

Trends in child and adolescent injury mortality in Taiwan, 1986-2006

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Objectives: To describe national trends in injury mortality rates for Taiwanese children aged 0-19 from 1986 to 2006. **Methods:** Data were obtained from the official Vital Statistics System of the Department of Health, Executive Yuan. Injuries were classified by intent and mechanism using ICD-9 criteria. Mortality rates were age-adjusted for each year's standard population. Simple linear regression was used to determine the trends. **Results:** From 1986 to 2006, the mortality rate per 100,000 for unintentional injuries at ages 0-19 declined by 63% (from 35.3 to 13.2) and the suicide rate declined by almost half (from 1.9 to 1.0). The homicide rate for ages 0-19 combined declined but the homicide rate for children under age 5 increased. Except for homicide in young children, all age groups showed decreasing trends. The 15-19 age group had the highest total death rate due to injury and accounted for 52% of all injury deaths. Motor vehicle injuries (MVI) were the most common cause of death (accounting for 50% of all injury deaths), followed by drowning (17%), suffocation (7%), fire and flames (4%), falls (4%) and poisoning (2%). Suffocation caused 68% of injury deaths in infants. **Conclusions:** After 1989, the mortality rates for unintentional injuries and suicide declined, but the homicide rate for young children increased. Laws to prevent violence in the home must be enforced, and drowning prevention programs implemented and incorporated into the Children and Adolescent Safety Implementation Program. Preventive efforts should also target MVI and suicide in the 15-19 age group, drowning at all ages, and suffocation and homicide for infants and children under 5 years of age. (*Taiwan J Public Health*. 2010;**29**(1):22-32)

Key Words: Trends, Children, Injury, Mortality

INTRODUCTIONS

Child injuries and violence are a global public health problem. According to WHO's Global Burden of Disease data, about 875,000 children and adolescents under the age of 18

years died as a result of an injury in 2002 [1].

In Taiwan, 885 children and adolescents aged 0-19 died in 2006 due to injury [2]. Previously, Lu et al reported that the injury mortality rate among adolescents increased

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from 1965 to 1994, due largely to the increase in motor vehicle injuries (MVI) mortality rates, with males aged 15-19 years accounting for most of this increase [3]. Since that time, many intervention policies have been enacted: a mandatory motorcycle helmet use law that required motorcyclists and their passengers to wear helmets was enacted in June 1997, a home violence prevention law to protect women and children was enacted in June 1998, and CPR training for first aid of drowning victims was initiated in 1999 for managers of bathing beaches and swimming pools.

Are the trends of children and adolescent injury mortality rates, which reportedly rose from 1965 to 1994, continuing to increase? What should be the future emphasis of child and adolescent injury prevention? The objectives of this study were to describe national trends in injury mortality rates of Taiwan children and adolescents younger than 20 years in 1986-2006, and to suggest a focus for governmental injury prevention programs for the youth of Taiwan.

MATERIAL AND METHODS

The data were obtained from official Vital Statistics System for the period from 1986 to 2006[2]. This system collects data from all administrative division areas in Taiwan. According to law, each division officer must report the death data to the Health Department of the Executive Yuan. Death data include demographic factors, date and site of death, and cause of death (according to the International Classification of Diseases, 9th Revision, Clinical Modifications). The coding of injury death did not change from 1986 to 2006.

In order to show the trend in injury mortality over a longer period of time, data presented by Lu et al for injury deaths in the 15-19 year age group in 1965-1994 [3]

were combined graphically with our data for 1995-2006.

Injuries were classified by intent and mechanism. Unintentional injuries included MVI (E810-E825), poisoning (E850-E869), falls (E880-E888), fire and flames (E890-E899), drowning (E910), suffocation (E911-E913), and other. Intentional injuries included suicide (E950-E959) and homicide (E960-E969). In order to understand infants mortality, age was divided into 5 groups (<1, 1-4, 5-9, 10-14, 15-19), which were compared with one another. Mortality rates were age- adjusted to each year's standard population. Annual population estimates were taken from Statistical Yearbook of Ministry of the Interior. Simple linear regression was used to test the trends of injury mortality rates. The dependent variable in the regression equation was the mortality rate and the independent variable was the year.

RESULTS

During the 21-year study period, 44,452 children and adolescents aged 0 to 19 years died of injuries; unintentional injuries accounted for 93% of the total, homicide for 3%, suicide for 3% and injuries of unknown intent for 1%. Ages 15-19 years had the highest mortality rate and accounted for 52% of all injury deaths. Males, the dominant group, accounted for 70% of injury deaths (Table 1).

For ages 0-19 combined, the total injury mortality rate peaked in 1987-89 at about 41/100,000. The mortality rates declined by 63% for unintentional injury (from 35.3 to 13.2/100,000) and by almost half for suicide (from 1.9 to 1.0), while the homicide rate fluctuated but changed very little between 1986 and 2006 (from 0.9 to 0.8). Figure 1 shows that for males aged 15-19, the upward trend in total injury mortality reversed direction after 1989. For females in the same age group, a downward

Table 1. Annual deaths and age standardized mortality rate per 100,000 population due to injury, total mortality rates by sex and age, by cause and gender, aged 0-19 years, Taiwan, 1986-2006

Cause of death			<1		1-4		5-9		10-14		15-19		0-19	
			n	rate	n	rate	n	rate	n	rate	n	rate	n	rate
Unintentional (E800-E949)	MVI	male	176	5.86	1,346	9.99	1,047	5.66	1,623	8.36	11,828	59.72	16,020	21.59
	(E810-E825)	female	141	5.11	1,073	8.62	766	4.46	976	5.38	3,317	17.73	6,273	9.06
	Poisoning	male	3	0.10	71	0.53	53	0.29	70	0.36	321	1.62	518	0.70
	(E850-E869)	female	7	0.25	71	0.57	53	0.31	76	0.42	219	1.17	426	0.62
	Fall	male	90	3.00	313	2.32	141	0.76	101	0.52	413	2.09	1,058	1.43
	(E880-E888)	female	60	2.28	194	1.56	70	0.41	53	0.29	154	0.82	531	0.77
	Fire and Flames	male	48	1.60	322	2.39	210	1.14	153	0.79	195	0.98	928	1.25
	(E890-E899)	female	50	1.81	244	1.96	181	1.05	126	0.69	147	0.79	748	1.08
	Drowning	male	43	1.43	1,425	10.57	1,120	6.06	1,319	6.79	1,945	9.82	5,852	7.89
	(E910)	female	29	1.05	688	5.53	378	2.20	359	1.98	274	1.46	1,728	2.50
	Suffocation	male	1,244	41.42	208	1.54	66	0.36	32	0.16	52	0.26	1,602	2.16
	(E911-E913)	female	1,078	39.09	146	1.17	44	0.26	37	0.20	14	0.07	1,319	1.91
	other	male	190	6.33	501	3.72	369	2.00	364	1.87	1,608	8.12	3,032	4.09
		female	148	5.37	413	3.32	230	1.34	193	1.06	364	1.95	1,348	1.95
Intentional (E950-E999)	Suicide	male	0	0.00	0	0.00	3	0.02	80	0.41	783	3.95	866	1.17
	(E950-E959)	female	0	0.00	0	0.00	2	0.01	72	0.40	447	2.39	521	0.75
	Homicide	male	24	0.80	87	0.65	66	0.36	63	0.32	485	2.45	725	0.98
	(E960-E969)	female	22	0.80	86	0.69	99	0.58	41	0.23	120	0.64	368	0.53
	other	male	33	1.10	48	0.36	31	0.17	56	0.29	224	1.13	392	0.53
		female	20	0.73	30	0.24	24	0.14	25	0.14	98	0.52	197	0.28
Total (E800-E999)	male	1,851	61.63	4,321	32.06	3,106	16.80	3,861	19.88	17,854	90.15	30,993	41.77	
	female	1,555	56.39	2,945	23.66	1,847	10.76	1,958	10.79	5,154	27.56	13,459	19.45	

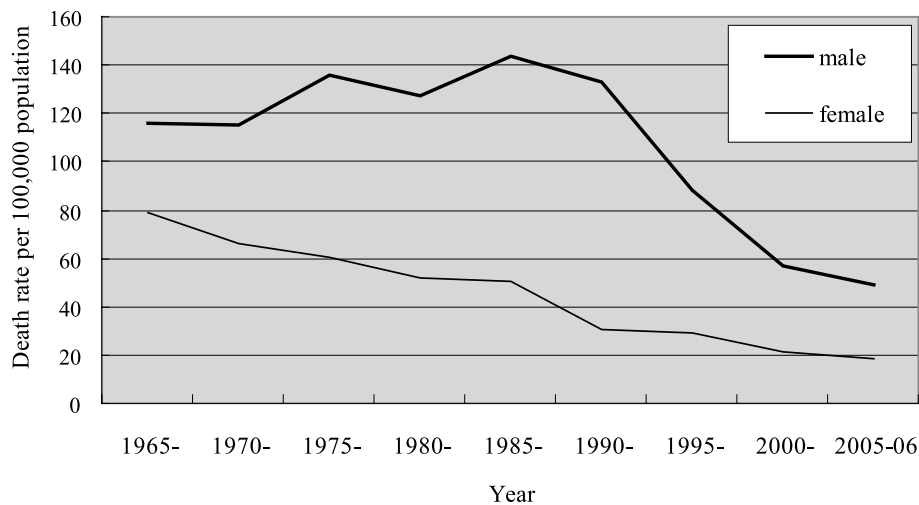


Figure 1. Total injury mortality for ages 15-19 by gender, Taiwan 1965-2006.

Data points prior to 1995 are from Lu et al. [3]

trend was apparent throughout the 4 decades ($p=0.037$ for male, $p<0.001$ for female).

Unintentional injury

Decreasing trends in unintentional injury death rates after 1989 were seen for adolescents and children of all ages (Figure 2, $p<0.001$ for all age groups), of whom 41,383 died during the 21 years from 1986-2006. Adolescents and infants consistently had higher injury mortality rates than other age groups. All specified mechanisms of unintentional injury showed a declining trend (Figure 3, $p<0.001$ for all mechanisms groups). The exception was injuries of 'other' mechanisms ($p=0.135$); their rate was stable during 1986-98, then had a notable peak due to the September 21, 1999 earthquake (called the "9/21 effect").

From 1986-2006, motor vehicle injuries (MVI) accounted for 54% of all unintentional injury deaths, decreasing by 45% from a rate of 15.9/100,000 in 1986 to 8.7 in 2006). Similar

to the overall injury rate for males aged 15-19, the peak was in 1987-89. The drowning rate decreased by 85%, from 9.7 in 1986 to 1.5 in 2006. Drowning was the second leading cause of unintentional injury deaths (18%), followed by suffocation (7%), fire and flames (4%), falls (4%), and poisoning (2%); 'other' mechanisms accounted for 10% (Table 1).

MVI mortality decreased after 1989, peaked again in 1994, then declined for the rest of the study period. MVI was the leading cause of injury death of adolescents aged 15-19 years and accounted for two-thirds of the injury deaths in this group. Three-fourths (78%) of all MVI deaths were of males (Table 1). Similarly, the drowning rate of males aged 0-19 was three times the female rate (7.9 vs. 2.5/100,000). MVI and drowning were the main causes of fatal unintentional injuries for children aged 1-4 year, and suffocation was the leading cause for infants, accounting for 68% of injury deaths at age <1.

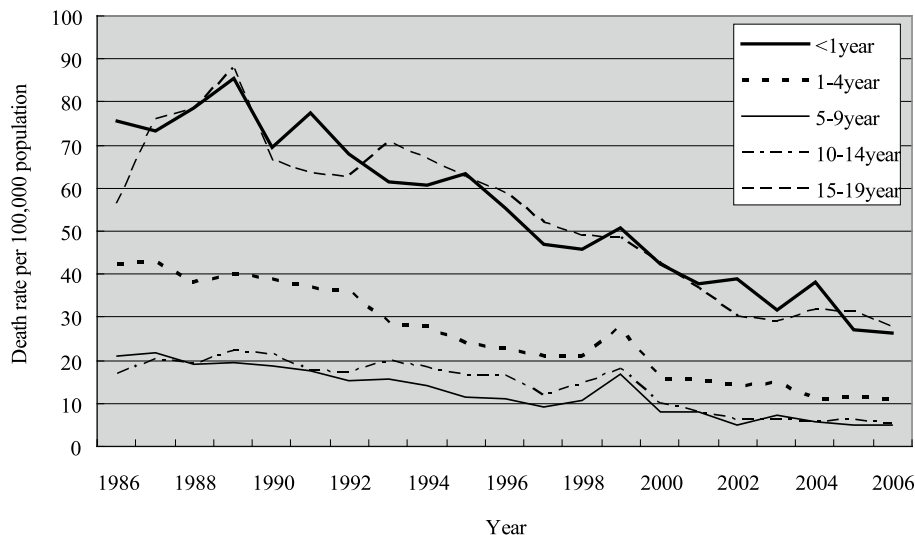


Figure 2. Unintentional injury mortality for children and adolescents by age group in Taiwan, 1986-2006.

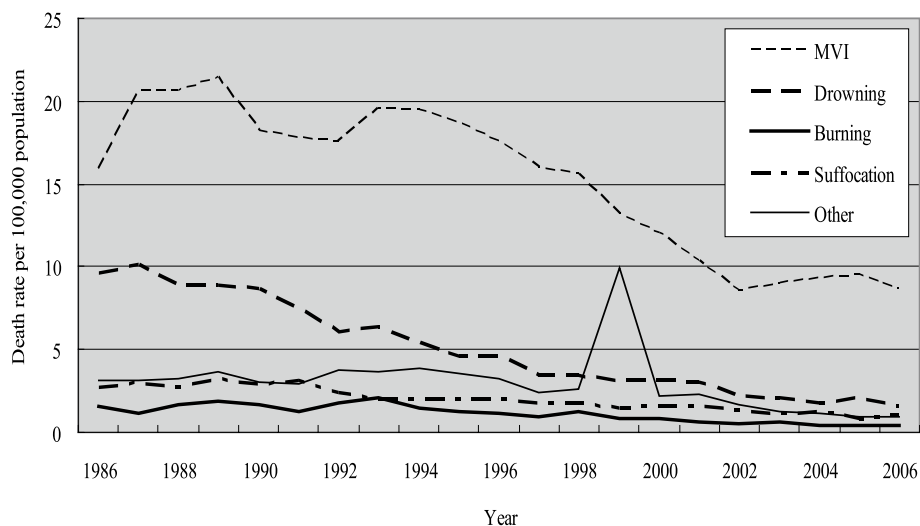


Figure 3. Unintentional injury mortality for ages 0-19 by mechanism in Taiwan, 1986-2006.

Homicide

There were 1,093 homicides during the 21-year study period. The homicide rates decreased for ages 15-19 but increased for infants and for children ages 1-4 (Figure 4, $p=0.001$, $p=0.011$, $p=0.003$, respectively). Children ages 5-14 had very low rates that fluctuated during the study period. Homicide rates were highest in males ages 15-19 (2.5/100,000) and for both sexes at ages <1 and 1-4. The homicide rates were similar for males and females up to age 5, slightly higher for females aged 5-9, and 4 times as high for males at ages 15-19 (Table 1).

Suicide

Suicide was more common than homicide; during the study period, there were 1,387 suicide deaths, 89% of which were in the 15-19-year age group (Table 1). Suicide rates in both males and females were high in 1986 and lower during 1993-2000, then increased (Figure 5, $p=0.034$ for male, $p=0.141$ for female). The number of suicides in females declined

markedly between 2005 and 2006 (from 29 to 12, a rate change from 3.8 to 1.6/100,000, $p<0.05$).

DISCUSSIONS

The leading cause of injury deaths for infant (<1) is suffocation, followed by MVI and fall. MVI and drowning are two leading causes of injury deaths for children aged 1-19. However, fire and flames is the third cause for children aged 1-14 but suicide for those aged 15-19 (Table 2).

Although Lu et al reported that the injury rate for Taiwanese adolescents ages 10-19 increased from 1965 to 1994, our access to more recent data revealed that the peak rate for children and adolescents was during the years 1987-1989, followed by a decrease that has extended at least through 2006.

Other investigators have presented annual data on trends in injury mortality rates in children and adolescents in Canada [4,5] and Finland [6,7]; Figure 6 compares these with data for Taiwan. From 1986 to 2002, the

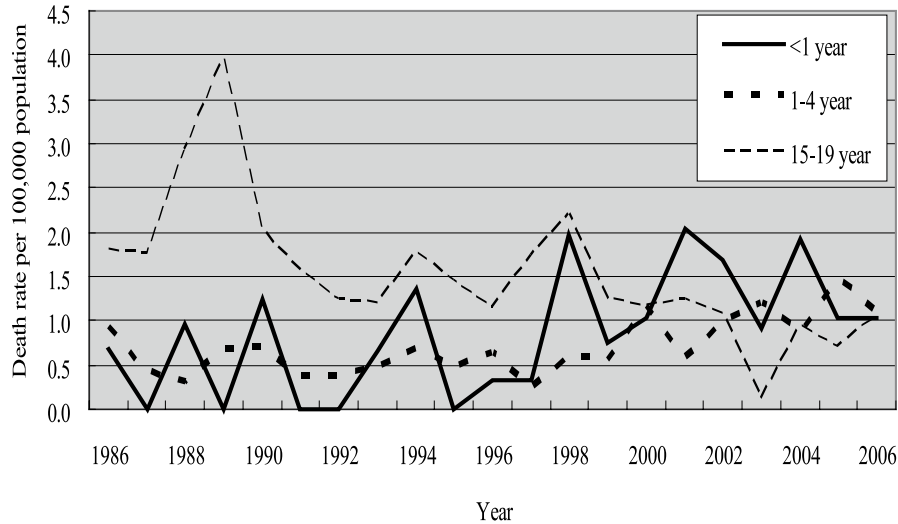


Figure 4. Homicide mortality for children and adolescents by age group in Taiwan, 1986-2006.

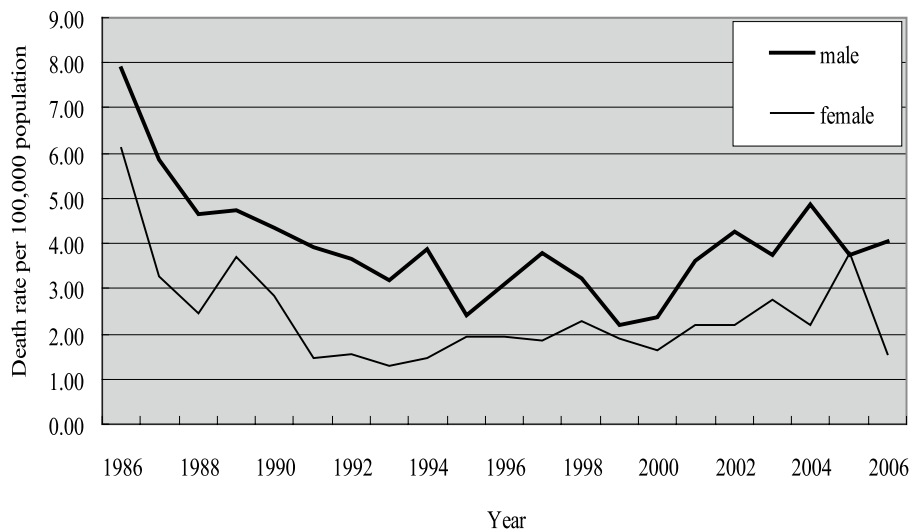


Figure 5. Suicide mortality ages 15-19 by year and gender, 1986-2006.

injury mortality rates in Taiwanese children and adolescents declined faster than rates in Canadian and Finnish children (Figure 6 shows the rates for ages 0-14, $p < 0.001$ for all three countries). Taiwanese children and adolescents had higher rates than rates of Canadian and Finnish children in 1986, but after 1995 their

rates were the same as Finnish rates [4-8]. Compared with Sweden [9], the male injury mortality rates from 1987 to 2001 in Taiwan declined faster than those in Sweden (53% to 37%), but female injury mortality rates declined equally (42% to 42%).

Homicide mortality rates in Taiwan were

Table 2. Leading causes of injury death, aged 0-19 years, Taiwan, 1986-2006

Rank	<1 year	1-4 years	5-9 years	10-14 years	15-19 years	0-19 years
1	Suffocation 2,322	MVI 2,419	MVI 1,813	MVI 2,599	MVI 15,145	MVI 22,293
2	MVI 317	Drowning 2,113	Drowning 1,498	Drowning 1,678	Drowning 2,219	Drowning 7,580
3	Fall 150	Fire and flames 566	Fire and flames 391	Fire and flames 279	Suicide 1,230	Suffocation 2,921
4	Fire and flames 98	Fall 507	Fall 211	Fall 153	Homicide 605	Fire and flames 1,676
5	Drowning 72	Suffocation 354	Homicide 165	Suicide 152	Fall 567	Fall 1,589
6	Homicide 46	Homicide 173	Suffocation 110	Poisoning 146	Poisoning 540	Suicide 1,387
7	Poisoning 10	Poisoning 142	Poisoning 106	Homicide 104	Fire and flames 342	Homicide 1,093
8	Suicide 0	Suicide 0	Suicide 5	Suffocation 69	Suffocation 66	Poisoning 944

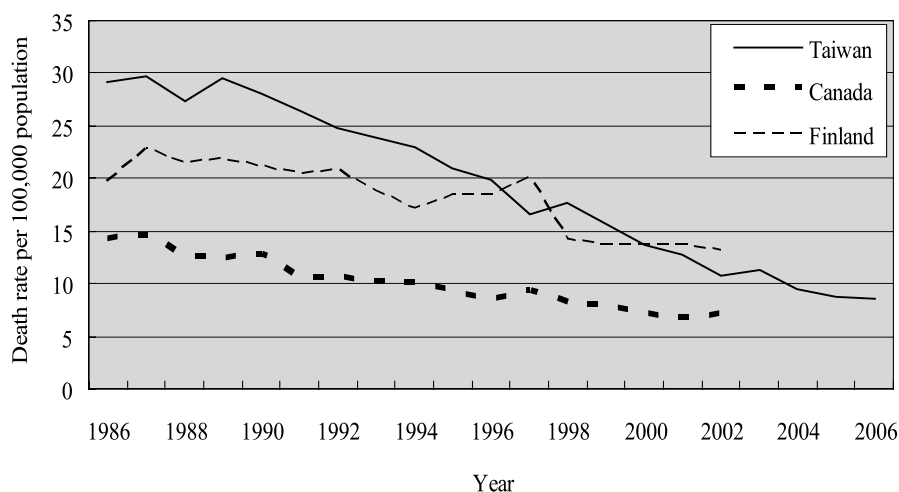


Figure 6. Injury mortality rate ages 0-14 in Taiwan, Canada, and Finland, 1986-2002.

lower than in Sweden [10], European Union [11] and the United States [12] in 2000 (0.7, 1.1, 1.2 and 5.9, respectively). Suicide was also lower in Taiwan (0.7, 12.2, 11.6 and 10.5, respectively). During the study period, 89% of the 1387 suicide deaths were contributed by the 15-19 age group. Both homicide and suicide rates are high in this age group and probably should be future targets of intervention programs, although major emphasis should be

placed on several causes of unintentional injury with far higher death rates.

As in most countries, MVI is an important problem of children and adolescents in Taiwan. Comparison with other studies reveals that the trend of MVI mortality rates in Taiwan was similar to the United Arab Emirates [13], but the declining trend in Taiwan began 5 years later in Taiwan than in UAE. In China, the MVI mortality rate was still increasing after 1989

and was highest in 2005 [14], although the MVI mortality rate curve of Taiwan declined after 1987-89 and the year 2005 had the lowest rate.

Research has indicated that motorcyclist helmet use can reduce the head injury fatality rate by 31% to 74% [15-17]; unrestrained children are three times as likely to be hospitalized as restrained children (21% vs. 7%) [18], and alcohol use contributes to 53% of traffic deaths [17]. In Taiwan, a mandatory motorcycle helmet law was enacted in June 1997. Every motorcycle driver and child rider must wear a helmet. Keng used the police-reported crash data from Taiwan between 1999 and 2001 to estimate the effectiveness of helmets. He concluded that motorcyclist helmets significantly reduced the likelihood of head and neck injuries in a crash by 53%, and that a helmet can produce a 71% reduction in the probability of death caused by head and neck injuries [16]. Fines for driver alcohol use and non-use of child passenger restraints have been implemented for many years: laws were passed in 1999 restricting alcohol use by drivers and in 2002 requiring child restraints. Because they were enacted during a steady decline in MVI death rates, neither of these laws explains the decline in MVI death rates that began in 1990. It is possible, however, that these policy interventions contributed to the reduction. Although the mortality rate declined, MVI remains the leading cause of injury mortality in children and adolescents ages 1-19 years and should be a focus for more preventive efforts, especially in 15-19-year-old males. Helmets should be required for motorcyclists of all ages, passengers as well as drivers, and of bicyclists as well; both are common means of transport in Taiwan and the source of many injuries and deaths.

Our study reveals that drowning was the second leading cause of injury deaths in

children and adolescents – and the leading cause in children ages 1-4. Similarly, Yang and colleagues reported that drowning was a severe problem for boys and girls younger than 5 years in China [19]. Taiwan is an island with a long seacoast as well as many rivers, streams and ponds in the interior and the climate is very hot for more than 6 months of the year. Children and adolescents commonly swim in the sea, rivers, streams and ponds. One study indicated that in Taiwan, drowning is even more common in ponds, ditches, and irrigation canals than in the ocean, rivers, and swimming pools [20]. In areas without lifeguards where swimming is prohibited, drowning is more common than in permitted areas with warning signs and lifeguards. Without lifeguards, there is no one to carry out first aid on the scene, resulting in a bad outcome [20]. To prevent drowning, we must identify and publicize the hazardous areas, educate children and adolescents not to swim at danger spots, and require every swimming pool owner to learn CPR and to provide water safe guards. Drowning prevention should be implemented and incorporated in the Children and Adolescent Safety Implementation Program.

Suffocation was the leading cause of injury death for infants and accounted for 68% of deaths in this group in Taiwan. Similarly, in New Zealand suffocation was the leading cause of death in infancy (< 1 year of age) and accounted for 43% of injury deaths [21]. Several factors are probably associated with infant suffocation in Taiwan although data are not available to confirm this. First, infants aspirated milk or vomit and their parents or caretakers didn't detect and deal with it immediately. Second, infants shared a bed with adults who inadvertently rolled over on them. Third, in order to have a good shape of infants' heads, parents let their babies lie in a prone sleeping position. Fourth, infants choked

on food such as round gelatinous candy (of a type banned in the United State). Finally, the incorrect classification of SIDS (sudden infant death syndrome) cases may have contributed. Many studies have indicated that sleeping on the back can reduce the SIDS mortality [22-24]. In the United States, after the “Back to Sleep” campaign was launched in 1992, the overall postneonatal mortality rate between 1991 and 1996 declined by 21.9%, whereas the SIDS rate declined 38.9% [25]. In Taiwan, in order to reduce the infant suffocation mortality rate, a Back to Sleep campaign should be initiated for infants.

During the study period, there were 219 homicide deaths among children less than 5 years old. The causes of homicide in children ages 0-4 were stabbing (21%), hanging (17%), poisoning (16%), drowning (5.9%) and child abuse (5%). Causes unspecified were found in one-third of cases. Since child abuse cases are often hidden, it is possible that the proportion of child abuse is much higher. Moreover, small children easily become the victims of domestic violence. It is sensible to strengthen the domestic violence in protecting the vulnerable young children.

Up to 2007, injury mortality statistics in Taiwan were shown with the first 3 digit of ICD-9 E-codes which provide very limited information regarding causes of injuries. In addition, the large proportion of “unspecified” cases make it impossible to use the data for developing appropriate intervention programs. To enforce cause of injury data collection is the key to improve this situation. With limited information, we are able to identify the types of injuries that frequently occur among different age groups.

For small children less than one year old, who spend most of their time at home,

suffocation is the leading cause of injury deaths. Home safety promotion should be the focus for this group. For children and adolescents (1-19) who spend more time for outdoor activities, MVI become the leading cause of injury death, followed by drowning. MVI and drowning prevention programs should be the priority. Adolescents aged 15-19 are normally in high schools. The heavy school work, peer pressure as well as conflict with parents may increase their risk of suicide. As the third leading cause of injury deaths, adolescent suicide should be given more attention. In addition to death prevention, nonfatal injuries are also important for future prevention programs.

The mortality rate for unintentional injuries and suicide declined during 1986-2006, but homicide rates of young children increased. The leading cause of injury deaths for infant (<1) is suffocation, followed by MVI and fall. MVI and drowning are two leading causes of injury deaths for children aged 1-19. However, fire and flames is the third cause for children aged 1-14 but suicide for those aged 15-19. Home violence prevention laws must be completely enforced, and drowning prevention programs be implemented and incorporated in the Children and Adolescent Safety Implementation Program. Preventive efforts should target MVI and suicide in the 15-19 age group, drowning at all ages 0-19, and suffocation and homicide of infants and children under 5 years of age.

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台灣地區1986-2006年兒童及青少年事故傷害死亡趨勢

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目標：描述台灣地區1986-2006年0-19歲兒童及青少年事故傷害死亡率的長期趨勢。**方法：**利用衛生署生命統計資料進行分析。以國際疾病傷害死因分類標準第九版，將事故傷害類型區分為非蓄意性及蓄意性，並以簡單線性迴歸對各類傷害死亡率進行趨勢檢定。**結果：**自1986-2006年，0-19歲兒童及青少年非蓄意性傷害死亡率下降63% (由35.3/10萬人，至13.2/10萬人)，自殺死亡率下降近五成(由1.9/10萬人，至1.0/10萬人)。0-19歲兒童及青少年整體他殺死亡率雖然下降，但5歲以下幼童他殺死亡率卻上升；而且，除了5歲以下他殺外，其他各年齡層死亡率均呈下降趨勢。15-19歲青少年事故傷害(佔全部傷害死亡的52%)死亡率是各年齡層中最高者。交通事故是最常見的傷害類型(佔全部傷害死亡的50%)，其次是溺水(17%)、哽塞窒息(7%)、燒燙傷(4%)、跌倒墜落(4%)及中毒(2%)。一歲以下嬰兒事故傷害死亡者中，有68%是哽塞窒息所致。**結論：**自1989年後，非蓄意傷害死亡率及自殺死亡率均呈下降趨勢，但幼童他殺死亡率呈上升趨勢。往後應加強家庭暴力防制法規的執行、強化溺水防範措施及納入「兒童及少年安全實施方案」；另外，亦應對15-19歲青少年的交通傷害與自殺、0-19歲兒童及青少年的溺水、5歲以下幼童的他殺及1歲以下嬰兒的哽塞窒息等傷害，擬定有效的防制計畫。(台灣衛誌 2010；29(1)：22-32)

關鍵詞：趨勢、兒童青少年、事故傷害、死亡率

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