



Nighttime seatbelt usage data collection: When and how long?



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ABSTRACT

Higher proportion of non-seatbelt usage rates in crashes occurring during nighttime shows that daytime seatbelt usage alone may not indicate the overall usage patterns. These findings have prompted various agencies to estimate seatbelt usage rates during nighttime. These agencies developed their own methodology for data collection and data analyses. In spite of all these recent developments, collecting representative sample at nighttime remains an issue which requires a lot of effort. This paper is an attempt to develop a methodology to collect nighttime seatbelt usage data more efficiently and accurately based on a mathematical sampling theory. Based on this methodology, two sets of data collection per site are recommended. Duration of data collection varies depending on vehicle miles traveled at the site of interest. The authors hope that this methodology could be used in other transportation related data collection efforts, where identifying critical time and time duration for collecting representative data samples are important.

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1. Introduction

Effectiveness of seatbelts in improving passenger safety is a known fact. Several studies including those by Houston and Richardson [1], Connor et al. [2], and Thomas et al. [3] studied the effectiveness of safety belt laws, level of enforcement, and amount of fine on seatbelt usage rates. Strine et al. [4] concluded that primary seatbelt laws are very effective in increasing seatbelt use. Several studies have documented advantages of using seatbelts, various methods to quantify characteristics of seatbelt usages using available resources and observational data [5–7].

Seatbelt usage is widely considered as one of the most important factors in reducing crash severity at nighttime [8]. Several studies show an increasing trend in driving under influence during night. This is one of several factors which lead to the assumption that the usage rate at night is lower than the daytime usage rates. Data from Fatality Analysis Reporting System (FARS) indicate that the use of seatbelts reduces the risk of fatal injury to front-seat passenger car occupants by 45% and the risk of moderate-to-critical injury by 50% [9]. The National Occupant Protection Use Survey (NOPUS) [10] conducted by the National Highway Traffic Safety Administration (NHTSA) reports

that the nationwide belt use exceeds 80%. It is important to note that all of the reported data are from daytime observations. Studies conducted in various states show that nighttime seatbelt usage rates are lower than daytime usage. The state of Nevada conducts several media and enforcement campaigns to improve seatbelt usage rates [6,11]. These evaluations are carried out only using daytime seatbelt usage observations.

Vivoda et al. [12] stated that the seatbelt usage rates among fatally injured front-seat passengers were less than 35% between the hours of 10:00 PM. and 5:00 AM whereas belt usage rates among fatality-injured passengers between 8:00 AM and 5:00 PM were about 55%. Chaudhary et al. [13] conducted a study to compare day and nighttime belt usage by means of night vision technology. The results from this study showed that belt use during the day was 83.0% while belt use at night was 76.6%.

2. Objective

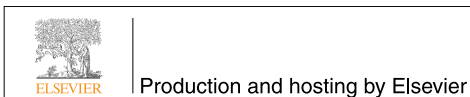
The objective of this paper is to study the available resources in estimating nighttime seatbelt usage rates and to develop a methodology for nighttime data collection using data collected from Las Vegas metropolitan area in Nevada. This includes identifying a methodology to estimate the appropriate time of data collection and data collection duration for efficient and accurate estimation of nighttime seatbelt usage rates that would be representative of overall nighttime usage rates.

3. Literature review

The first step in this paper is to study all the available documents in the area of nighttime seatbelt usage rates. NHTSA guidelines for

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nighttime observation are one of the latest and the most comprehensive publications addressing issues associated with nighttime data collection. Four major studies were also found from the states of Connecticut, Indiana, Pennsylvania, and New Mexico. Summary from each of these works is provided below.

3.1. 1 NHTSA guidelines

Chaudhary et al. [14] illustrated various issues associated with nighttime seatbelt usage observations and listed solutions for these. The authors explained steps involved in conducting nighttime observation such as re-sampling of sites based on nighttime vehicle miles traveled (VMT) data, re-weighting of daytime observation plan for nighttime observations, observation protocols and issues associated with the actual data collection in field, scheduling, duration, observation techniques, and limitations. All the information listed was very thoughtful and the authors explained these concepts using examples from actual data collected at various states. This document is a very useful starting point for agencies planning for nighttime seatbelt usage estimation.

3.2. Connecticut

Connecticut's nighttime state-wide seatbelt survey was conducted for 100 sites and was conducted from 9:00 PM to 3:59 AM [13]. Each site was observed for 45 min. Night vision equipment was used for nighttime observations when roadway lighting was insufficient. To supplement this equipment, handheld infrared spotlights, visible only with the use of the night-vision goggles were used to illuminate the roadway, making vehicle occupants visible for belt observations even in total darkness. Apart from some changes nighttime procedures were consistent with daytime procedures. Due to the operational challenges of the equipment, observations were conducted by a two-person team, with one person observing traffic and the other recording the results as stated by the observer. For estimating nighttime seatbelt usage rates, Connecticut used weighting scheme to estimate nighttime usage rates based on the volume data from all the sites included in the survey.

3.3. Indiana

Indiana conducted nighttime seatbelt surveys at 113 sites for a period of 55 min each [12]. A pair of observers was used to conduct the survey in each site. One person in each data collection team conducted observations, while the other entered data into a PDA. Night vision equipments and infrared spotlight were used to enhance the visibility during nighttimes. The nighttime survey was conducted between 9:30 PM and 5:45 AM. Wherever possible (61 of 113 sites), direct day-to-night matching of data was achieved (i.e., data were collected from a specific site on the same night as when the daytime data collection occurred). This study attempted to estimate state-wide seatbelt use by using the daytime weighting scheme on nighttime data. The guidelines required that weighting be representative of traffic volume and traffic distribution across functional class and population.

3.4. Pennsylvania

In Pennsylvania, two cities, Reading and Bethlehem were selected for nighttime seatbelt surveys with 20 sites in each city [8]. Reading served as the treatment site and Bethlehem served as the comparison location. Observations (day and night) were conducted for 45 min at each site. Daytime observations occurred between 9:00 AM and 3:59 PM. Night observations took place between 9:00 PM and 3:59 AM. Twenty sites in each city were selected for the survey. When lighting on the roadway was inadequate to make the observations, night vision equipment was used. Similar to Indiana and Connecticut, nighttime observations were done by a pair of observers, with one

person observing traffic (with the equipment) and the other recording verbalized results from the observer. Selection of observation sites was made from three functional classes of roadways: principal arterial roadways, minor arterial roadways and urban collectors. The collected data at each site were assigned an individual weight based on its own VMT and additional weight based on the VMTs for the region (or county) for the functional class it belonged to.

3.5. New Mexico

The annual state-wide survey of seatbelt use is conducted by the New Mexico Department of Health during the month of June [15]. A total of 108 sites were selected which represented the State's population demographics and roadway travel. Daytime observations lasted 20 min each and were conducted between 7:00 AM and 7:00 PM, whereas nighttime observations occurred between 9:00 PM and 3:59 AM at the same locations as daytime observations and usually on the night following the daytime observations. Nighttime observation periods lasted 45 min in order to sample a sufficient number of vehicles given the lower traffic volume at night. Observations at nighttime were conducted by two observers.

Table 1 summarizes nighttime seatbelt observational studies conducted. This shows that overall, except for the Connecticut pre-campaign and Indiana post-campaign data, the daytime and nighttime usage rates do not show a notable difference. Unlike other states, in New Mexico, the observations were conducted only once.

3.6. Summary of literature review

Review of literature shows that collecting nighttime seatbelt usage rates is a challenging process. Available resources indicate that each of the states developed and followed its own process for data collection. Most of these states used similar data collection process as that of the daytime data collection, collecting data for specific time periods at sites selected from the daytime observational sites. These states also collected both daytime and nighttime seatbelt usage rates for estimation and comparison purposes. NHTSA guidelines recommend having a single data collection duration as a starting point, then increasing it by 20 minute interval, if sufficient samples are not collected. It considers uniform usage throughout night at all sites. That is, by collecting seatbelt usage data for a site for a short duration during any time of the night, overall estimates of nighttime usage rate for that site could be estimated using VMT-based weighted rates. Most of the existing studies did a commendable job in estimating nighttime seatbelt usage rates with all the constraints they faced in terms of limited observers, limited time period, and limited equipments. These studies used time variance of traffic volumes at night to estimate final area-wide usage rates.

The NHTSA guidelines are an excellent resource for agencies who are initiating efforts on nighttime seatbelt estimation. They provide detailed information required for overall planning, site selection, actual data collection, and estimation. However, like any other guidelines, they have their own limitations and scope. One major issue that agencies face before actual data collection is the time of data collection and duration which would represent the overall nighttime usage. Collecting representative data is a critical element for this exercise. Any guidelines on this aspect would help these agencies to effectively estimate seatbelt usage rates.

4. Review of Las Vegas nighttime seatbelt use study

Due to the disproportional presence of non-seatbelt usages in nighttime fatal crashes, the Nevada Department of Public Safety-Office of Traffic Safety contacted the authors at the University of Nevada, Las Vegas (UNLV) Transportation Research Center (TRC) to estimate representative nighttime seatbelt usage rates for Las Vegas metropolitan area

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