Preventing Child Pedestrian Injuries and Deaths Arising From Vehicle-Child Accidents in Domestic Driveways

An Action Research Project

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The University of Waikato

2005

This project was funded through
Child Accident Prevention Foundation of New Zealand
2004-5 Summer Research Scholarships awarded to
Natalie Cowley, Mark Nicholls and Helen Parkinson

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Table of Contents

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Executive Summary and Recommendations

This research was a three-fold investigation into the viability of previous recommendations for vehicle-related child driveway accident safety. Firstly, the groups most at risk of these types of accidents were determined in order that they could be specifically considered when reviewing the practicalities of previous recommendations. Secondly, the feasibility of previous recommendations was systematically examined through both an extensive literature review and key and expert informant interviews. Based on these, the likelihood of implementation of previous safety recommendations for the identified high risk groups was ascertained, providing a basis on which to abandon some previous recommendations, remove obstacles to others which would enhance practicability and generate further recommendations that would be tenable for the at-risk groups in particular.

The key findings of this research were, foremost, that there is a noticeable lack of specific reference to vehicle-related child driveway accidents in any legislation or safety guidelines, as well as a shortage of official data that deal expressly with this type of accident. Further, it was found that the major obstacles to the implementation of previous recommendations – particularly the environmental ones – were *cost, autonomy,* and *spatial constraints*. While several recommendations were abandoned due to factors such as unproven or dubious effectiveness and/or prohibitive cost, it was found that the most viable recommendations were characterised by their relatively low cost for the families involved. These recommendations were typically environmental or educational in nature.

Thus, the recommendations in this report include some moderate regulatory changes to facilitate greater uptake of environmental and behaviour-modifying recommendations as well as practical ideas that all need to be part of a cohesive campaign to address the issue of vehicle-related child driveway accidents in New Zealand.

The recommendations include:

- wider publicity about this type of accident in order to raise public awareness and concern

- subsidies for both homeowners and landlords to fence appropriately – through community fundraising, commercial sponsorship and/or government funding via local authorities

- the adoption of a multi-pronged pilot scheme in one area which addresses issues of awareness, fundraising and sponsorship with a view to fine-tuning a national scheme

- use of the Building Act's "flexible solutions" option, which would stipulate the meeting of safety requirements with regards to driveways but allow some flexibility as to how those requirements are met

- a form of incentive offered by local authorities (such as a one-off rates rebate) for those who voluntarily make their sections safer for children

- the implementation of an educational campaign aimed at raising community awareness of the issue – one which addresses both adults and children

- the formation / identification of one all-encompassing group, agency or organisation which will be the responsible body for collating and disseminating information on child safety in relation to vehicle-related child driveway accidents

- the separation of records on vehicle-related child driveway accidents resulting in injuries or death from those on pedestrian accident injuries / deaths in general

- the establishment of an electronic database that would *inter alia* enable statistical analysis e.g. of injury and death rates, information that would be useful in various preventative initiatives such as educational / publicity campaigns

- the addition of a driveway safety component to Housing Corporation New Zealand's (HNZC) standards and designs – for both new houses and refurbishment projects

- the inclusion in HNZC's evaluations of their community renewal projects of residents' perspectives on safety issues including vehicle-related child driveway accident safety

- the inclusion of a reference to driveway safety in the Road Code and driver's licence test

- the inclusion of the role of SUVs and similar vehicles in vehicle-related child driveway accidents in future research into the suitability of off-road vehicles in urban and suburban environments and

- the trial of externally mounted convex mirrors (e.g. on a garage, house wall, pole or fence) to test for effectiveness in improving drivers' rear view vision when reversing on driveways.

Chapter 1: Introduction

Within New Zealand the principal cause of death to children aged between one and fourteen years is pedestrian injuries[6]. Of these child pedestrian deaths, one in five takes place in the family's own driveway[7]. Most children in such vehicle-related driveway accidents are toddlers, typically aged around two[8]. A sizeable body of research from both New Zealand and overseas has previously examined vehicle-related child pedestrian driveway accidents and identified a consistent set of recommendations to prevent such accidents.

Despite this, there has been no significant decrease in vehicle-related driveway accident injuries and deaths amongst New Zealand's children. The Injury Prevention Research Centre reports that over the past twenty years, New Zealand's rate of reduction in child pedestrian injuries ranks lowest in the Western world[9]. Similarly, New Zealand has a quite noticeably higher incidence of vehicle-related driveway accident child injury and death than many other industrialised countries[10].

Research focus and questions

What are the nature and scope of the problem?

The main objectives of this project were threefold: to determine the reasons for the prevailing high incidence of vehicle-related child pedestrian driveway accidents in the lowest socio-economic decile of the population; to ascertain the extent to which safety recommendations from previous studies have proven practicable, most particularly for the highest risk group; and to devise a new set of recommendations which would incorporate the most viable of previous recommendations but also include some new ones generated in light of our data.

Thus, our research questions were:

- Who are the victims of these vehicle-related child pedestrian driveway accidents?
- How successful have previous safety recommendations been in preventing these types of accidents?
- Are previous recommendations practicable for seriously at-risk groups? If not, which recommendations are least practicable and why, and which recommendations are most practicable and why?
- How many recommendations from previous studies have actually been implemented, and if (as we suspected) it is few of them, why have so few recommendations from previous studies been implemented?
- What roles do socio-economic status and ethnicity play in these accidents, and are the two separable?

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[6] Safekids, 2004.
[7] *Ibid.*
[8] Roberts *et alia*, 1995; Murphy *et alia*, 2002.
[9] Injury Prevention Research Centre, 2004.
[10] Murphy *et alia*, 2002.

- What other social and environmental factors may contribute to the incidence and severity of these accidents?
- Can we recommend effective, practical strategies that have an optimal chance of being implemented and thus reducing the incidence of these accidents?

These questions are addressed in the following paragraphs.

New Zealand has one of the highest rates of vehicle-related child pedestrian driveway accidents in the developed world[11]. Safekids estimate that deaths in New Zealand due to such accidents average four per year[12]. In addition, there were 299 New Zealand children hospitalised in off-road driveway accidents for the period 1994 to 1998,[13] and 71 serious, non-fatal injuries in greater Auckland for the period 1998 to 2001.[14]

Driveway accidents involve a distinctly different pattern of injury when compared with child pedestrian accidents in public road traffic. The children involved tend to be aged around two years[15]. Williamson *et alia* (2002) found that even three- and four-year-olds, while still involved in driveway accidents, were considerably less likely to feature[16]. As a generalisation, the older the child is the greater the ability he or she has to sense danger and move away from a *slowly* reversing vehicle. A lethal combination of increased mobility and new-found exploratory behaviour, with a probable lack of the cognitive ability to sense danger from a reversing vehicle, may explain the high incidence of accidents among the toddler age group. Toddlers are also more than likely to be around the home environment, as opposed to older children who will for significant periods be at school/pre-school. The fact that most accidents occurred on a sunny day not only points to toddlers playing outside; also on many occasions, and unbeknown to the caregiver, a toddler could and would follow a caregiver to their vehicle, resulting on occasion in tragic consequences.

Another salient feature with driveway accidents is that parents especially, but also family members and friends, are most likely to be the drivers who injure or kill their own, or loved ones' and friends', children[17]. Much of the literature focuses on ways caregivers and others could keep a better eye on toddlers; however often the sad situation arises that even the most vigilant caregiver cannot always account for a toddler who darts out behind a moving vehicle at the last minute. Attention has thus also focused on passive measures that include modifying the physical environment to make it difficult for toddlers to access the driveway, for example by fencing off the driveway or a play area.

Problems associated with reversing and rearward visibility feature in driveway accidents. Blind-spots and decreased capacity to see toddler movements due to

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[11] Murphy *et alia*, 2002.
[12] *Ibid.*
[13] Safekids, 2004.
[14] Murphy *et alia*, 2002.
[15] See: Roberts *et alia*, 1995; Murphy *et alia*, 2002; Williamson *et alia*, 2002; Henderson, 2000; Agran *et alia*, 1994; (See literature review).
[16] Williamson *et alia*, 2002.
[17] See literature review.

general poor rearward visibility make it extremely difficult to identify a mobile toddler who is the same height as a vehicle's bumper. Visibility problems are exacerbated with vehicles which stand high off the ground such as four-wheel drives, vans and trucks. A plethora of studies illustrate a high incidence of such vehicles in driveway accidents relative to their much lower overall ownership levels[18].

Children from lower socio-economic groups have been calculated by Roberts *et alia* (1995) to be over five times at risk of being involved in such accidents, whilst the same study estimated Maori children to be at close to four times the risk of driveway injury[19]. Murphy *et alia* (2002) have also shown the high incidence of those with lower socio-economic status, and Maori and Pacific peoples, in driveway accidents in their Auckland region study[20].

Lack of implementation of previous recommendations

Environmental recommendations

In New Zealand, Roberts *et alia* (1995) have argued that fencing is possibly the area that could be the most beneficial in reducing driveway accidents, and hence called for more research into the viability of fencing[21]. Thus, in 2002 with 84% of the 76 cases in their study living in rented accommodation, Murphy *et alia* (2002) recommended making it compulsory for landlords to fence the driveways of their rental properties at their own expense[22]. However, this measure was never implemented, perhaps because of the cost of compulsory fencing to landlords, and also because of much resistance to the concept of fencing the driveway itself. Opinions in the media for instance expressed annoyance that *more* regulations were to be applied to all landlords. These writers instead attributed child driveway accidents to the recklessness of a few careless parents[23].

Many other overseas studies saw the potential for fencing to reduce driveway accidents, with Holland *et alia* (2000) for instance describing fencing as the optimal solution. Yet most studies while praising fencing "in theory" also expressed doubts about its practical implementation, and tended instead to emphasise recommendations of short-term behavioural strategies.

In a study for the Motor Accidents Authority of New South Wales (MAA), in response to the landmark Child Death Review Team's *1999 Annual Report*, Henderson (2000) specified two recommendations relevant to fencing:

- firstly, that the MAA would approach the Australian Building Codes Board with the aim of establishing guidelines for the protection of driveways for at risk children[24]; and
- secondly, that the MAA would approach the NSW State government in order to encourage measures such as the fencing of driveways.

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[18] See literature review.

[19] Roberts *et alia*, 1995, p.406.

[20] Murphy *et alia*, 2002.

[21] Roberts *et alia*, 1995.

[22] Murphy *et alia*, 2002.

[23] The Daily News, 15 May 2002, p.8; The Dominion Post, 16 May 2002.

[24] Henderson, 2000, p.40.

While we understand that the first recommendation may have been or is likely soon to be met (with a reform of the Australian Building Code imminent), we have determined that the second recommendation (which included fencing driveways), worded in a fairly non-committal and "loose" manner, has not been implemented. The MAA's *Driveway Safety Grants 2005* explains that investigations are still continuing into planning and environmental strategies, and it recommends in the meantime that caregivers discourage children from playing on driveways.

Vehicle modifications and visual aids

Paine and Henderson's (2001) comprehensive study of vehicle aids (referred to by other studies such as Neeman *et alia* (2002), specifically recommended the following:

- circulation of their 2001 study to stakeholders;
- inviting companies to develop complete systems at their own costs (such as a combination proximity detector/video camera system);
- the MAA to promote this system (if one becomes available);
- the MAA to monitor uptake and gain feedback from motorists on such systems and then review their specification together with conducting possible promotional campaigns; and
- national-level adoption of a non-mandatory specification for vehicle owners (non-mandatory due to high cost) but requiring vehicle manufacturers to make such systems available as an optional accessory.

While the first recommendation could be regarded as having been implemented (with a fairly widespread circulation of the study evident in its citation in other studies[25], and with the complete study included as part of a driveway safety display kit[26]), we could not find any documentation indicating the development of a dual detector/camera system by relevant manufacturers/retailers. As the following three recommendations were contingent on the adoption of this second recommendation, we concluded that all of these latter recommendations have not been implemented.

Behavioural recommendations

Common to many of the studies was the targeting of behavioural recommendations to specific groups. The individual behavioural recommendations (bearing in mind that many studies recommended multiple strategies) included:

- targeting drivers (Silen *et alia*, 1999; Robinson and Nolan, 1997);
- targeting families with four-wheel drives, families with lower socio-economic status, and larger families generally through public health messages (Murphy *et alia*, 2002); and
- targeting parents (Henderson, 2000; Nadler *et alia*, 2001; Godbole, 2001; Williamson, 2002; Neeman *et alia*, 2002).

Those authors who recommended targeting parents differed on the best way to do so. Some authors advocated a safety message through early childhood centres and hospitals (see Neeman *et alia*, 2002) whereas others seemed to address their

[25] See: Neeman *et alia*, 2002, p.32; Hockey *et alia*, 2003, p.4.

[26] Macquarie University, 2004; http://www.kidsandtraffic.mq.edu.au/projects/safe.htm#who

recommendations more directly at parents without reference to appropriate organisations or campaigns (see Nadler *et alia*, 2001).

While various programmes were initiated both in New Zealand and overseas, particularly in Australia (see the next section), the message was usually limited to organisations within a close circle of state and non-state safety prevention groups. We failed to find evidence in New Zealand of a widespread awareness campaign of the kind likely to raise the consciousness of "the average kiwi family". Indeed throughout this project, we found most "lay" people were unaware of the high incidence of vehicle-related child pedestrian driveway accidents in New Zealand, never mind the specific characteristics of these types of accidents. Most awareness was of newspaper stories of specific incidents, and tended to focus on the circumstances of individual cases with less information on prevention strategies.

We also did not find a systematic awareness of driveway accidents in place at schools or other community organisations. Safekids have been the most prolific organisation advocating safer driveways in New Zealand. Yet perhaps because Safekids may be competing with other government-funded organisations, and with other safety and health issues, for a slice of the funding, driveway accidents appear not to have achieved the breakthrough to the general public consciousness that the authors of many of the studies we reviewed clearly desired. In this respect, recommendations to increase public awareness in order to effect behavioural change can be seen as having not been implemented.

Lack of success of previously implemented recommendations

Given that the fencing of driveways was not implemented in New Zealand or overseas, previous recommendations that have been implemented could be collectively summed up as those recommendations that involved increasing awareness of vehicle-related child pedestrian driveway accidents in the broadest sense. To this end, and perhaps spurred on by recommendations from some particular previous studies, Safekids and the Injury Prevention Research Centre (Auckland) in New Zealand, and the Motor Accidents Authority (NSW) in Australia, have undertaken several initiatives to increase awareness of driveway accidents.

A public awareness campaign generated by interest in the 2002 study by Murphy *et alia* was carried out by Safekids, Waitakere City Council and Plunket in Waitakere City in 2003. It involved free posters, door hangers and flyers[27]. The 2002 study also generated considerable media interest in New Zealand at the time, with several reports both in the newspapers and on the radio featuring calls for compulsory fencing and highlighting the high incidence of Maori and Pacific children in vehicle-related child pedestrian driveway accidents. In Australia the interest generated by the New South Wales Child Death Review Team (NSW-CDRT) 1999 *Annual Report* lead in late 2002 to the world's first Reversing Visibility Index[28]. Introduced by NRMA Insurance this index measures how well a driver can see out the back of a

[27] Waitakere City Council, 2003.

[28] NRMA insurance, 2002. http://www.nrma.com.au/pub/nrma/about_us/media_releases/20021031a.shtml

vehicle, and enables the consumer to pick vehicles with a good rating in terms of visibility while reversing[29].

However, the problem with many of these initiatives is that they have been too sporadic, and therefore not able to sustain awareness of the problem and the risk in the general public consciousness. There has never been a major and concerted vehicle-related child pedestrian safety campaign utilising media such as television that has been able to appeal to a wider audience but rather the current situation has been longstanding, in which only a handful of safety organisations appear to have been able to achieve a rudimentary level of awareness of the issue.

Thus, with an increasing injury rate over the last 20 years[30], these recommendations and the subsequent awareness campaigns may be judged to have had little success in decreasing vehicle-related child pedestrian driveway accidents in New Zealand.

Objectives and scope of the present project

A central objective of the present project was to establish the reasons for the high incidence of child vehicle-driveway related accidents among low socio-economic status families. This would mean:

- examining the social factors that may contribute to New Zealand's sustained and comparatively high rate of vehicle-related child pedestrian driveway accident injuries to and deaths of children;
- evaluating the success of previous studies in this area - whether their recommendations had been implemented, and if so what effect those recommendations had on the rate and/or pattern of child vehicle-related driveway accidents;
- in particular, assessing the viability of previous recommendations for low socio-economic families; and
- finally recommending further realistic strategies for reducing the incidence of these sorts of accidents – strategies which must be able to be implemented by those most at risk, and which have an optimum chance of adoption and effectiveness.

[29] *Ibid.*
[30] Injury Prevention Research Centre, 2004.

Chapter 2: Methodology

The objectives of this project were to establish the extent to which previous recommendations for vehicle-related child pedestrian driveway accident prevention had been implemented, the extent to which they had been successful, the obstacles to their success, and the modifications and/or new recommendations which were necessary to achieve reductions in vehicle-related child pedestrian driveway accidents.

In particular, we sought to ascertain the viability of recommendations in relation to previously identified at-risk groups: those of lower socio-economic status, Māori and Tagata Pasifika.

Literature Review

To investigate our research questions we first conducted an extensive literature review on the topic. This was to become the platform upon which the rest of the project was based. This review included all available New Zealand and – to the greatest extent practicable – international literature on the subject. As well as the conventional literature this included the websites (when available) of all organisations concerned with child accidents, child safety, or accidents in general. This search identified several prominent local and international studies, most significantly those by Roberts *et alia* (1993); Roberts *et alia* (1995); Henderson *et alia* (2000); Holland *et alia* (2000); Godbole *et alia* (2001); Mayr *et alia* (2001); Nadler *et alia* (2001); Paine and Henderson (2001); Murphy *et alia* (2002); Neeman *et alia* (2002); and Williamson *et alia* (2002).

The results from the literature review showed the nature and scope of the problem and were relevant to the key components of our research. It focused and justified our attention to those most at risk – Māori, Tagata Pasifika and lower socio-economic status groups.

New Zealand Statistics

An investigation into New Zealand statistics was undertaken to identify the extent of vehicle-related child pedestrian driveway accidents. ACC records were explored in an endeavour to locate reliable statistics regarding such accidents. It was established that there are scant statistical materials on this type of accident specifically, and further investigation revealed this to be because vehicle-related child pedestrian driveway accidents are not differentiated from pedestrian accidents in general, so are not separately available. The statistics that have been identified for this study therefore are from the above-mentioned studies on vehicle-related child pedestrian driveway accidents and were themselves sourced from coroners' and/or medical records.

Expert informant interviews

Our media release early in the project and the ensuing news media articles about the project meant that we were approached by several invaluable expert informants within the field of the research, while other expert informants were directly approached by the researchers. Information was gathered either from face-to-face interviews or by telephone and/or e-mail. The Safekids organisation offered information on vehicle-related child pedestrian driveway accidents in general, with discussion centred on resources, data, legislation and Safekids' own functions. A meeting with Professor Jane Ritchie (University of Waikato) gave us further information on the role different cultural practices might play in the incidence of these accidents. A building contractor was also interviewed as to the extent to which driveway safety is a concern within building regulations, and also to provide suggestions for possible changes within the Building Act.

Housing NZ Corporation was approached, and provided a brief outline of their guidelines regarding outdoor safety. The Waikato Property Investors Association was also approached in order to get private landlords' perspectives on the viability of environmental safety measures, but the Association declined to participate. In addition we consulted briefly with an Injury Prevention Consultant (IPC) from ACC.

Key informant interviews

Key informants were located via personal and professional networks with an (accurate) anticipation that these samples would snowball from our original contacts. Key informants were selected on the basis of two loose criteria: they must have children of their own or living with them in their household and they must have a driveway. While no one who met these criteria was excluded from participating, there was an emphasis on contacting people from the at-risk groups identified.

In conducting these interviews we aimed not to obtain a representative sample of participants but rather to ensure that all potentially relevant groups and points of view were covered. The former would have been an unrealistic goal given the limited scale and nature of our project. We instead attempted to obtain and represent, as far as possible, all opinions and facets of the issue. It would be therefore unwise to generalise from the key informant data, which must be taken as enabling a multiple-perspectives understanding of the issue(s) and perhaps as a basis for future representative sample survey research.

The interviews were mostly carried out in semi-structured interviews, either face-to-face or via telephone but several respondents who were difficult to contact via these methods were sent self-completion questionnaires in which the questions were based on those used in the interviews but formatted slightly differently to better suit a self-completion questionnaire. The objectives of these interviews / questionnaires were:

- to determine how familiar members of the general public are with the issue
- to ascertain the viability of recommendations from previous studies, and the extent to which they would be implemented

- to ensure that as many perspectives as possible were heard and thus taken into account in our analysis and recommendations

Generating our recommendations

The data collated by each of the methods used in this research were first organised and examined separately using appropriate methods of analysis. The literature review was analysed thematically with the interview and questionnaire data being collated and summarised then used to contextualise and interpret the data from official reports and the literature.

The material was then formed into three distinct types of recommendations: those that had been reviewed and critiqued and were to be abandoned as non-viable; those that were considered viable but needed suggestions for overcoming obstacles to their implementation; and new recommendations generated from our own research which included practical suggestions for enhancing child safety in situations of risk of vehicle-related child pedestrian driveway accidents, to be implemented by families themselves, the wider community and relevant official bodies.

Overall design, resource limitations and choices made

Overall, this project was focused on ensuring that any recommendations were practicable for the identified at-risk groups. This involved asking the opinions of members of those groups as to their practicability.

A significant limitation on the project was the difficulty and length of time involved in networking and in gaining access to various groups and organisations – particularly to the correct individual(s) within certain groups and organisations. This was compounded by time, geographical, and financial constraints (and the late provision of important material, while valued, meant that the planned deadline for completing the report had to be put back in order to process and write up this material).

Another limitation was simply the fact that there exist few quantitative data on the topic. This is due to the inconsistent manner in which vehicle-related child pedestrian driveway accidents are recorded. They can be recorded either as pedestrian accidents or as off-road accidents, often without being distinguishable from other sorts of accidents that fall under the same general category. Thus, we were compelled to rely on many mostly small datasets provided by the authors of the studies we examined – studies which, according to Murphy *et alia* (2002) almost exclusively used a retrospective methodology, uncovering data from medical and/or coroners' records relating to child driveway accidents. It is also difficult to know the extent to which studies and recommendations from other countries – even Australia – can be applied to the New Zealand context.

A specific and conscious decision was made not to interview people who had suffered the loss or injury of a child in vehicle-related child pedestrian driveway accidents as this was felt to be too sensitive a subject and unlikely to yield information that could not be obtained in other ways.

Dissemination of research outcomes

With effect from the 2004-5[31] Summer Research Scholarships the Child Accident Prevention Foundation of New Zealand requires scholarship researchers to promote the dissemination of their research findings. The University of Waikato's PR and Marketing Unit distributed a media release widely to New Zealand print and other media on 11 January 2005 and featured the media release as "story of the week" on the University's website. This resulted in a number of media outlets, individuals and organisations contacting the research team and both contributing to the research and following-up on its progress.

Anna Saunders, a journalist from *The Dominion Post* has kept in close contact about the project and received at her request an advance electronic copy of the report in order to prepare a substantial news item on the project and the safety recommendations arising from its findings. The research team hope this news media report will situate the report and its research-based recommendations firmly in the public domain so that it is likely to be accessed in the future by interested parties.

Other expressions of media interest are exemplified by contact from Neryda McNabb of *The Whakatane Beacon* who wished to relate the research and its findings to the community served by the newspaper and to one or more local incidents of vehicle-related child driveway accidents. We proposed that we highlight "at risk" factors and if the local journalist were to see them as characteristic of the Whakatane community her newspaper services then that is the basis for a "local angle". Such local coverage has a very useful role to play in the dissemination of results and the promotion of the research-based recommendations.

The research team were also told of radio news and other transient items dealing with the project from time to time.

Two approaches supporting wide dissemination were particularly welcome: from Joy Gunn, editor of *Safekids News* at the Auckland District Health Board and from Helen Borne, editor of *The New Zealand Injury Control Bulletin* at the University of Auckland. It is envisaged that the *SafeKids News* article will be focused specifically on our research-based recommendations for reducing vehicle-related child driveway injuries and deaths while the *New Zealand Injury Control Bulletin* article will be focused more on the issue of understanding why earlier research-based recommendations weren't implemented or if implemented didn't appear to reduce such injuries etc.

We have been advised by Joy Gunn that "this year for their Safekids Campaign they will be focusing on child pedestrian safety including driveway injuries to young children and that they are holding workshops around the country in April and May to discuss child pedestrian issues with many of the 91 community groups that work on the Safekids Campaign".

[31] See Smith, Cowley, Horgan and Swain (2004) in which the very limited dissemination to date of CAPFNZ SRS reports is outlined and recommendations are made for enhancing the value of the Scholarships by optimising the dissemination and implementation of recommendations arising from CAPFNZ SRS projects.

The *New Zealand Injury Control Bulletin* "is distributed to injury prevention practitioners, researchers, policy people, all MPs and key media" and aims "to provide up-to-date information and views from a variety of individuals and organisations, covering a wide range of injury prevention issues".

When the report has been provided to the Child Accident Prevention Foundation of New Zealand the University of Waikato PR and Marketing Unit will again distribute media releases to news organisations throughout New Zealand on the research and its recommendations.

Chapter 3: Data from Previous Studies / The Literature

This chapter summarises data from previous studies / reports and from the academic / research literature on vehicle-related child pedestrian driveway accidents. The former are typically from either state agencies and state-funded organisations or advocacy groups and organisations and tend to have a broad dissemination, while the latter are typically by individuals or research teams in tertiary education or medical institutions and tend to have a more narrowly specialised dissemination. Quantitative information is typically either specific research results or official data collected in the process of activity by state and community-based agencies. Qualitative information may be based on specific cases, key and/or expert informants or even anecdotes. A typical item would be a combination of previously reported research plus recent official statistics and might centre on a particular recent case.

Material is quite often recycled among different government departments and agencies, with original sources not always specifically acknowledged, and data is only occasionally presented in a "scientific report" format (where the methodology and details of all variables are explicit). Most of the organisations whose materials are examined here adopt an "objective" and evidence-based framework, but the data are often presented in an easily accessible and summarised format, which can make evaluation difficult.

This chapter is divided into sections which cover official / semi-official reports (e.g. by state and state-funded agencies), academic and other research studies (e.g. by academics and medical staff) and mass media reports. These are further divided into sub-sections by country so as to group together items with a common social and physical environment. The academic and other research studies are further sub-divided into specific and detailed substantive aspects of vehicle-related child pedestrian driveway accidents so that specific recommendations made in this report can be considered in light of information specific to each of the recommendations.

Official and semi-official material

New Zealand

Safekids

Safekids is an advocacy and safety service group at Auckland's Starship Hospital and is chiefly funded by the Ministry of Health. Their aim is to reduce preventable injuries. Safekids has an extensive knowledge base and access to resources concerning *inter alia* vehicle-related child pedestrian driveway accidents.

Safekids report that injuries to children peak between the ages of one and two years, and that deaths in New Zealand due to child driveway accidents average four per year. They also state that the number of children in New Zealand under 15 years old who were hospitalised by an off-road "drive-over" between 1994 and 1998 inclusive

was 299. Safekids points out that the vehicle involved in the "drive-over" is most likely to be driven by the child's father.

Safekids advances a "spectrum of prevention" model aimed at reducing *all* types of injuries to children that could well be relevant to the prevention of child driveway injuries and deaths. This model outlines a continuum of strategies that as a whole are geared toward social change.

In 2003 Safekids in conjunction with the Waitakere City Council and Plunket, instigated a "safe driveways" campaign in Waitakere City, which included posters and flyers as well as "door hangers" in both Māori and English to remind caregivers to check where the children are as they leave the house.

Injury Prevention Research Centre

The Injury Prevention Research Centre (IPRC) at the University of Auckland has a fact sheet available on the internet titled *Dangers to Child Pedestrians* which mentions fencing driveways off from the play area, the possibility of fitting cars with proximity detectors and for drivers to take extreme care when children are playing in driveways[32].

Accident Compensation Corporation

The ACC website briefly mentions driveway accidents to children, stating that the number of children killed in off-road environments is considerably higher than in many other industrialised nations. For further information about driveway safety, the ACC website refers the reader to the Safekids website.

Australia

Queensland Injury Surveillance Unit

The Queensland Injury Surveillance Unit (QISU) funded by Queensland Health addressed driveway accidents in their December 1997 *Injury Bulletin*[33]. They reported 15 low speed driveway injuries from 1994 to 1996. From these 15 incidents six children were admitted to hospital[34]; nine children were one year old, three were two years old, two were three years old and two were aged over three years[35]. They also cite their October 1997 Bulletin in which 22 driveway fatalities to children aged under five occurred in Queensland from 1992 to 1996[36].

Further, QISU devoted the entire March 2003 Injury Bulletin to an extensive four-page report "Low speed run-overs of young children in Queensland"[37]. This report included retrospective data from a number of Queensland hospitals regarding child driveway accidents in Queensland. The QISU manager, data analyst and paediatric

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[32] Injury Prevention Research Centre, http://www2.auckland.ac.nz/ipc/pdf/fs02.pdf

[33] Queensland Injury Surveillance Unit, 1997, p.1.

[34] *Ibid.*

[35] *Ibid.*

[36] *Ibid.*

[37] Hockey, Miles, Barker, 2003.

surgeon were the authors of the report[38]. The data from this report have been included in the following "Academic and other research studies by variable" section.

Motor Accidents Authority of New South Wales

The NSW Child Death Review Team's annual report for 1999 sought to bring to the public's consciousness and highlight the serious nature of child driveway accidents. This report identified 17 driveway fatalities and prompted the Motor Accidents Authority (MAA) of NSW to institute a range of activities intended to reduce vehicle-related child pedestrian driveway accidents.

These included several comprehensive studies into driveway accidents (Henderson, 2000; Paine and Henderson, 2001; Williamson *et alia*, 2002). The MAA also offers an annual Safety Grant; the 2005 Grant offers up to A$3000 for local governments or health or community agencies in NSW to undertake a driveway safety project[39].

Academic and other research studies by variable

Given that vehicle-related child pedestrian driveway accidents occur on private property, virtually all studies in this area are of a retrospective nature, whereby data is gained through examining coroners' and/or hospitals' records over a set period in time. Further, most if not all of this research has been carried out by members of the medical professions, especially by paediatric surgeons. The studies examined here all adhere to the conventions of academic research and the reports usually include an abstract and methods, results and discussion sections, and follow a conventional report format.

New Zealand

Age of children injured

Roberts, Norton, and Jackson (1995) found the typical age of children injured in the driveway to be 24 months[40]. This was consistent with an earlier study that found the median age of 91 children injured in driveways from 1986 to 1990 to be 25 months[41]. Similarly, of 76 children injured between January 1998 and October 2001, the median age of the injured child was 23 months[42].

Deaths

In Roberts, Kolbe and White's 1993 retrospective study of the Auckland region there were eight fatalities in the period from 1986 to 1990[43]. Six fatalities from 77 cases occurred in the 2002 Auckland study by Murphy *et alia* which covered a 45-month period from 1998 to 2001[44].

Injuries

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[38] Ibid, p.1.
[39] MAA Driveway Saftey Grants, 2004.
[40] Roberts *et alia*, 1995, p.406.
[41] Roberts *et alia*, 1993, p.233.
[42] Murphy *et alia*, 2002.
[43] Roberts *et alia*, 1993. p.233.
[44] Murphy *et alia*, 2002.

The 1993 study by Roberts *et alia* revealed 91 non-traffic pedestrian injuries in Auckland from 1986 to 1990, of which 85 occurred in the driveway[45]. A study in Auckland in 1995 identified 55 injuries due to vehicles reversed by adults from the period 1992 to 1994[46]. From 1998 to 2001 there were 71 non-fatal driveway injuries in Murphy, White and Morreau's 2002 retrospective study of all serious driveway injuries in the greater Auckland region[47].

Gender of child injured

Of 91 children injured between 1986 and 1990, 53 were boys and 38 were girls[48]. Further and from the same study, of eight fatalities five were girls and three were boys[49]. Eleven years later, the 2002 study by Murphy *et alia* found 58% (45 from 77) of the children injured were boys[50].

Relationship of driver to child

Just under 50% of 91 children injured between 1986 and 1990 were injured by a driver related to the child, while 11% of the children were injured by a friend or neighbour[51]. The relationship of the driver involved in the remaining cases was reported by Roberts et alia (1993) as unknown[52]. In the 2002 retrospective study of 76 injuries by Murphy *et alia* 30 injuries involved the parents as the driver (split equally by gender), 22 drivers were extended family, 14 drivers were neighbours and friends, four were listed as commercial drivers, and seven were unknown.

Gender of driver

The 2002 research by Murphy *et alia* in Auckland showed an equal gender distribution of drivers who drove over their own child with 15 drivers being men and 15 being women.

Vehicle type

The same research by Murphy et alia showed that vans, 4-wheel-drives and light trucks were involved in 28% of injuries to 77 children from 1998 to 2001, yet such vehicles only account for six percent of registered domestic vehicles in Auckland.

House rented or owned

Sixty percent of 53 children in the 1995 case-study in Auckland by Roberts *et alia* were injured in driveways at rented accommodation[53]. The 2002 greater Auckland study by Murphy *et alia* also highlighted rented accommodation, with 42 out of 50

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[45] Roberts *et alia*, 1993. p.233.
[46] Roberts *et alia*, 1995, p.406.
[47] Murphy *et alia*, 2002.
[48] Roberts *et alia*, 1993, p.233.
[49] Ibid, p.233.
[50] Murphy *et alia*, 2002.
[51] Roberts *et alia*, 1993, p.234.
[52] Ibid, 1993.
[53] Roberts *et alia*, 1995, p.406.

cases identified as occurring in the home driveway of the child injured involving families in rented accommodation. Further, 38% of the homes in the 2002 study by Murphy *et alia* study were state rentals.

Socio-economic status

Children from the lowest socio-economic stratum were calculated by Roberts *et alia* to be over five times at risk compared with children in the non-injured control cases in their study[54]. Only five children of the 53 injured were from socio-economic positions I, II and III, while 22 children injured were from socio-economic positions IV and V, and 26 were from VI and other positions – the lowest positions in socio-economic status[55]. Of the 53 cases, children from single parent families, and families with more than three children under the age of five, were also deemed to be at greater risk[56].

The 2002 Starship study continued to highlight the fact that vehicle-related child pedestrian driveway accident injuries are closely related to socio-economic status, with nearly half (47%) of the 77 injured children in the study being in the two lowest of the ten groups of the New Zealand deprivation index[57]. The authors had expected only 20% of the injuries to be in these two lowest socio-economic groups[58].

Ethnicity

Māori children were calculated in the case-control study by Roberts *et alia* to be at close to four times the risk of driveway injury compared with children in the reference category[59]. In this study, 15 injured children were Māori while 17 were Tagata Pasifika and the other 21 children were listed as "other"[60]. Māori and Pasifika children were also over represented in the 2002 Starship study, at 66% of 76 injuries, relative to their much lower representation in the general population[61]. However, the authors noted that the bigger family sizes (a perceived factor in higher child driveway accidents), of Māori and Cook Island Māori could be a factor in the over-representation of these ethnic groups[62].

Australia

Age of children injured/killed

Consistent with the New Zealand studies, a retrospective study published in 2002 by Neeman *et alia* reported a median age of 20 months from 36 driveway deaths in

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[54] Roberts *et alia*, 1995, p.406.
[55] Ibid, p.407.
[56] Ibid, p.407.
[57] Murphy *et alia*, 2002.
[58] *Ibid.*
[59] Roberts *et alia*, 1995, p.406.
[60] Ibid, p.407.
[61] Murphy *et alia*, 2002.
[62] *Ibid.*

Australia for the period 1996 to 1998 [63]. Henderson also noted that driveway accidents tended to occur to under-five-year-olds, and especially to two-year-olds[64].

This phenomenon is explained more specifically in the 2002 study by Williamson *et alia* of fatalities in New South Wales, which reported that children aged one to two years were over-represented in driveway and off-road pedestrian fatalities[65]. They also noted that children aged less than 12 months, children three to four years old and five-year-olds all exhibited distinct injury patterns and were proportionally less involved in driveway and other off-road pedestrian fatalities [66].

In their 2003 Queensland study Hockey et alia reported that low speed run-over fatalities most often happen to children from the ages of 12 to 23 months[67]. They believe this age group is commonly involved because they are old enough to be mobile but not old enough to understand the concept of personal safety[68].

A study conducted in Victoria from 1985 to 1995 by Robinson and Nolan (1997) found that for 28 fatalities the average age for the "interactive" group (eight fatalities where children were in some way interacting with the driver, such as sitting on a trailer being reversed), was 5.5 years while the average age for the "unaware" group (where the driver was unaware of the presence of the child) was 1.9 years[69].

Deaths

Vehicle-related child pedestrian driveway accident deaths in Australia averaged 12 each year during the period 1996 to 1998 according to the 2002 study by Neeman *et alia*[70]. The exact number of fatalities in the study each year were: 17 in 1996, 10 in 1997 and nine in 1998[71].

The landmark 1998-1999 *Annual Report* from the New South Wales Child Death Review Team (NSW-CDRT) prompted the highlighting of vehicle-related child pedestrian driveway accidents within the Australian media, and sparked off other comprehensive Australian studies into driveway injuries and deaths[72]. The 1998-1999 *Annual Report* of NSW-CDRT reported 17 fatalities in NSW from 1996 to 1999 from non-traffic reversing vehicle accidents, predominantly in driveways[73]. Subsequent NSW-CDRT *Annual Reports* list child driveway and driveway-related fatalities in NSW as follows: four fatalities 2000-2001[74] and three fatalities 2001-

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[63] Neeman *et alia,* 2002, p.1.
[64] Henderson, 2000.
[65] Williamson *et alia,* 2002, p.19.
[66] Williamson *et alia,* 2002, p.19.
[67] Hockey *et alia,* 2003, p.2.
[68] Ibid, p.2.
[69] Robinson and Nolan, 1997, p.735.
[70] Neeman, p.8.
[71] Ibid, p.8.
[72] NSW-CDRT, 1999, p.40.
[73] Ibid, p.40.
[74] NSW-CDRT, 2001, pp.46-47.

2002[75]. Also in New South Wales, Holland *et alia* reported 14 fatalities obtained from NSW coroners records in the period 1988-1999[76].

With data obtained from 15 Queensland hospitals, Hockey *et alia* accounted for 28 fatalities in Queensland to under-five-year-olds from 1994 to 2001 due to low speed pedestrian impact, including a significant proportion of driveway accidents (60%), but also accidents in car parks and other areas where reverse and low-speed driving and pedestrians occur together[77]. There were also 28 comparable fatalities (slow-speed non-traffic fatalities) in Victoria, from the period 1985 to 1995, in which the data was obtained retrospectively from a variety of the usual sources [78].

Injuries

Over a five-year period from 1995 to 2000 there were 42 admissions as a result of driveway accidents to New Children's Hospital, Westmead, New South Wales[79]. From 1998 to 2001 there were 68 injuries to under-five-year-olds (data obtained from15 participating Queensland hospitals) due to low speed pedestrian-related injury (with the same presumption as above)[80]. Robinson and Nolan (1997) report 250 hospital admissions to 234 Victorian children under 15, due to non-traffic pedestrian accidents [81].

Gender of child injured/killed

In Australia from 1996 to 1998, 23 boys (64%) and 13 girls (36%) were killed as a result of vehicle-related child pedestrian driveway accidents[82]. Holland *et alia* describe a similar pattern with their 2000 study in NSW in which 74% of children injured, and 78% of children killed, were boys[83]. In the 2002 study by Williamson *et alia* using coroners' records boys were involved in 66.7% of driveway fatalities, but significantly were only involved in 50% of other off-road pedestrian injuries[84].

The same pattern emerged with Hockey's 2003 Queensland study, in which every year from 1994 to 2000, boys outnumbered girls as fatal victims of "low speed run-overs"[85]. The situation was the same in Queensland for "low speed run-over" injuries from 1998 to 2001, with boys outnumbering girls every year[86].

Finally, more boys were killed than girls in Robinson and Nolan's 1997 study in Victoria of 28 fatalities; with seven boys and one girl killed in the "interactive" group (where the driver was interacting with the child) and nine boys and eight girls killed in

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[75] NSW-CDRT, 2002, p.53.
[76] Holland *et alia*, 2000.
[77] Hockey *et alia*, 2003, pp.1-2.
[78] Robinson and Nolan, 1997, p.732.
[79] Holland *et alia*, 2000.
[80] Hockey *et alia*, 2003, p.2.
[81] Robinson and Nolan, 1997, p.732.
[82] Neeman *et alia*, 2002.p.8.
[83] Holland *et alia*, 2000.
[84] Williamson *et alia*, 2002, p.19.
[85] Hockey *et alia*, 2003, p.2.
[86] Ibid, p.2.

the "unaware" group (where the driver was unaware of the child's presence)[87]. The total for all three groups was 18 boys killed and 10 girls killed[88]. However it should be noted that a socio-cultural pattern in which parents, especially fathers, were more likely to involve boys than girls in vehicle-related interactive activities is likely to be a significant factor in the last-listed data.

Relationship of driver

The child was known to the driver in 89% of fatalities (eight of nine cases) in the retrospective 1995-2000 NSW study by Williamson *et alia* of driveway accidents, while the child was known to the driver in 70% (seven of ten cases) of other off-road pedestrian accidents[89]. In nine of these 15 "child known" cases the driver was the child's parent, while other drivers were grandparents, family friends and siblings[90]. A similar pattern was also evident with the 2000 study by Holland et alia in which a family member or person known to the child was the driver in 86% of the examined fatalities[91].

In 15 out of 28 fatalities in the 2003 Queensland study by Hockey et alia a direct relative or friend of the family was the driver (most frequently a parent)[92]. In 28 fatalities in Victoria from 1985 to 1995 the driver was a parent in 16 fatalities and a relative in five fatalities, a friend in three fatalities, and a tradesman was the driver in one fatality[93] (and three fatalities involved driver-less vehicles)[94].

Gender of driver

Neeman *et alia* established that the driver of the vehicle involved in vehicle-related child pedestrian driveway accidents is most likely to be male[95]. They based this on an analysis of 36 fatalities from 1996 to 1998 in Australia, in which the father was the driver in 13 (36%) of the accidents while the mother was the driver in only three (8%) of the accidents[96]. Further, over all the 36 accidents 86% of the drivers were males [97].

These figures are similar to the 2002 NSW study by Williamson *et alia* that covered the period 1995 to 2000, in which two-thirds of the drivers involved in vehicle-related child pedestrian driveway accidents fatalities were male[98].

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87 Robinson and Nolan, 1997, p.735.
88 Ibid, p.735.
89 Williamson *et alia,* 2002, p.22.
90 Ibid, p.22.
91 Holland *et alia,* 2000, p.195.
92 Hockey *et alia,* 2003, p.2.
93 Robinson and Nolan, 1997, p.735.
94 Ibid, p.735.
95 Neeman *et alia,* 2002.p.1.
96 Ibid, p.14.
97 Ibid, p.14.
98 Williamson *et alia,* 2002, p.22.

Vehicle type

Neeman *et alia* found that the majority of vehicles involved in 36 fatalities from 1996 to 1998 in Australia involved large four-wheel-drives and trucks [99]. The over-representation of these vehicles in proportion to their much lower overall ownership was also pointed out in the study by Holland *et alia* which covered the period from 1995 to 2000 in NSW[100]. They established that four-wheel-drives and light commercial vehicles accounted for 42% of 42 injuries[101]. They also noted that firstly, a four-wheel-drive was involved in 34% of injuries where the child survived[102]. Secondly, four-wheel-drives were involved in 64% of cases where the child died[103].

The high proportion of children hit by four-wheel-drives or large commercial vehicles is even more obvious in the NSW-CDRT's analysis of deaths in NSW from 1996 to 1999, with 15 out of 17 fatalities involving these vehicles[104]. A retrospective study in NSW from 1995 to 2000 also highlighted the over-representation of four-wheel-drives, vans and trucks, with eight out of nine fatalities in driveways involving these vehicles[105]. Yet as Williamson *et alia* point out, four-wheel-drives, vans and trucks are only involved in 35.5% of <u>all</u> vehicle-related child pedestrian fatalities (*i.e.* including vehicle-pedestrian fatalities in other locations)[106]. This is evidence of a relationship between vehicle type and location in which these types of vehicles in driveways are more likely to be involved in accidents than elsewhere.

In the 2003 study by Hockey *et alia* of 28 low-speed pedestrian fatalities in Queensland, 19 of the 22 fatalities where the type of vehicle was known were categorised as involving large vehicles (vans, utilities, trucks, four-wheel-drives), with four-wheel-drives being the biggest single group at 41%, while cars accounted for under 15% of the fatalities[107].

Robinson and Nolan's study in Victoria of 28 fatalities in the period 1985 to 1995 found that four-wheel drives accounted for five fatalities while trucks accounted for two, utilities for five, vans for two, tractors for three, station wagons for five and sedans for six fatalities[108]. Many of these fatalities involved trailers attached to different types of the previously-mentioned vehicles (often when a child had been riding on a trailer being reversed)[109].

Socio-economic status

Henderson (2000) notes that in general many of the children in vehicle-related child pedestrian driveway accidents come from families of some social disadvantage[110].

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[99] Neeman *et alia,* 2002.p.12.
[100] Holland *et alia,* 2000.
[101] *Ibid.*
[102] *Ibid.*
[103] *Ibid.*
[104] Cited in Henderson, 2000.
[105] Williamson *et alia,* 2002, p.22.
[106] Ibid, p.22.
[107] Hockey *et alia,* 2003, pp.2-3.
[108] Robinson and Nolan, 1997, pp.733-734.
[109] Ibid, pp.733-734.
[110] Henderson, 2000, p.38.

North America

Age of children injured

North American studies also point to under-fives as the typical victims of vehicle-related child pedestrian driveway accidents injuries, with the majority of victims being two years old. In Canada records from 15 Canadian hospitals from 1990 to 1998, recorded 237 child driveway injuries, of which 110 children were aged four years and younger[111].

In the USA Agran, Winn and Anderson (1994) obtained data from a multi-hospital / coroner monitoring system over a two-year period in an urban county, the result being that the median age for child driveway accidents was two years old[112]. Two years old was also the mean (median not stated) age obtained from a comprehensive study of 44 admissions for child driveway accidents to the Children's Hospital of Pittsburgh from 1986 to 1999[113]. A retrospective study of Washington State death certificates from 1979 to 1983 led Brison *et alia* (1988) to state that a typical pattern of injury involved a one- to two-year-old child being the victim of a reversing vehicle in a residential driveway[114]. The 1998 retrospective study by Patrick *et alia* of driveway accident trauma found that 80% of 51 children injured were under the age of five[115]. The 1999 retrospective study by Silen et alia returned a mean (median not stated) of 44 months (3 years and eight months) for 28 children injured in driveways. Of the 28 injuries, 18 were as a result of a vehicle backed by an adult, and these injuries had a much lower mean age[116].

From168 cases, Patel *et alia* (2005) found that 81% of the children injured were aged between one and four years old[117].

Deaths

Thirty fatalities occurred from 1979 to 1983 in residential driveways in Washington State[118]. Patrick *et alia* (1998) reviewed admissions over six years to two urban US trauma centres and revealed 51 driveway injuries. They found that relative to the other 476 pedestrian injuries studied, children zero to four years (80% of the age group in driveway accidents) accounted for all the fatalities in the study[119]. Patrick *et alia* found that the severity of injury decreased with increasing age[120]. This was backed up by the 1999 study by Silen *et alia* of 26 driveway injuries which found that children 24 months and under had more severe injuries than older children[121]. All these data suggest a high fatality rate for vehicle-related child pedestrian driveway

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111 Canadian Safety Council, 2004.
112 Agran *et alia*, 1994.
113 Nadler *et alia*, 2001.
114 Brison *et alia*, 1988.
115 Patrick *et alia*, 1998.
116 Silen *et alia*, 1999.
117 Patel *et alia*, 2005, p.144.
118 Brison *et alia*, 1988.
119 Patrick *et alia*, 1998.
120 Patrick *et alia*, 1998.
121 Silen *et alia*, 1999.

accidents injuries (involving predominantly toddlers) relative to other pedestrian injuries.

Injuries

There were 237 driveway injuries in Canada from 1990 to 1998[122].

In Pittsburgh, USA, there were 64 driveway injuries from 1986 to 1999[123]. Silen *et alia* (1999) found that with admissions to a single trauma unit in an urban US centre, there were 18 'rollover' injuries to children caused by a vehicle backed by an adult[124] (vehicle collisions with children were excluded if the vehicle did not roll over the child).

Patel *et alia* (2005) analysed data from the National Electronic Injury Surveillance System All Injury Program (NEISS-AIP)[125] and were able to estimate from a nationally representative sample of 66 hospitals that in 2001 to 2003 there were an estimated 7,475 children injured due to non-fatal "vehicle back-over" incidents[126].

Gender of child injured

Fatalities were higher for boys than girls for all vehicle-child accidents in the Washington State study by Brison *et alia* and boys were involved in an even greater proportion of driveway fatalities compared to traffic fatalities[127]. The Pittsburgh study however, quite unusually compared with Australian and New Zealand data, returned a near-equal gender distribution for 64 driveway injuries[128] and similarly of 26 children injured in driveways (18 involving an adult reversing) in the 1999 study by Silen *et alia* 12 were boys and 12 were girls[129] (two children who died on admission to hospital were not included in the gender-related data).

Gender of driver

The father was most often the driver in the 1979 to 1983 Washington State study by Brison *et alia*[130].

Relationship of driver

In the Washington State study, a family member or a visiting family friend was 'usually' the driver in 41 non-traffic fatalities (30 fatalities were on driveways, while 11 fatalities were in apartment building or store parking lots)[131]. Patrick *et alia* (1998) found that the mother or father were responsible for at least 14 (34%) of 51 driveway

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[122] Canadian Safety Council, 2004.
[123] Nadler *et alia*, 2001
[124] Ibid, p.144
[125] Patel *et alia*, 2005, p.144.
[126] Ibid, p.144.
[127] Brison *et alia*, 1988.
[128] Nadler *et alia*, 2001.
[129] Silen *et alia*, 1999.
[130] Brison *et alia*, 1988.
[131] Brison *et alia*, 1988.

accidents, with siblings being involved in 10% of these injuries (usually due to such occurrences as releasing the handbrake on a gradient)[132].

Vehicle type

In Washington State, USA, from 1979 to 1983, light trucks or vans were involved in 76% of non-traffic fatalities (30 fatalities were on driveways, while 11 fatalities were in apartment building or store parking lots), while these vehicles were only involved in 14% of all child traffic fatalities[133]. Years later in Pittsburgh, from 1986 to 1999, light trucks or sports utility vehicle (known as four-wheel-drives in Australia and New Zealand) were involved in 50% of driveway injuries to children, despite the much lower level of ownership in the Pittsburgh population [134].

Europe

Age of children injured

A retrospective study in Graz, Austria, into vehicle-related child pedestrian driveway accidents from 1993 to 2001 determined from 32 children injured that the median age of the child injured was 2.1 years[135]. Godbole *et alia* (2001) stated that the findings from their British study were consistent with previous evidence that one- to two-year-olds are most at risk in driveways[136].

Deaths

There were no deaths over a ten-year period in Graz, Austria, according to the surgeons who authored this retrospective study[137]. In Sheffield, UK there were also no fatalities over the five years of another retrospective study[138]. However in the UK pedestrian injuries are a leading cause of mortality for children[139]. Godbole *et alia* take the view that compared to the USA a lower rate of vehicle ownership and of driveways at residences accounts for the incredibly low incidence of driveway accidents in the UK[140]. This physical environment variation (in which New Zealand would be closer to the USA than the UK in its built physical environment) illustrates the need to consider the social and physical environment when making cross-national comparisons.

Injuries

The retrospective study at Graz, Austria, highlighted a low injury rate for children under 15 hit by reversing vehicles (mostly in driveways and on farms). For the period 1993 to 2001 there were 32 children injured[141]. Likewise, in Sheffield, England,

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[132] Patrick *et alia*, 1998.
[133] *Ibid.*
[134] Nadler *et alia*, 2001.
[135] Mayr *et alia*, 2001, p.327.
[136] Godbole *et alia*, 2001, p.295.
[137] Mayr *et alia*, 2001
[138] Godbole *et alia*, 2001, p.294.
[139] Ibid, p.294.
[140] Ibid, p.295.
[141] Mayr *et alia*, 2001, p.327.

there were only five admissions to Sheffield Children's Hospital for driveway injuries from 1995 to 1999[142].

Gender of child injured

Consistent with much of the literature, there were more boys injured than girls over a ten year period in Graz, Austria, with 20 boys and 12 girls injured[143]. Of four of the five children injured from 1995 to 1999 in Sheffield where gender was stated, three were girls and one was a boy[144].

Relationship and/or gender of driver

Close to half (43.8%) of the children in the Graz study were injured by adult family members, while 37.5% of the children were injured by "persons not related to the children"[145]. Of the five injuries in the Sheffield study, the identity of the driver was only mentioned in three cases: one child was injured by a neighbour (gender not stated), one by her mother and one by his father[146].

Vehicle type

The Graz study included all "motorised passenger vehicles or trucks", and later listed all children hit by cars as 29.6%, of which 63.0% were "medium size" and 22.2% were "executive-type" cars[147]. All four cases in the Sheffield study in which the vehicle type was identified involved cars[148].

Mass media reports

New Zealand

A comprehensive but not exhaustive search of newspaper articles was undertaken covering 1998 to the present and 16 articles were located, in some cases more than one reporting the same accident. We divided the articles into three broad categories: those that simply reported a vehicle-related child non-pedestrian accident, and (to varying degrees) the circumstances surrounding the accident (with at most only a brief mention of statistics and the wider occurrence of such accidents)[149]; articles that reported on a specific accident but also reported at length (relative to the size of the article) either statistics about the wider occurrence and circumstances of these accidents or expert views on such accidents in general or both[150]; and articles that specifically commented on the findings of the 2002 Starship

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[142] Godbole *et alia*, 2001, pp.294-295.
[143] Mayr *et alia*, 2001, p.327.
[144] Godbole *et alia*, 2001, pp.294-295.
[145] Mayr *et alia*, 2001, p.328.
[146] Godbole *et alia*, 2001, pp.294-295.
[147] Mayr *et alia*, 2001, p.328.
[148] Godbole *et alia*, 2001, pp.294-295.
[149] See: The Evening Post, 2 May 1998, p.3; The New Zealand Herald, 31 July 2001; National News, 14 May 2002a; The Press, 5 June 2002, p.5; National News, 22 September 2002; Moffat, 22 October 2002; Binning, 28 July 2003; Carter, 25 September 2004.
[150] See: Grunwell, 17 March 2002; Trow, 6 September 2004.

article (Murphy *et alia*, 20022) around the time it was published (including an article highlighting and summarising the study's main findings)[151] as well as a few articles reporting or highlighting the authors' call for the state to make it mandatory for homeowners to fence driveways[152].

In response to these articles advocating fencing driveways, a few articles were critical of the need for compulsory fencing of driveways, and argued that the rate of accidents was too low, that excessive regulations not applicable to everyone were a hindrance and an unnecessary cost to many, and that parental vigilance should be the necessary measure undertaken to reduce driveway accidents[153]. One story titled "Polynesian kids at risk in drives" reported on the high rate of driveway accidents involving Polynesian children found in the study by Murphy et alia (2002)[154].

Most of the mass media articles were from 2002, perhaps reflecting the media interest generated by the study by Murphy *et alia* (2002).

Australia

Australian news reports tended to take a form similar to New Zealand coverage, reporting individual accidents as well as commenting on the wider incidence of driveway injuries and also reporting on Australian studies and initiatives to reduce driveway accidents.

USA

A cursory study of US media reports reflected the same pattern of reporting as the New Zealand and Australian print media. Generally, articles we looked at highlighted the high incidence of driveway accidents in the USA and listed typical characteristics of these incidents: toddlers were most at risk, parents were often the drivers and the high incidence of SUVs in driveway accidents as well as presenting individual examples of specific child driveway injuries[155].

Overview of the picture presented by the data

The scope of research and advocacy concerning child driveway accidents is somewhat limited. Most of the literature available is concentrated on child pedestrian injuries on public footpaths and roads. However, the lack of attention given to vehicle-related child pedestrian driveway accidents could also be attributed to a low rate of such accidents in most Western industrialised countries, with New Zealand, Australia and North America having the highest rates in the developed world[156] for particular reasons. The authors of an Austrian study, Mayr *et alia* (2001), reported that only a small number of studies have been undertaken in Australia, New Zealand and the USA[157]. In their literature review Murphy et alia (2002) found

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[151] See: Brown, 16 May 2002.

[152] See: The Dominion Post, 14 May 2002, p.1; The Press, 14 May 2002, p.5.

[153] See: The Daily News, 15 May 2002, p.8; The Dominion Post, 16 May 2002.

[154] The Dominion Post, 24 Aug 2002.

[155] See: Ledford, 30 September 1998, p.B2; Sforza, 24 March 2002, p.1.

156 Murphy *et alia*, 2002.

157 Mayr *et alia*, 2001, p.327.

driveway accidents to be uncommon in Europe, which they believe is due to longer driveways and the high proportion of subdivided properties in New Zealand, Australia and North America[158]. Similarly, Godbole *et alia* (2001), the authors of a British study into driveway accidents, believed that the low incidence in the UK when compared with the USA, might be due to the higher proportion of residences with cars and driveways in the USA[159].

It is also clear that most research and advocacy concerning vehicle-related child pedestrian driveway accidents, both in New Zealand and overseas, has emerged from within the medical community. This may be explained by the horrific nature of injuries sustained by toddlers and infants, with which paediatric surgeons deal firsthand. The authors of the studies examined in this report almost exclusively used a retrospective methodology in their research, by ascertaining data from medical and/or coroners' records relating to child driveway accidents. As this is the main method used for collating data, the true extent of child driveway injuries may not be known, especially as there is often no legal requirement to report to the authorities non-serious driveway accidents, as they usually occur on private property and involve related parties who may wish to avoid unwanted attention.

While bearing in mind issues of comparability, it may be said that a typical pattern of vehicle-related child pedestrian driveway accidents occurs across many of the studies examined. This would often involve a vehicle (with an overrepresentation of four-wheel-drives and light trucks) being reversed in a residential driveway at low speed (under eight k.p.h.), typically by a parent or someone known to the family, and either hitting or rolling over a child in the driveway. The child would most likely be a toddler, typically aged two years, but could also (to a lesser extent) be a four-year-old, mobile but not necessarily possessing the cognitive abilities to recognise the imminent danger posed by a reversing vehicle.

The driver is most likely unaware of the child in the driveway, and in various cases the driver immediately prior to reversing the vehicle will report seeing the child in a safe location. Further, the driver's ability to see a child in the driveway would probably have been restricted by a combination of the low height of toddlers and the lack of visibility afforded by rear view mirrors and indeed associated with rear-view vision in general. The accident would most likely have occurred in daylight on a sunny day (when toddlers would be more likely to be outside) so lack of vision due to poor weather would be unlikely.

Although not conclusive, according to some studies the driver is more likely to be male, as is the victim. The family is probably somewhat more likely to be of lower socio-economic status (but only a few New Zealand studies provided strong evidence to support this).

The location (according to some New Zealand studies) may be more likely to be a sub-divided or cross-leased property with a right-of-way or shared driveway (although Murphy *et alia*, 2002, found no correlation between multiple-use driveways and accidents). The evidence in respect of these location factors is anecdotal and

158 Murphy *et alia*, 2002.

159 Godbole, Crabbe, Stringer, 2001, p.295.

some Australian studies have stated that such locations do not especially feature in Australian cases, while the bulk of the foreign studies did not address the issue of shared driveways.

Tragically, serious injuries to young children resulting from vehicle-related child pedestrian driveway accidents are often untreatable either on the spot or in hospital, which seems to have led all of the authors of retrospective studies to advocate preventative strategies to deal with child driveway accidents. One strategy recommended by various studies is the erection of fences around driveways and/or a fenced-off play area for children. Other studies have recommended future research into the viability of proximity detectors and video cameras and Paine and Henderson (2001) undertook a comprehensive review of a range of visual aids.

There have been widespread recommendations of behaviour modification with a spectrum from personal parental responsibility to education aimed at young children to driver responsibility. The recommendations have varied in their emphasis on personal responsibility through to community responsibility and have generally envisaged publicity campaigns and education. Many studies have recommended a combination of different preventative strategies as an essential basis for reducing child driveway accidents.

Chapter 4: Recommendations from Previous Studies

Recommendations could be divided into two distinct categories: environmental modification and behavioural modification. Environmental recommendations include the modification of the house, driveway and section, such as fencing off the driveway, and also modification of the vehicle – such as installing a proximity detector. In theory, environmental modifications are passive measures. In contrast, behavioural recommendations aim at changing human behaviour, whether it is the behaviour of the driver, parents or the child - or even change in general public attitudes to safety in driveways. Further, although many studies tended to stress environmental over behavioural recommendations, or vice versa, many studies recommended a multi-pronged approach (a combination of environmental and behavioural modification) in preventing child driveway accidents.

Environment modification

Fencing and other physical barriers

New Zealand

The fencing of the driveway to separate it physically from the rest of the property was an environmental preventative strategy particularly recommended in both Australia and New Zealand. Murphy *et alia* (2002), paediatric surgeons at Auckland's Starship hospital, noted that none of the 76 New Zealand children in their retrospective study were injured in a fenced driveway or a driveway that was physically separated from the main house[160]. As 84% of the accidents occurred in the driveways of rental properties, Murphy *et alia* (2002) recommended making it mandatory for all rental properties to have a driveway fenced-off (at the expense of the property's owner) from the house and the remainder of the section. They cited the success of the campaign that made the fencing of swimming pools and similar water features compulsory in bringing down the incidence of accidental drowning of children in such pools as a worthy comparison that could be applied to fencing driveways, which could potentially reduce vehicle-related child pedestrian driveway accidents[161]. Further, Roberts *et alia* estimated in their 1995 study that children have a three-and-a-half times greater risk of driveway injury if the driveway is not separated by a fence from the children's play area[162]. Again, ten years ago Roberts *et alia* (1995) made comparisons between the fencing of pools and the fencing of driveways and recommended fencing driveways as a preventative strategy that even then demanded greater attention.

Compulsory fencing of driveways, however, appeared to be a contentious issue in New Zealand at the time of the publication of the Starship research by Murphy et alia. After newspaper articles highlighting the Starship call to fence all properties[163],

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[160] Murphy *et alia*, 2002.

[161] *Ibid.*

[162] Roberts, 1995, p.406.

[163] These news reports were obtained through University of Waikato subscription databases available only to University staff and students and thus the URLs which could be given here would only work for those with such access. Thus the references

a few newspaper articles critical of the call to introduce compulsory fencing appeared (*The Daily News*, 2002; *The Dominion*, 2002b). These latter articles argued that the problem was not big enough to warrant such measures, and instead appeared to reinforce the need for public awareness and parental vigilance. Roberts *et alia* (1993) briefly stated that potential interventions could take the form of barriers, improving rearward vision on vehicles or educating parents as to the potential hazards for children in driveways[164]. They conclude that further studies are needed to determine which strategy is most suitable[165].

The only instance of environmental modification being implemented, as evidenced from within the New Zealand literature, was on the Safekids website[166]. Safekids note that as a result of advocacy for safer driveways (in order to prevent injuries and deaths, especially to pre-schoolers) a specific guideline for vehicle access to driveways (particularly shared driveways) was included in the Safer House Design Standard (NZS402-1996)[167].

Australia

Many of the Australian studies have also suggested environmental prevention strategies, such as erecting fences. Henderson (2000) noted that the New South Wales Child Death Review Team's (NSW-CDRT) 1998-1999 *Annual Report* referred to the possibility of requiring all new multi-dwelling homes to be fenced under the Building Code of Australia[168]. Thus Henderson's fifth item of response to the recommendations of the NSW-CDRT specified that the Motor Accidents Authority (MAA) in NSW would approach the Australian Building Codes Board (ABCB) to initiate the process of including guidelines in building standards for driveways so as to protect at risk children[169]. Also, Henderson's fourth response specified that the MAA would approach the Local Government Association of NSW to seek ways of encouraging measures such as the fencing of driveways[170]. However as of late 2004 little progress had been made in legislating for any type of compulsory fencing measures in New South Wales, as evidenced by the guidelines for the MAA's Driveway Safety Grants 2005 which state that "investigations are continuing into options for planning and environment improvements to improve child safety" and that "in the meantime it is recommended that children be discouraged from playing on driveways and that, where possible, access from the house to the driveway is made difficult, particularly for small children"[171].

Much of the remainder of the Australian literature suggested fencing as a possible preventative strategy. According to Holland *et alia* (2000) the most advantageous measure to prevent child driveway accidents would be the separation of the driveway

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for these reports (*The Dominion*, 2002a; *The Press*, 2002; *Stuff*, 2002) in the References list at the end of this report do not include the URL.

[164] Roberts *et alia*, p.234.

[165] Ibid, p.234.

[166] Safekids, 2004.

[167] Safekids, 2004.

[168] Henderson, 2000, p.30.

[169] Henderson, 2000, p.40.

[170] *Ibid*, p.40.

[171] MAA, 2004.

from the children's play area by a fence or similar physical barrier[172]. Further, a comprehensive report by the New South Wales Risk Management Research Centre (NSW-RMRC), authored by Williamson *et alia* (2002), recommended measures such as fixing locks on doors and gates, and installing barriers such as fences, to prevent toddlers from being able to access driveways[173]. However their recommendations focussed on educational programmes aimed at making parents aware of the need for physical barriers coupled with behaviour modification.

The Australian Transport Safety Bureau's report on driveway deaths however, paid scant attention to fencing and physical barriers[174]. This retrospective research briefly noted that modifying the driveway environment and creating safe areas for children to play in was a significant priority, but that its practical implementation was potentially problematic, and they recommended further research in this area[175]. Henderson (2002) noted that sensibly many studies called for environmental recommendations such as fencing, but he added that it may not always be practical, especially for the families he perceived as most at risk – lower socio-economic status families[176].

In Queensland Hockey *et alia* (2003) stressed the importance of passive measures in combination with behaviour modification[177]. They also cite compulsory fencing of pools as the passive measure that has been the most effective in reducing toddler drownings in pools, and maintain that behaviour modification and education campaigns are only effective if combined with passive measures[178]. This was one recommendation of a previous report complied for the Child Accident Prevention Foundation of New Zealand (CAPFNZ) which used a similar conceptual framework [179]. Thus, Hockey *et alia* (2003) recommend further investigation into environmental and technological interventions in order to reduce driveway accidents. They advocate designing residential driveways so that children are separated from driveways and garages, and while they note that although this may be difficult to achieve in existing houses it could be incorporated in the building code for new houses[180]. Smart Housing, an initiative from the Queensland Department of Housing, is cited by Hockey *et alia* (2003) as it recommends separating driveways from children's play areas, and ensuring that external doors do not lead directly to the driveway[181]. Overall, while not suggesting that it is likely that widespread fencing will be implemented soon, and while acknowledging that the compulsory fencing of pools took several years of campaigning to achieve, Hockey *et alia* (2003) suggest that considering the success of the compulsory fencing of pools, they would expect similar outcomes from similar measures applied to driveway accidents[182].

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[172] Holland, *et alia,* 2000.
[173] Williamson, Irvine, and Sadural, 2002, p.35.
[174] Neeman *et alia,* 2002, p.17.
[175] Ibid, p.17.
[176] Henderson, 2000, p.38.
[177] Hockey *et alia,* 2002, p.3.
[178] Ibid, p.3.
[179] See DeKrout and Morgans, 2003.
[180] Ibid, p.3.
[181] Ibid, p.4.
[182] Ibid, p.4.

Europe

In the small-scale UK retrospective study in Sheffield[183] the authors did make a brief reference to separating driveways and children's play areas by a low level fence but stressed that it is more important to make parents aware of the hazard. The authors of the Austrian study[184] also stated that physical barriers may prevent some injuries but pointed to the anticipated greater future use of advanced infrasonic monitoring systems as a promising development.

Vehicle modifications

Paine and Henderson (2001) carried out for the Motor Accidents Authority of NSW possibly the most comprehensive and thorough examination ever of a number of devices designed to reduce child driveway accidents[185]. These included proximity detectors, rear-view mirrors, wide-angle lenses, video systems and backup warning devices, and this section also covers a rearwards visibility index.

Proximity detectors sound an alert to the driver when an object is sensed within a certain distance of the rear of the vehicle[186]. Paine and Henderson's extensive review of proximity detectors found that most were designed and marketed to reduce damage to the vehicle, with only three of 12 products marketed on the internet mentioning the possibility of the devices minimising the risk to small children[187]. They grouped the proximity detectors into three groups: ultrasonic (using similar technology to sonar location), microwave (using radar technology) and capacitive (detecting changes in electric fields near the vehicle)[188]. They also noted that all systems involved choosing a balance between sensitivity and both false alarms (going off when nothing is there) and nuisance alarms (going off when an unimportant object is detected – for example a judder bar)[189].

Paine and Henderson (2001) purchased and tested four proximity detectors. The costs were as follows: one ultrasonic sensor from NSW retailed for A$60, and was easily self installed while another ultrasonic sensor from NSW retailed for A$649 and required specialist installation and a Canadian ultrasonic sensor cost A$400 and was easily self-installed. Lastly, a US microwave (doppler) sensor cost Australian $700, but although it was designed to fit American number plates easily it did not fit Australian plates[190].

Tests showed that only the American detector had sufficient range to enable a collision to be avoided, and this was only at the very slow speed of five k.p.h. with an alert driver[191]. The other detectors sounded nuisance alarms too regularly[192] "have detection distances that are too small to be effective for the typical circumstances

[183] Godbole *et alia*, 2001, p.295.
[184] Mayr *et alia*, 2001, p.328.
[185] Paine and Henderson, 2001.
[186] Ibid, p.1.
[187] Ibid, p.1.
[188] Ibid, p.1.
[189] Ibid, p.1.
[190] Ibid, p.9.
[191] Paine and Henderson, 2001, p.10.
[192] Ibid, p.10.

under which children are being injured"[193]. Another potential problem would arise if a driver hearing the alarm go off were to see a vehicle say two to three metres behind him or her yet did not see a child less than a metre behind the car and upon hearing the detector sound an alarm thought this was due to the vehicle and thus treated it as a nuisance alarm[194].

Paine and Henderson (2001) also stated that the effectiveness of proximity detectors decreases with both the increasing speed of the vehicle and the greater distance between the vehicle and the child (*i.e.* the faster a vehicle is moving and the shorter the distance between the child and vehicle the less effective the detector). Both Paine and Henderson (2001) and Neeman *et alia* (2002) argued that it would be unlikely that a proximity detector would suffice as a stand-alone measure, and that rather a combination of proximity and visual aids (such as video cameras) is needed[195]. They also stressed that any form of visual or sensory technology is near enough ineffective if the driver is not alert to potential hazards[196]. Finally, Paine and Neeman (2001) voiced concern that proximity detectors could make some drivers complacent about reversing safely[197].

Visual aids that give the driver an improved view from the rear of the vehicle include additional rear-view mirrors, wide-angle lenses and video systems[198]. Four visual aids were evaluated by Paine and Henderson (2001): a wide-angle lens fixed to the rear window (A$20), another wide angle lens with a swivel mount (A$20), a "blind spot" mirror and a video security system (A$180)[199]. All these devices were problematic. The wide-angle lenses tended to obscure normal vision to the rear and were totally ineffective when fitted to vehicles with sloping rear windows[200]. All three lenses / mirrors had several blind spots. The image from the video was poor, but as this device was not designed to enable drivers to ascertain the whereabouts of children the driver could not see (*e.g.* behind the vehicle) the potential for the development of specialist systems was, Paine and Henderson (2001) argued, still promising[201].

Paine and Henderson (2001) proposed that a combination of devices could be a technologically viable proposition. This would comprise a combination of a low cost short-range proximity detector and a wide-angle video camera[202]. They believe such a system would cost no more than A$1000 to install yet they also note that as of 2001 when the study was published no commercially available systems met this specification[203]. Even if such a system was available, driver vigilance as well as a reduction in (especially reversing) speeds would be imperative to the system's effectiveness. Wide-angle lenses were seen by Paine and Henderson (2001) to have poor range and clarity, and thus offer little chance of implementation and future

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193 Ibid, p.15.
194 Ibid, p.15.
195 Neeman *et alia*, 2002, p.7.
196 Ibid, p.7.
197 Paine and Henderson, 2001, p.15.
198 Ibid, pp.1-2.
199 Ibid, p.11.
200 Ibid, pp.11-12.
201 Ibid, pp.13.
202 Paine and Henderson, 2001, p.16.
203 Ibid, p.16.

development in the intended role of reducing driveway accidents[204]. In contrast, they believe that continuing improvements in video technology have the potential for a specific system to be developed for vehicles to monitor hazards to the rear of vehicles[205].

Their specific recommendations are thus limited to circulating their study to stakeholders, inviting companies to develop such a system, promotion by the MAA of such systems and adoption of their specification at national level but not as a mandatory measure, rather that vehicle manufacturers be required to make such a system available as an optional accessory[206].

In a related development Hockey *et alia* (2003) mentioned that recently the MAA at federal level has graded all passenger vehicles available in Australia for rearwards visibility using an index[207]. They suggested that parents could use the index when purchasing a vehicle to ensure they bought one with a high rating on the index. They also appear to recommend that vehicle designers keep in mind when designing vehicles that they should minimise the risk to toddlers when the vehicle is reversed[208].

Sapien *et alia* (2003) carried out a test of a commercial back-up warning system in the USA using 33 pre-schoolers aged 38 to 61 months (three years and two months to five years and one month)[209]. This device emitted a beeping sound when the vehicle reversed (similar to the device fitted to trucks)[210]. They got the children to walk behind a stationary car, which then emitted the warning sound. None of the children displayed avoidance behaviour (none stopped, although 18 children looked at the vehicle and hesitated)[211]. The authors of this study concluded that all 33 children would have been injured if this test had been an actual back-up situation. They also mentioned that older children responded to the sound more than younger children, and they acknowledged that the study was a test situation and that there were some methodological limitations such as environmental factors and the possibility that some of the children had talked to each other[212].

Behaviour modification

New Zealand

Murphy *et alia* (2002) advocated increasing public awareness (along with compulsory fencing recommendations) as a means to decrease child driveway accidents. They specifically recommended targeting through public health messages

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[204] Ibid, p.17.
[205] Ibid, p.17.
[206] Ibid, p.17.
[207] Hockey *et alia*, 2003, p.3.
[208] Ibid, p.4.
[209] Sapien, Roux, Fullerton-Gleason, 2003, p.87.
[210] Ibid, p.87.
[211] Ibid, p.88.
[212] Ibid, p.88.

those groups deemed most at risk: lower socio-economic status families, larger families and families with vans and four-wheel-drives[213].

Australia

In assessing the risk factors to children in driveways in Australia, Henderson (2002) argues that the risk factor most open to direct modification is "preventable behaviour"[214]. He sees the achievement of this as through education targeted to parents[215] but does hint at the possibility of educating toddlers to be aware of the hazards of playing or simply being in driveways. He thus cites the work of Wazana *et alia* (cited in Henderson, 2002) who point to many educational theorists who argue that "it is never too early to help children develop road-use skills, even if the likelihood of success is low until the age of about four years"[216]. Through childcare centres and childcare services, Henderson (2002) sees the potential for these services to educate parents so as to be able to make their children aware of the dangers of driveways[217]. He also refers to organisations in New South Wales that have targeted messages to children (mostly regarding on-road pedestrian safety), such as a "Kidsafe House" in New Children's Hospital, NSW, in which children can enter a mock set-up house with potential household / yard dangers explained, and which he believes could include a component on driveway safety[218]. As well as advocating fencing as the "optimal prevention strategy", Holland *et alia* (2002) recommend that motoring and child safety organisations should make parents more aware of the risk posed by four-wheel-drives to toddlers in driveways[219].

The six lengthy recommendations for the MAA of NSW made by Williamson *et alia* (2002) were targeted at behaviour modification. The first recommendation was for road safety strategies aimed at raising parents' awareness of the high incidence of toddlers involved in driveway accidents. The second recommendation focussed on educational strategies to increase environmental security for toddlers by encouraging the installation of locks and gates and raising awareness of the developmental stages of toddlers as relevant to high-risk driveway-related behaviours such as following an adult to the car[220]. The third recommendation was directed at enhancing parents' safety practices such as holding a child when a car is moving or reversing. The fourth recommendation was directed at making all drivers more aware of the risks of vehicle-related child pedestrian driveway accidents. The fifth recommendation was for research into effective ways of reducing "pedal error" which results in sudden and unexpected vehicle movements[221]. The sixth recommendation was not directly relevant to child driveway accidents; parents were urged to ensure their children are well protected by being in appropriate child seats and safety equipment in vehicles[222] (which indirectly relates to accidents to children in trailers being reversed and similar situations).

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[213] Murphy *et alia*, 2002.
[214] Henderson, 2000, p.24.
[215] Ibid, p.24.
[216] Ibid, p.24.
[217] Ibid, p.24.
[218] Henderson, 2000, pp.26-27.
[219] Holland, *et alia*, 2000.
[220] Williamson, *et alia*, 2002, p.35.
[221] Ibid, pp.35-36.
[222] Ibid, p.36.

USA

In their Pittsburgh study Nadler *et alia* (2001) made recommendations mainly focused on parental responsibility[223]. Strategies they recommended included educating parents of young children about the danger of driveways, locking vehicles, never leaving children unattended in the driveway, and discouraging children from playing in the driveway[224]. They also mentioned that vehicle manufacturers could be made aware of the dangers of four-wheel-drives, adding that if these vehicles were to be fitted with relevant visual aids accidents might be reduced in number[225]. Also in the USA recommendations by Silen *et alia* (1999) focused on drivers, arguing that public education and injury prevention programmes should be used to make drivers aware of the dangers to children inherent in driveways used by vehicles, and specifically that drivers should walk around their vehicle to check for children before moving the vehicle[226].

In summary they argued that increasing public awareness in order to modify human behaviour (especially the behaviour of the parents – with no specific mention of drivers), modifying the environment (fencing and safe play areas are mentioned – but seen as problematic) and enhancing vehicle safety are the key measures to counter child driveway accidents[227].

Meta-analysis of previous recommendations

The following tables bring together the research on vehicle-related child pedestrian driveway accidents grouped by recommendations.

Table 1. Fencing recommendations

Degree of recommendation	Studies	Specific recommendation
Recommended fencing as the best and main solution.	• *Murphy et alia* (2002) (NZ). • *Roberts et alia* (1995) (NZ) • *Holland et alia (2000)* (Australia)	• *Murphy et al:* Compulsory for all landlords to fence off driveway at own expense. • *Roberts et al:* Fencing driveways as THE possible preventative strategy that needs more attention. • *Holland et al:* Optimal prevention is to separate driveway from child's play area by fence or other barrier.

[223] Nadler *et alia*, 2001, p.328.
[224] Ibid, p.328.
[225] Ibid, p.328.
[226] Silen *et alia*, 1999.
[227] Neeman *et alia*, 2002, p.16.

Fencing recommended equally with other measures.	• *Roberts et alia* (1993) (NZ). • *Neeman et alia* (2002) (Australia). • *Henderson (2000).* • *Mayr et alia* (2001) (Austria). • *Hockey et alia* (2003) (Australia).	• *Roberts et al:* Barriers as a possible intervention (one among other recommendations). • *Neeman et al:* Modify driveway environment – create safe-play areas. (further research required). • *Henderson (2000):* MAA to initiate process of improving building standards - including fencing driveways. • *Mayr et al:* Physical barriers may prevent some injuries. • *Hockey et al:* (1) Passive measures (Fencing/house design/vehicle design and aids) will provide most effective outcome – (combined with behaviour modification). (2) Implementation of passive measures problematic – therefore short term focus on awareness of govt/non-govt. agencies.
Fencing secondary to behavioural recommendations.	• *Williamson et alia* (2002) (Australia). • *Godbole et alia* (2001) (UK).	• *Williamson et al:* Educational strategies/Parents to focus on physical modification ie locks, fences etc (one of man y recommendations). • *Godbole et al:* Separation of driveway and play-area by low-level fence one preventative strategy; *but* more important is parental awareness of hazards.

Table 2. Behavioural modification

Degree of recommendation	Studies	Specific recommendation
Overriding emphasis on behavioural recommendations	• *Silen et alia* (1999) (USA). • *Nadler et alia* (2001) (USA). • *Williamson et alia* (2002) (Australia). • *Godbole et alia* (2001) (UK).	• *Silen et al:* Public awareness the key – target driver. • *Nadler et al:* Educate parents of young children (Driveway danger, locking cars, discourage children playing in driveway). • *Williamson et al:* various awareness and safety strategies aimed at parents. • *Godbole et al:* Parental awareness of hazards.

Behavioural strategies recommended equally with other measures.	• *Henderson* (2000) (Australia). • *Neeman et alia* (2002) (Australia). • *Robinson and Nolan* (1997) (Australia).	• *Henderson:* (a) Education targeted at parents is most cost effective. (b) Potential to educate toddlers (awareness). • *Neeman et al:* increase public awareness – target: families with small children (through early childhood centres/ hospitals), rural Australia, drivers of large vehicles. • *Robinson and Nolan:* (a) carefully targeted educational strategies at drivers (visibility), supervising children. (b) modification of vehicles. (c) modification of driveway – fencing/gates. (d) Visual aids.
Behavioural recommendations secondary to other recommendations.	• *Holland et alia* (2000) (Australia). • *Murphy et alia* (2002) (NZ).	• *Holland et al:* Child safety/ motoring organisations to increase parental awareness of dangers of 4WDs in driveways. • *Murphy et al:* Increase public awareness, target via public health message, families with 4WDs, lower socio-econ status, bigger families.

Table 3. Visual and auditory aids fitted to vehicle

Degree of recommendation	Studies	Specific recommendation
Recommended visual and auditory aids as the best and main solution.	• *Paine and Henderson* (2001) (Australia). *(This report only examined visual/auditory vehicle aids).*	• *Paine and Henderson:* combination of short range/low cost proximity detector, coupled with wide-angle video camera.

This table is continued on the next page.

Visual and auditory aids recommended equally with other measures. (perhaps requiring further research into).	• *Neeman et alia* (2002) (Australia). • *Mayr et alia* (2001) (Austria). • *Godbole et alia* (2001) (UK). • *Henderson* (2000) (Australia). • *Robinson and Nolan* (1997) (Australia).	• *Neeman et al:* Improve drivers' visual ergonomics. Reiterates *Paine and Henderson's* recommendations of Proximity detector/camera combo. • *Mayr et al:* Greater use of infrasonic distance monitoring systems is a promising strategy. • *Godbole et al:* Redesign rear-view mirror due to visibility problems. Car reverse alarm may be helpful. • *Henderson:* (a) Will actually test sample of proximity detectors. (b) Encourage use of lenses and mirrors. • *Robinson and Nolan:* Making it impossible for vehicles to be moved without adult control. Use of special mirrors and proximity detectors.
Visual and auditory aids secondary to other recommendations.	• *Roberts et alia* (1993) (NZ). • *Williamson et alia* (2002) (Australia). • *Nadler et alia* (2001) (USA). • *Holland et alia* (2000) (Australia).	• *Roberts et al:* One intervention could be improving rearward visibility. • *Williamson et al:* Investigate the need for vehicle design to reduce pedal error. • *Nadler et al:* Alert vehicle makers to dangers of SUVs – if such vehicles are equipped with extended mirrors etc, injuries may be reduced. • *Holland et al:* Proximity detectors may help reduce injuries (although effectiveness not tested).

Issues of comparability among previous studies

The degree to which study results are comparable, especially cross-nationally, should be taken into account when making comparisons and drawing conclusions from results of different studies and between countries. It was evident in the literature that authors' criteria for identifying vehicle-related child pedestrian driveway accidents varied across studies and across countries. Some studies included all off-road and/or non-traffic locations such as parking lots and farms. Some studies only examined reversing vehicles driven by adults on domestic housing driveways while others did not specify vehicle direction, and some included instances where children released a handbrake and were subsequently hit after leaving the vehicle. Some studies focussed solely on fatalities, some only on injuries and some included both.

What follows is a systematic presentation of the major differences among the studies included in this report. The population of each city or location is included in order to make it possible to calculate from published numerical counts of injuries and/or deaths any particular study's injury and/or death rate in relation to its population base.

New Zealand

Roberts *et alia* (1993), 1986 – 1990

- **Measured**: *all non-traffic pedestrian injuries/deaths to Auckland children under 15* in the period. Cases included: driveway accidents (85% of cases; 87% of deaths and 93% of injuries) together with accidents at a boat ramp (one case), car parks (three cases), playing fields (two cases)[228].

- **Where**: Auckland:
  Population: 936 981
  Population under 15: 213 177[229].

- Of 79 of 91 cases that recorded vehicle direction, 66 cases involved reversing vehicles; 60 were run over (vehicle wheel passed over child), 23 were hit but not run over, six were crushed between the vehicle and another object and two were dragged by a moving vehicle[230].

- **Non-traffic pedestrian injury rate**: from eight deaths = 0.77/100,000 children per year [231].

Roberts *et alia* (1995), 1992 to 1994

- **Measured**: *injuries to Auckland children under 15, by vehicles driven by adults who reversed over the child in a residential driveway only* [232].

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[228] Roberts *et alia*, 1993, pp.233-234.
[229] Roberts *et alia*, 1995, p.405.
[230] Roberts *et alia*, 1993, pp.233-234.
[231] *Ibid.* This was the only study of those quoted in this section to provide a rate.
[232] *Ibid.*

- **Where**: Auckland:
  Population: 936,981
  Population under 15: 213,177 [233].

Murphy *et alia* (2002), 1998 – 2001

- **Measured**: *all children under 15 in the greater Auckland region who had been admitted to Auckland Starship Children's Hospital due to a driveway injury*[234].

- **Where:** Greater Auckland.
  Population under 15: 250 000 (approx).
  Starship Hospital: Tertiary referral centre for *all* paediatric patients in greater Auckland[235].

- All 77 cases occurred in the *driveway*; three cases involved the handbrake being released by a child, while the remainder involved vehicles in driveways driven by an adult (mostly probably reversing but this is not entirely clear)[236].

- 71 non-fatal injuries produced a non-traffic pedestrian injury rate of 7.6/100,000 children per year.

- Six fatalities produced a fatality rate of 0.64/100,000 children per year[237].

Australia

Hockey *et alia* (2003), 1994-2000 (fatalities), 1998-2001(Injuries)

- **Measured**: *all children under 5 in Queensland who had been admitted to one of 15 Queensland hospitals due to a low speed pedestrian roll-over accident*[238].

- Of 28 fatalities where the direction of travel was known, 60% of the vehicles were reversing[239].

- Almost 60% of the injuries occurred in the driveway or garage, and nearly 80% occurred at home [240].

- Almost 60% of the fatalities occurred in the driveway or garage of the deceased child's home [241].

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[233] Roberts *et alia*, 1995, p.405.
[234] Murphy *et alia*, 2002.
[235] *Ibid.*
[236] *Ibid.*
[237] *Ibid.*
[238] Murphy *et alia*, 2002.
[239] Hockey *et alia*, 2003, p.2.
[240] Ibid, p.2.
[241] Ibid, p.2.

- **Where:** Queensland.
  Population: (a) 3,655,139 (Census 2001)[242], (b) 3,840,111 (2003 estimate)[243].
- **Population under five:** 242 551 (Census 2001) [244].

Neeman *et alia* (2002), 1996 – 1998

- **Measured**: *all non-traffic child pedestrian fatalities in residential driveways and other private property to children under eight years old involving vehicles moving at low-speed and under driver control*[245].

- Non-road vehicles (agricultural) were excluded.

- **Where**: Australia-wide.
  Population: 20,262,699 (on 14 February 2005)[246].
  Population under eight: 2,054,908 (June 2003)[247].

Williamson *et alia* (2002), 1995 – 2000

- **Measured**: *all fatalities* (coroners' reports*) to children five years and under due to vehicle-related incidents*, which comprised nine driveway fatalities and ten other off-road pedestrian fatalities (front yard (3), car park (1), supermarket car park (1), childcare centre (1), petrol station (1) and rural areas (3))[248].
- Six of the nine driveway fatalities involved a reversing vehicle while three of the ten off-road pedestrian fatalities involved a forward-moving vehicle [249].

- **Where**: New South Wales.
  Population: 6,716,277 (June 2003)[250].
  Population under six: 514,492 (June 2003)[251].

Holland *et alia* (2000), 1995 – 2000

- **Measured**: *42 driveway injuries to children younger than 16 via admission records from New Children's Hospital, NSW and 14 driveway fatalities of children under 16 via all coroner records in NSW*[252].

- **Where**: New South Wales.
  Population: 6,716,277 (June 2003)[253].

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[242] Australian Bureau of Statistics, 2005.
[243] *Ibid.*
[244] *Ibid.*
[245] Neeman *et alia*, 2002, p.3.
[246] Australian Bureau of Statistics, 2005.
[247] *Ibid.*
[248] Williamson *et alia*, 2002, pp.19-21.
[249] Ibid, p.23.
[250] Australian Bureau of Statistics, 2005.
[251] *Ibid.*
[252] Holland *et alia*, 2000.

Population under 15: 1,289,855 (June 2003; under 16 not available)[254]

Robinson and Nolan (1997), 1985 – 1995

- **Measured:** *28 slow-speed non-traffic vehicle fatalities to under-15-year-olds* (all were in fact under 10 in Victoria [255].

- From 28 fatalities, (a) 22 occurred in the home environment (usually the driveway, garage or carport), (b) two fatalities occurred in a friend's driveway, and (c) three occurred on a pavement or parking place (one not known)[256].

- Of the 28 fatalities, (a) three children were killed by a moving driver-less car, (b) eight children were killed by drivers who were aware of the presence of the child, and were in some way interacting with the child (such as racing the child in the car), (c) 17 drivers were unaware of the presence of the child[257].

- The direction of the vehicle in the 28 fatalities was: reverse in 16, forwards in nine, zigzag in two and unknown in one fatality [258].

- **Where:** Victoria.
  Population: 4,644,950 (2001 Census) [259].
  Population under 15: 943,713 (2001 Census) [260].

North America

Canadian Safety Council (2003), 1990 – 1998

This website reported on the work of the Canadian Hospitals Injury Reporting and Prevention Program of Health Canada, was not a retrospective study and did not provide details of the summary statistics quoted.

Nadler *et alia* (2001), 1986 - 1999

- **Measured**: *driveway-related injuries*, and in "group one" (the group mostly referred to in this report), *only children who were hit by an adult driver* in the driveway (all admissions to the Children's Hospital of Pittsburgh).

- Group one: 41 out of 44 cases were *under five years*.

- 80% of injuries involved a car moving in reverse.
- **Where:** Pittsburgh, Pennsylvania, USA.
  Population (Pittsburgh): 334,563 (2000 census)[261].

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[253] Australian Bureau of Statistics, 2005.
[254] *Ibid.*
[255] Robinson and Nolan, 1997, p.731.
[256] Ibid, p.733.
[257] Ibid, p.732.
[258] Ibid, pp.733-734.
[259] Australian Bureau of Statistics, 2005.
[260] Australian Bureau of Statistics, 2005.

Population under five: 17,607 (2000 census)[262].

Brison *et alia* (1988)

- **Measured**: *all children under five years from 1979 to 1983 who were killed as the result of a pedestrian-vehicle collision*.

- Of 71 fatalities, 30 occurred in driveways and 11 occurred in apartment building or shop parking lots (these non-traffic fatalities were focussed on in this report).
- **Where**: Washington State
  Population: 4,886,692 (1990 US Census)[263]
  Population under 18 years: 1,261,387 (1990 US Census)

Patrick et alia (1998), 1991 – 1996

- **Measured**: *driveway-related injuries in children under 18 years old from 1991 to 1996, data from two urban trauma centres*.

- **Where**: Denver, Colorado, USA.
  Population (Denver): 554,636 (Census 2000)[264].
  Population under 20 (Denver): 135,816 (Census 2000)[265].
  Population (Colorado): 4,301,261 (Census 2000)[266].
  Population under 18 (Colorado): 565,710 (Census 2000)[267].

Europe

Mayr et alia (2001), 1993 – 2001

- **Measured**: *32 children under 15 years old hit and injured by reversing or backward-rolling vehicles admitted to Department of Paediatric Surgery, Graz Hospital*.

- 37.5% occurred in residential driveways, 21.9% in farmyards, the remainder occurred on pavements or in car parks.

- A "run-over injury" was deemed to occur when a part of a child's body was crushed between a vehicle and the ground surface.

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[261] US Census Bureau, 2005. http://factfinder.census.gov/servlet/QTTable?_bm=n&_lang=en&qr_name=DEC_2000_SF1_U_DP1&ds_name=DEC_2000_SF1_U&geo_id=16000US4261000

[262] *Ibid.*

[263] US Census Bureau, 2005. http://quickfacts.census.gov/qfd/states/53000lk.html

[264] US Census Bureau, 2005. http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US08&-box_head_nbr=GCT-PH1&-ds_name=DEC_2000_SF1_U&-format=ST-2

[265] US Census Bureau, 2005. http://factfinder.census.gov/servlet/QTTable?_bm=n&_lang=en&qr_name=DEC_2000_SF1_U_DP1&ds_name=DEC_2000_SF1_U&geo_id=05000US08031

[266] US Census Bureau, 2005. http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=04000US08&-box_head_nbr=GCT-PH1&-ds_name=DEC_2000_SF1_U&-format=ST-2

[267] US Census Bureau, 2005. http://factfinder.census.gov/servlet/DTTable?_bm=y&-geo_id=04000US08&-ds_name=DEC_2000_SF1_U&-mt_name=DEC_2000_SF1_U_PCT012

- Self-powered agricultural machines were excluded from the study.

- The Department of Paediatric Surgery, Graz, serves the population of Styria (Graz is urban, but Styria takes in a sizable rural area).

- **Where:** Graz (County of Styria), Austria.
  Population (City of Graz): 240,513[268]
  Population (County of Styria): 1,185,911 [269]
  Population under 15 years (County of Styria): 193,806[270].
  Population of Austria: 8,132,505 (estimated 1997)[271].

Godbole *et alia* (2001), 1995 – 1999

- **Measured**: *Four driveway injuries all from reversing cars driven by adults*.

- **Ages:** 15 months, 13 months, two years, and four years.

- **Where:** Sheffield, England.
  Population: 514,100 (2000) [272].
  Population under five years: 29,900 (2000) [273].

[268] http://www.countriesquest.com/europe/austria/population.htm

[269] http://www.statoids.com/uat.html
[270] Mayr *et alia*, 2001, p.327.
[271] http://www.cfo.gov.ph/mais/austria.htm
[272] Sheffield City Council, 2003. http://www.sheffield.gov.uk/facts-figures/population/1991-2000-populations
[273] *Ibid.*

Chapter 5: Critical Review of Previous Recommendations

Environmental recommendations

Fencing off driveways

The key informants' perspectives and the views of the expert informants indicate that there would be several problems with this safety measure. Even without the major obstacles of cost and non-ownership of the relevant homes this safety recommendation would still remain highly impractical in many areas due to space and geographical constraints – particularly in high density housing areas and with properties that have shared or long right-of-way driveways.

While this previous recommendation would not be sensible as a universal safety measure, it could still be implemented *where practicable*, and may indeed where practicable be effective as an environmental safety measure. In light of the considerable obstacles however, it would not be feasible to make it compulsory for driveways to be fenced-off at all properties. If there were changes to the Building Act that incorporated in building codes specific safety requirements for driveways for new homes, then such fencing could become one measure that would enhance child pedestrian safety in respect of vehicle-related child pedestrian driveway accidents.

Fencing off play areas

This proved to be the most widely accepted idea amongst the key and expert informants in as much as it is rather more spatially practical than fencing off the driveway. The crucial obstacles remain, however: expense, issues of home ownership and compensation in rental properties, and in many cases lack of appropriate space to fence off. There is also the design challenge: the fenced-off play area would have to be a sustainable long-term possibility implemented only when the home includes children because those without children might find it oppressive to have to fence a play area when there are no children living in the home.

Again, this safety measure could be implemented if the aforementioned obstacles were overcome, although not universally. With modifications to the Building Act that would require driveway safety considerations at the design stage, this would be a valuable long-term safety initiative, and has the potential eventually to become widely available if not universal as it becomes incorporated into all new homes. This would be in keeping with the merits of passive measures provided inflexible and overly demanding legislation that might encounter considerable resistance is avoided. The retrospective fencing of play areas, however, would be largely impractical due to the previously mentioned constraints.

Creating vehicle turnaround space

The rationale behind this recommendation has been that if a vehicle can proceed forwards out of a driveway the driver is more likely to see children who may be on the driveway. However this recommendation seems to be the least practical of the previously recommended environmental safety measures, due largely to the fact that most residential properties simply do not have the space to create a turning bay. Space allocated for a turning bay would encroach considerably on all available

space within a property, which would leave less space for children to play in. Furthermore, if available space was as a result to be minimal, children might be *more* likely to play in the turning bay, thus creating more opportunities for vehicle-related child pedestrian driveway accidents. Lastly, there is a need in many cases for vehicle reversal during the process of turning around, unless the property has ample room for a complete 'U' shaped driveway. As this recommendation would be practical only on large properties, and given the socio-economic characteristics of the groups most at risk, it is thus not suitable for high-priority consideration as a safety measure.

Excluding children from playing in areas adjacent to the driveway

While plausible this recommendation proves to be decidedly impractical for most families and perhaps especially for those in high-risk groups. It is too restrictive as quite often the front lawn is the most appropriate – or only – place for children to play. It would work as a safety measure only in conjunction with a suitable fenced-off play area at the back or side of the house, which has been considered above. Even then, everyday domestic life is such that it is probably impossible to restrict children to one area of the property, especially as they grow older.

Educational and behavioural recommendations

Improving supervision of children in driveways

This is the most obvious preventative measure, but one which is difficult to implement universally insofar as it involves behavioural and cultural change, which is not something that is easily legislated. Moreover, even with the best of supervision and the best of intentions, modern urban life is such that accidents of this nature cannot be totally eradicated because that is what some are – *accidents* and not necessarily the result of serious negligence but sometimes simply *momentary* inattention (and that moment can be so short) which most people (parents) experience at some time.

Thus, while this is a fundamental safety measure to consider - it may be *the* most critical one - it cannot be carried out in isolation. Any campaigns aimed at changing parental / care-giver behaviour must be associated with, at the least, the implementation of whatever environmental measures are practicable, such as adequate fencing and / or a separate play area.

Driver education and awareness

Among previously suggested behaviour modifications this one seems to be among the most appropriate, and one that has legislative potential, regarding driver licensing and the Road Code. Although a Cochrane[274] study carried out by Roberts *et alia* (2003) found no evidence that post-licence driver education is effective in preventing *road traffic* injuries or crashes and excludes the possibility of even modest benefits, this may not be transferable to *driveway* accidents. A drivers' education / awareness-enhancing approach could thus still be a useful safety measure with regards to vehicle-related child pedestrian driveway accidents when teamed with other measures - both environmental and technical.

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[274] A Cochrane study is a systematic review or meta-analysis.

As a point of difference to the study by Roberts *et alia* (2003), driver education could be undertaken pre-licence, or even have a driveway safety component included in the licence test itself (the current road code does not have a specific focus on driveway safety) – something that was suggested by several of our key informants. In keeping with the current road safety laws that place the onus for pedestrian accidents on the driver, this could be extended to include driveways. Therefore, the first point of responsibility would lie with the driver of the vehicle (see chapter 10 for a recommendation relating to this).

Child education and behaviour modification

As with parent and driver education, this recommendation appears to be self-evident but the question must be asked: how practical and effective would such a measure be? Certainly, educating children on the dangers of any particular hazards in their environment is worthwhile, and is virtually universally assumed to go at least some way to reducing child accident rates overall. However the nature and effectiveness of such education and behaviour modification is a significant issue. It may be that some form of education and/or behaviour modification is already practised in some or even most families already but the education and the behaviour modification must be relevant to the child's age and developmental stage – as was the case with comparable recommendations in respect of education and behaviour modification in respect of the risk of family dog attacks[275].

Thus one problem if reliance is placed solely on raising children's awareness of the dangers of vehicles in driveways is that the developmental nature of children is such that those most at risk – toddlers especially – are simply not ready to assume responsibility for their own safety. Given that the most commonly injured and killed children in driveways are two-year-olds, the effectiveness of training this age group to become more aware of driveway safety is questionable due to their limited cognitive abilities[276].

Raising awareness amongst all of the community – children included – would be the most effective way of addressing the educational aspect of driveway safety. Any campaign could include a child-focused component, which would include colourful educational packs to be distributed at schools and pre-schools similar to the 'Sun-smart' campaign.

Technical recommendations

Proximity detectors

The responses of the key informants indicate that installing proximity detectors would not be a realistic safety measure due firstly to the cost and secondly to the perceived nuisance factor of frequent false alarm soundings. The MAA-funded study by Paine and Henderson (2001) supports these views in its findings: the proximity detectors that were tested were prone to sound either a "nuisance" alarm when coming into contact with the slightest small object or a "false" alarm when driving over judder bars or similarly subject to such movement. Further, the nuisance – and danger –

[275] Bennett and Snape, 2000.

[276] See: Robinson and Nolan, 1997; Henderson, 2000; Williamson et alia, 2002.

factor would be compounded if the alarm sounded near to an object (say a bicycle left in the driveway) which could be identified but then did not recognise a child who might for example be playing near the bicycle.

The MAA-funded study concluded that proximity detectors, which were designed to identify hazards when parking, would not be effective with regards to stopping for children. The study found that the higher the vehicle speed and the shorter the distance to the child the less effective these devices would be. With driveways there is usually quite a small distance to cover when reversing, and this distance may quite often be driven at a relatively high speed. Furthermore, the cost of installing proximity detectors would be prohibitive for low and indeed medium income families, with the one identified as the most effective by Paine and Henderson (2001) – a microwave device – retailing for approximately US$700 / NZ$945.

Thus, while an improved version of a proximity detector – one which was developed especially for sensing children in driveways – could possibly be of some benefit to child safety, the obstacle of great expense (and perceived value for money) would need to be addressed. Such devices would need to become standard in all new vehicles, while installation in existing vehicles would need to be made compulsory, and heavily subsidised, to ensure the uptake among families who are at high risk of vehicle-related child pedestrian driveway accidents. While there may be potential for a future combination of proximity detector and camera as technology improves and prices decrease, such technical measures are at this stage impracticable and, given the problems already noted with proximity detectors, not recommended.

Reverse warning devices and "beeping" reversing lights

This recommendation, while initially appearing feasible and useful, turns out to create further potential problems. While cost is not a significant factor – bulbs that sound when reversing can be bought for as little as $20 – the principal problem lies with the possibility that young children may be *attracted* to such lights or sounds rather than warned, alarmed or repelled by them. A study by Sapien *et alia* (2003) found that, with regards to the reverse warning device, children aged 3-5 years did not respond with avoidance behaviour. Most of the children acknowledged the sound, or hesitated, but the researchers concluded that all of the children in the study would have been injured if it were an actual back-up situation. It was also found that older children were more likely to acknowledge the sound than younger children – which leads to speculation that children under 3 might be more likely to be attracted to or curious about the sound.

A further problem with this approach is that children and adults alike could become desensitised to the sound were it to be heard frequently. Moreover, frustration could ensue with the repeated sounding of alarms, as may be the case with beeping warning devices which sound when seat belts are not done up. Finally, if back-up warning devices were to be implemented as a measure to help reduce the incidence of vehicle-related child pedestrian driveway accidents (despite all of the aforementioned potential problems) the issues of standardisation and enforcement for non-compliance would need to be addressed.

Fish-eye / wide-angle reversing lens

The problems associated with special (including fish-eye lens) reversing mirrors are that they do not fit all vehicles, they may obscure normal vision, many people do not use such mirrors when fitted but turn their heads when reversing and they do not eliminate blind spots. A 2003 report by the non-profit organisation *Consumer Reports* in the United States of America identifies larger vehicles such as SUVs, minivans and utility vehicles as featuring largely in vehicle-related child pedestrian driveway accidents because the drivers of these vehicles experience larger blind spots. The report identified the devices that would best alleviate that blind spot, finding that additional rear-view mirrors were of little assistance but that a US$20 / NZ$27 "plastic fish-eye lens" which attaches to the rear window was most effective in eliminating the blind spot. The Paine and Henderson study (2001) also found additional rounded rear view mirrors to be ineffective.

Special rear-view mirrors are thus probably of minimal value in efforts to reduce vehicle-related child pedestrian driveway accidents. However devices such as the "fish-eye" lens and perhaps vehicle rear-view video cameras such as those fitted to some campervans and similar vehicles (see below) and/or convex mirrors permanently situated external to the vehicle in the driveway area may be more effective – measures that are discussed further in chapter 10.

Recommendations from the literature search and informants

In the course of researching previous recommendations and their implementation or non-implementation further possible safety recommendations have been generated: from the ongoing literature review and in interviews with key and expert informants as well as in general discussion among the researchers and other stakeholders in the area of child accidents. These recommendations will now be examined in turn.

Video cameras

Several studies, such as the one conducted by Paine and Henderson *et alia* (2001) and the one reported in *Consumer Reports* (2003) have recommended the use of video cameras in vehicles to enhance visibility greatly when reversing – particularly with larger vehicles such as SUVs. While cost would be a considerable obstacle for the target groups of this study, this recommendation cannot be dismissed solely on that basis.

Both Paine and Henderson *et alia* (2001) and the *Consumer Reports* organisation suggest that cameras mounted on the rear view mirror or at the rear of the vehicle – with the monitor installed in the dashboard – give an extremely clear picture of what is behind the vehicle, and will work on any vehicle.

This recommendation is perhaps one that could be retained for future reference. As technology advances cameras could possibly become standard in all vehicles (as appears to be a trend in Japan with proximity detectors) and, teamed with environmental and educational approaches, would help reduce the incidence of vehicle-related child pedestrian driveway accidents.

Externally-mounted convex mirrors

These are large, externally mounted mirrors similar to those found along roads where there is a hidden side road or property exit. They could be mounted on a garage, house, fence, or pole – wherever would be most suitable to optimise rear visibility from a vehicle for a particular driveway environment. The advantages are that the effect of these mirrors may be similar to that of video cameras yet the cost would be minimal in comparison. The researchers have been unable to identify drawbacks to this recommendation and recommend testing the idea.

Improved Reporting/Record Keeping

The interviews with expert informants and the researchers' own endeavours to obtain specific data relating to vehicle-related child pedestrian driveway accidents in New Zealand both bring this recommendation to the forefront but one which does not fit in any of the categories used above – environmental, behavioural or technical. The implications of improved record keeping in this area are several and could provide a basis for the implementation of all the other safety recommendations. As has been noted earlier, apart from a few articles in newspapers documenting driveway accidents as they occur, these types of accidents do not appear to fall within the domain of any governmental body. They are not strictly road accidents, thus are not the responsibility of LTNZ; they do not constitute child abuse/neglect, so fall outside the parameters of Child Youth and Family (CYFS); ACC would seem to have a degree of responsibility, but does not have historical statistical data available.

The invisibility of the problem is manifested in multiple arenas, and this has been one of the most salient features of this project. It is imperative that some official body is assigned responsibility for this aspect of child safety. Improved record-keeping/reporting should be a high priority in helping to reduce the incidence of vehicle-related child driveway accidents, in that it could well raise public and organisational awareness, facilitate community involvement and lead to greater funding, and would thus increase the likelihood of uptake of the most practical safety recommendations.

Chapter 6: Expert Informant Interviews

Three expert informant interviews were conducted: with a building contractor, with an academic researcher of recognised expertise in both child development and bicultural matters and with a policy analyst from the Safekids organisation.

Interview with Robert Nicholls, Building Contractor

Requirements to build fences around new homes for child safety

There are no blanket requirements as such, and fencing for child safety is largely left to the individual property owner. However there are some rules under Resource Management Act (RMA) district schemes, which mostly related to apartments and other multi-unit houses and which do include some requirements as to fencing and the width of the driveway in relation to the number of cars using it. There are also backing and parking requirements: the Hamilton district scheme currently requires that vehicles must not be required by the driveway configuration to reverse further than thirty metres.

Possibility of RMA use for compulsory driveway / play area fencing

Territorial local authorities (the council) advertise a review of their district scheme under the RMA every five years, which makes it possible for anyone to make a submission. When considering submissions councils have to balance the wishes of the submitters and those of others. The submissions themselves are then advertised and people in the authority's district have the right to object. As councils throughout New Zealand have differing review times and differing rules, a national change with respect to driveways would be a stretched-out and fragmented process. In addition, under the RMA there are "existing use rights" and therefore submissions even if successful might affect only new dwellings.

Ideal new house design with driveway safety and good "living flow"

It was suggested that ideally driveways would be located on the south side of houses away from the sun and living rooms would be designed to open out onto outdoor living areas facing north. This would create an outdoor living area for children and parents that is separated from the driveway, thus keeping the driveway area strictly utilitarian.

It was felt that rather than legislating for such safety-conscious house design a campaign might be more effective – one that encouraged families and designers to consider the need for safety consciousness with respect to children and driveways.

Other ways of legislating for safety design

It was suggested that codes for child safety in relation to driveways could be developed under the Building Act. Designers could be required to address the degree of risk and provide some solutions to be incorporated in the overall design of

dwellings. This could be similar to current codes such as the one that requires staircases to have a safety rail – if there is no rail in the design, the permit is not issued. There is a degree of flexibility for these codes within the Building Act – for example a building must be structurally sound but in meeting this requirement the designer has the freedom to select among different designs.

There are also "acceptable solutions" under the Building Code, which could be addressed to child driveway safety. Here, designers would have options at the planning stage that would meet particular safety requirements. The design that is chosen would depend on the particular property's size and geographical layout but would be acceptable once the local authority had determined its safety effectiveness. Examples of design options would include childproof locks, fencing off a play area or locating the driveway away from all living and play areas.

Discussion

This expert informant observed that the consent process under the Resource Management Act can be protracted and fragmented and may not be the most practical method to assist in the implementation of environmental safety measures relating to children and driveways. Initiatives in matters such as this can be superfluous and bureaucratic measures can perturb those involved in housing design, ownership and/or renovation. There is also the prospect of some difficulty in applying one safety measure to all possible driveway situations; thus, a more creative approach may be needed.

The comments of the building contractor regarding the utilisation of flexible building solutions within the Building Act can perhaps point us to a more acceptable situation where there is specific reference to driveways and child safety in the Building Act – something lacking at present – but there is no legal compulsion to adhere to specific and rigid safety requirements. This approach would allow for more freedom of design within which the designer could match safety needs with the differing layouts of houses and other residential properties.

This, it could be argued, would increase the probability of safety recommendations such as fencing the driveway or fencing off a play area coming to fruition. If these specific measures were not adopted then at least such a provision would create a heightened awareness of child driveway safety among housing designers, leading to the design of more environments conducive to child safety such as the one described by the expert informant above.

Interview with Prof. Jane Ritchie, Child Development Psychologist

Cultural practices and high Māori and Pasifika driveway accident rates

One factor felt to be significant was the shared responsibility for children's welfare that is often intrinsic to Māori and Pasifika families. Professor Ritchie's extensive research into the child-rearing practices of the indigenous people of the Pacific has shown that there is a "village" mindset regarding the care of children – one that is frequently at odds with the dominant culture within which Maori and Pasifika are located. Dr Ritchie felt that within these cultures assumptions were made as to whom was caring for children, that in particular it was often assumed that *someone* would always be available to look out for the children. This was observed particularly in larger or extended families, which still comprise a considerable proportion of Māori and Pasifika families.

Extent to which "personal responsibility" is a helpful concept

A default assumption of individual "24/7" personal responsibility for children was thought to be an unrealistic focus. A significant number of vehicle-related child pedestrian driveway accidents occur in sole parent families, and it was felt that especially in a sole parent family the parent would already be experiencing high levels of stress and might feel overburdened. This is where the strength of having many caregivers would come into play, with the wider family being involved. However this would require greater *clarification* of <u>who</u> is responsible for the children at any particular <u>time</u>.

The practicality or appropriateness of previous recommendations

The question of the practicality and/or appropriateness for Māori and Pasifika families of the previous recommendations relates to fencing-off driveways, fencing a special play area, installing special rounded rear-view mirrors and proximity detectors on vehicles, creating space for vehicles to turn around, increasing parental vigilance and not letting children play on front lawns adjacent to driveways.

While Dr Ritchie thought that any – or all – of these measures could be appropriate *per se*, the expense of fencing and installing extras on vehicles was felt to be a significant inhibition, especially taken together with the lack of freedom to develop a property that one does not own, factors especially relevant to many Māori and Pasifika families.

With regards to increased vigilance, Dr Ritchie did point out that there is no financial cost in a driver checking for children before she/he gets into the car, and before she/he reverses out of a driveway, or alternatively in getting someone else to check the whereabouts of children while they reverse (where there is more than one adult in the household).

Culturally specific strategies to reduce child driveway accidents

Dr Ritchie mentioned that in pre-colonisation Pacific village societies the child peer group would be looking after each other. Here Māori and Pasifika children are often expected to be responsible for a particular younger child. While there are reasons for some reservations as to whether this peer group role assignment might work well in modern urban society Dr Ritchie felt that its reactivation could be beneficial. This could reduce the burden on the parent or parents while embracing the positive aspects of shared care for any given household.

Further strategies

Dr Ritchie cited evidence from previous campaigns for the introduction of mandatory child car seats and cycle helmets in pointing out that prior to these campaigns and associated law changes researchers had estimated the number of lives that would be saved each year with the introduction of these safety initiatives. She felt that if a similar type of projection could be carried out with regards to child safety in driveways and the introduction of mandatory safety measures, then a sound evidence-based prediction and the resultant publicity could motivate relevant organisations to fund-raise for subsidies towards the costs of the above safety measures and the necessary accompanying campaigns.

It was suggested that community groups such as Rotary or the Lions Club could be interested in aligning themselves with such projects. Such a campaign could be initiated as a pilot in one area and involve children's groups such as Plunket and Family Start. It was thought that a slogan such as the "make it click" one developed by the Ministry of Transport in conjunction with McDonalds would be a good idea, as this was thought to be very effective in raising children's and caregivers' awareness of the necessity of using seatbelts.

Discussion

Specific cultural obstacles to the implementation of safety measures appear to be inextricably interwoven with the major obstacle of relative poverty. While larger family size and the practice of shared responsibility for children may be contributory factors in the high incidence of such child driveway accidents among Māori and Pasifika families, this cannot be shown to be directly or solely causal. The fact that larger families may use larger vehicles such as vans, people-movers and SUVs, (which feature significantly in these types of accidents; these types of vehicles hindering rearward vision and thus the chances of seeing toddlers close to the ground) could contribute to the high incidence of such accidents among these families.

In addition, Māori and Pasifika families are more likely to live in rental accommodation, both state and private (Durie, 2001) – which is often associated with lower socio-economic status. In urban environments such as South Auckland this rental accommodation tends to be high density, a factor that further increases the likelihood of vehicle-related child pedestrian driveway accidents, and one that

(because of its association with lower socio-economic status) decreases the viability of various safety recommendations for children and driveways, be they environmental, technical, or behavioural.

The findings here are congruent with those generated from the key informants inasmuch as *expense* is the major barrier to ensuring a safer outdoor environment for children in general, especially when together with a lack of freedom to modify a rental home and being part of a larger family that practises more shared care (and thus perhaps scope for potentially tragic albeit momentary inattention) in an often highly-populated and vehicle-dense environment. The ensuing dynamic is one that not only places such families in a higher risk category for vehicle-related child pedestrian driveway accidents but also makes the implementation of previously-recommended safety measures rather highly improbable.

Interview with Julie Chambers, Safekids Policy Analyst

Safekids New Zealand is the child safety service of Starship Health, and is one of the more high profile organisations in New Zealand dedicated to reducing the number of children admitted to hospitals or killed by preventable injury. As such, Safekids is the organisation most likely to be in a pivotal position to influence policy-makers and to disseminate safety recommendations with regards to vehicle-related child pedestrian driveway accidents.

Policy levers

The "policy levers" used to enhance child driveway safety depend on the extent to which vehicle-related child pedestrian driveway accidents are made an important issue – one to which the Government will want to commit spending. These types of accidents are currently not differentiated from general pedestrian injuries in most record-keeping and it is likely that many less serious ones are not captured in the available statistics, which lessens the impact of these accidents on general public awareness.

One such policy lever may be inherent in the drafting of the current (early 2005) Land Transport Amendment Bill includes consideration of the capacity to prosecute those who are responsible for vehicle-related child pedestrian driveway accidents which cause injuries or death, thus shifting the data collection to the Ministry of Transport, wherein these accidents will be differentiated from other pedestrian accidents and are therefore more likely to gain attention. This in turn would create an improved basis for publicity and media interest around the issue of vehicle-related child pedestrian driveway accidents, which could result in more public awareness and could produce a higher likelihood of funding from all sources – *i.e.* government, community groups and/or private sponsors - to address the problem.

While prosecution might not be the ideal method for dealing with those who have run over children (usually their own, or a close family member's child – which is traumatic to say the least) it was emphasised that improved record keeping is imperative to help reduce the rate of these accidents. There may be other mechanisms that could be devised to achieve this.

A second policy lever suggested by the policy analyst is to facilitate good relationships and goodwill between government departments and relevant organisations. In order to achieve this a more collaborative and cohesive approach between all relevant organisations and parties is required. This would have the added advantage of consistency of information disseminated to the public, which would again facilitate a greater probability of funding for vehicle-related child pedestrian driveway accident safety measures.

The relationship between Safekids and the Housing NZ Corporation

Safekids regularly work with HNZC, attending meetings and liasing with property managers in an attempt to implement Safekids' safety measures in both new and existing homes. There is significant and ongoing attention given by HNZC to upgrading HNZC homes to meet the changing needs of families. For example one of the refurbishment projects HNZC is undertaking at present in Glen Innes – Talbot Park – incorporates a "blend in" strategy consistent with current HNZC developments. This brings with it landscaping, fencing, decks, and greater indoor/outdoor flow (Barton, 2004). Here Safekids meet with HNZC property managers in order to work for an optimal safe environment for children.

Although there is no overt reference to child driveway safety in HNZC policy, nor in consultation with Safekids, it was mentioned by the policy analyst that a fenced-off area for children "wherever possible" is now part of HNZC practice. Overall, the will is seen to be there for implementing child safety measures in general, but as is usual, this may be inhibited by ministerial priorities, budget constraints and the practicality of safety measures given the increasing high density of HNZC homes – despite the refurbishments and community renewal projects.

Chapter 7: Key Informant Interviews

Overview of the key informant interviews

The key informants were – deliberately – a diverse group. Each had characteristics or attributes that were relevant to our focus on environmental, socio-economic and cultural factors. Out of eighteen key informants five identified their families as Pakeha, three as both Pakeha and Māori; four solely as Māori; two as Samoan; one as Māori and Tongan; one as European and Cook Island Māori, one as Samoan and European; one as Niue Islander and European and one Cook Island [Māori].

Of these eighteen informants, 13 were living in rental accommodation while five owned their homes (including owned with a mortgage). All of the respondents had children, with most being under the age of five. The socio-economic spread was not wide but this was intentional as it is in keeping with the objective of identifying obstacles for lower socio-economic status families. Most informants fell into the lower socio-economic category; there were however two informants who could be said to have a significantly higher socio-economic status than the others.

Main outdoor safety concerns for children

All respondents identified the driveway as a safety concern, although some placed greater emphasis on this than others. However, this was probably due to the fact that they knew they were being interviewed about child safety in driveways.

Knowledge or experience of relevant driveway accidents

Seven respondents had personal experience of this type of accident.

Description of accidents

All children involved were under the age of five. Of the seven scenarios described, five occurred within Māori families and one involved a Samoan family (the seventh wasn't specified or apparent); five identified the driver involved as male. One respondent mentioned that following the accident they were involved in, the hospital staff treated them "horribly", insinuating that it was "all their own fault" and that they were irresponsible parents. Three respondents felt that the child who was run over was not being adequately supervised. Environmental factors such as fencing were not mentioned as a contributing factor, nor was the driver mentioned as being at fault.

Ideas for making children safer around vehicles in driveways

Five respondents thought fencing-off the driveway would be a good idea, while five thought a fenced play area was the best option. Four felt that child safety awareness would be an effective measure, while four placed greater emphasis on increased adult supervision. Most of the respondents mentioned driver awareness as an important component. Some felt that a campaign aimed at drivers and additional

driver education regarding driveway safety was important, with three respondents suggesting that questions on driveway safety be included in the driver's license test. One respondent mentioned extra mirrors for vehicles for the blind spot while another regarded SUVs and vans as big culprits and questioned the safety of SUVs in particular. Another four respondents thought that parking cars outside the front gate would be a suitable safety option.

Messages for a campaign to try and prevent driveway accidents

According to the majority of the respondents, messages in the campaign should focus firstly on "being more aware". In general, the respondents felt that this message should be aimed at the drivers of vehicles, the caregivers *and* the children. Most thought that educating children on the dangers of vehicles was important, as well as reminding caregivers to know where the children are at all times. Most felt there was no substitute for vigilance on the part of caregivers and drivers.

Two of the respondents placed emphasis on the need for *one* responsible adult / caregiver at all times *i.e.* no concurrent shared responsibility. However it was felt generally that a safety campaign aimed at older children would help heighten family awareness – so older children might look out for younger ones, but that messages aimed at younger children would not be helpful as they are not developmentally prepared to take responsibility for their own safety. One respondent noted the dangers of trees or large visual obstructions when reversing out of driveways, which make it difficult for the driver to see pedestrians. Three of the respondents felt that backing out slowly was of significance as a safety measure. In general, the responses to this question focused on caution and adult responsibility.

Viability of recommendations from previous research

a. *Fencing off the driveway to separate it from the house and areas where children may be playing*

The majority of the respondents thought this to be one of the best ideas and one respondent already had a fenced-off driveway at her residence. However, most of those who thought it an effective safety measure cited expense as a major drawback or obstacle to implementation. Three of the respondents felt that it would not be practical in all home environments, particularly in high density areas, while one suggested that a fenced-off driveway could provide another safety hazard in that it could potentially trap a child who would have nowhere to run if a vehicle was approaching. One respondent mentioned that it may not be possible in rented accommodation, as their own landlord would not erect a fence. One suggested that her own landlord would "tell her to find another house" if she asked for fencing to be installed. A further three respondents felt it is highly impractical for most homes, with one describing it as a "costly eyesore".

b. *Fencing an area specifically for children to play in*

Overall the respondents thought this was an ideal solution – space permitting. Along with space though, cost was also a factor to be considered. Two respondents

already had a fenced off backyard as a play area. Most felt it was good for peace of mind, although one thought it would create a false sense of security. Three respondents felt this measure to be restrictive, in that it would restrict the flow around the house and also curb children's movement and freedom to explore.

c. Installing extra rear-view mirrors on vehicles

While most of the respondents thought this would work for them, many felt it was not an ideal measure taken on its own. Two felt it needed to be teamed with increased awareness via an education campaign. Some of the drawbacks mentioned were that it could still be difficult to spot a toddler, that it would not eliminate blind spots completely, that drivers do not always use mirrors when reversing and that a lot of vehicles seemed to have too many mirrors already. Some would implement it themselves, but cost was the main inhibiting factor.

d. Installing proximity detectors on vehicles which sound an alarm when someone or something is near the vehicle

For most of the respondents this was not a good option. While three thought it a good idea, and said they would install them in their own vehicles if they could afford it, the other respondents mentioned numerous drawbacks. Firstly, it was felt that these would be too expensive to install. Secondly, some respondents thought that small children might be attracted to the noise, thereby running toward the vehicle rather than away from it. Thirdly, it was mentioned that the proximity detector would be frustrating as the alarm might sound at the slightest provocation, and that there might not be enough time to stop once the child was in close proximity to the car. Lastly, it was noted that enforcement might be a problem – would it be compulsory and for whom?

e. Creating enough space for vehicles to turn around

Several of the respondents felt this to be no use at all as a practical safety measure. Three felt that it would just create more space in which children could be run over, and that the children would be likely to play in the turning bay, as the size of their play area would decrease in direct proportion to the space used for a turning bay. Others felt it to be a worthwhile measure, but again space and cost were the main inhibiting factors. One respondent thought it would be a good idea for her family's outdoor environment, and had plans to install a u-shaped driveway.

f. Not allowing children to play on the front lawn or on driveways

The majority of respondents thought this to be a highly impractical measure, with several stating that the front lawn was the best area for their children to play on and that as far as driveways were concerned, their children often wanted a hard surface to play on – to bounce balls and ride tricycles / bicycles. Two respondents felt this measure to be too restraining, and thought that a lot of families did not have any choice about where their children could play as their outdoor environment did not always conform to the "front section – back section – driveway at the side" type of layout. Only one respondent did not allow her children to play on the front lawn or

driveway at all, but this was because the children had a suitable fenced-off play area at the back of the house.

g. *Improving supervision of children in driveways*

The respondents overwhelmingly thought this to be the best and most obvious preventative measure. However, four respondents, while supporting this measure entirely, included as a caveat that child safety education and environmental measures should be undertaken as well. They felt that the nature of everyday home life was such that it was unrealistic to expect consistent, uninterrupted surveillance of children.

h. *Improving driver education about children and driveway safety*

All respondents felt this was an important safety measure, with roughly half supporting this as *the* most significant measure. Several liked the idea of an awareness campaign for drivers in particular, while three respondents thought there should be something in the road code and driver's licence test regarding safety in driveways.

i. *Improving children's understanding of the dangers of moving vehicles*

Opinion was unanimous on this measure, with all respondents emphatically stating the need for children to understand how to keep themselves (and others) safe.

Recommendations that would be the most help

Most of the respondents, in thinking about their own home situation, felt that fencing-off a specific play area for children would be the most effective measure. However, viability was another matter, with several of those respondents stating that the spatial logistics of creating a fenced play area were impractical at best, and in a lot of cases impossible. Feelings were similar about fencing-off driveways, although this was for the most part deemed even more impractical than a fenced-off play area. Although two respondents had fenced-off play areas and one had a fenced-off driveway, this was possible because of a conducive outdoor spatial layout, which many homes would not have, and because the respondents in question happened to own their homes, thereby allowing much more scope in implementing outdoor modifications.

In addition to the physical impracticality of these two fencing measures, a further inhibiting factor was expense, and the fact that those in rental properties, even if space and spatial layout were not a problem, could often not erect fences on a property that was not their own.

As far as further helpful recommendations go, almost all of the respondents felt the need for increased education and awareness for both drivers and caregivers – *and* for children. Two respondents thought it to be a community problem, so there should be a community approach to solving the problem – inasmuch as everyone is involved so everyone should be educated.

Finally, all of the respondents thought that increased adult supervision was a pre-eminent safety measure in general, although most felt that supervision was adequate in their own home environments.

People other than the main caregiver looking after the younger children

Nine of the respondents lived in households where there were multiple caregivers for the children – including mothers, fathers, aunties, uncles, older children / siblings, grandparents, friends, and boarders - although responsibility was not generally shared equally. In most of these cases the *main* caregiver was the mother.

Further ideas from the respondents

In addressing the problem of the cost of fencing whether in rental properties or owner-occupied homes one respondent suggested that the government or local authority could subsidise the costs of materials for fences. Another respondent suggested that those renting could come to an arrangement with their landlord to erect fences; they could provide the labour if the landlord provides the materials. It was also suggested that costs might be absorbed by obtaining sponsors for a fencing project.

Regarding the prospect of legislating for any of the recommended safety measures, one respondent felt that we have too much legislation already on matters such as building consents, fencing pools *etc.*, and that there is a tendency at times to over-legislate. This respondent felt the solution to reducing these types of accidents lay with attitude and behavioural shifts rather than legislation for environmental measures.

Reasons for previous recommendations' unsuccessful implementation

a. *Fencing off the driveway to separate it from the house and areas where children may be playing*

The largest obstacle to the implementation of this recommendation was expense, closely followed by spatial impracticability. With regard to expense, those in rental accommodation felt this more acutely as they had the added factor of potentially making modifications to a property that they did not own and in many cases would find it difficult to acquire the landlord's permission and/or assistance. Those who did not already have a fenced-off driveway on their property but still thought it – at least in theory – a good idea stated that it would simply be a physical impossibility because of the layout of their property. For instance, in many cases the driveway comes directly up to the back door, or there might be a carport attached to the house making it impossible to fence-off the driveway. Further, many houses with shared driveways and even shared sections would find it spatially impossible to erect fences as a barrier to all possible modes of access to the driveway.

b. *Fencing an area specifically for children to play in*

While this was the most popular safety measure amongst the respondents, in as much as it was felt to be more spatially viable than the previous fencing

recommendation, many still found expense to be the main obstacle to implementation. A second concern for most of the respondents was that space would not permit a specific fenced area on their property. Again, several felt that living in rental accommodation would further hinder their ability to establish a fenced play area for the children.

c. *Installing extra rear-view mirrors on vehicles*

While some would implement this recommendation themselves, most of those felt that cost would be an inhibiting factor, and that it would not be an effective safety measure to have on its own. It was also generally felt that not everyone would install extra rear-view mirrors, even if it was made compulsory, therefore it could not be guaranteed that every vehicle backing out of a driveway had these, and further, it could not be assumed that everyone uses mirrors when reversing.

d. *Installing proximity detectors on vehicles which sound an alarm when someone or something is near the vehicle*

Although expense was thought to be a drawback to this safety option, most of the respondents found numerous other detractions which would make this undesirable, namely problems with enforcement, frustration with frequent alarm soundings, stopping time and child attraction to the alarm/beeping.

e. *Creating enough space for vehicles to turn around*

Almost all of the respondents would not implement this measure, due to limited space, and the fact that most felt it could possibly create further problems insofar as there would be more space for children to be hit by vehicles.

f. *Not allowing children to play on the front lawn*

This suggestion was largely deemed impractical by the respondents, due to limited space for the children to play in many cases, and also because it hampered children's movement and freedom around the home. Many felt it would simply not work because children will play wherever they see a nice patch of lawn or concrete.

g. *Improving supervision of children in driveways*

While all of the respondents thought this one of the most important measures generally, most did not feel the need to increase supervision in their own home environments. For the most part, it was felt that there were no obvious obstacles to implementation of this safety component aside from the normal trials and tribulations of domestic life (caregiver has to answer the phone, use the bathroom *etc*).

h. *Improving driver education about children and driveway safety*

Overwhelmingly the respondents felt there were no reasons for non-implementation of this safety measure – apart from the fact that there is no driver education programme aimed at child safety amidst vehicles in driveways (at least not that the respondents were aware).

i. Improving children's understanding of the dangers of moving vehicles

Again, no barriers could be discerned to the implementation of this safety measure – at least on a personal level. It was felt that a child safety campaign would further enhance child awareness and understanding of the dangers of vehicles in driveways.

Discussion

It is striking that the key informants had views and evaluations of previous recommendations very similar to those we have reported from the literature. The most salient finding generated by the key informant interviews was that environmental safety measures such as fencing were not considered to be a main factor in reducing vehicle-related child pedestrian driveway accidents. Although many of the respondents would erect fences where practicable, either along the driveway or to fence off a play area, this was not considered an ideal measure in itself. Notwithstanding the considerable obstacles and impracticalities involved in fencing, the general consensus was that, overall, awareness and attitudinal shifts were key components to keeping children safe in the vicinity of vehicles and driveways.

This appears to be pointing toward a multi-pronged approach to vehicle-related child pedestrian driveway safety: incorporating environmental measures where possible but focusing largely on education campaigns aimed at *driver* awareness and responsibility first and foremost, along with increased child and parental education. Further measures such as safety modifications / additions to vehicles would go hand-in-hand with such an education programme.

The key informant interviews have thus highlighted the discourse surrounding vehicle-related child pedestrian driveway accidents as one of personal responsibility "versus" environmental / socio-economic factors. We need to attend to the practical aspects of accident prevention as far as this is feasible while at the same time concentrating on increasing awareness – ideally at a community level – and thus altering relevant driving and caregiving practices.

In considering the socio-economic status of the key informants, the expense of any modifications to their outdoor domestic environment would be the largest obstacle to implementation. Therefore if this type of measure were to be used more often there would need to be a more community-focused approach – particularly in rental accommodation – which would include landlords (both private and state), local authorities and interested organisations. The only way fencing of any description could be a viable option (and allowing for spatial practicality) would be if the cost were to be subsidised for tenants and low-income home-owners.

As previous research has revealed, a high percentage of vehicle-related child pedestrian driveway accidents occur in Maori and Pasifika families. The responses from the key informants in this study tend to support those findings: six of the seven accidents mentioned occurred at the homes of Māori or Pasifika families. It is probably also significant that seven of the nine respondents who stated that there was shared care/responsibility for the children in their households were in Māori or

Pasifika families. The data for this study at least are not adequate to establish a link between shared care and child driveway accidents, but they do reinforce that, as Jane and James Ritchie (1978) discuss in *Growing up in Polynesia,* and as Mason Durie (2001) reiterates, Maori and Pasifika households do tend to share care of the children amongst all older children and adults who are in that domestic environment – and this may have consequences relevant to vehicle-related child pedestrian driveway accidents.

The key informant interviews and the literature review show that the mixture of low socio-economic status, rental accommodation and specific cultural practices such as shared caregiving has the potential to put such families at high risk for vehicle-related child pedestrian driveway accidents. While shared caregiving can be a positive and enriching practice – and indeed –can even help to lower the rate of accidents as there are potentially more eyes and hands to supervise the children (Ritchie and Ritchie, 1978) – a densely-populated and heavily-trafficked modern city environment may not be wholly compatible with such practices. There is also the danger that dispersed care responsibility could result in each shared-carer assuming another is adopting the role at the pertinent time, effectively leaving no-one 'in charge'. When this is coupled with the breakdown of traditional Māori/Polynesian family structures and post-colonial cultural displacement, the results can be serious with regards to child safety.

Any measures attempting to improve this situation must factor in specific cultural practices and avoid the tendency to further homogenise Māori and Pasifika family practices into the dominant and sometimes seemingly monolithic pakeha pattern. While the cultural factor looms large in statistics for vehicle-related child pedestrian driveway accidents, this cannot be extricated from the low socio-economic status that this and previous research has found to be a major thread which runs through the families involved.

Although a focus on gender was a small component of the key informant interviews/ questionnaires, the findings did concur with previous research, which suggests that drivers of vehicles involved in child driveway accidents are predominantly male. The reasons for this have not been explored in depth but the researchers speculate that it is because females are still largely the main caregivers which means males are more likely to come and go without the children in the vehicle. Further, they are probably more likely to assume the children are being adequately supervised by the mother / adult female member of the household.

Any campaign aimed at reducing these types of accidents could feature a focus on male drivers, although the way in which it is worded and delivered would need to be carefully considered. A previous road campaign that urged women to "speak up to slow him down" caused some consternation amongst the general public – with males feeling they were being unfairly targeted as irresponsible speedsters.

Chapter 8: The Broader Institutional Framework

Vehicle-related child pedestrian driveway accidents are multi-faceted in character, which means that there is no single organisation that takes ultimate responsibility for dealing with them. These multiple facets include families and their cultures, rented and owner-occupied housing, different kinds of vehicles, drivers, children and the layout of the physical domestic environmental. We thus drew from the literature (including the mass media reports) and our interviews (especially but not only those with expert informants) to scope the broader institutional framework within which our recommendations would need to be implemented.

Relevant organisations and provisions

The Accident Compensation And Rehabilitation Corporation (ACC)

This crown entity with its pledge 'to prevent injury' has the most obvious interest in and relevance to vehicle-related child pedestrian driveway accidents. ACC are responsible for preventing injury, paying compensation, and facilitating rehabilitation, and as such have a wide jurisdiction. Accidents that occur infrequently or on a small scale may not receive the attention that for example accidents due to drunk driving do. Vehicle-related child pedestrian driveway accidents are entirely absent from ACC literature and ACC statistics do not separate driveway injuries from the wider category of pedestrian injuries.

Safekids New Zealand

Safekids is associated with the Starship Children's Hospital in Auckland and appears to be the most prominent and proactive organisation in New Zealand dedicated to reducing the number of child accidents resulting in hospital admission or death. Safekids is thus perhaps the most likely organisation to take on the role of collating and disseminating information regarding child driveway accidents. Clearly they can also have an advisory role with respect to other organisations such as HNZC and this could be expanded (they have already discussed with this agency a driveway safety component for HNZC housing designs).

Housing New Zealand Corporation (HNZC)

HNZC are understood to be working, where they think this is possible, to ensure there are secure play areas for children at its homes (both new and existing) – for example fenced back yards (gardens). Safekids have indicated that HNZC also have regular constructive discussions with them where the former have input into HNZC's design and housing criteria. Thus, any environmental safety measures recommended or disseminated by Safekids are likely to be considered by HNZC and likely to have a reasonable likelihood of being implemented. Considering that a high percentage of these types of accidents occur in rental properties, and that a large percentage of these are state rental properties (Murphy *et alia*, 2002), the role of

HNZC in aiding the reduction of child-driveway vehicle related accidents is of considerable importance.

Private Landlords – The Property Investors' Association

According to the vehicle-related child pedestrian driveway accidents literature private landlords have just as much of a role to play as HNZC. If building codes were to have safety requirements relating to driveways included these would need to apply to both state and private rental properties. Given the number of child driveway accidents that occur in rental properties, it can reasonably be argued that it is not only the state's responsibility to ensure that homes meet certain safety standards. Both the Waikato Property Investors' Association and the national organisation, the Property Investors' Association, to which our enquiries were referred, declined to comment on these matters.

The Land Transport Safety Authority (Land Transport NZ)

Land Transport New Zealand (which was established, incorporating both the LTSA and Transfund NZ, on 1 December 2004 as a result of the Land Transport Management Amendment Act 2004) appears to be a potentially relevant agency as vehicle-related child pedestrian driveway accidents involve land transport vehicles, albeit on private property. Discussions in 2004 on the Land Transport Amendment Bill are thought to have included the possibility of bringing in provisions to prosecute drivers involved in vehicle-related child pedestrian driveway accidents but this did not eventuate. Whether prosecution would help in these situations is debatable, but legislative recognition of child driveway accidents could at least result in separate record keeping by LTNZ, who also have a role to play in any changes to the driver licensing theoretical and/or practical tests and the Road Code to include driver awareness of vehicle-related child pedestrian driveway accident risks and avoidance.

Local Authorities

Local authorities have jurisdiction over amendments to and implementation of the Building Code, which is relevant not only to the issue of appropriate fencing but also to the general safety of all existing and new houses with regards to children and driveways.

Child Accident Prevention Foundation Of New Zealand (CAPFNZ)

While the current interests of CAPFNZ may extend only to providing scholarships for research into child accident prevention, there is scope for the Foundation to become much more involved in the dissemination of child accident prevention and safety recommendations - for example by provision of a resource-rich website (Smith, Cowley, Horgan and Swain, 2004). Additionally, further action research on vehicle-related child pedestrian driveway accidents and the implementation of previous recommendations could be undertaken with CAPFNZ funding.

Effective leadership roles and responsibilities

The Community

This is of course a very broad and inclusive group, but specific community groups, and organisations such as Rotary or Lions, are salient in many localities. They could play a vital role in raising both awareness and funds in order to implement at least some of the safety recommendations made in this report.

Child- and Family-Centred Organisations

Organisations such as Plunket, Parents Centres and Family Start could play a crucial role in raising awareness and disseminating information.

Safekids New Zealand

Safekids with their extensive database and prominent position as a child safety organisation are an obvious choice for an organisation with which primary responsibility could lie for collating and disseminating information regarding vehicle-related child pedestrian driveway accidents. They also have standing and thus influence with at least some relevant government agencies such as HCNZ who liaise with them on a regular basis. In order for Safekids to optimise performance of such a role, record-keeping regarding these accidents needs to be improved.

ACC

With raised awareness of the issue ACC would be able to include prevention strategies in their literature.

Chapter 9: Discussion and Conclusions

This research was undertaken primarily to determine the viability of previous recommendations for child-driveway-vehicle safety and in cases where recommendations were found to be useful but untenable in their proposed form the further objective was to identify how to remove obstacles to implementation of such recommendations (and thus also to ascertain which recommendations should be abandoned).

We first had to identify the groups at risk for vehicle-related child pedestrian driveway accidents, as these groups were the ones to be targeted when considering the modification and implementation of valid safety recommendations. We thus needed to discover the reasons why these at risk groups feature so largely in these accidents, which could in turn inform the research as to why some previous recommendations were not be viable as proposed and also aid us in constructing new and more practicable recommendations.

The largest at risk group for vehicle-related child pedestrian driveway accidents are families of lower socio-economic status and within this group Māori and Pasifika families feature significantly, as do those (an overlapping group) in rental accommodation. The vehicles that play a large role in these accidents – in proportion to overall ownership of such vehicles – are sport utility vehicles and vans. The driver involved is more likely to be male, and the children injured or killed are most likely to be around two years old.

The combined data of the literature review and the key and expert informant interviews suggests several possible reasons for the high preponderance of both low socio-economic status and Māori and Pasifika families involved in these accidents:

- those of lower socio-economic status are more likely to live in high density areas with less suitable areas for children to play, and more opportunity for children to be hit on driveways;

- the fact that a lot of these accidents involve those in rental accommodation correlates not only with lower socio-economic status but also with the restrictions they may have in implementing environmental safety measures on their properties;

- Māori and Pasifika families are more likely to be large – and extended – and this teamed with the above factors leads to a higher risk of vehicle-related child pedestrian driveway accidents;

- larger families may tend to have larger vehicles such as SUVs or vans which feature significantly in these accidents due to poor rear visibility and larger blind spots;

- Māori and Pasifika families may practise more of a shared care style of caregiving, which is not always conducive to child safety in the physical environments described above;

- with larger families there is more activity to attract a caregiver's attention at any given moment and thus other things being equal a higher likelihood that small children may momentarily escape one's attention.

We thus needed to incorporate these factors into both our analysis of previous safety recommendations and our formulation of new ones.

Overall we found that the recommendations least likely to be implemented were those where *cost* and *space* were key factors. With the environmental recommendations especially there were questions over responsibility for implementing them when those who most needed such measures as fencing were in rental accommodation. Technical measures such as modifications to vehicles were also not likely to be implemented - due mainly to the prohibitive cost of such devices, but also to the fact that many people are simply unaware of them. Given the problems associated with all of the technical recommendations, and their as yet unproven effectiveness, raising awareness of these safety measures is not recommended.

We found that the most viable recommendations were both environmental and educational in nature. The obstacles to overcome then relate to responsibility and expense. Regarding responsibility, we advocate a community approach that includes landlords – both private and state, relevant community organisations, local businesses, local authorities, parents, drivers, and last but not least children themselves. We also recommend relevant (and modest) legislative changes that will bring about a more conducive environment for the implementation of the most realistic safety recommendations.

Perhaps the most significant finding of our research, and one which informed all subsequent recommendations, is the lack of reference to these types of accidents in any legislation or safety guidelines, as well as a dearth of information or data that deals specifically with vehicle-related child pedestrian driveway accidents. Consequently, a major recommendation is for improved – and separate – record-keeping in this area which, if accomplished, would help to improve publicity, which in turn would raise public awareness, which in turn we hope would facilitate greater funding of the implementation of any and all of the recommendations – from educational campaigns to erecting fences.

The issue of vehicle-related child pedestrian driveway accidents is one that has numerous contributing factors, and as such must be addressed by a multi-pronged solution that is not simply *ad hoc* but is part of a coordinated and cohesive campaig to reduce the rate of such accidents in our communities. We believe a major dimension of the problem is principally socio-economic and as such have endeavoured to tailor recommendations to achieve optimum results with the famili or households most at risk.

Chapter 10: Recommendations

Previous Recommendations to abandon

Compulsory fencing of driveways

The combined data generated from the key and expert informant interviews along with that from previous studies and literature points to the impracticability of compulsory fencing of driveways. Even if the obstacles of funding and enforcement could be overcome, the key problem with this recommendation is one of widespread physical / spatial impossibility. Most driveways – particularly those in high density and low socio-economic areas – simply will not lend themselves to complete fencing.

Although hazard isolation enforced by legislation has proven practicable and effective (albeit controversial) with the compulsory fencing of swimming pools our research suggests that this method cannot be successfully translated to the fencing of driveways. This does not mean, however, that fencing driveways could not be a successful measure in some instances – as passive measures such as fencing are an integral component of any multi-pronged strategy - but rather that legislating for *compulsory* driveway fencing simply would not work.

Reverse alarm signals or 'beeping lights'

The extensive literature and studies carried out on these devices cannot reasonably be said to conclude that they would be effective. The fact that children were found to be uninterested in them and the plausible but as yet not fully substantiated factor of younger children being attracted to the sound suggests that these alarms and/or lights should not be recommended. There is also the obstacle of implementation: if they were proven to be effective and were made compulsory for other than all vehicles (*e.g.* vehicles owned or used by adults in households with young children) how would enforcement work? Would the families that particularly need targeting for these types of accidents be able to have them installed? These devices need further investigation as to their effectiveness. Until then, this recommendation as a measure for reducing vehicle-related child pedestrian driveway accidents should not be promoted.

Rounded "fish-eye" rear-view mirrors

While we have hesitated before recommending abandoning this recommendation outright, the literature and key informant interviews suggest both that it is not an effective safety measure as the mirrors do not eliminate blind spots and that most families would be unlikely to install extra mirrors on their vehicles. We thus recommend abandoning promotion or enforcement of this measure but note that in some circumstances their use could enhance child safety.

Proximity detectors

While studies have shown certain types of proximity detectors to have some limited effectiveness in alerting drivers to the presence of children behind a reversing vehicle, the cost of purchase and installation would be prohibitive for most families, especially those most at risk of these types of accidents, and the cost-effectiveness of such devices is dubious. Unless this measure was carried out with full subsidies, or it became standard on all vehicles (which are unlikely given the inconclusive effectiveness of these devices) we do not regard this as a viable safety recommendation.

Creating space for vehicles to turn around

This recommendation has proven to be highly impractical due to space constraints in most domestic outdoor environments, and has the added potential problem of creating more space for children to be at risk of vehicle-related child pedestrian driveway accidents and less space for them to play in. Again, this may be useful for some environments, but only those with an abundance of space or a particularly conducive outdoor layout. We note that there is a current requirement for new homes to provide for turning vehicles if otherwise they would have to back more than 30 metres down a driveway.

Banning children from playing on the front lawn / yard and driveway

Even setting aside the likely widespread criticism of and opposition to any such measure, implementing it as a mandatory universal safety measure would be the first major obstacle. The second would be that in many outdoor environments the only suitable play space is in the front yard / garden or indeed the driveway itself. Children often like to use a smooth hard surface for activities such as ball games and bicycle riding. The third problem is that policing the ban would be impractical – especially with older children, and younger ones are likely to follow them – and that it severely restricts the everyday freedom of children (especially if there is nowhere else for them to play). We thus recommend abandoning this recommendation.

Previous recommendations to improve

Fencing

Fencing either a play area or an entire section of the yard is a viable environmental measure. It is more likely to be carried out by HNZC and might possibly be carried out by some private landlords. It is spatially feasible in most home environments and was thought by the key informants to be the most practical idea. The main obstacles to universal implementation are firstly cost – and the issue of who should be responsible for it – and secondly lack of community awareness and concern about the issue. The researchers see the issue as one of making a moderate change to current embedded cultural practices, insofar as fencing of this nature could come to be seen by many (if not all) as a normal and accepted aspect of domestic life, much

like the fencing of swimming pools (which is now widely albeit perhaps in a number of cases grudgingly accepted). The difference is that we recommend more passive measures to achieve this in regard to driveway safety. We recommend that:

- the issue of vehicle-related child pedestrian driveway accidents be publicised more widely in order to raise public awareness and concern;

- subsidies for homeowners and landlords to fence through either community fundraising, commercial sponsorship or government funding through local bodies;

- a multi-pronged pilot scheme be adopted in one area which addresses issues of awareness, fundraising and sponsorship;

- the Building Act's "flexible solutions" option, which would stipulate the meeting of safety requirements with regards to driveways but allow some flexibility as to how those requirements are met – fencing a large enough play area could be one way of meeting such requirements; and

- local authorities offer some form of incentive (such as a one-off rates rebate) to those who voluntarily make their sections safer for children.

Behaviour modification

Education and the raising of awareness of the risks of vehicle-related child pedestrian driveway accidents should take the form of a community approach. No one group need be singled out for responsibility for these accidents, although parents, drivers and home-owners alike will all need to play a part in helping to reduce the child-driveway accident rate. We recommend that:

- an educational campaign aimed at raising community awareness be implemented, which will include all previous safety tips and recommendations aimed at families in general – the campaign should be cohesive and distinctive and emanate from one organisation responsible for collecting information regarding these accidents; and

- a similar safety campaign is aimed at children – both pre-school and school age – which includes take-home safety packs with games and colouring-in sheets (a parallel could be drawn with Safekids' and the Waitakere City Council's 2003 child driveway awareness publicity campaign in which pamphlets and reminder door hangers were distributed.

New recommendations

These recommendations have arisen from the literature review, key and expert informant interviews, and general discussion amongst interested parties. They are for the most part generated by the lack of consideration for vehicle-related child pedestrian driveway safety in all aspects of legislation – be it buildings, vehicles,

drivers or accident prevention in general – and the lack of adequate record-keeping in respect of such accidents.

Improved record-keeping

The fragmentation and/or absence of data on vehicle-related child pedestrian driveway accidents is in part due to the fact that no organisation has or takes responsibility for collecting data on such accidents. The data that are collected are not distinguished from general pedestrian accidents and thus it is difficult to form any coordinated programme between relevant / interested organisations. A more collaborative and cohesive approach between all the groups, interests, and agencies in needed. An anticipated consequence of this is improved record-keeping that would enhance the salience of the issue. We recommend that:

- one all encompassing group be identified / formed as the responsible body for collating and disseminating information on child safety in relation to vehicle-related child pedestrian driveway accidents, and that this group gather information from all interested and relevant parties;

- records on child-driveway vehicle related accidents be kept separately from other pedestrian injuries; and

- an electronic database be established that would inter alia provide estimations of injury rates that could be useful for preventing vehicle-related child pedestrian driveway accidents via publicity.

Additions to regulations, codes and legislation

As vehicle-related child pedestrian driveway accidents are currently not identified as a separate event and hardly rate a mention in any safety legislation it is vital that they be included in housing, building and driver legislation particularly. It is our recommendation however that the approach be 'soft' – some passive measures – rather than legislation that would require constant enforcement and might be impractical anyway. We recommend that:

- a driveway safety component be added to the Housing NZ Corporation's standards and designs for both new houses and refurbishment projects;
- HNZC's evaluations of their community renewal projects include residents' perspectives on safety issues
- a reference to driveway safety be included in the Road Code and driver's licence test;
- the role of SUVs and similar vehicles in vehicle-related child pedestrian driveway accidents be taken into account in future research into the suitability of off-road vehicles in urban and suburban environments; and

New Zealand Reversing Visibility Index

Although already implemented in Australia by NRMA insurance in 2002, and hence not strictly new, a New Zealand version of the Reversing Visibility Index could prove valuable. An individual rear-view visibility rating for every make and model of vehicle available on the Australian market affords the new vehicle buyer the opportunity to select a vehicle with features that could play a part in the reduction of vehicle-related child pedestrian driveway accidents. Some cross-over benefits from the NRMA index with a NZ index could arise, in relation to makes and models common to both countries. NRMA Insurance note they are part of Insurance Australia Group (IAG), who own State and NZI insurance in New Zealand[277], which creates the possibility for one of these New Zealand insurance companies to implement a New Zealand Reversing Visibility Index drawing on relevant Australian data. We thus recommend:

- that an appropriate community organisation concerned with child pedestrian safety seek the participation of an IAG insurance company in New Zealand such as State or NZI in developing and implementing a New Zealand Reversing Visibility Index for at least all new vehicle makes and models available on the New Zealand market; and
- that the NZRVI be widely publicised and made easily accessible for New Zealand vehicle purchasers.

A new practical measure

One modest and practical new measure which has come to the notice of the researchers is the use in driveways of a convex mirror mounted in such a position as to afford drivers reversing out of garages and/or down driveways to see the area into which they are about to reverse their vehicle. We see no reason why this modest measure could not be encouraged and implemented right away, as it is relatively inexpensive and has the potential to make some difference to the number of vehicle-related child pedestrian driveway accidents. Of course such a measure would need eventually to be teamed with other aforementioned recommendations on awareness-raising publicity and education and indeed product availability would need to be checked. We thus recommend:

- trial of externally mounted convex mirrors (e.g. on a garage, house wall, pole or fence) to test for effectiveness in improving drivers' rear view vision.

[277] NRMA Insurance, 2005 http://www.nrma.com.au/pub/nrma/about_us/our-company/index.shtml

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