

Article

An Exploration into Younger and Older Pedestrians' Risky Behaviours at Train Level Crossings

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Abstract: Background: Younger and older pedestrians are both overrepresented in train-pedestrian injury and fatality collision databases. However, scant research has attempted to determine the factors that influence level crossing behaviours for these high risk groups. Method: Five focus groups were undertaken with a total of 27 younger and 17 older pedestrian level crossing users ($N = 44$). Due to the lack of research in the area, a focus group methodology was implemented to gain a deeper exploratory understanding into the sample's decision making processes through a pilot study. The three main areas of enquiry were identifying the: (a) primary reasons for unsafe behaviour; (b) factors that deter this behaviour and (c) proposed interventions to improve pedestrian safety at level crossings in the future. Results: Common themes to emerge from both groups regarding the origins of unsafe behaviours were: running late and a fatalistic perspective that some accidents are inevitable. However, younger pedestrians were more likely to report motivators to be: (a) non-perception of danger; (b) impulsive risk taking; and (c) inattention. In contrast, older pedestrians reported their decisions to cross are influenced by mobility issues and sensory salience. Conclusion: The findings indicate that a range of factors influence

pedestrian crossing behaviours. This paper will further outline the major findings of the research in regards to intervention development and future research direction.

Keywords: pedestrian behaviour; train level crossings; rule violations; qualitative research

1. Introduction

Pedestrian-train collisions are a significant problem internationally [1]. In Australia, between 2001 and 2010, there were 91 collisions between trains and pedestrians, which equates to an average of 10 collisions per year [2]. Importantly, such incidents have a higher likelihood of death compared to train-vehicle collisions, with survival rates approximately one in three [3]. In addition to the social and emotional cost of these accidents, an earlier estimate by the Australian Bureau of Transport and Regional Economics revealed the financial cost of a fatality to be \$1.9 million [4], and \$27,000 for a serious injury, however these figures are likely to be an underestimate of the total cost [5]. In the European Union, more than 400 people are fatally injured after being struck by a train every year [6], and in the US, more than 70 are fatally injured [7], excluding suicides. Despite the international scale of the problem, there is a paucity of research in the area of pedestrian safety at rail level crossings, with most research focussing on vehicle use at such sites [8]. Nevertheless, several factors have been proposed to increase the risk of being struck by a train. Broadly, these factors are predominantly related to demographics and will be briefly reviewed below.

Demographic Factors

While analyses of rail level crossing injuries and fatalities demonstrate that accidents involve pedestrians of all ages [1], some groups are over-represented. In particular, younger pedestrians, older pedestrians and males are disproportionately represented in collision databases [9]. One of the main themes to emerge from reviewing databases is that younger pedestrians can be considered a high-risk group at level crossings [1,9]. Several possible explanations have been proposed, but have yet to be confirmed. Firstly, it is widely accepted that adolescents have an elevated risk-taking propensity [10]. The propensity towards risky decision making increases from approximately the age of 10 following an inverted U-shape and peaking at approximately 14–15 years of age [11]. It has been suggested that this stems from a range of factors, including underdeveloped prefrontal cortices that are used in planning, decision making and inhibitory control [11], as well as higher levels of sensation seeking [11] or/and differences in the risk appraisal abilities [12,13]. In regards to the latter, two primary factors may contribute to younger persons placing themselves in high-risk situations. One factor is a perceived invulnerability and a failure to realise that common risks actually apply to themselves [12]. Often termed “adolescent invulnerability”, this concept relates to the perception that the consequences of high-risk behaviour only applies to others [14]. The second factor relates to impulsivity in decision making. This impulsivity is present in childhood from an early age and increases during adolescence and manifests itself in a propensity to make decisions and act without proper consideration of possible consequences and outcomes [13]. However, to what extent these factors relate to pedestrian level

crossing behaviour remains unknown, nor what other factors may contribute to this group's overrepresentation in train-pedestrian collision databases. Additionally, it is currently unclear what initiatives should form the basis for effective interventions to reduce this risk.

Another group that are at an elevated risk at level crossings are older pedestrians. This may be also be because of a variety of reasons, not least the physiological changes that take place as a normal part of the ageing process. For example, older people have poorer vision, hearing, physical mobility and cognitive functioning [15]. Additionally, sensory impairment is more common among older individuals than in other groups [16], and average walking speed decreases and mobility problems become more common [15]. Older groups also exhibit slower reaction times, decreased ability to divide and switch attention and process information sequentially [15]. In sum, these factors may lead to a higher likelihood of making errors and unsafer choices at crossings, and an inability to move quickly to deal with these situations. Again, this has yet to be explored in any depth in regards to pedestrians' behaviours at level crossings.

Finally and more broadly, males are consistently over-represented in both vehicle and pedestrian incidents at level crossings [5,17]. Fatality statistics show that males are almost two and a half times more likely to be killed by a train than females [1]. It may be argued that males of all ages are more likely to engage in risk taking behaviours across all domains of life (e.g., gambling, recreation, social, health and safety) [18], and, thus, risk taking at train level crossings may prove to be no different. For adolescent males, this is even more pronounced, with researchers suggesting that males are more likely to knowingly break the rules [9]. For example, one of the only studies in the area reported that 34% of males in a sample, compared to 9% of females, were willing to cross the tracks when warnings were active in the absence of a train [9].

Deliberate Violations *versus* Errors

Finally, and in addition to examining issues historically linked to each specific group, there is an overarching need to examine whether pedestrians (who violate crossing rules) deliberately engage in crossing violations or make errors while attempting to navigate across the tracks. More specifically, in regards to rule breaking, it is important to make the distinction between rule breaking that is intentional and unintentional. Intentional rule breaking is often referred to as a "deliberate violation" and includes any rule-breaking act committed with the knowledge that it is in violation of the rules, e.g., making a calculated decision regarding the risks involved. Unintentional rule breaking constitute "errors" and includes any rule breaking activity in which the behaviour is carried out with no knowledge of rule breaking or through confusion as to the correct behaviour. While both of these behaviours are likely to contribute to train-pedestrian collisions, the antecedents of these behaviours are different, are critical to the development of effective countermeasures, but have almost been totally overlooked in the literature.

In regards to deliberate violations, being in a hurry has been proposed to be a factor that increases the likelihood of deliberate violations, and this occurs most often when pedestrians are hurrying to work or to school in the morning [9]. Deliberate violations may involve pedestrians deliberately ignoring warning signals [19], crossing the tracks when they know a train is approaching [9], maximising convenience [20] or committing violations in the presence of others [5]. It has also been proposed that pedestrians are more likely to commit deliberate violations when they are trying to catch an

approaching train or when a train is already on the station platform [9], although this has yet to be confirmed with empirical evidence. In contrast, inattention has been proposed to be a cause of errors at level crossings, which may increase the likelihood of a pedestrian being struck by a train [9,21].

However, and when taken together, at present there are clear gaps in scientific knowledge regarding the origins of why younger and older pedestrians' are at an elevated risk at level crossings. This has clear implications in regards to developing effective evidence-based interventions to improve pedestrian safety. Due to this lack of research, the present study aimed to conduct an in-depth exploration into the origins of younger and older pedestrians' unsafe behaviours at level crossings, through the use of qualitative focus group methodology. The present study aims to identify the: (a) primary reasons for unsafe behaviour; (b) deterrent factors that could prohibit this behaviour, and (c) proposed interventions to improve pedestrian safety in the future.

2. Methods

2.1. Participants

A total of 44 individuals participated in the study comprising of two groups: younger and older pedestrians. The younger group consisted of three focus groups of 27 high school students (mean age 15.8 years, range 15–16 years, 77% females) who were enrolled in a secondary college in the Brisbane area. This college was selected as it was near a train station where a large number of younger pedestrian violations were recorded. The two older pedestrian focus groups involved 17 members of an active seniors group in the Brisbane area (mean age 75.2 years, range 56–89 years, 82% females). The senior group was purposely selected as it was in the area of a well-known “black-spot” station that records a high number of pedestrian crossing violations as well as recent train-pedestrian collisions that had resulted in fatalities. All focus groups consisted of between 8 and 10 participants.

The study method was approved by the Queensland University of Technology Ethics Committee (Approval Number: 1200000078). Adult participants provided written consent by signing a consent form that highlighted the aims and method of the study. The school children's consent was provided in written form by their parents who signed a similar consent form.

2.2. Material and Methods

The sample was invited to participate in focus groups conducted in a quiet room at their school or seniors group location. Informed consent was obtained from the seniors as well as the school students' parents. Participants were free to withdraw at any point and were assured that all information obtained was confidential. The focus groups were recorded and participants were informed that only non-identifiable information and quotes would be used to analyse the data. The focus groups were recorded and transcribed before being analysed. The sessions lasted approximately 30 to 45 min and consisted primarily of 13 pre-defined questions which covered topics including: frequency of level crossing use, understanding of rules and warning signals, penalties/fines for rule breaking, previous intentional and unintentional rule breaking, origins of rule breaking, factors influencing decision making, knowledge regarding train travel speeds and possible injuries from being hit by a train, *etc.* The questions related specifically to pedestrian level crossing locations (e.g., designated places where pedestrians are

permitted to cross) that usually incorporate locking gates, walking paths and signage, rather than other rule violations such as trespassing on the railway tracks. However, the use of open-ended questions provided opportunities to deviate and discuss other related matters. As the purpose of the study was to explore the underlying factors relating to level crossing usage in-depth, follow-up questioning often diverged somewhat from the set questions and was dependent upon the specific answers given by participants. Participants were reimbursed for their time in the form of \$30 cash for older participants and a movie voucher for younger participants.

2.3. Data Analysis

A thematic analytic technique was used to analyse the data and identify key themes.

Themes were developed by the method described by Fereday and Muir-Cochrane [22], which is a hybrid approach, utilising deductive and inductive coding. Deductive coding involves the application of a priori themes which are theory driven based on previous research, while the inductive approach involves the development of emerging themes based on common responses, which are data driven. *A priori* themes were derived from a previously completed literature review by the authors of the present study [8]. The research-derived themes were identified by reading and re-reading transcripts to elucidate common themes, and a coding manual was developed to reveal the most commonly emerging themes. The transcripts were independent analysed and coded by a second researcher for the purpose of inter-rater reliability.

3. Results and Discussion

The identified themes from the data were categorised in relation to the three aims of the research, which are to identify the: (a) origins of behaviour; (b) deterrent factors that could prevent unsafe behaviours, and (c) areas of need in regard to future intervention development. These categories will first be presented as themes that were commonly shared between the two groups, and then themes that were unique to each group.

3.1. Shared Themes: Origins of Behaviour

The first analysis focused on developing a deeper level of understanding into the factors that increase the likelihood of pedestrians violating or making errors at level crossings. In regards to shared themes, two themes were identified as common between the older and younger participants. These were: (a) running late and (b) a generally fatalistic perspective about human behaviour. In regards to the former, being in a hurry (e.g., running late) was a central theme to emerge from the findings. This included both a self-admission, as well as observing others engage in similar behaviours. Most frequently, participants reported that they (or others) would violate the rules as the train they intended to catch was approaching the station or while their train was on the actual station platform waiting to depart. One participant related her experience: *“I was on my way to the city and the train had passed through the crossing and was stopped on the platform... I looked and there wasn’t any train following it so I just pushed the gate to go through.”* Participant’s also made comments that an impromptu risk-benefit evaluation was often undertaken prior to engaging in this form of violation. That is,

whether the risk was worthwhile depending on what they were running late for (e.g., exam or job interview vs. meeting a friend). Participants also reported checking for the presence of other approaching trains and/or transit officers (who could fine them).

The second shared theme that emerged was the belief that violations at pedestrian crossings were inevitable and will always occur as part of human behaviour. Participants believed that measures to prevent violation-based behaviours, such as education, may be effective in reducing the problem to a degree, but some people would still violate the rules regardless of the intervention. When directly asked what measures would work for these people, the most frequent responses were that nothing would prevent everyone from committing a violation, other than physically preventing them from accessing the tracks, e.g., incapacitation-based interventions such as locking gates and high fences. The shared violation themes are shown below in Table 1.

Table 1. Shared Origins of Unsafe Behaviour Themes.

Theme	Frequency of Themes			Examples
	Older	Younger	%	
Running late	9	15	55	<i>“I think it (likelihood of violation) depends on how late you are and what you were late for.”</i> <i>(When running late for an exam) “If the lights were flashing and there was no train, I probably would (violate).”</i>
Human behaviour	5	12	39	<i>“Yes, it’ll happen whatever you do (violation). There is no total prevention for anything.”</i> <i>“It comes down to common sense and human behaviour.”</i>

3.2. Deterrent Factors

The second focus of the study was to examine what factors were perceived to deter unsafe behaviours. The one common deterrent theme to emerge was the danger posed by being hit by a train. Both groups (e.g., all participants) were aware that being hit by a train could result in extremely serious injuries, if not death. Some participants stated that it was better to wait and catch a later train and be late, rather than taking such a major risk just to be on time, e.g., *“Trains don’t go for that long, so there’s no need to do it”*. The shared deterrent theme and examples are depicted in Table 2.

Table 2. Shared Deterrent Factors.

Frequency of Themes	
Theme	Perceived Danger
Older	7
Younger	22
%	66
Examples	<i>“Crossing when you’re not allowed to, it’s not worth the risk”</i> <i>“We do break the rules it’s just not in a way that’s going to risk our lives.”</i>

3.3. Proposed Interventions

The next series of analyses focused on identifying possible methods and interventions that participants believed would improve safety at level crossings. Two common themes emerged. The most common theme was to physically incapacitate pedestrians by the use of locking gates and higher fences to prevent both violations and errors. At the time of publication around the Brisbane metropolitan area, most level crossing gates automatically close when a train is approaching, but can be pushed open. The most frequent suggestion was that gates automatically close and lock so errors (and deliberate violations) are more difficult to make: *“You shouldn’t be allowed to push the gates open.”* It was also suggested that fences and gates be made larger and lock so that commuters are completely prevented from breaking the rules. These systems could also include an emergency button to allow people to exit if the gates locked while they were on the tracks: *“You need a button if someone gets trapped.”*

Another common theme to emerge for both age groups was the need for greater public education regarding level crossings. Specific targets of education identified by participants were correct use of level crossings, dangers of violating the rules, fines incurred for violations and that transit officers may be in plain clothes. Level crossing rules were universally understood, as was the time required for a train to come to a complete stop. However, importantly, only half of the people were aware of the possibility of a second train: *“I didn’t think of a second train.”* In contrast, when questioned regarding train speeds, estimates were generally accurate. Importantly, approximately half of the participants were aware of the possibility of being fined for breaking the rules at level crossings. Furthermore, even less were aware of the amount of the fine: *“I have no idea how much the fine is.”* Again, while most were aware that police and transit officers were able to issue fines, only two participants knew that transit officers may be plain clothed (and this was because both individuals had been fined by plain clothed officers). The respective frequencies and examples of the shared themes for proposed interventions can be seen in Table 3.

Table 3. Common Proposed Intervention Themes.

Theme	Frequency of Themes			Examples
	Older	Younger	%	
Incapacitation	23	15	86	<i>“In the 70s they had gates, the gates were high and they went right across, so you couldn’t walk across the tracks, they were better, they were tops. These boom gates, you can just walk around them.”</i> <i>“I think the moment they shut they should be locked so you can’t open them and maybe make them a bit higher”</i>
Education	14	11		<i>“Yeah, you need to educate the people about the risks maybe going in doing a speech, educating like primary school kids.”</i> <i>“Put it on the TV that you can be fined because I’d never heard of it until {name’s} husband got caught.”</i>

In addition to the above-mentioned common themes, several themes unique to each age group were also identified and are discussed below.

3.4. Young People: Origins of Behaviour

In regards to the origins of pedestrian behaviour, three unique themes were identified for young people, all of which related to intentional rule breaking. The two most common themes were: non-perception of personal risk and a general propensity towards risk taking. While these themes are similar, there was a subtle difference in the reasons behind such violations.

Firstly, non-perception of personal risk was characterised by the belief that the risks of being struck by a train did not apply to them. Young participants exhibited a failure to realise that such risks applied to them as well as others: *“I’ll never be hit by a train.”* Additionally, this group also demonstrated a generally blasé attitude in which other concerns, such as the desire to look *“cool”* or *“show off”* held greater importance than did safety concerns: *“I’ll do it if friends are around.”* The second theme for why younger pedestrians committed deliberate violations was a general propensity towards impulsive risk taking. This theme was characterised by a failure to acknowledge that the behaviours exhibited were dangerous or risky at all. There appeared to be no cognition associated with the actions, they were just carried out impulsively with no consideration of the consequences.

3.5. Proposed Interventions

A corresponding discussion on areas in which changes or improvements could be made to increase pedestrian safety at crossings revealed a theme unique to the young group. There was an openness to utilise social media, such as Facebook and YouTube, to educate and highlight the dangers associated with level crossings. Participants indicated that they would watch such material on the recommendations of friends, especially if the story was either engaging (e.g., someone similar to themselves) or was humorous (as well as containing a serious safety message). The frequencies for the themes unique to younger participants and examples of each can be found in Table 4.

Table 4. Themes unique to younger pedestrians.

Theme	Frequency of Themes		Examples
Origins of Behaviour		%	
Non-perception of danger	20	74	<i>“Everybody’s like “why cross at the lights? I’m late for my lesson I’ll just go across the road.”</i> <i>“It wouldn’t cross my mind that ‘oh, I might get hit by a train”</i>
Impulsive risk-taking	19	70	<i>Researcher: “What do you do when the warning signals are active and the gate is closing?”</i> <i>“I occasionally stop”</i> <i>“I try to hurry”</i>
Peer Factor	9	33	<i>“I reckon some of the guys (would violate), I don’t think any of the girls would do that, like show off at the train tracks.”</i>
Proposed Interventions			<i>“Guys would be waiting at the train tracks and their friends would be ‘like come on let’s just go”</i>
Social media	14	52	<i>Researcher: “So hands up if you saw it on a friend’s Facebook page that they’d shared it on their wall, whether you’d watch it?” (Everyone puts hand up)</i> <i>Researcher: “What about things that might be better for your age group?”</i> <i>“Advertise on Facebook, online”</i>

3.6. Older Pedestrians: Origins of Behaviour

In contrast to the younger group, an analysis into the origins of pedestrian behaviour for the older group revealed that inattention was a common cause of errors. This often occurred due to older pedestrians basing their behaviours on the actions of those around them, rather than assessing the situation for themselves. Older pedestrians were aware of this factor in their own actions, as well as for other older pedestrians. The general perception was that the older the pedestrian, the more likely they were to make errors and that this was related to sensory or cognitive deficits. For example, a former member of the active seniors group had been fatally struck by a train after she followed two teenaged pedestrians across the tracks without looking. Her former best friend noted: *“she was always walking with her head down, she just followed them and the train got her.”*

3.7. Deterrent Factors: Reason for Non-Violation

In addition to the shared deterrent theme for both groups regarding the perceived dangers of violating crossing rules, an additional theme emerged regarding a recognition among the older groups of reduced mobility that uniquely applied to them. Older participants commented that they were less likely to violate the rules as they had reduced mobility and, thus, were unable to move quickly if they did get into trouble on the tracks. This reduced mobility made them less likely to take risks such as intentionally violating rules by rushing across the tracks in front of a train. In the current sample, the group's increased risk also proved to be a deterrent: *“I might have tried it in my younger days (violation), but now I'm a bit unsteady on my feet”*.

3.8. Proposed Interventions

A theme that emerged from the older pedestrians' focus groups to improve pedestrian safety was the need for greater sensory salience of crossing warning systems. Older pedestrians noted they often did not realise when they were not permitted to cross, especially if engaged in a conversation or alternatively distracted. Participants commented that this is an even more important issue for those with visual, hearing or cognitive impairment, which is relatively common in the elderly community.

The frequency of themes that emerged from the older participants and examples of these are provided in Table 5.

Table 5. Themes unique to older pedestrians.

Theme	Frequency of Themes	%	Examples
Origins of Behaviour			
Inattention	6	35	<i>“Yes, either they're guided by the people beside them or they can't see or can't register not to walk.”</i> <i>“They follow the other people they don't look. They just walk. They don't have good eyesight. They follow other people because they think it's safe, but isn't necessarily safe”</i>

Table 5. Cont.

Theme	Frequency of Themes	%	Examples
Deterrent Factor:			
Mobility	11	65	<i>“Well that’s the problem isn’t it, we can’t hurry if we need to” “I know I’m very careful.....I couldn’t dart across”</i>
Proposed Interventions			
Sensory salience	15	88	<i>“Sometimes you can’t hear the warning bell” “Older people would take more notice of a flashing light and might stop.”</i>

4. Conclusions

This study aimed to conduct an in-depth qualitative exploration into the origins of younger and older pedestrians’ unsafe behaviours at level crossings. This analysis revealed that:

- Both groups had shared as well as unique themes. The two shared themes were: (a) running late and (b) a generally fatalistic perspective about human behaviour. The current study is one of the few scientific investigations to actually confirm the hypothesis proposed in the literature that being in a hurry contributes to crossing violations [9];
- The most common theme into the origins of younger participants’ unsafe behaviours was a non-perception of personal danger. This finding is consistent with research from the broader injury prevention domain that has highlighted an injury risk bias [11], commonly known as comparative optimism bias [14];
- The second most common violation theme for younger participants was impulsive risk taking. Again, this is consistent with the broader injury prevention field that has highlighted adolescence’s impulsiveness increases subsequent engagement in risk taking behaviours [13];
- There was less variability found between the two age groups in regards to deterring pedestrians from engaging in unsafe level crossing behaviours, as both groups were aware that being hit by a train could result in extremely serious injuries, if not death;
- In regards to group differences, the most frequent deterrent theme to emerge for the older pedestrian group was the issue of decreased mobility. Mobility has been highlighted as a concern for older pedestrians in the broader literature on road safety [15] and has also been proposed as a contributing factor for older pedestrians at level crossings [9].

Recommendations

These findings have important implications for the design of interventions to combat violations, especially at black-spot areas near schools. Such interventions could involve either incapacitation-based schemes (such as locking gates) or educative initiatives designed to highlight the risks. Given the current knowledge gaps as well as the personal and social costs associated with train-pedestrian collisions, future research is needed into a range of areas, including: (a) the frequency of violations and errors; (b) the primary causes of such behaviours; (c) factors that promote and deter unsafe behaviours at crossing; and (d) the development and application of effective interventions. In regards to

developing interventions, it is also encouraging that both groups believed that incapacitation and education have a primary role. Previous research identified several areas in which education may be required, particularly in reinforcing the following: level crossing rules, train speeds and time taken to slow down, the possibility of a second train at level crossings, *etc.* [8].

The limitations of the study should be borne in mind when interpreting the results. The major limitation of this study is that findings are based on self-report data, which are susceptible to social desirability responding, especially in group formats. The sample was also a small convenience sample (rather than randomly selected) and one dominated by females. Additionally, the sample did not consist entirely of individuals who regularly violated crossing rules (which would have been ideal), but rather only pedestrians who resided near “black spot” locations. As there has been little research undertaken in this area, not all findings can be validated against pre-existing literature. Despite the above limitations, this study is one of the first to conduct an examination into the origins of pedestrians’ unsafe behaviours at level crossings. The findings indicate that a plethora of factors may influence pedestrians’ decisions to violate crossing rules, both for younger and older groups.

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Authors Contributions

All three authors contributed to the development of the methodology, analysis of the data and interpretation of the findings. Authors Freeman and McMaster undertook lead roles in collecting the data.

Conflict of Interest

The authors declare no conflict of interest.

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