

PATTERN OF CHILD PEDESTRIAN COLLISIONS AND INJURIES IN MALAYSIA

Nur Shaeza Darus^{a*}, Muhamad Nazri Borhan^a, Siti Zaharah Ishak^{b,d}, Rozmi Ismail^c, Siti Fatin Mohd. Razali^a

^aDepartment of Civil and Structural Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), 43600 Bangi, Selangor, Malaysia

^bMalaysian Institute of Road Safety Research (MIROS), Taman Kajang Sentral, 43000 Kajang, Selangor, Malaysia

^cSchool of Psychology and Human Development, Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia (UKM), 43600 Bangi, Selangor, Malaysia

^dFaculty of Civil Engineering, MARA University of Technology (UiTM), 40450 Shah Alam, Selangor, Malaysia

Article history

Received

12 June 2017

Received in revised form

30 November 2017

Accepted

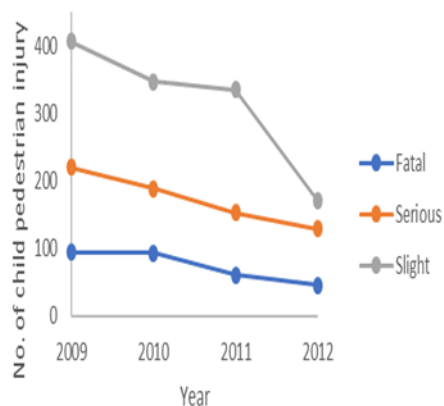
15 February 2018

Published online

3 June 2018

*Corresponding author
p72768@siswa.ukm.edu.my

Graphical abstract



Abstract

Child pedestrians are the most vulnerable road users. They are at high risk involving in road traffic collision. This present study is to highlights the magnitude of road safety problem amongst child pedestrians in Malaysia. In addition, the objective of this study is to determine the pattern of child pedestrian collisions and injuries during the period 2009 to 2012. Police records of reported child pedestrian collisions and injuries in Malaysia from 1 January 2009 to 31 December 2012 were collected. The selected variables on demographic factors, injuries related to the child and crash site characteristics were extracted and analyzed. A total number of 2,243 child pedestrian casualties were reported accounted for 27.9% of all pedestrian casualties in 2009 to 2012. Over 4 years period of study, the greatest number of incidence crash consistently occurred in the state of Sabah. Most of the involved children were the young children, aged 5 to 10 years and boys most commonly involved. Majority of the victims belonged to the rural populations. The collisions were more likely occurred on the roadways with two-way traffic system with a posted speed limit of 50km/h. These findings may have important contributions to the improvement and development of road safety initiatives and interventions related to child pedestrian collision in Malaysia. Road safety strategies should be improved by introducing more targeted measures for high-risk groups based on variables that have been studied.

Keywords: Child pedestrian, collisions, injuries, high risk, road safety

Abstrak

Pejalan kaki kanak-kanak adalah antara pengguna jalan raya yang paling lemah. Mereka mempunyai risiko dan kadar yang tinggi terlibat dalam kemalangan jalan raya. Kajian ini adalah untuk menunjukkan masalah keselamatan jalan raya di kalangan pejalan kaki kanak-kanak di Malaysia adalah amat besar. Selain itu, objektif kajian ini juga adalah untuk menentukan corak pelanggaran dan kecederaan di kalangan pejalan kaki kanak-kanak bagi tempoh 2009 hingga 2012. Rekod pelanggaran dan kecederaan pejalan kaki kanak-kanak di Malaysia dari 1 Januari 2009 hingga 31 Disember 2012 diperolehi dari rekod pihak polis. Maklumat berkaitan dengan pembolehubah seperti faktor-faktor demografi, ciri-ciri kecederaan dan lokasi kemalangan yang berkaitan dengan kanak-kanak diperolehi dan dianalisis. Sejumlah 2,243 mangsa pejalan kaki kanak-kanak yang terbunuh dan cedera dilaporkan menyumbang sebanyak 27.9% daripada jumlah semua pejalan kaki yang terbunuh dan cedera pada tahun 2009 hingga 2012. Jumlah kemalangan yang tertinggi berlaku di negeri Sabah bagi tempoh 4 tahun berturut-turut. Sebahagian besar daripada mangsa adalah kanak-kanak dalam kumpulan umur 5 hingga 10 tahun dan kanak-kanak lelaki biasanya terlibat dalam kemalangan. Majoriti mangsa adalah penduduk luar bandar. Pelanggaran lebih cenderung berlaku di jalan raya yang mempunyai sistem lalulintas dua hala dengan had laju 50km/j. Penemuan ini mungkin mempunyai implikasi penting untuk memperbaiki inisiatif dan intervensi keselamatan jalan raya berkaitan pelanggaran yang membabitkan pejalan kaki kanak-kanak di Malaysia. Starategi keselamatan jalan raya perlu diperbaiki dengan memperkenalkan langkah-langkah yang lebih disasarkan untuk kumpulan berisiko tinggi berdasarkan pembolehubah yang telah dikaji.

Kata kunci: Pejalan kaki kanak-kanak, pelanggaran, kecederaan, risiko tinggi, keselamatan jalan raya

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1.0 INTRODUCTION

Child pedestrians are vulnerable road users. They interact together with other users in mixed road traffic situations with a variety of purposes [1]–[7]. As stated by Petch and Henson, the risk of children in a road traffic accident is greater due to the complex interactions in our transportation system. It encompasses interactions between children and driver behaviour as well as the interaction of children and the physical/social environment [8]. Children are predominantly at high risk involving in road traffic accidents due to the small physical stature and limitation of cognitive ability [1], [5]. The fact that their physical and cognitive aspects are in a state of growth and underdeveloped resulting in a high rate of involvement.

Several researchers highlighted that children's short stature limits their ability to see or be seen by other road users [5], [9], [10]. In a study conducted in German, it was found that head impact conditions, as well as injury severities, were mainly dependent on the stature of the children, the impact speed and the shape and stiffness of the car front [11]. In related to cognitive aspects, most of the work related to cognitive development is founded on Jean Piaget's Theory [5], [12]. Piaget believed that cognitive development of children takes place in stages according to certain age levels [13], [14]. In a study

done by Barton *et al.* [15] on measuring cognitive functioning, it was found that boys and younger children aged 5 to 9 years old selected riskier pedestrian routes.

Globally, World Health Organization (WHO) reported that child pedestrians form the largest group involved in road traffic collisions [4]. A report from UNECE highlighted that 32% children aged 0-15 years were killed as pedestrians in European Union [16]. Meanwhile, in a study carried out by Linnan in Asia comprised of Vietnam, Bangladesh, Thailand, Philippines, Jiangxi Province and Beijing, China found that the highest group of road traffic accidents deaths were among young child pedestrians and bicyclists [17].

In Malaysia, the statistic of fatal collision involving children is particularly worrying due to a higher rate of child pedestrian fatalities. Between 2007 to 2009, 12% of children aged 1 to 18 years old suffering from fatal road collisions were recorded in Malaysia [2]. In comparison, this figure is higher than the high-income countries with only 5–10% of fatal deaths [4]. According to Schwebel [10], road and traffic situations in lower and middle-income countries is more complex related to many factors. The children in these countries may need more developed cognitive skills to interact in road traffic situations. Hence, this present study is to highlight the magnitude of the road safety problem amongst child pedestrians in Malaysia

and to determine the pattern of child pedestrian collisions and injuries during the period 2009 to 2012.

2.0 METHODOLOGY

2.1 Data Source, Variables Description and Method of Analysis

This study is a descriptive secondary data analysis of child pedestrian (≤ 18 years) collisions and injuries in Malaysia that occurred between 2009 and 2012. The raw data were obtained from POL-27 forms administered by the Royal Malaysian Police (RMP), Traffic Branch. The form is used to record traffic accidents details occurred in Malaysia by manual. Then, the information is stored in the Computerized Accident Reporting System managed by RMP with the collaboration of Malaysian Institute of Road Safety Research (MIROS). The selected variables were analyzed using SPSS version 23. The variables with its sub-categories are presented in Table 1.

Table 1 List of selected variables

Variable	Level
Age	continuous data
Gender	male and female
Severity	fatal, serious and slightly
Type of location	city, urban, built-up, rural
Type of area	residential, office, shopping, and others
	industrial/construction, bridge/ footbridge, school and others
Traffic system	one way, two ways, three lane and dual carriageways

2.2 Definitions

The present study applies the definitions[18] as depicted in Table 2.

Table 2 Term used defined by Royal Malaysian Police(RMP)

Term	Definition
Pedestrian	Any person who is not/on a vehicle but occupying a portion of road; includes road construction workers, a person pushing a breakdown vehicle, etc.
Fatal	Any person who died within 30 days as a result an accident
Serious injury	Any person who has injured as a result of an accident as referred to section 320 of the Penal Code which includes any of the following; <ol style="list-style-type: none"> i. Emcisculcition; ii. Permanent privation of the sight of either eye; iii. Permanent privation of the hearing of either ear; iv. Privation of any member of joint;

Term	Definition
	v. Destruction or permanent impairing of the powers of any member of joint;
	vi. Permanent disfiguration of the head or face;
	vii. Fracture or dislocation of a bone; and
	viii. Any hurt which endangers life, or which causes the sufferer to be, during the space of twenty days, in severe bodily pain or unable to follow his ordinary pursuits.
Slightly injury	Any injury that does not fill under death or serious injury

3.0 RESULTS AND DISCUSSION

3.1 Magnitude of Child Pedestrian Casualties

Overall, there were 2,243 child pedestrian casualties were reported accounted for 27.9% of all pedestrian casualties between 2009 and 2012. Of this value, 12.9% children were killed from the remaining casualties. It was found that the child pedestrian casualties were as follows; 30.2% (2009), 29.1% (2010), 21.5% (2011) and 21.2% (2012). Between the study periods, the number of reported casualties were decreased by 9% ($n=720$ and $n=345$) in the 2009 to 2012 period. Declining trends in child pedestrian accident rates in Malaysia during the period 2009 to 2012 partly reflect the impact of the road safety intervention program implemented by Malaysia government in 2007 to 2014. The education intervention program known as Road Safety Education (RSE) program has been introduced and implemented in stages for primary and secondary school children nationwide[19]. Table 3 shows trends in reported pedestrian casualties and fatalities in Malaysia, 2009-2012

Table 3 Trends in reported pedestrian casualties and fatalities in Malaysia, 2009-2012

Year	Reported pedestrian casualties	Child pedestrian casualties	Reported pedestrian fatalities	Child pedestrian fatalities
	*C (A)	*C (B) ^{**P} (B/A) (%)	*C (C)	*C (D) ^{**P} (D/C) (%)
2009	2385	720 30.2	593	94 15.9
2010	2161	629 29.1	626	93 14.9
2011	1859	549 29.5	530	61 11.5
2012	1629	345 21.2	530	46 8.7
Total	8034	2243 27.9	2279	294 12.9

*C=count, **P=proportion

3.2 Distribution of Child Pedestrian Collisions by State and Territory

There are 13 States and three (3) Federal Territories in Malaysia. Table 4 gives the percentage distribution of child pedestrian collisions, by states and territories. Between 2009 and 2011, the highest incident rate

occurred in the state of Sabah followed by the state of Kelantan. However, the state of Sabah witnessed an increase of twice fold in child pedestrian incidence rate from 2009 (17.1%) to 2012 (36.8%). In 2012, the state of Sabah remained as the highest number of collisions followed by Sarawak (7.5%) and Perak (7.5%). The state of Sabah accounted for a greater number of child pedestrian collisions in Malaysia over 4 years' study period. Contrasting to that, a lesser number of reported collisions from the Federal Territory of Putrajaya over the same period. The dissimilarities between these two (2) states may due to differences in geography, environmental variations [20], [21] and the level of urbanization rate [22]. Malaysian Department of Statistics (DOS)[23] reported that Sabah is classified as a state with a low level of urbanization with 54% urbanization rate, whereas, Putrajaya has reached 100%. In addition, the facts that Putrajaya is a well-planned city [24] and provided with integrated public transportation, extensive shared footpath for cycling and walking activities, therefore, led to the reduction in accident rate [25].

Table 4 Distribution of child pedestrian collisions by state and Federal territory in Malaysia (2009 to 2012)

State	Year							
	2009		2010		2011		2012	
	N	(%)	N	(%)	N	(%)	N	(%)
Kedah	64	8.9	45	7.2	41	7.5	22	6.4
Perak	68	9.4	44	7.0	28	5.1	26	7.5
Pulau Pinang	32	4.4	18	2.9	11	2.0	3	0.9
Selangor	49	6.8	39	6.2	35	6.4	11	3.2
Negeri Sembilan	35	4.9	41	6.5	29	5.3	5	1.4
Melaka	30	4.2	16	2.5	10	1.8	3	0.9
Johor	56	7.8	64	10.2	52	9.5	16	4.6
Pahang	31	4.3	16	2.5	19	3.5	9	2.6
Terengganu	42	5.8	30	4.8	27	4.9	15	4.3
Kelantan	115	16.0	100	15.9	108	19.7	24	7.0
Sabah	123	17.1	136	21.6	121	22.0	127	36.8
Sarawak	36	5.0	31	4.9	28	5.1	26	7.5
Perlis	8	1.1	7	1.1	7	1.3	7	2.0
Federal Territory of Labuan	2	0.3	4	0.6	5	0.9	6	1.7
Federal Territory of Kuala Lumpur	15	2.1	15	2.4	12	2.2	3	0.9
Federal Territory of Putrajaya	2	0.3	1	0.2	2	0.4	0	0.0
Missing value	12	1.7	22	3.5	14	2.6	42	12.2
TOTAL	720		629		549		345	

3.3 Profile of Child Pedestrian Casualties

This section presents the trends of child pedestrian fatalities and injuries in Malaysia over the study period and some of the collision characteristics. The number of fatal, serious, and slightly child pedestrian injuries in Malaysia is presented in Figure 1. A total of 2,243 child pedestrian collisions were reported. The annual number of all type of injuries has fallen over the study period. Between 2009 and 2010, fatalities remained stable and decreased between 2011 and 2012. However, the annual decreased in the child pedestrian injury rate are steeper for serious and slight injuries compared to fatal injuries.

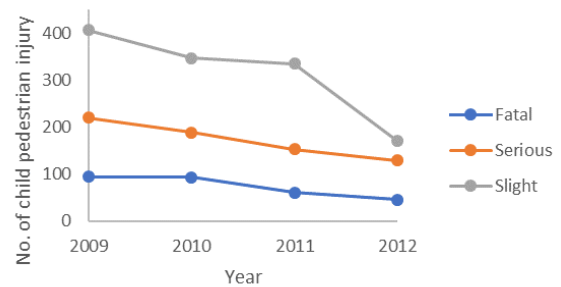


Figure 1 Number of child pedestrian accidents by type of injuries in Malaysia (2009-2012)

3.4 Gender and Age

As Figure 2 depicts, boys' preponderance was observed during the study period. Between 2009 and 2012, boys had almost twice the injury rates with boys to girls' ratio of 1.7:1 (2009), 1.6:1 (2010), 2.2:1 (2011) and 1.8:1 (2012). The results conclusively identified that boys injured in greater numbers over 4 years study period. Similar results were reported abroad, such in Ireland [26], New South Wales, Australia [27], New Mexico [28] and in Manchester and Salford [29]. However, contrasting to the findings female preponderance was observed in Alberta, Canada [30]. The greater numbers of boys may due to the risk of exposure, such as long walking distance, unaccompanied journey, riskier route selection, behavioural differences, or any combination of the factors [1], [15], [31].

Figure 3 shows the percentage of child pedestrian injuries in Malaysia by age. The available data showed that child pedestrian injury rate peak was recorded in the age group of 8 to 10 years over the study period excluding the year 2012. Moreover, it was observed that children in the age 5 to 7 years fall in secondary peak between 2009 and 2011. However, in 2012, it was observed that children in the age 5 to 7 years recorded the greatest injury rate. It can be simplified that most of the road injuries were most prevalence among children aged 5 to 10 years old. Similar to that,

the results are in accordance with the prior studies conducted in Scotland [32], Lima, Peru [33] and New Mexico[28]. While, Stevenson et al. [34] found that children in Perth, Australia, particularly at the age of 13 to 14 has the highest exposure. Whereas DiMaggio & Phil [35] found an incidence rate peaked at the age of 6 to 14 years old. The higher proportion of collisions involving children at 5 to 10 years old can be explained by the fact that children being allowed to play on the streets, unaccompanied journey, less developed physical and cognitive aspects could be contributed to the statistics [1], [3], [28].

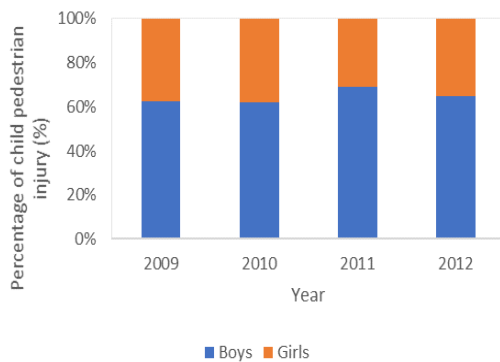


Figure 2 Percentage of child pedestrian injuries in Malaysia by gender (2009-2012)

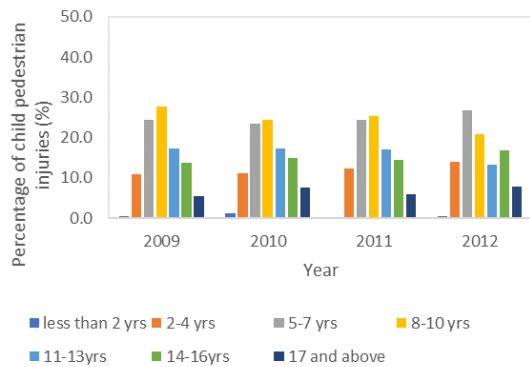


Figure 3 Percentage of child pedestrian injuries in Malaysia by age (2009-2012)

3.5 Type of Location and Area

The percentage of child pedestrian collisions by type of location in 2009-2012 are shown in Figure 4. It was observed that the largest incidence rate belonged to the rural population. This proportion consistently higher than the other location. During the study period, it was recorded as follows; 66.2% (2009), 63% (2010), 64.3 % (2011) and 55.1% (2012). This result is in accordance with the findings reported in India [36]. However, the incidence rate in urban centres in New South Wales, Australia [27] was consistently higher. In rural, previous

studies discovered that lack of roads maintenance, poor quality of public transports, less awareness of traffic rules, higher vehicle speeds, fewer separated pedestrian facilities and limited access to a medical emergency might be the contributing factors [37].

The percentage of child pedestrian collisions in Malaysia by type of area is compared in Figure 5. The incidence rate was greater in a residential area followed by school areas over the study period. The ratio of the child pedestrian incidence rate on residential areas was about two times that in school areas from 2009 to 2012 (1.6:1 (2009), 1.6:1 (2010), 1.9:1 (2011) and 1.7:1 (2012)). Other researchers reported similar situations abroad [38]–[41]. The child pedestrian most common scenario of a crash is the child dashes in or out onto streets [1], [42], [43]. In addition, it was found that child pedestrian injuries occur mostly in residential areas specifically on the same streets as their homes [35], [39], [40], [44].

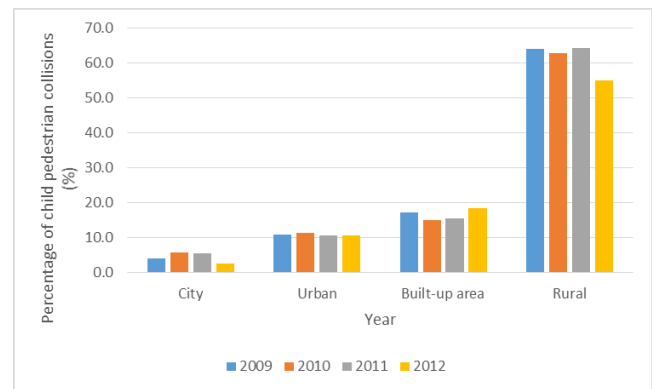


Figure 4 Percentage of child pedestrian collisions in Malaysia by type of location (2009-2012)

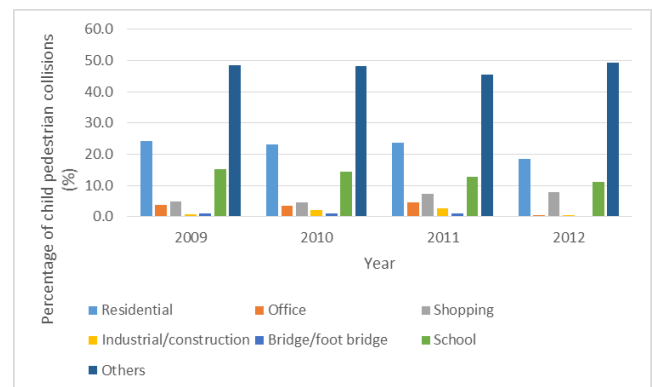


Figure 5 Percentage of child pedestrian collisions in Malaysia by type of area (2009-2012)

3.6 Traffic System and Speed Limit

The percentage of child pedestrian collisions in Malaysia by type of traffic system is presented in Figure 6. During this time (2009 to 2012), it shows that the crashes tend to take place on two-way system

followed by one-way system. The injury incidence rate was greater on two-way roads with more than 70% between 2009 and 2012. From the results, the collisions were more likely occurred on two-way traffic system over 4 years study period. This result is consistent with the findings observed in Riyadh, Saudi Arabia [38]. Furthermore, Al-Ghamdi [38] reported that most incidents in Riyadh occurred on divided roadways (two-way with median). Factors such as higher traffic volume [38], less developed skills and incapable to execute appropriate responses [45] in transportation system might be the contributing factors to the higher incidents on two-way traffic system.

The incidence rates occur in areas categorized by speed limit can be seen in Figure 7. It demonstrates that the number was greatest in areas with a speed limit of 50km/h and the least in areas with 110km/h. This finding was similarly reported abroad in Auckland [41] and British Columbia, Canada [39]. Additionally, WHO [46] stated that 40% to 90% of fatality risk occurred on roads with an impact speed of 50km/h. The fact that a higher number of injuries occurred on roads with a posted speed limit 50km/h might be due to speeding in the area that children tend to play in or near to the residential streets [47] or in areas that children walked to and from school [42]. Profile of child pedestrian collisions and injuries in Malaysia is depicted in Table 5. There were some limitations in this study. The data used retrospective data which may be incomplete for some variables.

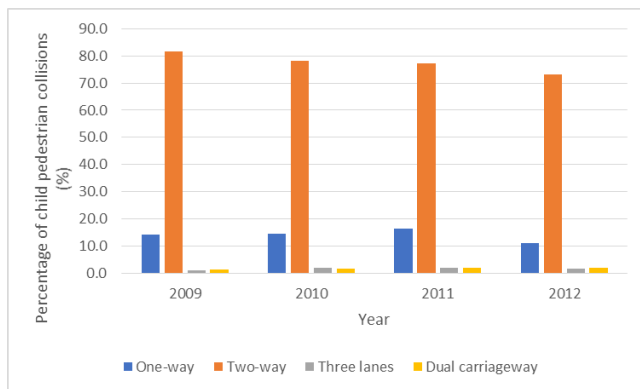


Figure 6 Percentage of child pedestrian collisions in Malaysia by traffic system (2009-2012)

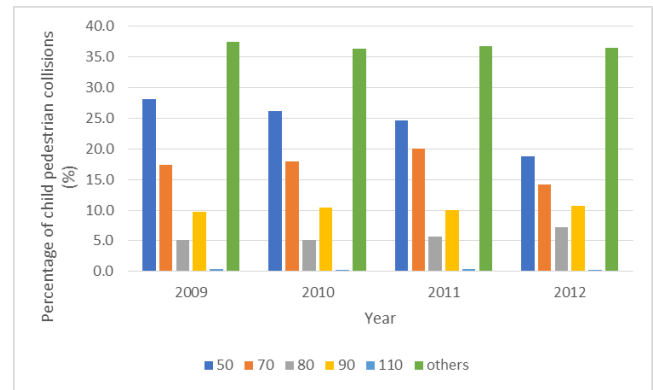


Figure 7 Percentage of child pedestrian collisions in Malaysia by speed limit (2009-2012)

4.0 CONCLUSION

This study aims to understand child pedestrian safety issues and scenario in Malaysia. Between 2009 and 2012, the annual percentage of child pedestrian casualties accounted for 21.2% and 30.2% of all pedestrian casualties. The state of Sabah had the highest incidence rates while the Federal Territory of Putrajaya had the lowest. The most commonly involved were rural populations involving boys aged 5 to 10 years old. The present study observed most child pedestrian collisions occurred in residential areas followed by the school areas. The greatest number of the crashes occurred on roads of two-way traffic systems and the speed limit of 50km/h.

This present study highlighted the urgent need for the government and local authorities to improved road safety policies for child pedestrian. The role of local authorities is crucial in planning and implementing policies concerned with the child pedestrian safety. Pedestrian facilities should be designed based on the capabilities, limitations and behaviour of children, as young children are vulnerable and less capable to interact in complex traffic situations [1], [3], [48]. Local authorities are suggested to review the speed limit in residential areas and schools. In addition, local authorities should monitor the speed of vehicles passing through the areas. Attention must be directed to the children who live in rural areas due to the lack of pedestrian infrastructures and facilities. In addition, parents should be made aware of their responsibility to monitor the movements of their children. Spending time indoors may provide additional protection for boys[49].

Table 5 Profile of child pedestrian collisions and injuries in Malaysia (2009-2012)

Variable	Level of variable	2009		2010		2011		2012	
		N	%	N	%	N	%	N	%
Type of injury	Fatal	94	13.1	93	14.8	61	11.1	46	13.3
	Serious	220	30.6	189	30.0	153	27.9	129	37.4
	Slightly	406	56.4	347	55.2	335	61	170	49.3
Gender	Boys	449	62.4	390	62.0	378	68.9	222	64.3
	Girls	270	37.5	237	37.7	170	31.0	121	35.1
Age	Missing value	1	0.1	2	0.3	1	0.2	2	0.6
	less than 2 years	4	0.6	7	1.1	1	0.2	2	0.6
	2-4 years	78	10.8	70	11.1	68	12.4	48	13.9
	5-7 years	175	24.3	148	23.5	134	24.4	92	26.7
	8-10 years	200	27.8	153	24.3	139	25.3	72	20.9
	11-13 years	124	17.2	109	17.3	94	17.1	46	13.3
	14-16 years	99	13.8	94	14.9	80	14.6	58	16.8
	17 years & above	40	5.6	48	7.6	33	6.0	27	7.8
Location type	Missing value	0	0	0	0.0	0	0.0	0	0
	City	29	4.0	37	5.9	31	5.6	9	2.6
	Urban	78	10.8	72	11.4	59	10.7	37	10.7
	Built-up area	124	17.2	95	15.1	86	15.7	64	18.6
	Rural	462	64.2	396	63.0	353	64.3	190	55.1
Area type	Missing value	27	3.8	29	4.6	20	3.6	45	13.0
	Residential	175	24.3	145	23.1	130	23.7	64	18.6
	Office	26	3.6	22	3.5	25	4.6	2	0.6
	Shopping	35	4.9	28	4.5	40	7.3	27	7.8
	Industrial/construction	6	0.8	13	2.1	14	2.6	2	0.6
	Bridge/foot bridge	7	1.0	6	1.0	6	1.1	0	0.0
	School	109	15.1	90	14.3	70	12.8	38	11.0
	Others	350	48.6	303	48.2	250	45.5	170	49.3
Traffic system	Missing value	12	1.7	22	3.5	14	2.6	42	12.2
	One-way	103	14.3	91	14.5	90	16.4	38	11.0
	Two-way	588	81.7	492	78.2	424	77.2	252	73.0
	Three lanes	8	1.1	13	2.1	10	1.8	6	1.7
	Dual carriageway	9	1.3	11	1.7	11	2.0	7	2.0
Speed Limit	Missing value	12	1.7	22	3.5	14	2.6	42	12.2
	50	203	28.2	165	26.2	135	24.6	65	18.8
	70	125	17.4	113	18.0	110	20.0	49	14.2
	80	37	5.1	32	5.1	31	5.6	25	7.2
	90	70	9.7	66	10.5	55	10.0	37	10.7
	110	3	0.4	2	0.3	2	0.4	1	0.3
	others	270	37.5	229	36.4	202	36.8	126	36.5
TOTAL	Missing value	12	1.7	22	3.5	14	2.6	42	12.2
		720		629		549		345	

Acknowledgement

Technical review by Malaysian Institute of Road Safety Research (MIROS) and financial support from Ministry of Education, Malaysia research Grant no. FRGS/1/2015/TK08/UKM/02/2 are acknowledged.

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