic characteristics would be present at the upstream or downstream sites as would have been present at the original intersection. In either case, if an adequate site could not be found before the next intersection was reached, one of the two alternate sites was investigated. Very few original sites were discarded in favor of alternates. Those that were discarded had no safe area for the observer to stand or park or necessitated that the observer be below the level of the roadway, making observation impossible. The data collectors were given a site map indicating the layout of the site and the location from which data would be collected, as well as photographs of the site and the observation point.

After selection, the sites were sorted geographically into seven groups. The days of the week were randomly assigned, without replacement, to each geographic group. Data were collected for 1 hour at each site. The December 2003 survey began and ended the first three weeks of December with rescheduling of rained-out sites during the fourth week. For each day, the sites in a geographic group were assigned a random hour to begin, without replacement, from 7 A.M. to 3 P.M. When inclement weather precluded the collection of data at a site, data were collected at that site at a later date but at the originally specified time and on the same day of the week.

It should be noted that because of the change in survey dates, modification of times necessitated during the winter survey, addition of new sites, and reexamined population figures, longitudinal comparisons between use rates in 2002 and 2003 and use rates in other years should be interpreted with caution. Any differences between use rates might be attributable to seasonal differences in travel patterns and restraint/helmet use rather than solely to changes in driver and occupant behavior.

Data Collection Procedures

The specified drivers and outboard front seat adult passengers 16 years and older traveling in all passenger motor vehicles in the curb lane were observed for shoulder belt use. The designation "passenger motor vehicle" included cars, pickup trucks, vans, minivans, and sport utility vehicles. Observations began precisely on the hour and ended on the hour. If a momentary interruption occurred, the observer was instructed to resume observing vehicles, but to ensure that the beginning observation was not a nonrandom selection by the observer, data collection resumed with the third vehicle to pass the site after the observer was ready.

Observations were recorded using eight counters mounted on a hand-held board. A "yes" or "no" count was made for shoulder belt use for drivers and outboard front seat passengers for each passenger car in the curb travel lane and for motorcycle driver and passenger helmet use in any lane at the intersection. Since observation points were preselected at each site, the data collectors were instructed to use intersection diagrams and photographs to locate the point at which observations were to be made.

Data collectors received thorough training on the survey protocol prior to the actual observation period. They were required to complete a training program on the use of the counter

board and how the data were to be collected and recorded. This training included several roadside observation periods in which all of the data collectors made observations at the same location at the same time. They were then instructed to record their observations, which were subsequently checked by the trainer for accuracy and inter-rater reliability. In order to gauge data collector consistency in various kinds of traffic, sessions were held at observation sites that differed by geographic characteristics and traffic volumes. Training continued until all data collectors obtained the same observation outcomes at all sites.

Calculation of Use and Error Rates

Because safety belt use was observed only in the curb lane, NHTSA's guidelines required that the observations on multilane highways be weighted by the number of lanes of travel. However, no such weighting was necessary for motorcycles, which were observed in all lanes of travel. For passenger motor vehicles at each site, the number of driver and passenger observations was multiplied by the number of lanes in the observed direction of travel. Thus, at a site with two lanes in the travel direction, the number of observations was doubled to estimate the total number of drivers and passengers crossing through the site. As previously discussed, the selection of sites was stratified to represent urban and rural areas in proportion to their populations. Thus, more than two-thirds of the sites were in urban areas.

In accordance with the recommendation by NHTSA's Washington Headquarters staff, Virginia used the following formulae to compute the state's safety belt use rate.[13] The use rate P_B, is the estimated proportion of drivers and passengers using safety belts and is calculated by the formula:

$$P_B = \frac{\sum_{t=1}^{2} \frac{N_t}{n_t} \sum_{i=1}^{n_t} N_{ti} B_{ti}}{\sum_{t=1}^{2} \frac{N_t}{n_t} \sum_{i=1}^{n_t} N_{ti} O_{ti}}$$

where: t = stratum (1 = urban, 2 = rural)
t_i = each site within a stratum
N_t = total number of grid boxes within stratum t
n_t = number of grid boxes selected from each stratum t
N_{ti} = total number of intersections within each sampled grid box
B_{ti} = number of belted occupants observed at site ti (weighted by lanes)
O_{ti} = total number of occupants observed at site ti (weighted by lanes).

The variance of the estimated belt use, $V(P_B)$, was approximated by the formula:

$$V(P_B) = \frac{1}{\bar{O}^2} [V(B) + P_B^2 V(O) - 2P_B COV(B, O)]$$

where $\overline{O}$ is the weighted average number of occupants observed per site and is computed by the formula:

$$\overline{O} = \frac{1}{2}\sum_{t=1}^{2}\frac{\sum_{i=1}^{n_t} N_{ti}O_{ti}}{n_t}$$

and where *V(B)* is the variance of the number of belted occupants and is computed by the formula:

$$V(B) = \frac{1}{(N_1+N_2)^2}\sum_{t=1}^{2}\frac{N_t^2}{n_t(n_t-1)}\sum_{i=1}^{n_t}(N_{ti}B_{ti}-\overline{B}_t)^2$$

$$\text{where } \overline{B}_t = \frac{\sum_{i=1}^{n_t} N_{ti}B_{ti}}{n_t}$$

and where *V(O)* is the variance of the number of observed occupants and is computed by the formula:

$$V(O) = \frac{1}{(N_1+N_2)^2}\sum_{t=1}^{2}\frac{N_t^2}{n_t(n_t-1)}\sum_{i=1}^{n_t}(N_{ti}O_{ti}-\overline{O}_t)^2$$

$$\text{where } \overline{O}_t = \frac{\sum_{i=1}^{n_t} N_{ti}O_{ti}}{n_t}$$

and where *COV(B, O)* is the covariance of the number of belted and observed occupants and is computed by the formula:

$$COV(B,O) = \frac{1}{(N_1+N_2)^2} \sum_{t=1}^{2} \frac{N_t^2}{n_t(n_t-1)} \sum_{i=1}^{n_t} (N_{ti}B_{ti} - \bar{B}_t)(N_{ti}O_{ti} - \bar{O}_t)$$

The standard error of the estimate was calculated by the formula [13]

$$SE = \frac{SD}{\sqrt{n-1}}$$

where SE = standard error of the estimate
n = total number of sites sampled
SD = standard deviation or square root of variance.

The relative error of the estimate was calculated by the formula:

$$RE = \frac{SE}{P_B}$$

where RE = relative error of the estimate.

RESULTS

The survey team observed 14,591 drivers and 3,809 right-front passengers for the use of a shoulder belt. Because the survey data were collected from moving traffic, the use of the lap portion of a belt system could not be observed. For computing a statewide use rate, the observations were weighted by the number of traffic lanes in the direction of traffic flow at the site where the data were collected (see Tables A-1 and A-2 in the Appendix for the complete data counts).

There were 18,354 weighted observations of occupants in passenger motor vehicles. There were 10,640 drivers and 2,554 right-front passengers who were observed to be using a shoulder belt. Motor vehicle occupants had a weighted safety belt use rate of 73.1 percent. The relative error of the estimate was 0.89 percent.

There were also 10 motorcycle riders observed (10 drivers and 0 passengers). The sample size for motorcycle drivers and passengers is considerably smaller than in the summer 2003, consistent with the previous December survey, probably because of the cold weather. The rate of helmet use was 100 percent, and because the use rate was 100 percent, there was no relative error of the estimate.

The results of the 1992 to 2003 surveys are summarized in Table 2. In each of the 11 most recent years of the survey, virtually all of the motorcycle drivers and passengers observed

Table 2. Survey Results for 1992 through 2003

Year	Vehicle Type	Weighted Observations	Drivers Protected	Passengers Protected	Use Rate (%)	Variance (%)	Standard Error (%)	Relative Error (%)
December 2003	Cars	18,354	13,268	2,547	73.1	0.50	0.65	0.89
	Motorcycles	10	10	0	100.0	0.00	0.00	0.00
Summer 2003	Cars	22,924	13,672	3,341	74.6	0.61	0.71	1.01
	Motorcycles	263	241	20	98.7	0.17	0.38	0.38
December 2002	Cars	18,424	10,543	2,305	71.1	0.24	0.44	0.62
	Motorcycles	20	18	1	95.7	1.10	0.30	0.32
Summer 2002	Cars	20,911	11,718	2,577	70.4	0.60	0.71	1.01
	Motorcycles	87	77	10	100.0	0.00	0.00	0.00
2001	Cars	37,393	21,056	5,583	72.3	1.10	0.96	1.33
	Motorcycles	387	332	55	100.0	0.00	0.00	0.00
2000	Cars	38,668	21,014	5,539	69.9	0.47	0.63	0.89
	Motorcycles	222	201	20	99.9	0.00	0.004	0.04
1999	Cars	37,869	20,213	5,445	69.9	0.49	0.64	0.92
	Motorcycles	198	169	28	99.1	0.27	0.47	0.48
1998	Cars	31,877	17,987	4,686	73.6	1.33	1.06	1.44
	Motorcycles	229	205	23	99.6	0.00	0.04	0.04
1997	Cars	35,508	18,544	5,013	67.1	1.88	1.26	1.87
	Motorcycles	134	121	11	98.7	0.04	0.18	0.18
1996	Cars	26,975	14,278	4,577	69.6	1.63	1.17	1.68
	Motorcycles	99	85	14	100.0	0.00	0.00	0.00
1995	Cars	29,584	15,632	4,521	70.2	1.52	1.13	1.61
	Motorcycles	247	208	39	100.0	0.00	0.00	0.00
1994	Cars	25,291	14,146	4,271	71.8	0.74	0.79	1.10
	Motorcycles	105	90	15	100.0	0.00	0.00	0.00
1993	Cars	24,299	13,045	4,396	73.2	0.89	0.86	1.18
	Motorcycles	236	208	28	100.0	0.00	0.00	0.00
1992	Cars	26,320	14,701	4,233	71.6	1.11	0.97	1.35
	Motorcycles	53	47	6	100.0	0.00	0.00	0.00

were using a helmet. For the passenger motor vehicle drivers and right-front passengers observed in the 11 years of the study, use rates varied from 67.1 percent in 1997 to 74.6 percent in the summer 2003. The December 2003 use rate of 73.1 percent represents an increase from the December 2002 use rate of 71.1 percent but a decrease from the 74.6 percent use rate in the summer 2003. It should be remembered, however, that because of the change in survey dates, modification of times necessitated during the winter survey, addition of new sites, and reexamined population figures, longitudinal comparisons between use rates in 2002 and 2003 and use rates in other years should be interpreted with caution. Any differences in annual use rates might be attributable to seasonal differences in travel patterns and restraint/helmet use, rather than solely to changes in driver and occupant behavior.

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APPENDIX: DECEMBER 2003 RAW DATA BY SITE

Table A-1. 2003 Urban Raw Data by Site[a]

SITEID	LANES	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	MC O_{ti}
2	1	10	12	28	0	0
7	2	408	55	79	0	0
8	1	7	3	4	0	0
11	1	82	4	4	0	0
15	2	6	238	296	0	0
17	4	115	184	236	0	0
19	1	10	118	146	0	0
20	1	7	18	22	0	0
21	1	148	50	61	0	0
28	1	3	3	7	0	0
30	1	3	131	188	0	0
32	1	244	52	62	0	0
40	3	254	163	249	0	0
41	1	211	237	272	0	0
42	1	36	20	40	0	0
46	1	5	31	46	0	0
49	1	6	2	2	0	0
54	2	504	190	240	0	0
58	1	15	198	284	0	0
67	1	5	2	8	0	0
68	1	24	7	19	0	0
69	1	1	623	820	2	2
81	1	6	13	22	0	0
86	2	7	150	231	0	0
90	1	1	60	94	0	0
92	2	142	215	291	1	1
105	1	24	66	90	0	0
118	1	7	17	25	0	0
119	2	32	461	618	2	2
120	2	546	64	90	0	0
121	1	7	300	328	0	0
124	1	21	49	85	0	0
136	1	23	79	131	0	0
140	3	3	518	633	0	0
154	1	8	48	74	0	0
169	4	4	185	266	0	0
170	1	19	17	22	0	0
173	2	331	200	313	1	1
183	1	8	15	30	0	0
202	1	59	49	94	0	0
206	1	17	18	21	0	0

Table A-1 (continued)
2003 Urban Raw Data by Site[a]

SITEID	LANES	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	MC O_{ti}
210	2	73	260	359	0	0
211	1	253	136	191	0	0
213	1	376	96	133	0	0
234	1	197	4	7	0	0
236	1	87	61	100	0	0
250	1	16	0	3	0	0
259	3	532	77	81	0	0
275	2	526	345	399	1	1
280	1	104	22	28	0	0
290	2	3	184	249	0	0
300	1	110	6	9	1	1
306	1	12	0	2	0	0
313	3	186	623	760	0	0
315	1	9	131	188	0	0
317	2	444	17	21	0	0
322	1	1	68	90	0	0
324	2	82	161	207	0	0
330	1	16	75	114	0	0
332	3	8	228	276	0	0
353	1	11	100	140	0	0
359	1	9	91	110	0	0
371	2	64	66	87	0	0
372	3	5	320	481	0	0
374	1	26	16	21	0	0
375	1	12	106	132	0	0
385	3	30	204	372	0	0
388	1	10	8	9	0	0
400	1	385	86	130	0	0
403	2	341	174	234	0	0
406	2	374	263	456	0	0
411	1	19	86	136	0	0
420	1	223	88	97	0	0
425	1	365	76	102	0	0
426	2	626	280	421	0	0
434	1	25	7	11	0	0
450	2	15	117	192	0	0
458	2	180	110	176	0	0
464	1	21	22	44	0	0
471	1	13	2	3	0	0
476	1	13	86	111	0	0
477	1	11	22	38	0	0
483	1	2	135	175	0	0
508	2	628	90	156	0	0
512	1	15	141	160	0	0

Table A-1 (continued)
2003 Urban Raw Data by Site[a]

SITEID	LANES	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	MC O_{ti}
621	1	32	120	206	0	0
674	1	4	6	13	0	0
712	1	10	8	12	0	0
746	1	11	21	38	0	0
781	1	5	122	171	0	0
932	3	2	371	480	0	0

[a]Site ID = identifier of site sampled.
Lanes = number of lanes in sampled direction at site.
N_{ti} = number of intersections within sample grid.
B_{ti} = number of belted occupants observed at site.
O_{ti} = number of occupants observed at site.
MC B_{ti} = number of motorcycle occupants with helmets at site.
MC O_{ti} = number of motorcycle occupants observed at site.

Table A-2. 2003 Rural Raw Data by Site[a]

SITEID	LANES	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	MC O_{ti}
1	1	15	40	83	0	0
4	1	9	49	77	0	0
5	2	9	2	12	0	0
6	1	16	91	116	0	0
10	1	5	7	9	1	1
12	2	4	170	284	0	0
13	1	17	29	35	0	0
16	1	4	5	8	0	0
22	1	12	63	93	0	0
23	1	7	91	132	1	1
25	1	6	49	77	0	0
26	1	9	10	25	0	0
27	1	13	0	2	0	0
29	1	6	20	27	0	0
31	1	7	4	19	0	0
33	1	15	99	157	0	0
35	1	9	38	48	0	0
36	1	12	54	87	0	0
37	1	1	28	40	0	0
39	1	10	3	13	0	0
44	1	7	5	8	0	0
45	1	7	60	117	0	0
47	2	18	315	346	0	0
48	1	15	6	8	0	0
50	1	8	81	120	0	0
51	1	11	2	6	0	0
52	1	3	16	43	0	0
53	1	2	75	107	0	0
55	1	12	24	43	0	0
56	1	5	33	59	0	0
57	1	13	12	36	0	0
59	1	7	4	7	0	0
62	1	13	100	165	0	0
63	1	15	135	163	0	0
587	1	7	73	106	0	0
593	1	21	11	19	0	0
595	2	19	237	400	0	0
617	1	4	0	7	0	0
679	1	15	106	145	0	0
695	1	14	24	68	0	0
718	1	13	44	85	0	0

Table A-2 (continued).
2003 Rural Raw Data by Site[a]

SITEID	LANES	Nti	Bti	Oti	MC Bti	MC Oti
725	1	5	137	163	0	0
802	1	3	4	4	0	0
860	1	18	12	24	0	0
899	1	15	4	7	0	0
910	1	8	8	11	0	0
927	1	16	52	74	0	0
935	1	3	4	5	0	0
957	1	10	5	8	0	0

[a]Site ID = identifier of site sampled.
Lanes = number of lanes in sampled direction at site.
N_{ti} = number of intersections within sample grid.
B_{ti} = number of belted occupants observed at site.
O_{ti} = number of occupants observed at site.
MC B_{ti} = number of motorcycle occupants with helmets at site.
MC O_{ti} = number of motorcycle occupants observed at site.