People Do Not Identify Tire Aging as a Safety Hazard

Jennifer A. Cowley, Soyun Kim & Michael S. Wogalter
Department of Psychology
North Carolina State University
Raleigh, North Carolina 27695-7650 USA

Abstract

Tires are among the most critical components of motor vehicles, requiring proper maintenance to minimize the risks of accidents associated with failure. Tire failures at high speeds in vehicles such as SUVs have resulted in vehicle rollovers, serious injuries and occupant death. Tire degradation, as a result of age-related factors, can be contributor to tire failure for which many people may have little awareness. A total of 225 participants (101 non-student adults and 124 college students) were asked to list all contributors that they believed could cause tire problems. Although most respondents mentioned one or more causes of tire failure, only 4.0% of the participants mentioned tire aging as a cause. These results suggest that a substantial proportion of the population is not aware of tire aging as a potential hazard. Implications for a multi-method labeling and warning system are described

INTRODUCTION

Although it is well known that many people are killed in vehicular crashes, it is less well known that a substantial number of crashes (an estimated 6000 in the U.S. annually) are caused by improper vehicle maintenance and defective tires (National Highway Traffic Safety Administration, NHTSA, 2001). The pervasive role of improper maintenance and defective tires in crashes was brought sharply into focus following the discovery of a large number of Ford Explorers with Firestone tires that were involved in rollover accidents around the world.

Since the Firestone-Ford Explorer disclosures, U.S. lawmakers have taken action to improve tire safety by ratifying the Transportation Recall Enhancement, Accountability, and Documentation Act (TREAD, 2000). The TREAD Act was designed to: (1) give government officials the authority to collect timely reports from manufacturers, presumably to serve as an "early warning" for dangerous tire defects; (2) provide a database of tire problems to the public to catalyze quick, large-scale solutions; and (3) call for a phase-in of sensor and warning systems to detect and promote drivers' awareness of under-inflated tires. To date not all of the provisions of the Act have been implemented. In addition, research evaluations concerning the effectiveness of the safety provisions in the Act have been sparse.

One way to evaluate effectiveness is to measure people's level of tire safety knowledge and associated behavior. The American Automobile Association (AAA) Foundation investigated U.S. consumer's knowledge of tire safety (Starch, 1999). This study revealed that of the participants who experienced a flat tire, 46% changed their own tire, 22% asked someone else to change the tire, 9% called AAA for help and 10% called some other road service provider. This suggests that a large proportion of the participants may not know how to change a flat tire which is similar to a finding by Mayer (1990) which revealed that many drivers did not have the critical knowledge to deal with common vehicle emergencies. The AAA study also evaluated how often the public checked and maintained their tire pressure. Incorrect tire pressure is a hazard (e.g., NHTSA, 2001), and to avoid it, the usual recommendation is to check tire pressure monthly. Even so, a substantial proportion of participants in the AAA study (Starch, 1999) indicated that they checked their tire pressure less often than recommended or not at all.

Worn tread and improper air pressure are probably the more well-known reasons for tire failure (although probably still not well-known in some sectors of the population). However, other lesser-known aspects about tires are also important for safety such as tire aging. According to one source (Kane, 2003), old tires – more than five or six years old – become increasingly susceptible to separation or blow-out because tire components dry with age and can separate, causing the tire material to disintegrate. Tires are even more susceptible to failure when they are driven at high speeds or in hot and dry weather even if they have plenty

of tread (Kane, 2003). In a 1997 report from Mercedes Benz Research and Technology Division, it says, "Tyres [the British spelling] undergo an ageing process even when they are not in use. The rubber parts become less elastic, the steel webbing inside the tyre corrodes and the rubber mixture of which the tread is formed hardens (Safety Research & Strategies, Inc., 2005)." Thus, spare tires, tires in storage or on a shelf prior to use, or tires that are infrequently used on trailers or recreational vehicles, run the risk of premature aging and may be unsafe even though they may have sufficient amounts of tread or appear "new."

Information in the past about tire aging hazards have been relatively sparse in the U.S. with one exception in 2000 and 2001 when Firestone ATX/Wilderness tires were recalled, due to tire failures that were partially attributed to aging. However, in the U.K., the Tyre Industry Council (TIC) in 2001 issued a warning to consumers about the dangers of old tires (Kane, 2003). Some tire manufacturers have also had information about tire aging on their websites for the U.K. market for years (e.g., www.PirelliSafety.com). Also, in the early 1990s, German and Japanese auto manufacturers began to include tire aging information in their manuals (Safety Research & Strategies, Inc., 2005).

Recently, U.S. vehicle manufacturers have begun to mention tire aging in their owner's manuals (e.g., Ford, beginning in model year 2005). Even though some auto manufacturers currently include warnings about aged tires in their owner's manuals, people with these manuals may not know they exist because according to past research, a substantial number of drivers have read little or none of the owner's manual for their primary vehicle (Mehlenbacher, Wogalter, & Laughery, 2002).

Although currently there is some information in the public's hands on tire aging, the method, format and content of that information may not be sufficiently informing people about tire aging and the associated tire failure hazard. Warnings about tire aging hazards are necessary because the visual cues of the hazard can be invisible and unknown, therefore it should be considered a "hidden" hazard.

Without knowing exactly how much information the public has been exposed to about tire aging, there have been recent efforts to begin to understand consumer's perceptions about the hazards of tire aging. A study by Kalsher, Wogalter, Lim and Laughery (2005) suggested that a substantial percentage (26%) of people thought that tires could last 10 years or more. This indicates at the very least, some incomplete consumer knowledge about tire aging. Unfortunately, participants in Kalsher's study were not asked if they knew whether tire aging was even a hazard.

People's level of knowledge about tire aging can be considered an assessment of the effectiveness of the current warning system propounded to U.S. consumers. For example, if people were asked to name the potential causes of tire failure and that yielded only a few answers naming tire aging as a cause, then that result would be an indication of a warning system with low effectiveness.

The present study evaluates people's knowledge of tire aging by asking them to list in as much detail as possible, all of the types of problems that they believe could occur with the vehicle's tires. Several categories of answers to this question were recorded, but the main focus was on how many individuals mention anything related to "aging." Other data related to tire safety were also collected.

METHOD

Participants

A total of 227 individuals participated in this study. Two participants were discarded because they did not own a vehicle or have access to one. There were 107 (47.6%) males and 118 (52.4%) females, with an overall mean age of 26.04 (*SD* = 10.31). Ethnicity classifications were 74.2% Caucasian, 11.6% Hispanic/Latino, 6.7% Asian and 7.5% were of other ethnic backgrounds.

The entire group was composed of 124 students (age *M* = 20.25 yr, *SD* = 3.09) and 101 non-students (age *M* = 33.15 yr, *SD* = 11.56). The undergraduate students were from introductory psychology courses at either North Carolina State University (*n* = 187) or California State University in Los Angeles (*n* = 38).

Materials and Procedure

Each participant was given a multi-topic questionnaire. This report focused on a set of questions concerning tire safety. Each participant was asked to provide the following information:

- The number of miles they drove annually.
- Whether they ever experienced a flat tire.
- Whether they had ever had the opportunity to use a spare tire.
- Whether they had read their owner's manual of their primary vehicle and approximately how much (on a 0 to 100% scale) they have read.

In order to give some context to the question, each participant was asked to read the following description before answering:

> *"One of the most important safety components of a vehicle is the tire because it is the part of the vehicle that makes contact with the road. While*

*most tires come with a warranty suggesting they will give good service for 30-40,000 miles or more, sometimes they fail earlier than expected. Not only are tire blow-outs inconvenient but also they may endanger passenger's lives by causing the vehicle to lose control possibly resulting in a crash. Assume that you own a 12-year old vehicle. Please describe in as much detail as you can, **all** of the types of problems that you believe could occur with the vehicle's tires."*

Participants provided their responses in a set of numbered spaces that followed the description.

RESULTS

A total of 88.4% of the participants reported that they owned a vehicle. Of the 11.6% participants who said they did not own a vehicle, all (100%) reported that they have access to one. The mean number of miles that participants reported to have driven in the past 12-month period was 11,618 miles (*SD* = 8,890 miles).

Each participant's responses to the open-ended question were coded and scored by two judges. The inter-rater reliability was 98.9%. Both judges created 10 categories of possible answers and each participant's answers were assigned to the categories. Table 1 shows the categories, response frequencies, and percentage of participants who reported a response as categorized. The sum of the response frequencies across all categories adds up to more than the total number of participants because participants could contribute answers to more than one response category. Similarly, percentages add up to greater than 100%.

Table 1. *Frequencies and percentages of participants who reported each response category as a potential tire problem.*

Response Categories	*Frequency*	*Percentage*
Poor or worn tread	157	69.8
Flat & blowout	125	55.6
Other (miscellaneous)	75	33.3
Pressure	70	31.1
Balancing & alignment problems	69	30.7
Objects lodged	45	20.0
Leaks	30	13.3
Dry rot / cracking	23	10.2
Tire detached from vehicle	12	5.3
Aging	9	4.0

While many participants mentioned tread wear and tire pressure as tire-failure causes, only 4.0% of the participants named "aging" as a contributor to tire problems. The mean age of participants who mentioned "aging" was significantly higher (*M* = 35.3 years, *SD* = 18.0) than the mean age of participants (*M* = 25.7 years, *SD* = 9.7) who did not mention it, $t(223) = 1.76$, $p < .05$.

This data set was also analyzed to determine if demographic categories were related to patterns of responses. Table 2 shows the means of responses to questions asked about experiences of having a flat tire and whether or not they ever used a spare tire. Across all participants, 41% answered that they have used a spare tire on their primary vehicle and 60% of participants reported that they have had a flat tire.

Table 2. *Proportion means for tire-related experiences for having a flat tire, using a spare tire and whether they read the owner's manual (0 = no, 1 = yes). The last column specifies the mean percentages for the amount of the owner's manual that was read.*

Grouping	*Flat Tire*	*Spare Tire*	*Read Owner's Manual*	*Percent Manual Read (%)*
Younger	.46	.33	.50	40.6
Older	.73	.49	.60	49.9
Male	.64	.41	.66	47.2
Female	.57	.42	.45	44.1
Non-student	.47	.76	.62	50.3
Student	.37	.47	.49	41.3
All participants	.60	.41	.55	45.9

Proportion means are also shown and only the significant comparisons are described ($p < .05$). Non-students reported that they have had flat tires more than students, $t(223) = 4.68$, $p < .0001$. A significantly greater number of non-students reported reading their owner's manual more than students, $t(223) = 1.99$, $p < .05$. Of the participants who reported to have read the owner's manual, non-students reported reading a significantly larger amount of the owner's manual (*M* = 50.3%) than students (*M* = 41.3%), $t(122) = 2.05$, $p < .05$. More males (*M* = 66.0%) reported reading their owner's manual than females (*M* = 45.0%), $t(223)=3.29$, $p = .001$. Also, males reported reading a larger amount of the

owner's manual (M = 31.3%) than females (M=19.1%), $t(223) = 3.00$, $p < .05$. A median age split (22 years) was used to form two age groups. Participants over 22 years of age (M = 49.94%) reported having read a larger amount of the owner's manual than participants 22 and under (M = 40.56%), $t(122) = 2.14$, $p < .05$. Table 2 also shows participants' reported reading of the owner's manual for their primary vehicle or the vehicle they have access to.

Approximately half (44.9%) of the participants reported that they have *not* read the owner's manual for the vehicle they drive. Of those who reported reading the owner's manual, 63.7% reported that they have read less than 50% of the manual. Six participants (4.8%) out of the 124 who read the manual, read 100% of the owner's manual, which confirms similar findings by Leonard (2001) and Mehlenbacher et al. (2002).

DISCUSSION

The results show that very few people (4% of 225 respondents) identified aged tires as a potential cause of tire failure. Clearly, the communications regarding this topic have not been strongly incorporated into people's memories and this suggests that vehicle owner's manuals (Leonard, 2001; Mehlenbacher et al., 2002) have not done much to inform people that tire aging is a hazard. This is probably because only about half of the people do not read them at all, and the ones who do, only read portions of it. This was shown by Leonard (2001) and Mehlenbacher et al. (2002) and confirmed here.

Another reason for the inadequacy of manuals is that sometimes the warnings are incomplete. Although many automobile manufacturers' owner's manuals are now mentioning tire aging as a component to tire safety and maintenance (e.g., that tires need to be discarded after some number of years, usually 6-10), the information does not meet the standard of good warnings. In part, they would need to explicitly state that aged tires can be dangerous, i.e., that they can cause tire failure. Also, needed are the kinds of conditions under which the aging process can be accelerated such as hot temperatures, frequent heavy loading, and lack of use. Therefore, it is not surprising that few people identified tire aging as a hazard. Even if the participants read most or all of the information on tire aging in their owner's manuals, they probably would not being well informed.

Ten percent of the participants also mentioned dry rot or cracking. While these conditions are characteristics that may result from tire aging, they are not the same as the tire aging issue described in this article. An unsafe tire due to tire aging might not visibly show (to the naked eye) any obvious degradation. However, dry rot and cracking can usually be discerned by visual inspection. Even if dry rot and cracking were categorized as aging, there would still only be 14% of the participants who identified some form of tire aging as a potential cause of tire failure.

In addition to the owner's manual, other methods of hazard communication may carry messages about tire safety. For example, some media attention has focused on the contributory effects of incorrect tire pressure to tire failures and the hazards associated with these failures. Despite the media attention, there was still a meager 31.3% of the participants who mentioned it. One reason why tire pressure is identified more than tire aging could be that tire pressure is given more coverage in printed material and on websites concerning tire safety. Very frequently little or nothing is said at all about the aging hazard in tire safety communications for consumers.

If the public, much like our study participants, is simply not aware of tire hazards, then a Human Factors/Ergonomics (HF/E) approach is needed to design effective hazard and warning communication systems to be used by auto and tire manufacturers. The goal would be to provide consumers with better and more accessible information about tire hazards, safety and maintenance. Warnings are usually not needed if people already know about the hazard (except when warnings are used as reminders). However, if people generally do not know about hazards, then people ought to be apprised of them in an effective way. A large body of knowledge has been accumulated over the years to guide designers of warnings systems in making warnings and safety messages salient, legible, understandable and persuadable. A multi-method approach based on consumer testing may be needed to gain public awareness of potential hazards associated with tire aging.

One warning strategy would be to place labels on or adjacent to spare tires and new tires so that consumers and tire technicians could be exposed to them. Expiration dates or other related information could be made available and could have the benefit of promoting the sale of fresh tires. Safety literature (e.g., technical bulletins, consumer brochures and waiting-room posters) could be disseminated by tire and automobile dealerships and automotive-related companies and organizations. Regardless of what specific strategies are employed the lack of consumer knowledge would likely minimized.

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