ORIGINAL ARTICLE

Changes in injury mortality by intent and mechanism in Taiwan, 1975–98

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Background: Most official mortality publications do not present the mechanism of injury (for example, cut/pierce, drowning, fall, poisoning, or suffocation) for intentional injuries (for example, suicide or homicide).

Objectives: To determine if the presentation of mechanism of injury for intentional injuries had different mechanism profiles.

Methods: Age adjusted injury mortality rates by intent and mechanism of injury for Taiwan were calculated for the years 1975 to 1998. The *International Classification of Disease* codes for the matrix by intent and mechanism groupings were based on recommendations of the US Centers for Disease Control and Prevention.

Results: If rates for both groups (intentional and unintentional) are combined, the importance of poisoning and suffocation increase relative to their contribution for unintentional injuries alone. Given the same mechanism of injury, different intents showed different patterns of change during the study period and given the same intent, the changes over time differed for different mechanisms of injury.

Conclusions: It is important to include the mechanism of injury within intentional injuries because it provides different profiles of injury problems. Thus the simultaneous tabulation of injury mortality data by both intent and mechanism is a necessary step for identifying and prioritizing injury problems. The argument that good preventive measures could prevent both unintentional and intentional injuries was also confirmed.

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Mortality data help identify and prioritize injury problems. The *International Statistical Classification of Diseases and Related Health Problems* (ICD) is widely used to ensure the comparability of mortality data across countries.¹ Using the ICD, most injuries can be grouped into two dimensions: intent (that is, manner of death) and mechanism (that is, cause of death). The classification by intent has the following groupings: accident (that is, unintentional), suicide (that is, intentionally self inflicted), homicide (that is, intentionally inflicted by another), and intent unknown. The classification by mechanism characterizes the external agents or particular activities that caused the injury (for example, motor vehicle, submersion, fall, or poisoning).

The intent of injury takes precedence in the classification. Mechanism of injury is coded within an intent category. Nevertheless, most official mortality publications, for example the *World Health Statistics Annual*² or *Vital Statistics* reported by the Taiwanese government,³ tabulate mechanisms of injury only for unintentional injury. Thus the identification and prioritization of problems related to differing mechanisms are confined only to unintentional injuries.

However, data users and providers pay increasing attention to the mechanism of injury, because evaluation research indicates that passive protection through modification of products and environments is highly effective in reducing injury, regardless of intent.⁴ Thus, the US Centers for Disease Control and Prevention (CDC) has recommended the use of the matrix approach (simultaneous tabulation by both intent and mechanism) for presenting injury mortality data to provide more relevant information for injury prevention.⁵

Injury mortality presented simultaneously by intent and mechanism has been used to investigate differences in rates among 11 high income countries^{6–9} and one middle income country.¹⁰ Nevertheless, most of these studies were cross sectional and confined to children and teenagers. The purpose of the present report is to examine changes in injury mortality for

all age groups by both intent and mechanism in Taiwan, a country with high injury mortality.^{11–13} More specifically, this study aimed at determining if the presentation of mechanism of injury within intentional injuries provides different profiles than what is provided by combined or unintentional injuries alone.

METHODS

Computerized national mortality data were obtained from the Department of Health of Taiwan for the years 1975 to 1998. Nine age groups (<4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, and >75 years) were used to calculate age adjusted injury mortality rates by intent and mechanism of injury. The standard world population of 1976 was used for adjustment.²

The ICD codes for the matrix by intent and mechanism groupings were based on CDC recommendations.⁵ However, because the Taiwan Office of Statistics, Department of Health uses only three digit codes for external causes of death, many categories in the matrix (for example, motor vehicle traffic injuries, fire/burn, and firearm) could not be further specified by intent. Thus the detailed analyses by both intent and mechanism were only available for five mechanisms of injury: cut/pierce, drowning, fall, poisoning, and suffocation.

RESULTS

On average, more than 10 000 people die from injuries each year in Taiwan, a country with a population of 21 million in 1998. The number of injury deaths in 1975–78 was 44 046 and increased to 59 552 in 1995–98. The age adjusted death rate increased from 106.4 per 100 000 in 1975–78 to 124.2 in 1987–90 and leveled off in 1990s (table 1). Unintentional

Abbreviations: CDC, Centers for Disease Control and Prevention; ICD, *International Classification of Diseases*

Table 1 Number of injury deaths and age adjusted death rates (per 100000) from 1975–78 to 1995–98 by mechanism and intent, Taiwan*

Mechanism	1975–78		1979–82		1983–86		1987–90		1991–94		1995–98	
	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate	Deaths	Rate
All external causes	44414	107.48	54310	123.33	56563	121.48	63512	124.45	61545	110.55	59583	99.70
All injury	44046	106.42	54050	122.66	56487	121.26	63413	124.22	61477	110.43	59552	99.63
Unintentional	36863	85.94	44837	100.17	46158	97.47	54629	106.11	53209	95.20	47644	79.29
Suicide	6253	18.96	7762	20.47	8823	21.71	6573	15.22	5598	11.34	7814	14.26
Homicide	723	1.17	1246	1.68	1335	1.86	1853	2.38	1404	1.78	1396	1.64
Intent unknown	207	0.34	205	0.33	171	0.23	358	0.50	1266	2.11	2698	4.44
Drowning	7305	12.45	7105	11.50	6581	10.41	6399	9.94	5392	8.37	4663	6.84
Unintentional	7154	12.10	6914	11.05	6345	9.85	6271	9.62	5073	7.78	4078	5.87
Suicide	126	0.31	159	0.39	206	0.50	105	0.29	138	0.27	283	0.51
Homicide	10	0.01	1	–	11	0.02	7	–	6	–	9	–
Intent unknown	15	0.03	31	0.05	19	0.03	16	0.02	175	0.31	293	0.45
Fall	2289	9.58	3088	10.93	3570	10.33	4050	10.00	4650	10.32	5662	10.95
Unintentional	2237	9.49	2916	10.61	3401	9.98	3951	9.81	4375	9.84	4769	9.61
Suicide	50	0.08	157	0.29	156	0.33	86	0.17	174	0.32	586	0.94
Intent unknown	2	–	15	0.03	13	0.02	13	0.01	101	0.15	307	0.40
Poisoning	6125	14.73	7194	15.93	8326	16.99	7090	13.71	5715	9.80	5323	8.66
Unintentional	2176	5.11	2206	4.99	2960	6.03	3552	6.86	3391	5.80	1947	3.06
Suicide	3916	9.57	4931	10.84	5303	10.89	3471	6.74	2040	3.55	2557	4.25
Homicide	9	–	19	0.03	42	0.05	12	0.01	14	0.02	7	–
Intent unknown	24	0.04	38	0.08	21	0.03	55	0.10	270	0.43	812	1.34
Suffocation	2813	10.59	3516	11.36	4374	13.10	4275	11.40	4589	10.60	5587	11.54
Unintentional	842	2.00	1164	2.75	1376	3.39	1470	3.58	1325	3.28	1418	3.25
Suicide	1925	8.51	2282	8.49	2907	9.53	2614	7.52	2877	6.62	3820	7.71
Homicide	38	0.06	56	0.08	76	0.13	151	0.19	103	0.14	85	0.11
Intent unknown	8	–	14	0.04	15	0.04	40	0.11	284	0.56	264	0.48
Cut/pierce	771	1.41	1145	1.64	1166	1.78	1506	2.11	1163	1.59	1150	1.48
Unintentional	129	0.23	94	0.16	96	0.18	107	0.15	121	0.18	54	0.09
Suicide	70	0.26	88	0.22	115	0.28	151	0.32	152	0.27	221	0.36
Homicide	563	0.91	957	1.25	946	1.29	1226	1.60	843	1.07	806	0.93
Intent unknown	9	–	6	–	9	–	22	0.04	47	0.07	69	0.09
Motor vehicle traffic	15767	34.89	21878	45.83	22897	44.68	29475	52.62	29155	50.34	26923	42.35
Transport, other	1591	3.87	1600	3.51	906	1.90	916	1.71	635	1.09	621	0.94
Fire/burn	974	2.34	1299	3.04	1374	3.20	1573	3.08	1783	3.01	1333	2.19
Struck by, against	692	1.24	657	1.19	608	0.96	487	0.78	409	0.56	429	0.54
Natural/environmental	508	1.06	2354	6.84	4014	10.72	4475	10.83	5418	11.03	4436	8.16
Firearm	129	0.14	128	0.13	215	0.20	132	0.12	71	0.06	57	0.06
Others	5450	15.20	4346	11.43	2532	7.22	3134	8.13	2565	3.77	3399	5.99

*The death rate was not calculated where the number of deaths was less than 10.

injuries accounted for 80% of all injury deaths in each period. Motor vehicle traffic, drowning, falls, poisoning, and suffocation were the top five mechanisms in each period and comprised 80% of all injury deaths.

The various mechanisms of unintentional injury were ranked as motor vehicle traffic followed by drowning, fall, poisoning, and suffocation in most periods. Drowning was the second leading mechanism of death in most periods in Taiwan except in 1995–98 when falls ranked second. If all intents are combined, motor vehicle still ranked first in each period, although the relative importance of poisoning and suffocation

increased. Poisoning became the second leading mechanism of death from 1979–82 to 1991–94. The number of deaths from suffocation also surpassed those dying from falls from 1975–78 to 1987–90. In 1991–94, 4589 people died from suffocation; this increased by 22% to 5587 in 1995–98 (table 1).

The trends of age adjusted death rates for four selected mechanisms of injury are illustrated in fig 1. The patterns of changes in mortality trends for falls and drowning were similar between unintentional only and all intents combined. However, for poisoning and suffocation, the pattern of changes showed large differences between unintentional only and all

Figure 1 Trends of age adjusted death rates for four selected mechanisms of injury in Taiwan: unintentional only (left) and all intents combined (right).

Figure 2 Patterns of changes in age adjusted death rates for selected injuries by mechanism and intent, Taiwan, 1975-78 to 1995-98.

intents combined. The poisoning death rate for all intents combined was three times as high as for unintentional poisoning, and that for suffocation there was a fivefold difference between total and unintentional death rates. Mortality trends of poisoning by all intents combined revealed a steeper increase from 1975-78 to 1983-86 and a steeper decrease from 1987-90 to 1995-98, in contrast to the generally flat pattern for unintentional poisoning only. An increase in suffocation with all intents combined was noted in 1995-98.

Intent was further classified into four subcategories. A large surge in death rate for "intent unknown" was seen in the 1990s (fig 2). The increase in suicide death rates in the mid-1990s differed by different mechanisms: poisoning was the main mechanism before the 1990s, accounting for three fifths of suicide deaths, with suffocation (hanging) becoming the most common means of suicide in the 1990s. Cut/pierce was the main mechanism of homicide in Taiwan throughout

the entire study period, although the proportion decreased yearly, from 78% in 1975-79 to 58% in 1995-98 (table 1).

DISCUSSION

The results show that the relative importance of poisoning and suffocation increased if all intents are combined. Given the same mechanism of injury, different intents showed different patterns of change during the study period. And, given the same intent, the patterns of change for different mechanisms of injury also differed across time. The simultaneous presentation of mortality data by both intent and mechanism of injury provides quite different profiles from those that present mechanism only within unintentional injuries.

One important rationale underpinning the presentation of mortality data by both intent and mechanism is that an effective passive measure will prevent unintentional as well as intentional injuries.³ Baker, a major proponent of this idea,

points out that the large declines in both unintentional and suicidal poisonings in England and the United States were probably due to the replacement of poisonous coal gas by natural gas. She further illustrates the experience of Sri Lanka and China where agricultural poisons are used as a means of suicide by many despondent women, while at the same time killing many curious children.¹⁴ One recent example was legislation restricting package sizes of paracetamol and salicylate in the United Kingdom. This produced substantial reductions of mortality and morbidity associated with self poisoning with these drugs.¹⁵

In 1972, the government of Taiwan passed the Pesticides Regulation Act. Most of the regulations are targeted at manufacturers to decrease exposures to pesticide during the manufacturing process. In 1989, the Council of Agriculture promulgated a series of regulations on the use of pesticides. In the early 1990s, the Council of Agriculture required that manufacturers of paraquat, the most common agent of fatal poisoning in Taiwan,¹⁶ add an unpleasant odor and color, as well as an emetic which make paraquat difficult to drink regardless of whether it is done unintentionally or intentionally. The decreasing proportions of people using poisoning as a means of suicide might in part be due to these measures.

Some people might argue that if we make it harder to commit suicide by one means, people will choose another. As shown in fig 2, we did not see any compensated increasing of suicide death rate by other means. We thus confirm Hassall and Trethowan's argument that the total suicide rate went down when the preferred means became impossible.¹⁷

With regard to suffocation (mainly hanging), cut/pierce, drowning, and fall, it is impossible to design a passive preventive measure to prevent both unintentional and intentional injuries in all kinds of settings. We have to "nibble away" at them according to specific circumstance and high risk group. For example, after identifying the high incidence of suicide attempts in jails among Hopi American Indians the authors suggested removing belts, shoelaces, and other means of attempting suicide from recently arrested men.¹⁸ The same would apply to people in other institutions, such as mental facilities. Bars on windows in mental facilities can prevent suicide, just as bars on windows in apartments prevent unintentional falls. The idea also applies to motor vehicles—when someone tries to kill themselves by driving into a tree, they are much less likely to succeed now that cars have airbags. The design of personalized handguns can also prevent both unintentional injuries from children and intentional assaults from others.¹⁹

When injury mortality data are presented using both intent and mechanism of injury, we need to be cautious about the possibility of misclassification of intent for different mechanisms.^{20–24} Rockett and Smith proposed that suicide by elderly Japanese women is relatively underestimated because of the misclassification of suicidal drownings as unintentional.²⁵ Fingerhut and McLoughlin also recommend that the criteria used to rule if a death is intentional or unintentional or undetermined vary by country.⁴ These points should be taken into consideration when interpreting cross national comparisons of mortality rates by intent.

When interpreting differences in temporal trends in injury mortality by both intent and mechanism of injury, we also need to consider the possibility of changes in the people who certify deaths by providing information on death certificates, as well as changes in the habits of people who code the assignment of external causes of death. There has been a surge in death rates with unknown intention (fig 2) which may reflect these attitudinal changes.

This study shows that presentation of mechanism of injury within intentional injuries yields different profiles of injury problems. Thus the simultaneous tabulation of injury mortality data by both intent and mechanism is a necessary step for identifying and prioritizing injury problems. We also confirmed the argument that good preventive measures could prevent both unintentional and intentional injuries.

Key points

- When describing intentional injuries (that is, suicide, homicide, and intent unknown) most official mortality publications do not present the mechanism of injury (for example, cut/pierce, drowning, fall, poisoning, or suffocation).
- In 1997, the US Centers for Disease Control and Prevention recommended a matrix framework for presenting injury mortality data by both intent and mechanism.
- This study demonstrates that if all intents are combined, the relative importance of poisoning and suffocation increases in contrast to that seen by presenting the mechanism of injury only for unintentional injuries
- Presenting the mechanism for intentional injuries provides different profiles of injury problems.
- The simultaneous tabulation of injury mortality data by both intent and mechanism is a necessary step for identifying and prioritizing injury prevention initiatives.

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