Pedestrian self-reported exposure to distraction by smart phones while walking and crossing the road

Amy Williamson[a] and Alexia Lennon[a]

[a] Centre for Accident Research and Road Safety – Queensland, Queensland University of Technology, K Block , 130 Victoria Park Road, Kelvin Grove 4059, Australia

Abstract

Pedestrian crashes account for approximately 14% of road fatalities in Australia. Crossing the road, while a minor part of total walking, presents the highest crash risk because of potential interaction with motor vehicles. Crash risk is elevated by pedestrian illegal use of the road, which may be widespread (e.g. 20% of crossings at signalised intersections at a sample of sites, Brisbane) and enforcement is rare. Effective road crossing requires integration of multiple skills and judgements, any of which can be hindered by distraction. Observational studies suggest that pedestrians are increasingly likely to 'multitask', using mobile technology for entertainment and communication, elevating the risk of distraction while crossing. To investigate this, intercept interviews were conducted with a convenience sample of 211 pedestrians aged 18-65 years in Brisbane CBD. Self-reported frequency of using a smart phone for activities at two levels of distraction: cognitive only (voice calls); or cognitive and visual (text messages, internet access) while walking or crossing the road was collected. Results indicated that smart phone use for potentially distracting activities while walking and while crossing the road was high, especially among 18-30 year olds, who were significantly more likely than 31-44yo or 45-65yo to report smart phone use while crossing the road. For 18-30yo and the higher risk activity of crossing the road, 32% texted at high frequency levels and 27% used internet at high frequency levels. Risky levels of distracted crossing appear to be a growing safety issue for 18-30yo, with greater attention to appropriate interventions needed.

Introduction

Background

In Australia, pedestrians represent approximately 14% of road fatalities, accounting for 2,022 deaths in the ten years 2003-2012 (calculated from data reported in BITRE 2013). Pedestrians aged 75 and older have the highest fatality rate (between 1.7 and 3.4 times more likely than the next closest age group over the last 10 year period to 2014), followed by those aged 17-25 years (BITRE 2015). Crossing or walking along roads forms a minor part of total walking, but presents the highest risk because of the interaction with motor vehicles. As identified in the National Road Safety Strategy 2011-2020, pedestrians are an important vulnerable road user group, and represent, globally, 22% of all road deaths (WHO 2013). In addition to their relatively low mass (compared to motorised traffic), pedestrians are also rendered vulnerable by their inherent lack of protection in a crash. This is exacerbated by factors which increase the likelihood of pedestrian interaction with motorised traffic. For these reasons, pedestrian road use is regulated to some extent, and certain regulations that are protective of pedestrians also apply to drivers. However, illegal use of the road by pedestrians is widespread (e.g. 20% of crossings at signalised intersections at a sample of sites in Brisbane: King, Soole & Ghafourian 2009) and enforcement is rare for logistical reasons. In addition, most road crossing requires pedestrians to integrate visual and auditory information, make judgements of speed and driver intention, and decide when it is safe to cross within the constraints of their walking speed and ability to vary it. Even for pedestrians who can successfully integrate this information under normal circumstances, distraction (e.g. from technology) or temporary impairment (e.g. from alcohol) can interfere with the decision making process at a range of points –

pedestrians may fail to notice important auditory or visual information, or make incorrect judgements of speed (especially where multiple lanes or vehicles are involved), or incorrectly make an attribution of driver intention, or misjudge their own ability to get across in a given gap. Distraction and impairment therefore have the potential to exacerbate crash risk for pedestrians.

Mobile phone use is now commonplace in Australia, with increasing popularity among young people. A majority of young Australians (94%) aged 18-24 years use a mobile phone (Department of Broadband Communications and Digital Economy 2008). In 2012, almost a third (29%) of all children aged 5-14 years had a mobile phone. This number increases towards the upper age band, with 73% of 12-14 year olds shown to own a mobile phone (ABS 2013). Furthermore, mobile phones are increasingly the 'smart' type, with ownership in Australia estimated to sit at 81%, with 51% considering it their go-to device (Deloitte 2014). Smart phones enable pedestrians to not only use their mobile device for making voice calls and sending text message while they are 'on the move', but also to access the internet for email, social media and satellite navigation, as well as for their own personal music device. In their national survey of 802 teens aged 12-17 years, Madden, Lenhart, Duggan, Cortesi & Gasser (2013) showed that 74% of American teens aged 12-17 reported accessing the internet on mobile phones, tablets, and other mobile devices at least 'occasionally'. One in four teens are "mobile-mostly" internet users and older girls are especially likely to report this (34% compared to 24% of boys).

Pedestrian distraction from hand-held technological devices

Given the increase in popularity of smart phones, it is unsurprising that the prevalence of pedestrian distraction by hand held technological devices appears to be increasing, with studies showing that up to 40% of observed pedestrians are distracted when crossing the road (Ferguson, Green & Rosenthal, 2013; Thompson, Rivara, Ayyagari & Ebel, 2013; Bungum, Day & Henry, 2005). Mobile phone use while crossing the road and mobile phone-related injuries has been found to be higher for people under the age of 31 years (Nasar & Troyer, 2013; Nieuwesteeg & McIntyre, 2010) and particularly high among teens (Ferguson et al 2013). A US report recently published by Safe Kids Worldwide examined teens' walking behaviours. Over 34,000 students were observed crossing roads in front of schools and over 2,400 students participated in discussion groups. Twenty percent of high school students and twelve percent of middle school students were observed crossing the street while distracted. Students were most often texting on a phone (39%), or using headphones (39%). A further 20% were talking on their mobile phone. Girls were 1.2 times more likely than boys to be walking while distracted, with 17% of girls and 14% of boys observed as distracted by the devices they were using. The odds of being distracted were found to be 26% higher if there was a traffic light present, suggesting that teens may be more willing to use smart phone technology when they perceive their surroundings to be safe (Ferguson et al 2013).

Previous research has suggested that distraction can be of different types with differing levels of influence over ability to carry out driving or pedestrian tasks (Stavrinos, Byington & Schwebel 2009). Pedestrians distracted by mobile phones may be at increased risk of collisions with results showing that mobile phone users walk more slowly, change directions more frequently, are less likely to acknowledge other people, look left and right fewer times, are less likely to look at traffic before starting to cross, and make more errors than pedestrians who are not distracted (Thompson et al 2013; Bungum et al 2005; Hatfield & Murphy 2007). The effect of personal music devices on pedestrian behaviour has also been investigated with results suggesting that listening to music with headphones represents a different type of distraction from that of using a mobile phone (Walker, Lanthier, Risko & Kingstone 2012). The effect of mobile phone internet use on pedestrian injury has also received some attention. Byington and Schwebel (2013), for example, investigated crossing behaviour while accessing the internet on a phone among 92 college students. In a virtual environment, participants crossed a street 20 times, half the time while undistracted and half the time while conducting a mobile internet task. When distracted, participants waited longer to cross the street, missed more safe opportunities to cross, took longer to initiate crossing when a safe gap was available, looked left and right less often, spent more time looking away from the road and were more likely to be hit or almost hit by an oncoming vehicle. Furthermore, participants reported using mobile internet with great frequency in daily life, including while crossing the road. These results are particularly relevant as analyses controlled for gender, age, ethnicity, and pedestrian and mobile internet experience.

With the growth in use of mobile technology for entertainment and communication, pedestrians are increasingly likely to ‘multitask’ while walking, elevating the risk of distraction during road use. This area of pedestrian distraction is not well researched, though there are studies emerging in relation to crash outcomes (whether pedestrians who were distracted by mobile phones have a higher risk) (Thompson et al 2013; Bungum et al 2005; Hatfield & Murphy 2007) and several observational studies have been published (Ferguson et al 2013; Thompson et al 2013; Bungum et al 2005). The current research aimed to estimate the extent to which pedestrians are exposed to potential crash risk as a result of using technology.

Method

Prior to the design of the intercept interview questions, the potential sources of pedestrian distraction were identified as audio, visual, cognitive, physical, or combinations of these. Audio distraction from listening to music while walking or crossing represents audio-only distraction and is thus of a different order from that presented by using a smart phone to carry out more complex activities such as voice calls (cognitive + audio) or text messaging (cognitive + visual + physical). To keep the interviews brief, the questions focussed on only three of the potentially distracting activities: cognitive only (operationalised as using a smart phone for voice calls); and cognitive plus visual (operationalised as using a smart phone for text messages or internet access) while walking or crossing the road. To examine whether there were differences in pedestrian exposure to types of interaction, three interactions were distinguished: initiate, monitor, respond to, for the different activities. Data was collected in relation to both walking and crossing behaviour. An additional item in relation to audio-only device use (with headphones) was also asked. Several items relating to walking after having consumed alcohol were also included but are not reported in this paper.

A convenience sample of pedestrian commuters was sought. Intercept interviews were chosen in order to capture information directly from people about their typical behaviour (exposure) in relation to smart phones/MP3 players while walking and crossing and the types of activities that they typically engaged in.

Participation was anonymous and intercept interviews took place on week days between 8am and 5pm during the first week of November 2014. The research was approved by the Queensland University of Technology Human Research Ethics Committee (Approval number 1500000210).

Procedure

Two sites at which to approach pedestrians were selected from the five Brisbane city centre intersections with the highest pedestrian crash numbers (identified using Queensland Government Web Crash online database for 2001 and 2013). Selection was further based on high pedestrian volume and considerations of safety for the research personnel and potential participants (presence of signals and wide footpaths).

Four experienced Research Officers worked in pairs at the selected intersections (corner of Albert and Elizabeth Streets; corner of Edward and Ann Streets). Interviewers were instructed to invite participation from all pedestrians who appeared to be between the ages of 17 and 65 years, regardless of whether they were using a mobile phone or MP3 player at the time. This age range was chosen in order to focus on those most likely to be influenced by the use of technology (and older pedestrians are influenced by additional factors associated with ageing). Adolescents were excluded from the study for ethical reasons. A screening criterion was that participants had to own a smart phone. Only a few people were ineligible on this basis. Response rates were not calculated as refusal using this type of data collection method typically involves active avoidance of any contact with the researchers and therefore it cannot be determined whether everyone who passes the interviewer understands the purpose of the study (rather than, say, mistaking the approach for an attempt at marketing, sales or begging activity).

Interviewers administered the survey verbally, noting the responses on response proforma. Visual displays of the response options were used to assist participants in answering. Interviews were approximately 10 minutes in duration. Participants were offered a $5 Coffee Club voucher in acknowledgement of their time.

Results

Demographics

Responses were obtained from a convenience sample of 211 pedestrians (53% women) aged 17-65 years (mean 32 years, SD = 13.6). Of these, over half were aged 17-30 years (56%), with a further 23% aged 31-44 years as might be expected given the choice of location for recruitment (central business district of a metropolitan city). The majority indicated that they were employed (full time 45%; part time 17%), while 22% were students and 12% neither employed nor studying. Purpose of trip was primarily going to or from work (25%) or study (19%), with a further 25% shopping (31% ‘other’).

Almost half of the participants (47%) used public transport at least once a day, and 25% reported using public transport several times a week, suggesting the sample was commuter-based. Average time spent walking for transport or on a public roadway was high, equivalent to 3 ½ hours per week, with 30% of the sample walking 60-120 minutes per week, and 23% walking 2 ½ to 7 hours per week. Only 22 % walked less than 60 minutes per week. Most of the sample (79%) reported crossing a road while walking for transport at least 10 times per week, and a further 9% crossed 6-10 roads each week while walking for transport.

Smart phone use while walking and crossing the road

Table 1 displays the questions, response options and proportions of the sample giving each response. Examining walking first, overall use of smart phones while walking was high, with 28-50% of the pedestrians indicating that they used their smart phones for one or more of the activities at least daily (responses of ‘more than once per day’ or ‘once per day’). A further 11-25% did so several times per week. Thus 43-65% responded ‘several times per week’, ‘once per day’ or ‘more than once per day’ to the activities. Monitoring or responding to the internet while walking appeared to be less common activities, with 48% and 43% respectively giving responses of ‘several times per week’, ‘once per day’ or ‘more than once per day’. It is notable that for each of the text, internet and voice call activities there were around 20% of the sample who said they ‘never’ did this while walking (see Table 1).

For crossing the road, the proportion of pedestrians giving the higher use responses was much lower. Proportions of the sample who ‘never’ used their smart phones while crossing ranged from 50% (answering a call) up to 72% (monitoring internet). However, around 16% indicated they used their smart phones for texting activities (initiate, monitor, respond to) or voice calls (initiate, answer) while crossing (that is, responses of ‘more than once per day’ or ‘once per day’). A somewhat lower proportion, 12%, used their phones for internet access activities (initiate, monitor, respond) on a daily basis while crossing the road. Use of audio-only devices was more widespread and more frequent, with almost 30% of the sample using these at least daily while crossing.

Table 1: Proportions of pedestrians who use their smart phones while crossing the road by activity and frequency (self-report)

Question wording and target activity

Walking How often do you use your smart phone to…. while walking	More than once per day (%)	Once a day (%)	Several times a week (%)	Once a week or less (%)	Never (%)
Initiate a text	33.2	9.0	15.6	16.1	26.1
Monitor text messages	42.7	9.5	16.1	10.9	20.9
Respond to a text	31.8	6.4	15.0	14.7	29.9
Initiate a call	24.8	8.1	19.5	26.2	21.4
Answer a call	26.5	9.0	24.6	23.7	16.1
Initiate an internet search or interaction	24.6	6.6	14.7	10.9	43.1
Monitor internet (e.g. Facebook)	24.2	7.6	14.7	8.5	45.0
Respond to internet (e.g. email)	19.9	7.6	15.2	8.5	48.8
Use an audio-only device to listen to music/radio with earphones/buds	29.4	2.8	11.4	4.7	51.7

Crossing How often do you use your smart phone to…. while crossing a road?	More than once per day (%)	Once a day (%)	Several times a week (%)	Once a week or less (%)	Never (%)
Initiate a text	9.5	6.2	5.7	9.0	69.7
Monitor text messages	13.3	6.2	9.0	9.5	61.9
Respond to a text	11.4	4.8	6.7	8.6	68.6
Initiate a call	11.4	4.8	4.8	18.1	61.0
Answer a call	13.3	8.6	10.0	17.6	50.5
Initiate an internet search or interaction	9.5	4.7	5.2	11.8	68.7
Monitor internet (e.g. Facebook)	8.5	4.3	6.2	10.4	70.6
Respond to internet (e.g. email)	7.6	4.8	6.2	9.0	72.4
Use an audio-only device to listen to music/radio with earphones/buds	26.1	3.3	9.5	3.8	57.3

Age group and exposure in relation to smart phone use while walking and crossing the road

Participants were grouped according to three age categories: 18-30 years (n = 118); 31-44 years (n = 48); and 45-65 years (n = 44) (total n = 210 for which age was stated). Two categories of exposure for smart phone use were distinguished: High exposure – responses of ‘more than once per day’, ‘once per day’ and ‘once per week’; Low exposure – responses of ‘less than once per week’ or ‘never’. The inclusion of ‘several times per week’ in the high exposure category was based on the patterns of distribution in the responses: individuals giving these responses to some activities were more likely to give high frequency of use responses to the other behaviours than to give the lower frequency responses (that is 'once per week or less' or 'never'). When categorised according to age and frequency of the behaviour, it was clear that pedestrians aged 30 years or under reported the greatest engagement in each type of smart phone use while walking and while crossing, with the exception of audio-only devices. Table 2 displays the responses to the walking items, and Table 3 responses to the crossing items according to age and exposure category.

Table 2: Walking while using a smart phone by level of exposure and age group

	Age group					
	18-30 (N=118)		31-44 (N=48)		45-65 (N=44)	
	Low exposure	High exposure	Low exposure	High exposure	Low exposure	High exposure
	(% of age group)	(% of age group)	(% of age group)	(% of age group)	(% of age group)	(% of age group)
Question **How often do you use your smart phone to…while walking?**						
Initiate a text	23.7	76.3	50	50	81.8	18.2
Monitor text messages	16.9	83.1	62.5	37.5	63.6	36.4
Respond to a text	27.1	72.9	47.9	52.1	81.8	18.2
Initiate a call	38.1	61.9	51.1	48.9	72.7	27.3
Answer a call	27.1	72.9	52.1	47.9	65.9	34.1
Initiate an internet search or interaction	38.1	61.9	37.5	62.5	86.4	13.6
Monitor internet (e.g. Facebook)	35.6	64.4	35.4	64.6	88.6	11.4
Respond to internet (e.g. email)	40.7	59.3	31.3	68.8	88.6	11.4
Use an audio-only device to listen to music/radio with earphones/buds	40.7	59.3	35.4	64.6	90.9	9.1

Two separate two-way analyses of variance (ANOVA; age group, 3 levels; gender, 2 levels) were carried out in order to determine if the differences in reported behaviours for the different age groups were statistically significant, and whether there were differences between men and women (overall or in the specific age groups). Total exposure to distraction while walking or crossing was deemed to be the sum of responses to all questions (nine items in Table 2 and nine items in Table 3). Mean scores for each person were used as an average of each person's exposure to distracted walking or crossing respectively. Responses were given on a 5-point scale: more than once a day, once a day, several times a week, once per week or less and never (low scores indicate responses equivalent to *more* frequent use). In addition, we reasoned that use of headphones only (for listening to music) might represent a lower level of risk when walking because it provides an auditory only distraction.. To examine this, a second mean score was calculated, excluding the audio only item (eight items). Mean score for responses to walking or crossing items, respectively (with and without the audio only item), were the dependent variables.

Walking.

A main effect of age group only was found for mean responses to the full set of items on use of smart phones while walking (i.e. including audio-only) $F(5, 203) = 18.064$, $p < .001$, $\eta^2(adj) = .291$, suggesting a large sized effect. There was no significant main effect of gender, nor a significant interaction effect for age group by gender. Post hoc testing (Tukey) revealed that pedestrians aged 18-30 years (M = 2.66; SD = 1.05) were significantly more likely than the 31-44 year olds (M=3.34, SD = 1.22) to indicate that they walked while using their smart phones ($p < .001$). The 31-44 year olds were in turn significantly more likely than the 45-65 year olds (M = 4.29, SD = .74) to report doing so ($p < .001$).

Similarly, excluding the item for walking while using audio-only, a main effect of age was detected for mean responses to use of smart phones while walking F (5, 203) = 15.299, $p < .001$, η^2 (adj) = .256, which is a large sized effect. There was no significant main effect of gender, nor a significant interaction effect for age group by gender. Post hoc testing (Tukey) revealed that pedestrians aged 18-30 years (M = 2.63; SD = 1.13) were significantly more likely than the 31-44 year olds (M = 3.29, SD = 1.38) to indicate that they walked while using their smart phones ($p < .01$). The 31-44 year olds were in turn significantly more likely than the 45-65 year olds (M = 4.24, SD = .79, $p < .001$) to report doing so.

Crossing.

Age-based differences were also evident for smart phone use while crossing the road. A main effect of age group only was found for mean responses to the full set of items on use of smart phones while crossing (including crossing with audio only) F (5, 199) = 8.378, $p < .001$, η^2 (adj) = .153, suggesting a large sized effect. There was no significant main effect of gender, nor a significant interaction effect for age group by gender. Post hoc testing (Tukey) revealed that the pedestrians aged 18-30 years (M = 3.77; SD = 1.14) were significantly more likely than either the 31-44 years (M = 4.26, SD = 1.01) ($p < .01$) or 45-65 years (M = 4.82, SD = .48) ($p < .001$) pedestrians to indicate that they crossed a road while using their smart phones. Although there was also a difference between the mean responses for the 31-44 year olds and the 45-65 year olds at $p = .022$, Levine's test of equality of error variances was significant, suggesting that a more conservative significance level be used in this test, and thus this difference did not meet the more stringent 1% significance level.

Similarly, excluding the item for crossing while using audio only, a main effect of age only was detected for mean responses to use of smart phones while crossing F (5, 199) = 6.518, $p < .001$, η^2 (adj) = .119 suggesting a medium to large sized effect. Post hoc testing (Tukey) revealed that 18-30 year olds were significantly more likely to report using their smart phones while crossing (M = 3.84, SD = 1.14) than were either the 31-44 year olds (M = 4.30, SD 1.01) ($p < .05$) or the 45-65 year olds (M = 4.84, SD = 1.08) ($p < .001$). The difference between the two older age groups was not statistically significant ($p = .054$).

Discussion

It is encouraging that around one fifth of the pedestrians sampled reported that they 'never' text, use internet or voice call actions on their smart phone while walking, and there was a higher proportion who indicated this for crossing.

Proportions of the sample who indicated that they used their smart phones while crossing the road were much lower than for walking, and this result was found for all age-groups. This finding is encouraging to the extent that it suggests that there is some acknowledgment of the increased dangers that such use constitutes when attempting to cross the road as opposed to walking. However, excluding the voice call and audio-only activities, around 30% of the 18-30 year olds indicated they used their smart phones at least once per week for a cognitively and visually distracting activity (that is, texting or internet access) while crossing the road. Many of them did so daily or more often. Moreover, it appeared that those 18-30 year olds who reported engaging in one activity also tended to report that they engaged in most of the others too, suggesting a subgroup that crosses the road frequently while using a smart phone (higher exposure) and is also more distracted (more complex activity level). This finding is of concern given it suggests that almost one in three young adult pedestrians are at relatively high risk of a crash while crossing the road. These patterns potentially reflect age-group related familiarity and facility with smart phone technology. Given that it is 17-25 year olds who are at second highest risk of death as pedestrians (after older pedestrians, 75 years and over), (BITRE 2015), it appears that we may expect a rise in both absolute numbers and the proportion of pedestrians deaths that this age group represents.

Overall, the results of the intercept interviews suggest that there is a particular subgroup of pedestrians who should be targeted in interventions to address distracted crossing. These are the 18-30 year old, high frequency (characterised by high use of various activities on their phones) smart phone users. However, the research did not attempt to include adolescents in the sample. Since adolescents comprise a larger proportion of the pedestrian activity and are also more likely to both own and be high-frequency users of smart phones, we would expect that interventions should target this age group too.

Table 3: Crossing the road while using a smart phone by age group and level of exposure

	Age group					
	18-30 (N=118)		31-44 (N=48)		45-65 (N=44)	
	Low exposure	High exposure	Low exposure	High exposure	Low exposure	High exposure
Question	% of age group	% of age group	% of age group	% of age group	% of age group	% of age group
How often do you use your smart phone to…. while crossing?						
Initiate a text	70	30	81	19	98	2
Monitor text messages	61	39	77	23	93	7
Respond to a text	67	33	83	17	98	2
Initiate a call	71	29	81	19	98	2
Answer a call	58	42	72	28	91	9
Initiate an internet search or interaction	71	29	88	12	98	2
Monitor internet (e.g. Facebook)	73	27	88	12	96	4
Respond to internet (e.g. email)	73	27	88	12	96	4
Use an audio-only device to listen to music/radio with earphones/buds	48	52	69	31	91	9

Limitations

There are several important limitations to our study. Firstly, we cannot be certain that pedestrians in the sample interpreted our questions in relation to crossing to mean ‘once you have stepped off the kerb’ and so their reported frequency of using their smart phones while crossing may not be as high as we have reported. Participants gave no feedback, however, to suggest that they were unsure

as to whether we were asking about while they were waiting to cross or while they were actually in the roadway.
Since these were intercept interviews, participants could have asked for clarification from interviewers, and none did, so we assume here that they interpreted the questions as we had intended. Similarly, we did not ask participants to think specifically about crossing at a signalised crossing versus a non-signalised location (such as mid-block). It is possible that their use of smart phones may be affected by this in terms of whether they perceive the risk at one location to be higher than the other and whether they accommodate for it. This is an important direction for future work especially in survey form with larger samples.

A second limitation is the self-report method used, which is subject to potential bias from socially desirable responding or errors of recall. We are unable to determine the extent to which our results may have been affected by either of these biases. However, the interviews were carried out in places where pedestrians were likely to actually be engaged in smart phone use while walking or crossing the road, or where they might typically be doing so as part of their normal activity, so we would hope that this would be more likely to facilitate ready and accurate recall.

Finally, the study results are based on a relatively small sample drawn from Brisbane CBD, which may limit the generalizability of the results to other locations. As indicated above, there was no attempt to include adolescents in the sample, and this is potentially a very important age group of pedestrians. However, as described, locations for the interviews were carefully chosen based on evidence of pedestrian crashes, and therefore highly relevant locations for the purposes of the research. We have no reason to expect that pedestrian behaviour in other Australian or New Zealand cities is substantially different from Brisbane, and so would expect that the results can be useful when considering other city centres. However, we regard it as important that similar research be carried out for adolescent pedestrian behaviour in future studies.

Acknowledgements

This study was supported by funding from Austroads. Views expressed are the authors own. The authors wish to thank Bianca Reveruzzi, Teodora Stefanova, Wanda Griffin and Helen Haydon for their assistance in data collection.

References

Australian Bureau of Statistics. (2013). *Internet and mobile phones.* Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/Products/4901.0~Apr+2012~Main+Features~Internet+and+mobile+phones?OpenDocument

Bureau of Infrastructure, Transport and Regional Economics. (2013). *Road safety statistics.* Retrieved from https://www.bitre.gov.au/statistics/safety/index.aspx

Bureau of Infrastructure, Transport and Regional Economics. (2015). *Road safety statistics.* Retrieved from http://www.bitre.gov.au/publications/2015/is_070.aspx

Bungum, T.J., Day, C., & Henry, J. (2005). The association of distraction and caution displayed by pedestrians at a lighted crosswalk. *Journal of Community Health, 30*(4) DOI: 10.1007/s10900-005-3705-4

Byington, K.W., & Schwebel, D.C. (2013). Effects of mobile internet use on college student pedestrian injury risk. *Accident Analysis and Prevention, 51,* 78-83.

Deloitte, (2014). *Media Consumer Survey 2014.* Retrieved from http://www2.deloitte.com/au/en/pages/technology-media-and-telecommunications/articles/media-consumer-survey-2014.html

Department of Broadband Communications and Digital Economy. (2008). *Online statistics*. Retrieved from http://www.archive.dbcde.gov.au/2008/01/statistical_benchmarking/online_statistics.

Ferguson, R.W., Xu, Z., Green, A., & Rosenthal, K.M. (2013). *Teens and Distraction: An In-Depth Look at Teens' Walking Behaviors.* Washington, DC: Safe Kids Worldwide.

Hatfield, J., & Murphy, S. (2007). The effects of mobile phone use on pedestrian crossing behaviour at signalised and unsignalised intersections. *Accident Analysis and Prevention, 39,* 197-205.

King, M. J., Soole, D.W.,& Ghafourian, A. (2009). Illegal pedestrian crossing at signalised intersections: Incidence and relative risk. *Accident Analysis and Prevention, 41*(3), 485-490.

Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). *Teens and Technology 2013.* Pew Research Center. Retrieved from http://www.pewinternet.org/files/old-media/Files/Reports/2013/PIP_TeensandTechnology2013.pdf

Nasar, J.L., & Troyer, D. (2013). Pedestrian injuries due to mobile phone use in public places. *Accident Analysis and Prevention, 57,* 91-95.

Nieuwesteeg, M., & McIntyre, A. (2010). *Exploring the pedestrian crash problem from the perspective of injured pedestrians.* Peer reviewed conference paper, Australasian Road Safety Research, Policing and Education Conference, 31st August- 1st September, 2010, Canberra, ACT. Retrieved from http://acrs.org.au/publications/conference-papers/database/

Stavrinos, D., Byington, K.W., & Schwebel, D.C. (2009). Effect of cell phone distraction on pediatric pedestrian injury risk. *Pediatrics, 123,* e179. DOI: 10.1542/peds.2008-1382.

Thompson, L.T., Rivara, F.P., Ayyagari, R.C., & Ebel, B.E. (2013). Impact of social and technological distraction on pedestrian crossing behaviour: an observational study. *Injury Prevention, 19,* 232-237.

World Health Organisation. (2013). *Pedestrian Safety: A road safety manual for decision-makers and practitioners.* WHO, Geneva, Switzerland.

Walker, E.J., Lanthier, S.N., Risko, E.F., & Kingstone, A. (2012). The effects of personal music devices on pedestrian behaviour. *Safety Science, 50,* 123-128.