

## Falls from Ladder in New Zealand (NZ): Incidence and Longitudinal Trends in Spinal Injuries After Such Falls

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### Abstract

**Objective:** To examine national (NZ) trend of falls from ladder over period of thirteen years (2000-2013) and explore the incidence of related spinal injuries.

**Methods:** Retrospective analyses of national morbidity data to examine the incidence and demographics of falls from ladder injuries and explore the incidence of spinal injuries.

**Results:** Falls from ladder incidence: During the study period (Jan 2000 till Dec 2013), there were 10,095 hospitalized falls from ladder, increasing from 588 in January 2000 to 843 in December 2013. The incidence rate of fall from ladder was 20.13 per 100,000 people with male predominance (80%). Median age at the time of admission was 55 years (IQR 25). Males had the highest age standardised rate rising from 25.20 per 100,000 population (95% CI 23.22–27.18) in 2000 to 36.07 per 100,000 (95% CI 34.09–38.05) in 2013; Females age standardised rate increased from 5.88 per 100,000 (95% CI 5.08–6.68) in 2000, to 8.49 per 100,000 (95% CI 7.69–9.29) in 2013.

Spinal injuries: 1426 patients with spinal injuries were identified, with median age of 59 (IQR 22) and male predominance. Spinal injuries accounted for 14% (1426) of fall from ladder injuries. 93.7 % (1336) of spinal injuries were vertebral fractures and 4.8 % (69) were spinal cord injuries. 33% (474) of people with spinal injuries had more than one spinal injury.

**Conclusion:** This study presents the most comprehensive overview of New Zealand's falls from ladder and related spinal injuries data to date. Data indicates an increase in admission numbers after falls from ladder, young men at increased risk and a significant proportion of those hospitalised have primarily vertebral fractures and some do have associated spinal cord injuries.

**Keywords:** Fall from ladder, Ladder related fall, spine injuries, spinal injuries.

**Falls from ladder and ladder related falls have been used synonymously in this study.**

### Introduction

Falls are one of the most common cause for morbidity and mortality injury world-wide [1,2,3]. A United States (US) study reported that 80% of these falls injuries among construction workers in the US involved a ladder [4]. Several other studies have reported falls from ladder based on location, type of injuries and age groups involved but most yield mix consensus [3,5,6,7,13]. For example, fall from ladder was more common in non-occupational setting in one study [4] while the opposite was true for another [7,21]. Some studies have reported strains, sprains, contusion, fractures of upper arm and lower arm as the most common types of ladder fall related injuries [3,5,6,7]. All age groups have been described to be at risk of ladder fall Injuries (LFIs) [1,2]. Spinal injuries carry a huge

healthcare burden due to complex treatment modalities and extensive rehabilitation programmes [8,9]. None of these studies have described spinal injuries especially vertebral injuries.

Most of these studies on falls from ladder concluded that targeted preventive interventions are needed to curb the high morbidity and mortality associated with this fall [1-6]. Limited data is available on magnitude, demographics and injuries associated specifically with falls from ladder in New Zealand.

The purpose of this study is to describe falls from ladder in New Zealand. It also aims to briefly mention about ladder fall related injuries with focus on spinal injuries since these were the second most common skeletal injuries (after

forearm fractures). To the writers' knowledge, this is first NZ study to describe the magnitude, demographic distribution and associated injuries after fall from ladder with specific interest in spinal injuries.

Accident and compensation corporation, New Zealand (ACC NZ) has several safety programmes in place including safety measures while using ladders. These recommendations are based on the studies from other countries. This study will help our policy makers to present local data on falls from ladder and be able to design and implement better strategies that suit our people thereby decrease the associated morbidity and mortality.

## Methods

### *Inclusion and Exclusion criteria*

Included in this study were all the patients admitted to a tertiary care centre in New Zealand following fall from ladder between 1<sup>st</sup> January 2000 and 31<sup>st</sup> December 2013. Fall from ladder (for purpose of this study) is defined as fall from any height while on ladder. A spinal injury is defined as injury involving vertebrae, spinal cord, cauda equina injuries, sacro-coccygeal nerve injuries and intervertebral disc injuries. The search results not meeting the above criteria were defined as general back injuries and excluded. The duplicates resulting from transfer of patient from one point of care to another (identified by NHI, date of transfer) were removed. Also missing data/ incomplete information data was removed from the analysis.

### *Data Collection and Diagnostic codes*

Data was obtained from Ministry of Health on a CD ROM. Data was presented to the writers in excel spreadsheet format. It included data on all the patients who presented to emergency department or were hospitalised after fall from ladder. Identifiable variables were date of birth and NHI number. Other variable was length of stay (date of admission and discharge), District Health Board (DHB) of admission, gender. After screening the data, it was noted that there were 60 deaths after ladder fall (which were not included in this analysis\*). Only 13% of the cases reported location of fall. Since it was hard to assess the occupational vs non-occupational settings, this was excluded from the study. Heights were not provided in this datasheet.

Diagnostic codes from the *International Statistical Classification of Diseases and Related Health Problems 10th Revision Australian Modification* [10] were used to search the data for the various injuries experienced by the

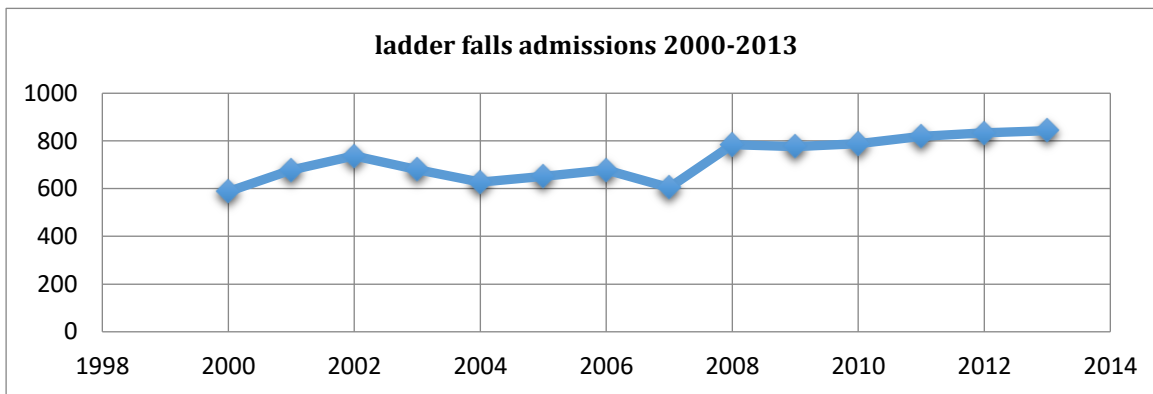
included patients. Since the data was exclusively for falls from ladder, it was used as such for analysis of national trend and incidence rates. For spinal injuries-a search of common diagnoses such as fracture of "x" vertebra (x being-cervical, thoracic, lumbar and sacral) was entered into the database. For example, to look for cervical vertebra fracture the ICD 10 code's code S120 was used. Also searched were the words like cauda equina injuries/syndrome. Since the database had up to 20 subsets of diagnosis including the primary diagnosis (ladder fall), all the subsets were included in the search for spinal injuries. As mentioned in the inclusion criteria, 410 instances of general back injuries (which were categorized as spinal injury) including soft tissue, musculoskeletal and open wounds of the back were excluded from the study. Total ladder fall admissions per capita calculations were made from Statistics New Zealand historical population data. DHB per capita calculations were made per 10,000 residents from Ministry of Health District Health Board 2006 population data sourced from Statistics New Zealand to acquire per capita figures above zero for clearer presentation [11,12]. Data analysis was done with excel spreadsheets.

## Results

A total of 13,742 falls from ladder resulting in presentation and, or hospitalization to a tertiary health care facility in New Zealand over the 14-year period were retrieved from a Ministry of Health database. Patients' age ranged from 11 months to 102 years. A total of 10,095 falls from ladder were obtained after applying inclusion/exclusion criteria and used in data analysis.

### *Incidence of fall from ladder and percentage change over fourteen years*

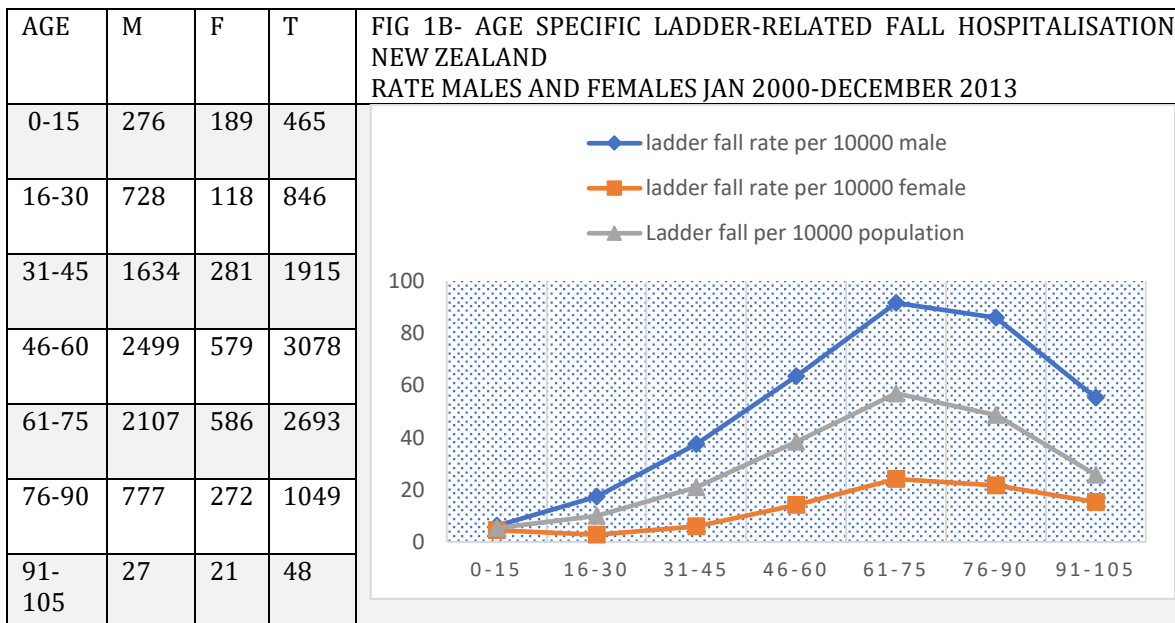
Median rate of fall from ladder over the study period was calculated to be 737 per annum. During the study period, there were 10,095 hospitalized falls from ladder, increasing from 588 in January 2000 to 843 in December 2013. The average percentage change of fall from ladder per annum was an increase of 4.29%. During the 14-year period the NZ population change was estimated at an average of 1.08% increase in population per annum [11,12]. The average percentage change of falls from ladder per annum was four times higher than the average percentage change in New Zealand's population per annum. (Fig 1a illustrates the trend of falls from 2000 to 2013). The incidence rate of fall from ladder was 20.13 per 100,000 people with male predominance (80%).



**Figure 1a:** Ladder Fall Admissions 2000-2013.

**Demographics**

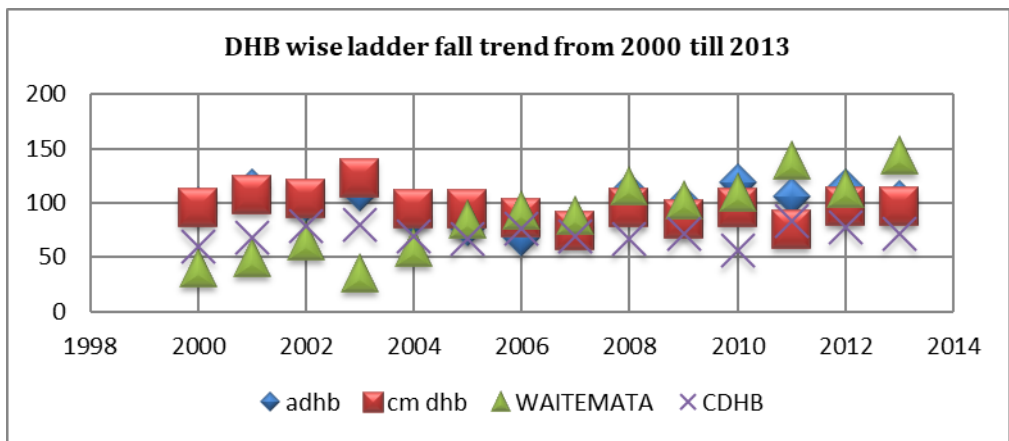
Median age at the time of fall from ladder was 55 yrs., (IQR -25). Median age for women was 57 and men was 53. There were 79.73% men and 20.25% women (p<0.01). Males had the highest age standardised rate rising from 25.20 per 100,000 population (95% CI 23.22–27.18) in 2000 to 36.07 per 100,000 (95% CI 34.09-38.05) in 2013; Females age standardised rate increased from 5.88 per 100,000 (95% CI 5.08–6.68) in 2000, to 8.49 per 100,000 (95% CI 7.69–9.29) in 2013. The age standardised rate significantly increased by 3.29 % annually for all people (p<0.001); by 3.34% annually (p<0.01) for men, and by 3.47% annually for women (p<0.01).



**Figure 1b:** Reports age group and gender data for ladder falls.

**Regional Comparisons**

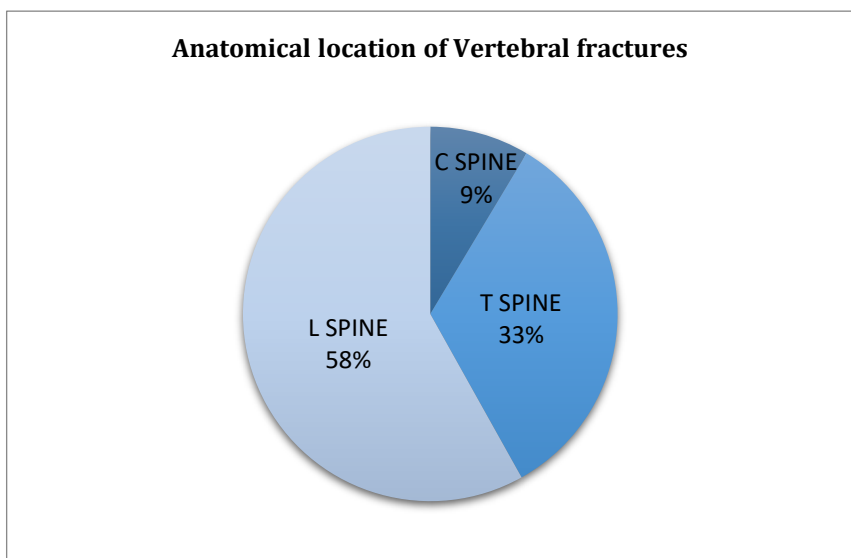
Most number of falls were noted in Counties Manukau DHB, closely followed by Auckland District Health Board (DHB) and Waitemata DHB. As shown in fig 2 the rate of fall remained steady high for Counties Manukau DHB, Canterbury DHB and Auckland DHB but there is a rising trend in Waitemata DHB.



**Figure 2:** Regional Differences in Ladder Fall Admissions 2000-2014

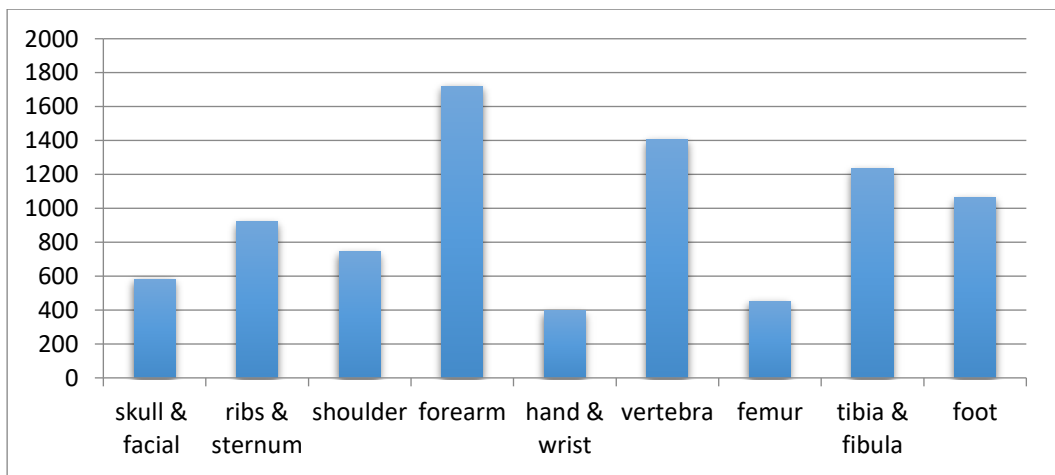
**Common injuries after fall from ladder**

There were 2,223 different diagnoses made in the MOH database with 822 unique types of primary diagnoses. The most common diagnosis and also the most common primary diagnosis was fractures of the radius at 1415 occurrences. Fractures of vertebrae were the second most common primary diagnosis followed by tibia-fibula fractures.



**Figure 3:** Pattern of fractures after fall from ladder.

**Spinal Injuries from falls from ladder**



**Figure 4:** Anatomical Location of Vertebral Fractures.

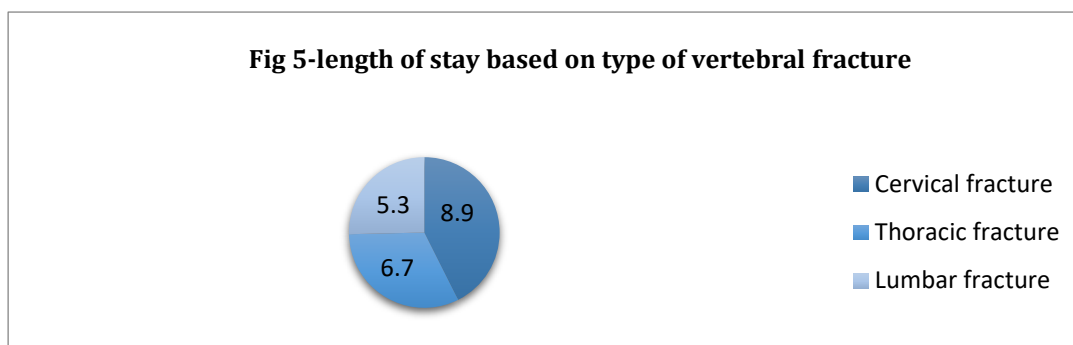
A total of 1,426 spinal injuries were reported in 852 patients from admissions due to fall from ladder. Spinal injuries accounted for 14.12 % of all injuries and 8.5% of people admitted acutely from a ladder fall sustained a spine related injury. One in every 11 patients admitted with a ladder fall injury had a spinal injury. This included 1,336 patients with a vertebral fracture and 69 patients with a spinal cord injury. The remaining spinal injuries reported were fractures of sacrum and coccyx, vertebral dislocations, injuries to nerve roots, spinal plexuses and cauda equina injury.

The median age of a spinal injury was 59 with IQR of 22. The median age of vertebral fractures was 59 and spinal

cord injuries was 57. As fig 4 illustrates lumbar fractures were most common (58%) vertebral fracture followed by thoracic at 33% and cervical spine fractures at 9%.

### **Length of stay**

Although number of lumbar fractures surpass the thoracic and cervical fractures in combination, the less common cervical fracture had a greater length of admission ( $p < 0.01$ ) as demonstrated in figure 5 below. There were total of 3588 days stay (same day discharge) and 56,629 days of admission. Median length of admission from all ladder related falls injuries was 2 days with a wide range from 0 to 176 nights.



**Figure 5:** Length of stay based on type of vertebral fracture.

## **Discussion**

Ladder fall injuries (LFIs) are preventable injuries but pose a substantial public health burden [2]. According to a study conducted in Australia, the number of ladder related injuries presenting to emergency departments and hospitalisation are increasing [8,16,17]. Some studies reported low fatality rate ( $< 2\%$ ) [3,6]. Since the mortality rates are low, falls from ladders are considered less dangerous [7]. Also, most these falls from ladders are preventable [18].

Overarching data on the pattern and demographic of fall from ladder in New Zealand and regional comparisons have not been collated to this degree and formally reported on until now. With national data on falls from ladder and related spinal injuries, over this extended length of time we can now better estimate the burden of ladder related injuries to the healthcare system in New Zealand.

### **National and regional trend of falls from ladder**

This study demonstrates the falls from ladder are on rise in New Zealand consistent with studies from overseas. Regional comparison shows that while most of the counties had steady pattern over these years, Waitemata DHB has shown a rising trend in these falls. Looking into detailed demographics and reassessing the incidence of falls will yield insight into the reasons behind the high number.

### **Age and gender distribution**

Our study indicates that young men are more likely to sustain injuries after these falls. Kool et al conducted study

in Auckland to assess the rate of unintentional fall among young population and found that age group 16-55 are at an increased risk. 45% of these falls involved ladder/scaffolding. Study by Kent et al proposed that elderly population are at increased risk of falls and prolonged hospital stay [14]. Another argument arises that since men are more involved in ladder related work the risk and rate of falls is high as well. Interestingly, women represented approximately 51% of the total population during the study period.

### **Injuries after falls from ladder**

Forearm fracture especially radius fractures were found to be most common injury after falls from ladder. This is first study to report on spinal injuries after falls from ladders. Spinal injuries namely vertebral fractures are the second most common injury in this study. A lumbar spine injury which forms the majority of spinal injuries are a huge financial burden due to long rehabilitation periods. Spinal cord injuries are associated with high healthcare cost [19,20].

Ladder related falls in this study shows that spinal injuries especially vertebral fractures are more common than we estimated. With advanced medical treatments and extensive rehabilitation programmes the outcome of the population injured after falls has improved. However, the costs associated with these treatment modalities are very high [15].

There is now evidence presented in this study of a large component of fall from ladder admissions to tertiary level care with a vertebral fracture or spinal cord injury. The



New Zealand National Falls Prevention Strategy launched in 2005 identifies falls in the home as a priority area [13]. The strategy also acknowledges that while falls among those aged 15 to 64 years are a considerable cost to the government, little is known about how to prevent falls in this age group. These injuries incur significant morbidity and costs requiring extended rehabilitation. This study will help funding organisations covering accident costs, namely the Accident Compensation Corporation, as well as health and safety organisations and policy makers.

This study has established a four-fold increase in the rate of fall from ladder admissions in New Zealand over the last 14 years revealing a growing injury type and financial burden to the country. Counties Manukau and Auckland were stand out areas of concern with the highest number falls from ladder. Waitemata's numbers of falls from ladder are increasing over the study period. It is unsurprising to find greater length of admission for cervical vertebral fractures given this is the more unstable, fragile and mobile region of the spine.

### Limitations and Recommendations

There are many falls from ladder that do not result in injuries. There are also many falls from ladder that result in injuries that then do not present to a tertiary level centre. There are different safety standards of the industry compared to safety standards required of residential use of ladders. Data collection of the different rate and nature of injuries in these respective areas was incomplete. Establishing the reporting of all injuries from different mechanisms including falls from ladders in a workplace environment, from different heights fallen and including days of work lost would be useful for further determining the extent of the injury burden from fall from ladder. This would allow industry safety regulators to more usefully quantify the percentage of these particular work-related falls from ladders that result in serious injuries and therefore provide a better estimate to the degree of disruption in the workplace.

This study is first to report the incidence of falls from Ladder in New Zealand. It demonstrates the significant increase in the number of falls from ladder in 14-year time period. These implies evaluation of our current measures of prevention of ladder related falls, and further continue collecting data on these falls to assess effectiveness of current preventive strategies.

**Conflicts of Interest: None**

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