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Decade of fatal injuries in workers in New Zealand: insights from a comprehensive national observational study

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ABSTRACT

Introduction Current priorities and strategies to prevent work-related fatal injury (WRFI) in New Zealand (NZ) are based on incomplete data capture. This paper provides an overview of key results from a comprehensive 10-year NZ study of worker fatalities using coronial records.

Methods A data set of workers, aged 15–84 years at the time of death who died in the period 2005–2014, was created using coronial records. Data collection involved: (1) identifying possible cases from mortality records using selected external cause of injury codes; (2) linking these to coronial records; (3) retrieving and reviewing records for work-relatedness; and (4) coding work-related cases. Frequencies, percentages and rates were calculated. Analyses were stratified into workplace and work-traffic settings.

Results Over the decade, 955 workers were fatally injured, giving a rate of 4.8 (95% CI 5.6 to 6.3) per 100 000 worker-years. High rates of worker fatalities were observed for workers aged 70–84 years, indigenous Māori and for males. Workers employed in mining had the highest rate in workplace settings while transport, postal and warehousing employees had the highest rate in work-traffic settings. Vehicle-related mechanisms dominated the mechanism and vehicles and environmental agents dominated the breakdown agencies contributing to worker fatalities.

Discussion This study shows the rates of worker fatalities vary widely by age, sex, ethnicity, occupation and industry and are a very serious problem for particular groups. Future efforts to address NZ's high rates of WRFI should use these findings to aid understanding where preventive actions should be prioritised.

INTRODUCTION

Work-related injury is responsible for major health loss, disability and death worldwide.^{1 2} Estimates of the most severe outcome, fatal injury, vary according to the source data. However, evidence-based estimates from 2004 indicate that approximately 105 workers are killed annually in New Zealand (NZ) from work-related injuries.³ The broader social and economic impacts of NZ's worker fatalities are estimated at NZ\$15–21 billion per annum (2%–4% of gross domestic product).^{4–6} Historically, NZ's work-related fatal injury (WRFI) record has been poor compared with other Organisation for Economic Co-operation and Development (OECD) countries, being twice as high as

Australia's and four times that of the UK, although there are likely to be variations in terms of coverage of different types of incidents.^{7 8}

High-profile occupational fatality events, including a multiple-fatality mine explosion in 2010, have placed NZ's workplace safety record under public scrutiny. Addressing NZ's poor workplace safety record has become a major priority for successive NZ governments following three independent reviews of NZ's occupational safety performance.^{6 9 10} The reasons for NZ's poor performance are highly debated, and in-depth analyses to inform this argument/conversation are limited by a dearth of detailed WRFI data. The lack of high-quality data has been identified as a significant impediment to developing strategies to reduce workplace deaths.^{9 11}

Two previous NZ studies covering the periods 1975–1984 and 1985–1994 used coronial records to overcome the limitations of relying solely on existing official administrative data, which are known to undercount WRFI.^{12 13} These studies provided the most complete and detailed evidence used to evaluate occupational safety performance and target policy.^{4 9 12–14} This paper presents results from research updating and expanding this data series to include on-road fatalities, thus providing the only comprehensive overview of the numbers and rates of all worker fatalities in NZ over the decade 2005–2014.

METHODS

Methods for establishing a WRFI data set of coronial records are published elsewhere.¹⁵ In summary, this data set included all unintentional WRFI in persons aged 15–84 years at the time of death that occurred in the period 2005–2014 and had an underlying cause of death external code (E-code) from the Ministry of Health's Mortality Collection recorded as one of V01–99, W20–99, X01–59, X01–Y34 and Y85–89 from the International Classification of Diseases, Tenth Revision, Australian Modification. The use of these codes excludes those who died as a primary result of disease or injury due to legal intervention; medical misadventure/complications; suicide; or war.

Work-relatedness of an injury event was based on whether the decedent at the time of the fatal incident was working. 'Work activity' was defined as working for pay, profit or payment in kind, assisting with work in an unpaid capacity, or being engaged



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in work-related activities even when on a break or away from the workplace, for example, rest stops taken during work-related travel. This included those who died from work-traffic injuries occurring on public roads but excludes commuters travelling to or from work.

Workers were defined as persons who were fatally injured while engaged in a work activity for pay, profit or in kind. Delayed deaths were included when the decedent was off duty at the time of the injury incident but there was clear evidence of cumulative work-related exposure, for example, work-acquired fatigue resulting in an off-duty fatigue-related vehicle crash where such fatigue was identified in the coronial record. Workers injured in the course of their work in motor vehicle incidents on public roads were categorised as work-traffic; all other incidents were classified as workplace.

Age, sex and ethnicity (individuals with multiple ethnicities had responses prioritised in the order of Māori, Pacific, Asian and European/Other to give a single ethnicity as per ethnicity data protocols¹⁶) were obtained from the Mortality Collection while employment status, breakdown agency (source of energy involved in the initiation of the cascade of events leading to transfer of energy to inflict the fatal injury), mechanism of incident, occupation and industry were coded from coronial records. Standard coding frameworks including the Type of Occurrence Classification System, the Australian New Zealand Standard Classification of Occupation, and the Australian New Zealand Standard Industry Classification were used.^{17–19} Both inter-rater and intra-rater agreement were assessed during coding, as previously described,¹⁵ and were found to be high, with at least 90% agreement between and within coders.

To describe the overall burden and patterns of fatal injury in workers, numbers and percentages were calculated. Rates per 100 000 worker-years with 95% CIs were calculated by year of death, age, sex, ethnicity, employment status, occupation and industry, counting each individual in the denominator equally irrespective of full-time equivalency. Counts from Census 2006 and 2013 for those aged 15–84 years and employed were used to obtain worker-years for the calculation of rates. The overall rate was directly standardised by occupation using the 2014 population. Data were analysed using Stata V.13.1 SE.²⁰

RESULTS

Deaths of workers

There were 955 workers fatally injured in a work-related fatal incident during 2005–2014, a fatality rate of 4.8 (95% CI 4.5 to 5.1) per 100 000 worker-years. The majority of worker deaths were male (89%), most of whom were aged over 44 years of age ($n=473$, 55% of males). Workers were more commonly fatally injured in the workplace setting ($n=740$, 3.7 (95% CI 3.5 to 4.0)) compared with the work-traffic setting ($n=215$, 1.1 (95% CI 0.9 to 1.2)).

Twenty-seven multiple fatality incidents occurred: 20 resulted in the deaths of two workers each, and another five resulted in the deaths of three workers each. These multiple fatality incidents most commonly involved a vehicle crash or boat capsizing. The remaining two incidents involved 29 mine explosion and 74 earthquake fatalities.

Secular trends

The general trend in rates of worker fatalities over the decade varied by setting (figure 1). Rates of fatal injury are higher and more variable in the workplace setting compared with a more consistent, moderate decline in rates for work-traffic fatalities.

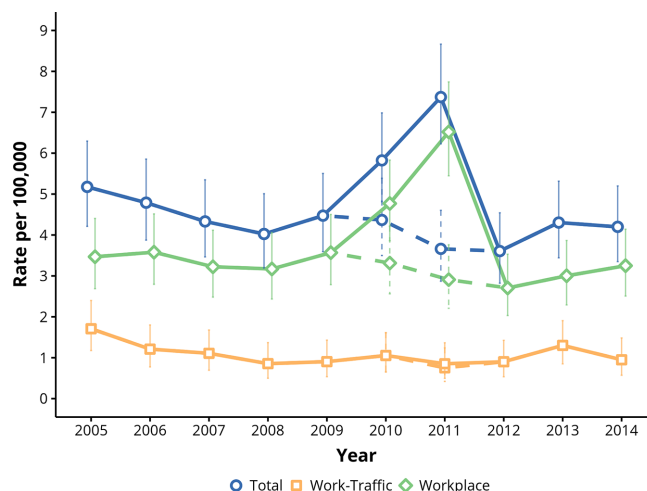


Figure 1 Rate per 100 000 worker-years of WRFI in workers by work setting, 2005–2014, New Zealand. Dashed lines exclude catastrophic injury events occurring in 2010 and 2011.

The difference between the solid and dashed lines in 2010 and 2011 highlights the influence of the two catastrophic events which underpin the sharp increase in rates observed these years, with both events substantially increasing the rate of worker fatalities for those fatally injured in the workplace setting. Using the rates at the start (2005) and end (2014) of the period identified a crude reduction in the rate of total WRFI of 19%. Standardisation based on occupation in 2014 reduced the decline in rate in worker fatalities to 12%. Crude reductions in annual rates over the period were larger for work-traffic, with a 44% reduction compared with a 10% reduction for workplace deaths.

Workers fatally injured in the workplace setting

The lowest rate of workplace fatal injuries was observed for the youngest workers (15–24 years) and rates increased with age (table 1). Females comprised just 11% of workers fatally injured in the workplace, with close to half of these fatalities occurring during the Christchurch earthquake ($n=37$, 47%). The burden of workplace fatal injury was highest in workers of European ethnicity ($n=570$, 77%), although the rate for Māori workers was higher than the rate observed for European workers. The rate for self-employed workers was 20% higher than that for employees.

The agriculture, forestry and fisheries sector contributed 38% of the worker deaths in the workplace (table 2). The high rate of workplace fatal injuries for those employed in the mining sector (47.8, 95% CI 30.6 to 71.1) reflects the impact of a mine explosion in 2010 which resulted in 19 mining sector deaths (80% of all workers fatally injured in mining and 66% of fatalities in the incident). Excluding this catastrophic incident reduced the rate to 11.9 (95% CI 4.3 to 26.0). Other sectors with high rates of worker fatalities included 'Agriculture, Forestry and Fisheries' (20.9, 95% CI 18.5 to 23.5) and 'Electricity, Water and Gas Supply' (15.3, 95% CI 9.0 to 24.2).

The major-level occupational groupings of labourers (10.9, 95% CI 9.5 to 12.3) and machinery operators and drivers (10.7, 95% CI 8.8 to 12.8) had the highest rates of workplace fatal injuries (table 2). Additionally, legislators and managers had a high burden of workplace fatal injuries but a moderate rate ($n=155$, 4.4 (95% CI 3.7 to 5.2)). Occupational subgroups with a high burden of workplace WRFI included farm owners/managers ($n=117$), farm workers ($n=78$), road drivers (including truck

Table 1 Number and rate (per 100 000 worker-years) of worker WRFI by age, sex and ethnicity, stratified by work setting, 2005–2014, New Zealand

	Workplace		Work-traffic		Total	
	n	Rate* (95% CI)	n	Rate* (95% CI)	n	Rate* (95% CI)
Total	740	3.7 (3.5 to 4.0)	215	1.1 (0.9 to 1.2)	955	4.8 (4.5 to 5.1)
Age						
15–24	62	2.1 (1.6 to 2.7)	37	1.3 (0.8 to 1.7)	99	3.4 (2.8 to 4.1)
25–34	113	3.0 (2.5 to 3.6)	27	0.7 (0.4 to 1.1)	140	3.8 (3.1 to 4.4)
35–44	158	3.5 (2.9 to 4.1)	37	0.8 (0.5 to 1.1)	195	4.3 (3.7 to 4.9)
45–54	158	3.5 (2.9 to 4.1)	51	1.1 (0.8 to 1.4)	209	4.6 (4.0 to 5.2)
55–64	154	4.9 (4.1 to 5.7)	41	1.3 (0.9 to 1.7)	195	6.2 (5.3 to 7.1)
65–69	41	6.4 (4.6 to 8.7)	9	1.4 (0.7 to 2.7)	50	7.8 (5.8 to 10.3)
70–84	54	13.8 (10.4 to 17.9)	13	3.3 (1.8 to 5.7)	67	17.1 (13.2 to 21.7)
Sex						
Male	660	6.3 (5.8 to 6.8)	194	1.9 (1.6 to 2.1)	854	8.2 (7.6 to 8.7)
Female	80	0.8 (0.7 to 1.1)	21	0.2 (0.1 to 0.3)	101	1.1 (0.9 to 1.3)
Ethnicity†						
Māori	117	5.2 (4.3 to 6.2)	56	2.5 (1.9 to 3.3)	173	7.7 (6.6 to 8.9)
Pacific	17	1.9 (1.1 to 3.0)	8	0.9 (0.3 to 1.7)	25	2.8 (1.8 to 4.1)
Asian	29	1.5 (1.0 to 2.2)	13	0.7 (0.2 to 1.2)	42	2.3 (1.7 to 3.1)
European	570	3.9 (3.6 to 4.2)	137	0.9 (0.8 to 1.1)	707	4.8 (4.5 to 5.2)
MELAA	6	3.6 (1.3 to 7.8)	0	0 (0.0 to 2.2)	6	3.6 (1.3 to 7.8)
Missing	1	0.8 (0.02 to 4.4)	1	0.8 (0.02 to 4.4)	2	1.6 (0.1 to 5.8)
Employment status						
Self-employed	163	4.3 (3.7 to 5.0)	27	0.7 (0.5 to 1.0)	190	5.0 (4.3 to 5.8)
Employee	577	3.6 (3.3 to 3.9)	188	1.2 (1.0 to 1.4)	765	4.8 (4.4 to 5.1)

*Rates per 100 000 worker-years calculated using the same denominators used for traffic, workplace and total WRFI.

†Prioritised ethnicity.

MELAA, Middle Eastern, Latin American, African; WRFI, work-related fatal injury.

drivers, n=43) and forestry workers (n=45). Staggeringly high rates of workplace fatalities were found for fishing and deck hands (126, 95% CI 81 to 188), miner and drillers (129, 95% CI 77 to 201) and forestry workers (94, 95% CI 69 to 126).

Table 3 presents the contributing agencies and mechanism of incident, after excluding the two major catastrophic events. The predominant breakdown agencies of incidents in the workplace were environmental (n=213, 29%), predominantly sloping ground and adverse weather/water conditions. Other prominent categories included mobile plant and transport (n=98, 13%) and human factors (n=77, 10%) (mainly worker impairment or violent behaviour from others involved in the incident). The most prevalent mechanism of fatal injury incidents in the workplace was being hit by a moving object (n=231, 31%), followed by vehicle roll-overs and falls, mainly from heights. The majority of cases involving being hit by a moving object involved being hit by moving vehicle (n=102).

Workers fatally injured in work-traffic setting

The burden of worker fatalities due to injury was lower for work-traffic compared with those occurring in workplaces. Similar to the workplace setting, work-traffic fatalities were more common in males, with females comprising only 9.8% of these fatalities (table 1), and the rate increased with age, although the highest burden (n=51) occurred for workers aged 45–54 years. The rate of work-traffic fatalities for Māori workers was almost three times higher than other ethnic groups examined. The rate for employees was 40% higher than for self-employed workers.

Two industry groups stood out as major contributors to work-traffic WRFI. ‘Transport, Postal & Warehousing’ was the major contributor (n=89, 42%) and had the highest rate of work-traffic

fatalities (10.9; 95% CI 8.7 to 13.4) (table 2). ‘Electricity, Water and Gas Supply’ had considerably less workers fatally injured in work-traffic incidents (n=10, 1.4% of work-traffic WRFI), yet had a notably high rate (8.5, 95% CI 4.0 to 15.6).

The major-level occupational group of machinery operators and drivers had the highest rate of work-traffic fatalities (n=102, 9.4 per 100 000 workers), eight times higher than the next-highest group. Notable occupational groups with high numbers and rates of work-traffic WRFI included road driving professions (n=99; 22.3, 95% CI 17.9 to 27.3), farm owners/managers (n=15; 2.5, 95% CI 1.4 to 4.1) and farm workers (n=13; 3.8, 95% CI 2.0 to 6.4).

The breakdown agency and mechanism of injury overwhelmingly consisted of vehicle-related causes; most commonly mobile transport vehicle agents (40%) and vehicle crashes (n=196, 91.2% of work-traffic WRFI) (table 3). Human factors, which mainly reflect the condition of the driver (29%), and outdoor environmental conditions (14%), were also important breakdown agents.

DISCUSSION

Considerable variation was observed in the number and rates of WRFI in workers depending on the grouping used for analysis. The most striking differences were observed by industry and occupation, where the rates for certain groups were substantially higher (up to 10–30 times) than others. This study estimated close to a quarter of worker fatalities involved a work-traffic crash on a public road, an important, yet often overlooked, contribution to worker fatalities. Differences in the relative contributions of the high-risk groups and common causes were also observed by work setting, with the majority of deaths of workers occurring

Table 2 Number and rate (per 100 000 worker-years) of worker fatalities by industry and occupation, stratified by work setting, 2005–2014, New Zealand

	Workplace			Work-traffic			Total		
	n	%	Rate* (95% CI)	n	%	Rate* (95% CI)	n	%	Rate* (95% CI)
Industry of employment									
Agriculture, forestry and fishing	277	37.5	20.9 (18.5 to 23.5)	33	4.5	2.5 (1.7 to 3.5)	310	41.9	23.4 (20.9 to 26.2)
Mining	24	5.2	47.8 (30.6 to 71.1)	1	0.1	1.9 (0.1 to 11.1)	35	4.7	49.8 (32.2 to 73.5)
Manufacturing	41	9.4	2.0 (1.4 to 2.7)	8	1.1	0.3 (0.1 to 0.7)	49	6.6	2.4 (1.7 to 3.1)
Electricity, gas and water supply	18	3.3	15.3 (9.0 to 24.2)	10	1.4	8.5 (4.0 to 15.6)	28	3.8	23.8 (15.8 to 34.4)
Construction	104	5.7	6.8 (5.6 to 8.3)	15	2.0	1.0 (0.6 to 1.6)	109	14.7	7.88 (6.9 to 9.4)
Wholesale trade	5	0.4	0.5 (0.1 to 1.2)	6	0.8	0.6 (0.2 to 1.3)	11	1.5	1.1 (0.5 to 2.0)
Retail trade and accommodation	24	4.1	0.7 (0.5 to 1.1)	8	1.1	0.2 (0.1 to 0.5)	32	4.3	1.1 (0.7 to 1.5)
Transport, postal and warehouse	77	4.5	9.4 (7.4 to 11.7)	89	12.0	10.9 (8.7 to 13.4)	166	22.5	20.3 (17.3 to 23.6)
Information and communication	18	1.1	4.9 (2.9 to 7.7)	3	0.4	0.8 (0.1 to 2.4)	21	2.8	5.7 (3.5 to 8.7)
Finance and insurance	18	1.1	2.7 (1.6 to 4.2)	0	0		18	2.4	2.7 (1.6 to 4.2)
Professional, science support	17	1.5	0.7 (0.4 to 1.2)	3	0.4	0.1 (0.0 to 0.3)	20	2.7	0.8 (0.5 to 1.3)
Public administration and safety	19	1.7	2.1 (1.2 to 3.3)	11	1.5	1.2 (0.6 to 2.2)	30	4.1	3.3 (2.2 to 4.8)
Education and training	20	1.3	1.3 (0.8 to 2.0)	1	0.1	0.1 (0.0 to 0.3)	21	2.8	1.3 (0.8 to 2.1)
Health and social assistance	24	1.6	1.4 (0.8 to 2.0)	3	0.4	0.2 (0.1 to 0.5)	22	3.0	1.5 (1.0 to 2.2)
Arts, recreational services	49	4.4	4.3 (3.2 to 5.7)	10	1.4	0.9 (0.4 to 1.6)	59	8.0	5.3 (4.8 to 8.1)
Missing/Not classified	4	0.4	0.4 (0.1 to 1.0)	12	1.6	1.2 (0.6 to 2.2)	16	2.2	1.7 (0.9 to 2.7)
Occupation (major level)									
Legislators and managers	155	20.9	4.4 (3.7 to 5.2)	22	3.0	0.6 (0.4 to 0.9)	177	23.9	5.0 (4.3 to 5.8)
Professionals	82	11.1	2.0 (1.6 to 2.5)	12	1.6	0.3 (0.1 to 0.5)	94	12.7	2.3 (1.9 to 2.9)
Technicians and trades	75	10.1	3.2 (2.5 to 4.0)	19	2.6	0.8 (0.5 to 1.3)	94	12.7	4.0 (3.2 to 4.9)
Community and personal service	44	5.9	2.6 (1.9 to 3.6)	15	2.0	0.9 (0.5 to 1.5)	59	8.0	3.6 (2.7 to 4.7)
Clerical and administrative	18	2.4	0.7 (0.4 to 1.2)	1	0.1	0.04 (0.0 to 0.2)	19	2.6	0.8 (0.4 to 1.2)
Sales	10	1.4	0.5 (0.2 to 1.0)	12	1.6	0.7 (0.5 to 1.5)	23	3.1	1.1 (0.8 to 1.9)
Machinery operators and drivers	117	15.8	10.7 (8.8 to 12.8)	102	13.8	9.4 (7.9 to 11.8)	219	29.6	20.1 (17.5 to 22.9)
Labourers	234	31.6	10.9 (9.5 to 12.3)	25	3.4	1.1 (0.7 to 1.7)	259	35.0	12.0 (10.6 to 13.6)
Missing/Not classified	5	0.7	0.4 (0.1 to 1.1)	7	0.9	0.6 (0.2 to 1.3)	12	1.6	1.1 (0.5 to 2.0)
Occupation (subunit level)†									
Farm owners/managers	117	15.8	19.5 (16.1 to 23.4)	15	2.0	2.5 (1.4 to 4.1)	132	17.8	22.0 (18.4 to 26.1)
Other managers	38	5.1	1.3 (0.9 to 1.8)	7	0.9	0.2 (0.1 to 0.5)	45	6.1	1.5 (1.1 to 2.1)
Air transport professionals	26	3.5	76.7 (50.1 to 112.3)	0	0		26	3.5	76.7 (50.1 to 112.3)
Other professionals	56	7.6	1.4 (1.1 to 1.8)	12	1.6	0.3 (0.2 to 0.5)	68	9.2	1.7 (1.3 to 2.2)
Construction trades	18	2.4	4.0 (2.4 to 6.3)	6	0.8	1.3 (0.5 to 2.9)	24	3.2	5.3 (3.4 to 7.9)
Automotive and engineering trades	18	2.4	3.5 (2.1 to 5.5)	4	0.5	0.8 (0.2 to 2.0)	22	3.0	4.3 (2.7 to 6.5)
Other technicians and trades	39	5.3	2.8 (2.0 to 3.9)	9	1.2	0.7 (0.3 to 1.2)	48	6.5	3.3 (2.4 to 4.4)
Outdoor adventure guides	13	1.8	78.7 (41.9 to 134.6)	0	0		13	1.8	78.7 (41.9 to 134.6)
Other community and personal service	31	4.2	1.9 (1.3 to 2.7)	15	2.0	0.9 (0.5 to 1.5)	46	6.2	2.8 (2.1 to 3.8)
Road drivers	43	5.8	10.4 (7.5 to 14.0)	92	12.4	22.3 (17.9 to 27.3)	148	20.0	32.7 (27.4 to 38.7)
Miners and drillers	19	2.6	129.3 (77.8 to 201.8)	0	0		19	19.0	129.3 (77.8 to 201.8)
Earthmoving machine operators	12	1.6	19.7 (10.2 to 34.5)	0	0		12	1.6	19.7 (10.2 to 34.5)
Other machinery operators and drivers	43	5.8	10.5 (7.6 to 14.1)	10	1	2.4 (1.2 to 4.5)	53	7.2	12.9 (9.7 to 16.9)
Farm workers	78	10.5	22.6 (17.9 to 28.2)	13	1.8	3.8 (2.0 to 6.4)	91	12.3	26.4 (21.2 to 32.4)
Forestry workers	45	6.1	94.6 (69.0 to 126.6)	1	0.1	2.1 (0.1 to 11.7)	46	6.2	96.7 (70.8 to 129.0)
Construction labourers	37	5.0	22.9 (16.1 to 31.6)	3	0.4	1.9 (0.4 to 5.4)	40	5.4	24.8 (17.7 to 33.7)
Fishing and deck hands	24	3.2	126.7 (81.2 to 188.5)	0	0		24	3.2	126.7 (81.2 to 188.5)
Other labourers	50	6.8	2.9 (2.1 to 3.8)	8	1.1	0.4 (0.2 to 0.9)	58	7.8	3.3 (2.5 to 4.3)

*Rates per 100 000 worker-years calculated using the same denominators used for traffic, workplace and total work-related fatal injury (WRFI).

†Occupations selected on basis of high count and/or high rate.

in the workplace as opposed to the work-traffic setting. Most WRFI incidents involve single deaths making it difficult to appreciate the size and scope of worker deaths.

Groups of workers with a substantially higher burden or risk of WRFI point to opportunities in terms of employing occupational and road safety mechanisms to address a significant contributor

to injury fatalities in NZ. This study found males, older workers and indigenous Māori were at higher risk of WRFI, consistent with previous findings in NZ and internationally.^{12 21 22} Differences in crude rates by age, gender and ethnicity are likely to be due, in part, to these sociodemographic groups having different patterns of employment and resulting differences in exposure

Table 3 Numbers and proportion of worker deaths* by breakdown agency and mechanism, stratified by work setting, 2005–2014, New Zealand

Cause of injury	Workplace		Work-traffic		Total	
	n	%	n	%	n	%
Breakdown agency						
Fixed machinery	52	7.0	1	0.5	53	5.5
Mobile plant and transport	98	13.2	87	40.5	185	19.4
Road transport	34		80		114	
Other plant and transport	64		7		71	
Powered equipment and tools	15	2.0	0	0.0	15	1.6
Non-power equipment and tools	90	12.2	7	3.3	97	10.2
Chemical and products	12	1.6	0	0.0	12	1.3
Material and other substances	51	6.9	0	0.0	51	5.3
Environmental	213	28.8	29	13.5	242	25.3
Sloping ground	74		1		75	
Weather/water conditions	37		3		40	
Other environmental	102		25		127	
Animals and biological	18	2.4	1	0.5	19	2.0
Humans	77	10.4	63	29.3	140	14.7
Other and unspecified	50	6.8	25	11.6	75	7.9
Mechanism						
Falls	90	12.2	2	0.9	92	9.6
From heights	71		2		73	
At same level	19		0		19	
Hitting object	11	1.5	0		11	1.2
Hit by moving object	231	31.2	11	5.1	242	25.3
Other falling objects	76		0		76	
Trapped between objects	58		1		59	
Hit by moving object	64		10		74	
Other	33		0		33	
Heat and electricity	28	3.8	1	0.5	28	2.9
Drowning	40	5.4	0		40	4.2
Chemicals	14	1.9	0		14	1.5
Weapons	26	3.5	2	0.9	28	2.9
Vehicle crash	32	4.3	196	91.2	228	23.9
Vehicle roll-over	99	13.4	0		99	10.4
Aircraft crash	38	5.1	0		38	4.0
Multiple and other	24	3.2	0		24	2.5
Unknown	4	0.5	1	0.5	5	0.5

*Excluding 103 deaths due to catastrophic earthquake and mine explosion events.

to work-related hazards.^{22 23} Industries over-represented in worker deaths included 'Agriculture, Forestry and Fisheries' and the 'Transport, Postal and Warehousing' sectors. Occupational groups over-represented in worker deaths included machinery operators and drivers, and labourers. Vehicle incidents, such as collisions, roll-overs or being hit by a moving vehicle, were the most common mechanisms of fatal incident regardless of work setting.

It is difficult to directly compare omnibus national or international estimates of WRFI due to substantial limitations in their data capture, such as the exclusion of work-traffic deaths or agricultural deaths, which can substantially impact estimates.²⁴ Previous harmonised comparisons of WRFI between NZ, Australia and USA, now over two decades old, indicated that NZ had the highest average annual rate, but most of the incident characteristics were similar between all three countries.^{7 25} Crude comparisons of recent data on WRFI from various data sources in the USA and Australia suggest that the major patterns observed for NZ also remain common in these countries.^{26 27} For example, industries with high burden and high risks in common

between all three countries include agriculture, forestry and fisheries; road transport; and construction, while high-risk occupational groups in common include logging workers, fishers and related fishing occupations, and aircraft pilots.^{26 27} The level of risk, however, may be lower in other countries than in NZ for some sectors, like agriculture, forestry and fishing where NZ's rate is substantially higher than the average for primary production industries in other high-income global regions.²⁸ Vehicle-related incidents are also dominant causes of worker deaths, both on public roads and in workplace settings in all three countries.^{26 27}

Inadequate data have repeatedly been highlighted as a serious impediment to reducing work-related injury in NZ.^{7 9 29 30} The official NZ government estimate of 51 worker deaths on average per year for 2012–2014 is much lower than this study's estimates, from coronial files, of an average of 81 deaths per year (59% more) for the same period.³¹ Previous retrospective coronial reviews found that official government data on WRFI underestimate the burden by 40%–60% depending on the data source, indicating official data do not accurately capture or

identify the total number of worker fatalities in NZ.²⁹ This has also been identified as an issue in Australia.³² In addition, official data sources considerably underestimate work-traffic fatalities³³; therefore, detail-rich coronial data currently offer the most comprehensive evidence available for establishing WRFI prevention strategies.

A direct comparison of progress since the previous retrospective review of coronial records for the period 1975–1994 is limited by the current study's inclusion of work-traffic and female fatalities unlike in earlier studies. Notwithstanding the differences in working population captured by the different studies, the previous coronial reviews of fatalities occurring in the workplace setting identified similar high-frequency, high-risk industry and occupational groups to those found in this study. The primary production sector of Agriculture, Forest and Fishing is one such group, with repeatedly high numbers and rates of WRFI (23.4 for 2005–2014 compared with 31.9 for 1985–1994).¹³ Although the overall rate of worker fatalities has declined over time, the general patterns of high risk remain the same providing clear targets for further attention. Therefore, stronger efforts to lower the burden and rates of WRFI in NZ are clearly needed in certain occupational and industry groups.

Long-standing failures in safety leadership and governance across NZ's safety system, as well as low levels of surveillance and poor utilisation of available data, such as coronial records, to inform preventive actions have been well canvassed in independent reviews of NZ's health and safety performance.^{9–34} There has been an over-reliance on employer self-management of safety risks in the workplace.^{9–34} The few targeted sector-based interventions have been short lived, had low uptake and failed to change patterns of injury.³⁵ Failure to respond to consistently high rates of fatal injury sits with many actors within NZ's safety system and future efforts to address these failures need to start with using the most comprehensive and detailed data available to inform effective, targeted injury prevention interventions.

The key strength of this study is that it provides the most contemporary and comprehensive data on WRFI both in NZ and internationally. Few analyses examining WRFI consider the wider implications of work, beyond traditional conceptualisations of settings of work activity, to examine the impact of work-traffic fatalities. These findings support recent efforts in NZ to expand health and safety emphasis and actions into public road settings.³⁶ The additional inclusion of females and ethnicity expands the coverage of the working population and the demographic factors that can be considered. The inclusion of a large number of WRFIs due to an earthquake is unusual for studies examining patterns of work fatalities. Earthquakes are, however, a prominent natural hazard in NZ³⁷ and the resultant risks ought to be controlled to the greatest extent possible. It was for this reason these deaths have been included in this study.

A few limitations exist in this study. A number of cases were indeterminate, meaning they were unable to be appropriately classified, for example, 92% of cases with insufficient information to determine work-relatedness involved traffic crashes on public roads. To the extent that some of these deaths should have been classified as work related, the estimates for work-traffic fatalities will thus be conservative. Denominators were used that count each individual in the denominator equally, regardless of full or part-time employment status. Previous studies have found little relative difference in rates when accounting for part-time work.¹² The use of coronial records and the timeliness of these data is limited by the time it takes for a case to proceed to closure within the coronial inquest process.

This study's findings and detailed comprehensive data are currently being used to help inform the development of specific work-related injury prevention strategies in NZ, especially those focusing on working in and around vehicles.^{33–36} Our study suggests that to effect the desired 25% reduction in worker fatalities in 2020 proposed by the NZ government in response to high-profile WRFI events,¹¹ injury prevention strategies and actions to control common causes need to focus on groups such as those identified in this study with high frequency and/or high rates of WRFI, as well as the cross-cutting common causes. Interventions targeting public work-traffic need to use both occupational and general road safety mechanisms. This analysis is restricted to an overview of the 10-year period; future in-depth analyses using these rich coronial data will examine areas of historical and emerging risk; investigate trends in WRFI over time and examine possible reasons for these trends; and consider in-depth recurring circumstances leading to fatal injury.¹⁵

CONCLUSION

The present study shows the rates of WRFI are a very serious problem for particular age, sex, ethnic, occupational and industry groups. It also highlights that comprehensive review of coronial data can play an important role in identifying high-priority areas for preventive activities such as through occupation-specific and road safety interventions. Future efforts to address NZ's high rates of WRFI need to use the most comprehensive data available. Further in-depth examination of WRFI from this study will make a crucial evidence-based contribution to identifying where preventive actions are needed to address NZ's high rates of WRFI.

What is already known on the subject

- ▶ Work-related fatal injury (WRFI) is responsible for major health loss, disability and death in New Zealand (NZ) and internationally.
- ▶ Recent high-profile occupational fatality events have put NZ's workplace safety record under close public scrutiny.
- ▶ High-profile reviews have highlighted the lack of comprehensive WRFI data as a significant impediment to reducing workplace deaths in NZ.

What this study adds

- ▶ Coronial data currently offer the most comprehensive evidence available for establishing WRFI prevention strategies that reach beyond traditional conceptualisations of work.
- ▶ The rates of WRFI vary widely and are a very serious problem for particular age, sex, ethnic, occupational and industry groups.

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