A systematic review on close-following or short headways: Preliminary findings

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Abstract

Rear-end crashes account for the highest number of crashes among all crash types. An important component in understanding rear-end crashes is close-following tendency of drivers. However, headway is not consistently defined or measured in the research literature. In order to consolidate common headway definitions, a systematic review was conducted to summarize the definitions of headways and methods of measurement. Over half of the reviewed articles did not clearly define headway, which includes contextualizing reference points of headway measure (e.g., bumper/axle/rear) and explaining the accuracy of setups used to measure headway.

Background

The safety of car-following is an important segment in making the traffic system safe. Close following and unsafe headway lead to rear end crashes leading to long term injuries, such as head and spinal cord injuries, “whiplash” neck injuries and memory loss (Nekovee & Bie, 2013). Short distances between two vehicles are sometimes the result of aggressive driving or “tailgating”, which most often lead to rear end crashes resulting to disabilities or injuries or, in worst-case scenarios, fatalities (Fiorani, Mariani, Minin, & Montanari 2008).

In order to consolidate common headway definitions, and to make recommendations on best uses and reporting of driver behavior, the objective of this study is to conduct a systematic review to summarize research articles that reported or methodological approaches related to headways.

Method

Two study authors searched four research databases (EMBASE, COMPENDEX, SCOPUS and MEDLINE) for peer-reviewed literature with the key terms being vehicl*, headway* and tailgat*, where studies prior to 1980 were excluded. From an initial 3552 documents, duplicate articles, non-English language documents and abstracts that did not match the search criteria were excluded. Primarily, abstracts where headway was considered either as a predictor or as an outcome variable were retained. Studies for light vehicle drivers in moving traffic flows on roads or in simulator studies that reported headways, and similar review, methodology and theoretical papers were retained.

After inspection of these 973 abstracts, with headway definitions and evaluated driver performance or driving behavior, 153 unique articles were chosen for full text review (Figure 1). Finally, 89 articles were considered fit for inclusion and they were added for qualitative synthesis.

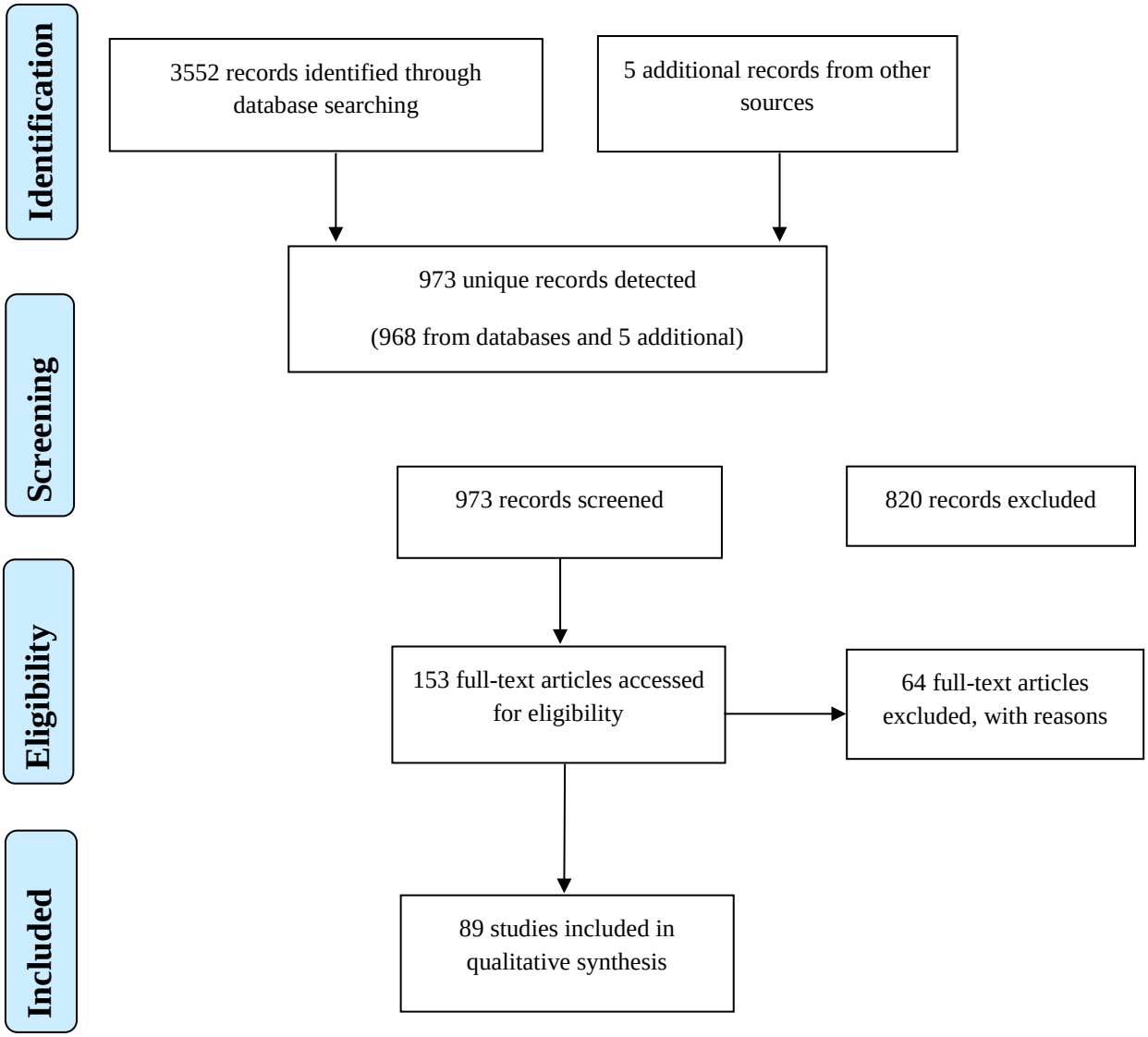

Figure 1: PRISMA Flowchart for the systematic review of unsafe headways.

Results and Conclusions

For specifying the time/distance reference points (e.g., bumper/axle/rear) of headway, studies used either texts or figures. Studies measured headway in different ways. First, studies measure headway in terms of time or distance making it difficult to compare them unless distance headway is defined in terms of the speed of the vehicle at the time. Second, even across studies looking at headway distance, measures differ. Studies can measure, for example, from the bumper of the lead car to the bumper of the following car (Taieb-Maimon and Shinar, 2001; Ding et al., 2017), from the axle of the lead car to the axle of the following (Mitra and Utsav, 2011) or from a range of other points (He et al., 2014).

Based on the empirical measurements for headways from the reviewed studies that focused driving behaviors, they were categorized into four types studies: simulation, roadside external features, on-road features and on-vehicle instruments. Table 1 shows that among the included 94 studies in the review, 23 (43%) of them characterized headway clearly using distance reference points (e.g., bumper/axle/rear) and explained the measuring method.

Table 1: Distribution of articles for various types of headway measurement

Measurement for headway	Number of articles	Headway defined (Percentage)
Empirical simulation	34	12 (35%)
Roadside external features	20	11 (55%)*
On-road features	16	10 (63%)
On-vehicle features	24	9 (38%)
Total	94**	23 (43%)

*One study measured headways manually using a stopwatch by an observer watching from a road bridge crossing (Postans and Wilson, 1983). **Some studies used multiple techniques, which were counted multiple time. Also, 3 studies were reviews, which were not counted here. Thus, the total went beyond the PRISMA Flowchart total of 89 studies (Figure 1)

Three recommendations could be made from reviewed articles. Firstly, definition of headway should include the reference points (e.g., bumper/axle/rear) of measurement. These could be greatly helped by using comprehensive mathematical definitions and/or pictorial depictions. Secondly, it should be mentioned and explained why vehicle length was included/excluded as part of the headway definition. Fourthly, the accuracy level of measuring devices used for headway quantification with their version number should be mentioned to inform the readers on the precision of findings.

References

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