Brief report

Association between prescription medications and falls at home among young and middle-aged adults

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ABSTRACT
Using data from a population-based case—control study of people aged 25—60 years in Auckland, New Zealand, the authors investigated the association between medications and fall-related injuries at home. The 335 cases comprised people who died or were admitted to hospital as a result of unintentional falls at home, and the 352 controls were randomly selected from the electoral roll. After controlling for confounding by demographic, personal and lifestyle factors, the use of two or more prescription medications relative to one or no medications was associated with an increased risk of fall injury (OR 2.5, 95% CI 1.3 to 4.8). Antihypertensives and lipid lowering drugs were the most common groups involved. The findings suggest that, as in the case of older people, younger working aged adults who use multiple prescription medications are at increased risk of falls, an aspect that should be considered in falls prevention programmes.

INTRODUCTION
Falls are a leading contributor to injury morbidity and mortality, globally.[1][2] However, research on falls has largely focused on children and older adults. A previous study in New Zealand found falls account for 24% of injury admissions among people aged 20—64 years,[3] the consequences of which can pose significant problems for both work productivity and family life.[4] Almost 30% of fall injuries in this age group that result in admission to hospital in New Zealand occur at home.[5]

In order to inform fall prevention strategies, we explored available evidence regarding putative risk factors for falls in working aged adults. We found that while there is a well-established association between prescription medications and falls among older adults,[6–10] this relationship has received scant attention in younger age groups. The risk of falls may be increased as a result of both the intentional and unintentional effects of pharmacological therapy such as orthostatic hypotension, psycho-motor impairment, extra-pyramidal symptoms and dizziness.[9][11] Polypharmacy can increase the severity and frequency of these side effects, with the potential for further increase in the risk of falls.[8] To address the gap in knowledge regarding the role of medications in falls in the younger adults, we analysed the data from a case—control study that was designed to explore risk factors for unintentional falls at home among working aged people. We specifically investigated if people aged 25—60 years who were on prescription medications had an increased risk of fall-related injuries resulting in death or hospital admission.

MATERIALS AND METHODS
A population-based case—control study of fatal or hospitalised unintentional falls among working aged people was conducted in the Auckland region of New Zealand between July 2005 and July 2006. The cases of interest were all individuals aged 25—60 years from the study region who died or were admitted to the hospital within 48 h of an unintentional fall-related injury at home (theirs or another's). The Prevention of Falls Network Europe (ProFaNE) definition of fall was used—'An unexpected event in which the person comes to rest on the ground, floor, or lower level'.[12] Eligible people were identified prospectively through a case finding system established at all three trauma admitting public hospitals and the single coroner's office in the region. The research nurses checked the admission registers of the recruiting hospitals four times a week to identify patients who met the study eligibility criteria. Interviews took place either in hospital or in the subject's home. Proxy interviews were obtained for participants who were too unwell to be interviewed. Cases were excluded if: the injury occurred in a residential institution or in the course of paid work carried out in another person's home; or the subject was unable to complete the questionnaire in English.

The control group comprised a random sample of people of the same age group from the General and Māori electoral roll for the region. To enable the analysis of exposures specifically related to the time of the falls, controls were randomly assigned an index day of the week and time of day based on the distribution of previous unintentional home fall admission data. Control interviews took place via phone.

Participants were interviewed by trained study nurses using a structured questionnaire. Self-reported data collected on prescription medications included: the trade or generic name, dose and frequency. Medications were classified into broad categories (eg, antihypertensives, psychotropics, thyroid agents, narcotics), and categories with more than five participants each were specifically identified in analyses. Potential confounders considered in analyses were: age, sex, ethnicity, socioeconomic status (employment status and the New Zealand index of socioeconomic deprivation for individuals (NZiDep)), living arrangements (eg, alone or with others), average hours spent at home awake, general health, physical activity and acute alcohol and marijuana use. NZiDep is an individual level index of socioeconomic deprivation and comprises a five-category scale based on responses to eight simple questions.[13] Usual physical activity was assessed using the New Zealand Physical

Activity Questionnaire Short Form (NZPAQ-SF).[14] Acute alcohol use was obtained by asking participants how many standard drinks (12 g alcohol units) they consumed in the 6 h before injury (cases) or index time (controls). Acute marijuana use was classified as use in the 3 h before injury or index time.

The inclusion of potential confounders in the multivariable regression model was assessed using Greenland's change in estimate model.[15] Each type of medication category (eg, antihypertensives, statins) was examined in separate regression models, adjusting these for a common group of confounders.

Ethical approval for the study was obtained from the Northern Regional Ethics Committee, and institutional approval from the hospitals where the recruitment took place.

RESULTS

Of the 344 eligible cases identified during the study period, 335 (97.4%) completed interviews, 8 (2.3%) declined and there was one missed case (0.3%). Seven interviews were conducted with a proxy respondent (2%). The response rate among controls for those who were eligible and contactable was 63.4% (352/555). The characteristics of the cases and controls are presented in table 1. Differences in acute alcohol use between cases and controls have previously been reported[16]: these differences were significant. With respect to medications, a higher proportion of cases were on prescription medication than controls (40.3% vs 29.8%).

Based on the limited data available on those controls who did not agree to take part, there were no significant differences by socioeconomic status as measured by NZDep96[17] (a population-based measure of deprivation) between those who took part and those who refused.

This study did not collect a systematic profile of comorbidities. However, only 8.1% of cases and 8.9% of controls reported their general health as 'poor' or 'fair', while the remainder noted their health was 'good', 'very good' or 'excellent'.

An increase in fall injury risk was associated with the use of two or more prescription medications compared with one or no medications after controlling for age, gender, ethnicity, paid employment and deprivation. This association remained significant following adjustment for acute alcohol use, chronic hazardous drinking, physical activity, smoking, marijuana use and sleep in the previous 24 h (OR 2.5; 95% CI 1.3 to 4.8) (table 2). Of the six groups of medications which had sufficient numbers for analysis, antihypertensives and lipid lowering medications were associated with an increased risk of falls after controlling for confounders (OR 3.1; 95% CI 1.6 to 6.0 and 2.5; 95% CI 1.2 to 5.5 respectively). No significant association was found between fall risk and bronchodilators, anti-inflammatories, corticosteroids and psychotropics. There was insufficient study power to examine the effect of subcategories of medications, for example, different antihypertensives.

DISCUSSION

Our findings suggest that young and middle-aged adults using two or more prescription medications are at 2.5 times increased odds of fall related injury at home compared with those on fewer or no medications. While significant associations were apparent for antihypertensive and lipid lowering drugs, this study was not able to determine if these effects related to the drugs or underlying comorbidities.

To the best of our knowledge, this is the first aetiological study exploring the association of medications with falls at home in younger working aged adults. The population-based

Table 1 Characteristics of case and control participants

Characteristic	Cases (n=335) n (%)	Controls (n=352) n (%)
Gender		
Female	180 (53.7)	208 (59.1)
Age		
Median in years (IQR)	47 (38−54)	44 (36−51)
Ethnicity		
NZ European	214 (63.9)	204 (58.0)
Māori	37 (11.0)	27 (7.7)
Pacific Islands	29 (8.7)	35 (9.9)
Other	55 (16.4)	86 (24.4)
In paid employment		
Yes	216 (65.1)	287 (81.8)
New Zealand Index of Deprivation		
1: no deprivation characteristics	196 (60.7)	205 (59.8)
2: 1 deprivation characteristics	52 (16.1)	74 (21.6)
3: 2 deprivation characteristics	39 (12.1)	26 (7.6)
4: 3 to 4 deprivation characteristics	14 (4.3)	25 (7.3)
5: ≥5 deprivation characteristics	22 (6.8)	13 (3.8)
Number of medications prescribed		
0	200 (59.7)	247 (70.2)
1 to 2	90 (26.9)	86 (24.4)
3 to 4	22 (6.6)	10 (2.8)
≥5	23 (6.9)	9 (2.6)
General health		
Excellent	107 (32.1)	87 (24.9)
Very good	113 (33.9)	136 (39.0)
Good	86 (25.8)	95 (27.2)
Fair	22 (6.6)	27 (7.7)
Poor	5 (1.5)	4 (1.2)
Current smoker		
Never	137 (41.1)	196 (56.3)
Past	84 (25.2)	79 (22.7)
Current	112 (33.6)	73 (21.0)
Acute marijuana use		
No	313 (96.9)	345 (99.1)
Yes	10 (3.1)	3 (0.9)
Sleep in previous 24 h (>5 h)		
Yes	273 (87.2)	321 (92.0)
No	40 (12.8)	28 (8.0)
Physical activity: ≥30 min moderate or ≥15 min vigorous exercise on ≥5 days/week		
Yes	82 (24.7)	139 (39.5)
No	250 (75.3)	213 (60.5)

Column totals may differ as a result of missing data.

study attempted to identify all cases (fatal and non-fatal) arising from the study base and achieved a high case response rate. However, the findings need to be considered in light of several limitations. The study had few exclusion criteria, the most important being participants needed to speak English. The most recent census (2006) data indicates that only 4% of New Zealanders do not speak English.[18] Control response rates were lower than anticipated but typical of response rates in epidemiological studies of this nature. Those who participated were similar with respect to socioeconomic status from the study base from which they were sourced. While analyses were adjusted for a range of relevant demographic, lifestyle and other potential confounders, residual confounding by measured and unmeasured factors remains a possibility.

We relied on self-report to ascertain exposure to a medicine, and did not establish medication compliance. Any resulting misclassification is likely to be non-differential and therefore likely to dilute the true effect. We did not establish when the

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Table 2 The association of prescription medication use with moderate to serious injury falls

Variable	Cases (n=335) n (%)	Controls (n=352) n (%)	Model 1: single risk factor model Adjusted OR (95% CI)*	Model 2: multivariable model OR (95% CI)†
Number of current medications prescribed				
≥2‡	64 (9.3)	19 (5.4)	2.57 (1.38 to 4.79)	2.46 (1.26 to 4.82)
Medications prescribed§ ¶ **				
Antihypertensive drugs	54 (16.1)	17 (4.8)	3.91 (2.11 to 7.24)	3.07 (1.57 to 6.03)
Lipid lowering drugs	28 (8.4)	11 (3.1)	2.59 (1.23 to 5.48)	2.52 (1.16 to 5.48)
Psychotropic drugs	30 (9.0)	28 (8.0)	1.01 (0.56 to 1.81)	0.90 (0.47 to 1.74)
Corticosteroids	18 (5.4)	12 (3.4)	1.59 (0.72 to 3.53)	1.43 (0.60 to 3.38)
Anti-inflammatory drugs	9 (2.7)	13 (3.7)	0.47 (0.19 to 1.21)	0.56 (0.21 to 1.52)
Bronchodilators	11 (3.3)	13 (3.7)	0.98 (0.40 to 2.35)	0.87 (0.32 to 2.38)

*Adjusted for age, gender, ethnicity, paid employment and NZiDep.
†Models adjusted for age, gender, ethnicity, paid employment, NZiDep, smoking, acute marijuana use, alcohol use in previous 6 h, sleep in previous 24 h and physical activity.
‡Reference category=0 to 1 drugs.
§Prescribed medications with more than 5 per cell.
¶Reference category=not prescribed these medications.
**Participants may have been on more than one of these medications.
NZiDep, New Zealand index of socioeconomic deprivation for individuals.

medication was last taken or duration of medication use. An increased risk of fall injury has been noted among patients recently prescribed benzodiazepines,[19] and antihypertensives.[20]

Indication bias is of concern in this study. This bias arises when the condition for which the drugs are prescribed is itself associated with the outcome of interest.[21] For example, a previous review focusing on older adults found the estimated risk of falling was similar among patients prescribed antidepressants and those with untreated depression.[10] We did not collect comorbidity information; however, cases and controls were similar with respect to their responses to the self-reported general health question.

Differential recall of information relating to a situation by cases and controls may have resulted in recall bias in this study.[21 22] The methods used to minimise this in the study included the standardised administration of identical exposure questions for cases and controls. In addition, the majority of cases were interviewed face-to-face while controls were interviewed via telephone this may have affected the way in which participants responded to questions.

We found a threefold increase in the odds of falls among people on antihypertensive medications, consistent with previous research among older adults.[20 23] While this study did not have sufficient power to examine different groups of antihypertensives, Gribbin *et al* found thiazide prescription was associated with a threefold increase in risk of falls among older adults, and that the effect was strongest in the first 3 weeks of prescription.[20]

An increased risk of falls was also associated with the use of lipid lowering medications, a finding that contrasts with research in older populations which suggest either a protective effect of statins,[24 25] or no change in fall injury risk.[26] This may reflect differences in the cardiovascular risk profiles of younger and older adults prescribed statins, an aspect that could not be explored in this study. In contrast to studies among older adults,[7 8] we found no association between psychotropic medication use and an increase in fall risk. However, this study was not powered to estimate effects relating to specific medication groups or interactions between medication types.

The findings of this study indicate the need for more focused research that can disaggregate the effect of drugs relative to underlying conditions, as well as examine the effects of specific drugs, dosages and their possible interactions. In addition, the relationships between patterns of medication use and the severity of fall-related injuries, or the inter-relationships between factors such as alcohol use, fatigue, sleepiness or shift work are worthy of exploration.

In conclusion, the association between prescription medications and fall-related injuries revealed a largely unrecognised problem among this younger age group. Notwithstanding the limitations of this study, the findings signal a need for greater awareness of the association between prescription medications and falls in younger adults, whether this is due to the medications, underlying conditions or a combination of both related factors.

What is already known on the subject

▶ Falls are a leading contributor to injury morbidity and mortality, globally.
▶ There is a well-established association between prescription medications and falls among older adults.

What this study adds

▶ After controlling for confounding by demographic, personal and lifestyle factors, the use of two or more prescription medications relative to one or no medications was associated with an increased risk of fall injury at home among young and middle-aged adults.

Competing interests None.

Ethics approval This study was approved by the Northern Regional Ethics Committee.

Contributors BK led the study design, analysis of the study findings and writing of the manuscript. SA led the conception of the study and contributed to the study design, analysis of the study findings and critically revised the draft manuscript for important intellectual content. ER helped design the study's analytical strategy and contributed to the analysis and the interpretation of the study findings.

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Data sharing statement The original study protocol is available with the authors and can be obtained on request. Access to the dataset used in these analyses is restricted to the authors only as stipulated by the ethics approval body.

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Hits in US football rewarded by bounties

It seems that NFL (National Football League) players on one team (and perhaps others) are being paid for injuring their opponents. An investigation by the league confirmed that such bounties were paid by some of the players, with contributions by some in authority. Subsequently, the NFL suspended the coach for 1 year without pay for his role in the team's bounty program, and also suspended the defensive coordinator indefinitely.

Dangers to Bali tourists

Thousands of Australians who holiday in Southeast Asia are injured. In Thailand and Indonesia where the rates of injury are highest, traffic is chaotic, drink-driving is rarely policed, and helmets are not compulsory. Recently, a popular model, Lana O'Connell, was killed on a motorbike. She had little experience riding a motorcycle and may not have been using a helmet. An insurance company states that claims from moped and motorcycle accidents in the region outweigh those for car accidents and the extra work for embassies is such that a surcharge on passports has been proposed.

IP

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