



U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

TRAFFIC TECH

Technology Transfer Series



DOT HS 813 280

June 2022

Safety in Numbers: Literature Review Report

Background

Fatalities involving bicyclists and pedestrians continue to rise. Over the last decade (2011–2020), the number of bicyclist fatalities increased 31% and the number of pedestrian fatalities increased 40% (NCSA, 2020a, 2020b; NHTSA, 2021). Many agencies are trying to understand what factors influence bicyclist and pedestrian crash risk, and how to better improve non-motorized safety. One of the factors that may help explain bicyclist and pedestrian crash risk is the concept of Safety in Numbers (SIN).

The theory of SIN posits an inverse relationship between the extent of walking/bicycling and the probability of a motorist collision with a pedestrian/bicyclist (Jacobsen, 2003). In other words, this theory proposes that when the volumes of bicyclists and pedestrians increase, the probability of bicyclists and pedestrians involved in crashes decreases. This perspective can be used to encourage programs and policies that expand the amount of walking/bicycling. However, this theory has faced challenges in the research community, with some research indicating the opposite effect; increasing rates of walking/bicycling can increase the risk of crashes involving vulnerable road users (Ramsey & Richardson, 2017).

This literature review explored these competing perspectives by investigating and summarizing available studies on the topic of SIN. The goal of this report is to allow readers to develop a more clear understanding of evidence related to the SIN concept and the factors that should be considered when implementing and evaluating policies or programs that promote walking and bicycling.

Literature Review Methodology

The literature review was designed to consider multidisciplinary fields of study and areas of practice as shown in Table 1. This breadth was especially important due to the broad target audience of this report that may apply the literature review results to their own future practice. These audiences include State Highway Safety Offices, national organizations interested in the SIN topic, constituents from the Federal Highway Administration, planners, engineers, educators, advocacy groups, policymakers, State DOTs, metropolitan planning organizations, law enforcement professionals, and roadway users—motorists, pedestrians, and bicyclists.

Search terms were constructed to identify the greatest number of relevant papers, although not all papers explicitly used the phrase “safety in numbers.” The search terms were used to discover and obtain relevant documents, which were

then subject to initial and then more critical review activities. As part of the literature review, 250 items were critically reviewed, including domestic and international sources relevant to understanding the SIN concept. Table 2 displays the number of sources by topic area, which are based on the research objectives identified in planning the review.

Table 1. Number of Sources by Field of Study or Area of Practice

Field of Study/Practice	Number of Sources
Engineering	136
Planning/Land Use	58
Encouragement	54
Behavioral Sociology	52
Behavioral Psychology	52
Education	44
Public Health	24
Enforcement	23
Behavioral (Other)	12
Human Factors	10

Table 2. Number of Sources by Topic Area

Topic Area	Number of Sources
Infrastructure	126
Findings That Support SIN	114
Includes/Discusses Collision Data	102
Factors Affecting Crash Rates	93
Programs/Efforts	67
Pedestrian/Bicyclist Behavior	31
Driver Behavior	30
Findings That Refute SIN	28
SIN Effects: Bicyclists Versus Pedestrians	8
Distraction	4

Literature Review Findings

Jacobsen (2003) completed the foundational research into the SIN theory, coining the term “safety in numbers.” He found that as the number of people walking or bicycling increased, the risk of motor vehicle and pedestrian or bicyclist crashes decreased. Jacobsen calculated that at the population level, the number of motorists colliding with people walking or bicycling will increase at roughly the 0.4 power of the number of people walking or bicycling. To exemplify this calculation, Jacobson gave the example of a community that doubled the number of people walking or biking. Using his calculation, this community would expect crashes to grow by 32%. Following the publication of his work, there began an acceleration of research using the SIN terminology.

As the theory rose in popularity, some researchers began to critically question the theory. These researchers identified several flaws regarding SIN-related research, but concluded that there is some effect present that research could not fully explain. Recent research into the SIN theory typically looked to apply Jacobsen's method to different datasets, and/or looked to incorporate other explanatory variables to better understand the effect.

As a part of this literature review, a sample of studies was analyzed to understand the robustness of the statistical methods and data used. Much like the research critical to the SIN theory, this statistical review highlighted methodological issues in several SIN-related studies. A weakness of many SIN-related studies is the data commonly used by researchers. The two required data sources to conduct a SIN-related study are exposure and safety, and there have been limitations with both types throughout the literature. Count or volume data are rarely readily available, and collecting this data is often resource intensive. Issues with safety data stem from under-reporting of injury data in crash datasets developed through police crash reports. Some researchers have been successful in introducing variables describing the built environment and behavioral characteristics, but these topics are a current gap in SIN research and are often covered only briefly, if at all, by current research.

While the SIN theory is often used to support programs and policies that encourage walking and biking, it is important to realize that crashes, injuries, and fatalities will continue to increase as more road users are entering the system; the theory states that this increase will be at a rate less than the rate of the increase in road users.

Implications and Considerations

From a public health perspective, the SIN research underscores the need to consider these other factors when moving forward with programs to increase bicyclist and pedestrian activity. Given that there are still increases in bicyclist and pedestrian injuries as volume increases, practitioners and advocates should consider adopting a multi-prong approach that includes additional education to inform and support new and vulnerable users who might adopt bicycling or walking as a mode of transit, as well as education for road users about applicable laws and practices (e.g., helmet use, infrastructure changes).

Programs and Initiatives

This literature review also identified a sample of programs and initiatives at transportation and advocacy organizations that work to increase pedestrian and bicycle travel and safety. Many of these agencies have measures of success—whether that be implementing programs or initiatives, seeing increases



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in bicycle and pedestrian volumes, and/or decreasing bicyclist and pedestrian crash rates. However, program evaluation results are not formally published or do not make the correlation between an increase in pedestrian and bicycle volume and reduced crashes, or the other factors that may influence SIN. Further, this review stated that the SIN theory is more commonly referred to and used in academia than in practice. More guidance could be useful to help transportation practitioners integrate the SIN theory into their planning and policy.

Conclusion

Despite the wealth of research on this topic, the exact cause of the SIN effect is unknown. Some research points to behavioral changes, others question the involvement of related infrastructure. There also are challenges in obtaining data in some cases, specifically regarding infrastructure and non-motorized volume data, and frequently, a lack of information about human behavior such as driver and other road user distraction. Understanding the SIN concept may help researchers and practitioners seeking to develop policies and initiatives to improve safety for all road users.

References

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How to Order

The final report *Safety in Numbers: Literature Review Report* (Report No. DOT HS 813 279) was prepared by Toxcel. It can be downloaded at <https://rosap.ntl.bts.gov/>. Kristie Johnson, Ph.D., was the task order manager for this project.

Suggested APA Citation for This Document:

Office of Behavioral Safety Research. (2022, June). *Safety in numbers: Literature review report* (Traffic Tech Technology Transfer Series. Report No. DOT HS 813 280). National Highway Traffic Safety Administration.

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