

# BMJ Open Financial impact of injury in older workers: use of a national retrospective e-cohort to compare income patterns over 3 years in a universal injury compensation scheme

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## ABSTRACT

**Objective** The study aims to quantify the impact of injury on the financial well-being of older workers. The hypothesis was that injured older workers have substantially reduced income from work following injury, but that New Zealand's (NZ) universal injury compensation scheme mitigates the difference for total income.

**Design, setting and participants** An e-cohort of 617 722 workers aged 45–64 years old was created using de-identified linked administrative data in NZ's Integrated Data Infrastructure. Person-level data from numerous government agencies were used to compare 21 639 with an injury-related entitlement claim in 2009 with the remaining 596 133. Event date was the date of injury, or for the comparison group, a randomly selected date in 2009.

**Primary and secondary outcome measures** Geometric mean ratios (GMRs) were used to compare income from work and total income from all taxable sources between those injured and the comparison group. Adjusted GMRs estimated income differences up to 36 months following the event date.

**Results** Differences in total income increased over time. In the third year, those injured received 6.7% less (adjusted GMR 0.933 (95% CI 0.925 to 0.941)) than the comparison group, equivalent to an average loss of \$NZ2628. Restricting to income from work, those injured received 29.2% less than the comparison group at 3 years (adjusted GMR 0.708 (95% CI 0.686 to 0.730)). For both men and women, those injured at 45–49 years consistently had the greatest relative income loss compared with those aged 50–54, 55–59 or 60–64 years.

**Conclusions** Although the substantial impacts of injury on income were mainly mitigated by public income transfers, relative losses in income in those aged 45–64 years increased in the 3 years following injury. Policies focused on adequate compensation and reducing the time away from employment could reduce these financial impacts in older workers.

## INTRODUCTION

Injury is responsible for major health loss and disability and results in significant individual,

## Strengths and limitations of this study

- This is a large, national retrospective e-cohort examining the financial impact of injury in older workers (aged 45–64 years) in New Zealand (NZ) using the Integrated Data Infrastructure (IDI).
- Rather than rely on self-reported income, the IDI provides access to taxation records for wage and salary earners, enabling more accurate estimates of the financial impacts of injury.
- Data obtained from the IDI are limited by both restrictions on researcher access to certain earner groups (ie, the self-employed) and the inability to identify those taking early privately funded retirement.
- Costs to NZ's social welfare system are captured, which allows for the role of public income transfer to mitigate work income losses to be assessed.

workplace productivity and societal costs.<sup>1</sup> The annual healthcare, compensation and rehabilitation costs of New Zealand's (NZ) universal injury rehabilitation and compensation scheme, the Accident Compensation Corporation (ACC), were \$3 billion in 2014 for a population of 4.6 million.<sup>2</sup> As is the case internationally, injury is the most common cause of disability in NZ, with 29% of disability attributed to injury alone.<sup>3–5</sup> In the working population aged 18–64 years old, proportionately more injury-related disability is reported in older workers (aged 45 years or greater).<sup>5–7</sup>

Like many developed nations, NZ's working age population is rapidly ageing, which has implications for the burden of injury and subsequent injury-related disability in NZ. In developed countries, older workers are an increasingly important and prominent segment of the working population; by 2023, one in three of NZ's workers will be aged over 45.<sup>8,9</sup> Alongside this growth in the number

of older workers, there is a strong desire among this group to work beyond the traditional age of retirement remaining in the labour market for financial and social reasons. For example, 20% of over 65-year-olds in receipt of NZ's universal retirement income (NZ Superannuation, NZ Super) remain in the labour market, the fourth highest rate of work participation beyond 65 years in the Organisation for Economic Co-operation and Development (OECD).<sup>10 11</sup> The rapidly ageing workforce across all OECD nations provides profound social and economic challenges that will persist into the coming decades. It is crucial that older people wanting to participate in work can do so unimpeded by the consequences of injury, thereby continuing to contribute to working society.<sup>12 13</sup>

Health shocks, including those due to injury, are a major reason older workers withdraw from the labour force.<sup>6</sup> Little is known about how injury affects premature withdrawal from work and the quantifiable social and individual impact of injury on financial well-being for older workers. Scarce international evidence suggests outcomes following injury for older workers compared with younger workers are poorer with longer and less complete recovery,<sup>14–16</sup> subsequently impacting quality of life through decreased income and standard of living, poorer health, social connection and ability to stay active in the retirement years.<sup>17–20</sup>

NZ is in the unique position of being able to quantify for older workers the individual, and subsequently societal, financial costs of injury incurred due to lost or interrupted employment using routinely collected data available in Statistics NZ's Integrated Data Infrastructure (IDI), a linked longitudinal data set of national governmental administrative and survey data.<sup>21</sup> NZ's no-fault universal injury rehabilitation and compensation scheme, ACC, covers 'minor' treatment-only claims as well as entitlement claims for those who have received moderate to severe injuries regardless of the injury setting (ie, both work and non-work injuries covered).<sup>22</sup> The range of entitlements injured people may be eligible for include rehabilitation (treatment, social and vocational), lump-sum payments for permanent impairment and compensation for lost earnings.<sup>23</sup> For those requiring more than a week off work following their injury, compensation from ACC (ACC benefit) is payable at 80% of the claimant's preinjury weekly earnings, up to a weekly maximum. The availability, in NZ's IDI, of records on all taxable sources of income provides a unique data source for income, enabling research aiming to understand the complexities of income source transfer between work, benefits (ACC and other) and NZ Super.

This study aims to quantify the impact of injury on the financial well-being of older workers (aged 45–64 years) by comparing income for those injured with the remainder of the e-cohort over a 3-year period using national routinely collected linked records. Specifically the following hypothesis will be tested: injured older workers compared with the remainder of the e-cohort will have substantially reduced income from work at 1, 2

and 3 years following injury, but that NZ's universal injury compensation scheme will mitigate the differences for work income and therefore total income.

## METHODS

A population-based, retrospective e-cohort of older workers was identified using Inland Revenue's income tax data available in the June 2016 'refresh' of NZ's IDI. Injury claims data in the IDI are provided by the ACC; this was used to determine who in the e-cohort had at least one entitlement claim accepted by ACC for an injury that occurred in 2009. Claim acceptance depends on the detailed definition of 'accident' as specified in ACC's legislation. In brief, the no-fault scheme covers everyone in NZ (regardless of setting or work status) if they are injured in an accident (including sexual violence or conditions that come on gradually because of work) and does not cover illness, stress and conditions from ageing.<sup>24</sup> Those who had a 2009 entitlement claim were defined as 'injured', while the remainder of the e-cohort were classified as an 'un-injured' comparison group (hereafter referred to as comparison). No formal sample size calculations were undertaken; rather all eligible older workers were included. Date of injury was used as the 'event date' for the injured; for the comparison group a date during 2009 was randomly assigned. For those with multiple entitlement claims in 2009, the date of the first was used. The e-cohort (injured and comparison workers) was restricted to those who were aged 45–64 years at their event date, had earned at least \$120 from wages and salary in the 12 full months prior to the event,<sup>25</sup> and were not receiving ACC earnings-related compensation from a previous injury at the time of the event. A maximum age of 64 years was used as New Zealanders are eligible for NZ Super at 65 years of age. Income tax records for self-employed persons were not available.

## Outcome measures

To assess financial well-being, taxable annual income of individuals in the e-cohort was obtained from the IDI at three time points (1, 2 and 3 years) post event date. As income details are recorded in Inland Revenue's Employer Monthly Schedules (EMS), it was not possible to separate income for the preperiods and postperiods within the month of the event. Thus all taxable income except that from lump-sum payments was summed for 12, 24 and 36 full months following each individual's event date. For example, if the event date was 21 November 2009, EMS details for the months of December 2009–November 2010 were used to estimate income in the 12 months following the event. Sources of income were grouped into work income (wages and salary, withholding payments), ACC benefit (ACC claimant's compensation), other benefits (including income replacing benefit, student allowance and paid parental leave) and pension (NZ Super) (table 1). No structural changes to

**Table 1** Purpose, components, eligibility and level of payments available for New Zealanders by income source

Income source	Payment purpose	Eligibility	Level of payment in 2009 (\$NZ per week before tax)
<b>Work income</b>			
Wages/Salary	Payment for employment.	Registered to pay income taxation.	Varies according to employment agreement. Median weekly wage and salary income was \$760.
Withholding payment	Payment for atypical employment arrangements, that is, director fees, contractor payments, proceeds of sales.	Registered to pay income taxation.	Varies according to employment agreement.
<b>Accident Compensation Corporation (ACC)</b>			
ACC benefit	Payment for income lost due to incapacity due to injury.	Universal no-fault coverage of healthcare, compensation and rehabilitation costs regardless of injury setting.	Covers 80% of preinjury wages/salary to a weekly maximum of \$1638.
<b>Other (non-ACC) benefit</b>			
Income replacement benefits	Income support for those unemployed or ill.	If seeking employment or during a work absence due to illness and aged between 18 and 65 years.	Depends on circumstance, for example, \$218 (single, no children) to \$316 (single with children) + additional supplements.
Student allowance	Income support for those engaged in tertiary-level training.	Undertaking approved course over 1 year in length and aged between 18 and 65 years.	Depends on circumstance, for example, \$210 (single, no children, not living with parent) to \$316 (single with children).
Paid parental leave	Time-limited income support for primary carers.	Employed or self-employed (working on average >10 hours/week) primary carers of child under 6 years of age.	100% of weekly wage up to \$475. Time limited to 18 weeks.
<b>Pension</b>			
Superannuation benefit (NZ Super)	Income support for retirement from workforce.	Universal payment for NZ residents/citizens ≥65 years of age. Able to receive NZ Super while still employed.	\$274 (per person for couples) to \$365 (single person living alone); set at 66% of national average wage.

NZ, New Zealand.

the eligibility or entitlements of wage and salary earners occurred over the period of this study.

### Explanatory variables

For each individual, the total income in the 12 full months prior to the event was determined to provide baseline information (hereafter referred to as baseline total income). For descriptive purposes, this baseline total income was categorised into five groups (all \$NZ): <25 000, 25 000–50 000, 50 000–75 000, 75 000–100 000 and ≥100 000. The Personal Details table in the IDI was used to obtain the age, sex and ethnicity of individuals. Due to confidentiality restrictions only month and year of birth are available, so the 15th was used as the day of birth in calculating age at event date, which was categorised into 5-year age groups (45–49, 50–54, 55–59 and 60–64). Ethnicity ‘ever-recorded’ by a government agency and a prioritisation algorithm of Statistics NZ were used to derive the following categories: Māori, Pacific,

Asian, Sole European and Other. This algorithm gives Māori the highest priority, so anyone that is recorded as Māori and any other ethnicity has been categorised as Māori. The next highest priority group is Pacific followed by Asian.

The residential address recorded in the IDI for the period covering each individual’s event date was used to obtain two geographically based variables: region of residency and a small area-based deprivation measure (NZDep). The region of residency variable has 17 categories—the 16 distinct regions covering all of NZ and ‘missing’. The NZDep Scale, derived from Census data, has values of 1 (an area in the least deprived 10% of small geographical areas) to 10 (an area in the most deprived 10% of small geographical areas) and ‘missing’.<sup>26</sup> NZDep was categorised into 1–3, 4–7, 8–10 and ‘missing’.

Industry codes specific to individuals’ income payments are recorded in the IDI using the 2006 Australian and



New Zealand Standard Industrial Classification (ANZSIC). Use of level 1 ANZSIC resulted in 16 industry categories plus 'missing'. For individuals with income from multiple industries, the industry associated with the highest total sum earned in the year prior to the event was used. A binary industry variable was used to classify the following industries as higher risk: agriculture, forestry and fishing; construction; manufacturing; mining; and transport, postal and warehousing.<sup>27–29</sup>

The diagnosis of eight chronic conditions or significant health events (coronary heart disease, gout, chronic obstructive pulmonary disease, diabetes, cancer, traumatic brain injury, stroke and acute myocardial infarction) is supplied by the Ministry of Health to the IDI. Chronic conditions or significant life events that had a first incident date recorded during the 4 years prior to an individual's event date were included. Consistency of coverage between source data sets was the reason behind the use of a 4-year period. The number of chronic conditions/significant health events recorded for individuals was categorised into none, one, or two or more.

### Statistical analysis

The distributions of the injured and comparison groups by the categorical explanatory variables were compared using  $\chi^2$  tests. The number of participants receiving any income from each income source is presented as a percentage with binomial exact 95% CIs. All income variables were log-transformed with geometric means calculated. Since some participants did not receive any work income post 'event', a small constant (\$1) was added to all participants' work income prior to log transformation.<sup>30</sup> The difference between the geometric means of income for those injured and the comparison group at baseline and each of the following 3 years was assessed using the ratio of the geometric means (GMR) and its 95% CI.

Model-based estimates of differences in income between the groups were obtained using analysis of covariance with income in a given year (1, 2 and 3 years postevent) as the outcome variable and a group indicator (injured or comparison) as an explanatory variable.<sup>31</sup> Estimates from models that include the group indicator and adjust for baseline income only have been referred to as 'simple'. The exponentiated coefficient for the group indicator from the 'simple' model estimates the ratio of the average income postevent for those injured compared with the comparison group after adjusting for preinjury income. Adjusted GMRs were obtained by extending this 'simple' model to include other covariates. Separate models were used for total income and work income at each of the three annual time points postinjury. GMRs for income from ACC benefit, other benefits and pension were not calculated as 90%–98% of the cohort did not receive income from these sources. Subgroup analyses estimated adjusted GMRs for all combinations of sex and 5-year age groups. 'Simple' and adjusted GMRs were also estimated for each subgroup identified by baseline income categories.

Data were analysed using Stata V.14.0. As per Statistics NZ's protocol, all count data were randomly rounded to base 3.

### Patient and public involvement

Patient or public involvement in this research was not required as the data source was a subset of a pre-existing anonymised linked data set of routinely collected governmental data.

### RESULTS

Of the 703 254 workers aged 45–64 years who met the study criteria, 623 433 had EMS records in the 3 years following their event date. Of these 5711 had missing ethnicity; the remaining variables were complete by design. The e-cohort thus consisted of 617 772 older workers, of whom 21 639 (3.5%) lodged an ACC entitlement claim for an injury that occurred in 2009.

Univariate comparisons of baseline sociodemographic and health characteristics for the injured and comparison groups are presented in [table 2](#). Those who sustained an entitlement claim injury were on average slightly older than the comparison group (18% aged 60–64 compared with 17%; mean age 53.7 years compared with 53.5 years). Fifty-eight per cent of the injured group were male compared with 48% of the comparison group. Those injured included a higher percentage of those of Māori ethnicity and a higher percentage of those employed in the construction and manufacturing industries than the comparison group. A lower percentage of those with Asian ethnicity, those employed in the 'Education and Training' industry, those in the least deprived category and those from the two main regions of NZ Auckland and Wellington was observed in those injured compared with the comparison group. The prevalence of one or more chronic conditions at baseline was low at 3.2% in both the injured and comparison groups. Clear differences were apparent for baseline total income with those injured, including a smaller percentage of those earning less than \$25 000 per annum (18% compared with 23%) and a smaller percentage of those earning \$100 000 or more per annum (5% compared with 7%) ([table 2](#)).

Although the percentage that did not receive work income increased over time for both groups, the increase was greater for those injured, with 6% and 8% not receiving any work income in year 2 and year 3 compared with 4% and 6%, respectively, for the comparison group ([table 3](#)). More than half (53%) of the injured group received income compensation from ACC in the first year following injury; in the second year this dropped to 12% and then 8% in the third year. For the comparison group the rate of income compensation from ACC was between 1% and 2% over the 3-year period. Receipt of income from non-ACC benefits remained constant at 10% in the comparison group over the 3 years, whereas in the injured group the percentage increased from 11% to 13% over the same period. Although a substantial increase in

**Table 2** Baseline sociodemographic and health characteristics of injured and comparison e-cohort ‘participants’ (n=617722)

	Injured		Comparison	
	(n=21 639)		(n=596 133)	
	n	%	n	%
<b>Age group (years)</b>				
45–49	6954	32.1	198 369	33.3
50–54	5985	27.7	165 114	27.7
55–59	4899	22.6	132 180	22.2
60–64	3801	17.6	100 470	16.9
<b>Sex</b>				
Male	12 591	58.2	284 187	47.7
Female	9048	41.8	311 946	52.3
<b>Ethnicity*</b>				
Māori	3570	16.5	84 990	14.3
Pacific	966	4.5	34 251	5.7
Asian	675	3.1	31 677	5.3
Sole European	13 251	61.2	368 205	61.8
Other	3177	14.7	77 010	12.9
<b>Chronic conditions</b>				
None	20 937	96.8	577 332	96.8
One	588	2.7	16 008	2.7
Two or more	114	0.5	2 793	0.5
<b>NZDep</b>				
1–3 (least deprived)	6402	29.6	196 539	33.0
4–7	8709	40.2	230 037	38.6
8–10 (most deprived)	5994	27.7	152 715	25.6
Missing	534	2.5	16 842	2.8
<b>Region</b>				
Auckland	5454	25.2	171 684	28.8
Bay of Plenty	1551	7.2	37 704	6.3
Canterbury	3468	16.0	81 906	13.7
Gisborne	309	1.4	6642	1.1
Hawke’s Bay	984	4.5	24 270	4.1
Manawatu-Wanganui	1107	5.1	31 383	5.3
Marlborough	303	1.4	7074	1.2
Nelson	276	1.3	7722	1.3
Northland	810	3.7	19 185	3.2
Otago	1245	5.8	29 151	4.9
Southland	759	3.5	14 658	2.5
Taranaki	552	2.6	15 948	2.7
Tasman	267	1.2	6978	1.2
Waikato	2049	9.5	53 058	8.9
Wellington	1809	8.4	69 585	11.7
West Coast	237	1.1	4896	0.8
Missing	459	2.1	14 289	2.4
<b>Industry</b>				

Continued

**Table 2** Continued

	Injured		Comparison	
	(n=21 639)		(n=596 133)	
	n	%	n	%
Agriculture, forestry and fishing	1122	5.2	21 324	3.6
Arts, recreation and other services	831	3.8	26 943	4.5
Construction	1962	9.1	32 226	5.4
Education and training	1635	7.6	72 213	12.1
Electricity, gas, water and waste services	189	0.9	4449	0.7
Financial and insurance services	321	1.5	15 234	2.6
Healthcare and social assistance	3051	14.1	81 654	13.7
Information media and telecommunications	213	1.0	9150	1.5
Manufacturing	3720	17.2	73 401	12.3
Mining	129	0.6	1950	0.3
Professional, ..., and support services†	1704	7.9	61 761	10.4
Public administration and safety	1227	5.7	34 131	5.7
Rental, hiring and real estate services	228	1.1	7587	1.3
Retail trade and accommodation	2118	9.8	63 102	10.6
Transport, postal and warehousing	1509	7.0	28 578	4.8
Wholesale trade	1041	4.8	32 874	5.5
Missing	639	3.0	29 556	5.0
<b>Total income in the 12 months prior</b>				
\$120–\$24 999	3909	18.1	134 304	22.5
\$25 000–\$49 999	9366	43.3	222 105	37.3
\$50 000–\$75 000	5727	26.5	143 517	24.1
\$75 000–\$100 000	1650	7.6	53 034	8.9
≥\$100 000	987	4.6	43 173	7.2

\*Ethnicity has been derived within the Integrated Data Infrastructure using an ‘ever-recorded’ approach. As multiple ethnicities are recorded, prioritisation based on a Statistics NZ algorithm has been used.

†Full category heading ‘Professional, Scientific, Technical, Administrative & Support Services’.

receipt of the pension (NZ Super) is apparent over the study period (<1% at baseline to around 10% at year 3), the percentages receiving NZ Super over time were very similar between the two groups.

Despite starting at a higher average total income, the average total income for those injured was lower than the comparison group at all three time points (table 4). In the third year the geometric mean total income for those injured was 5% lower than the comparison group,

**Table 3** Number and per cent receiving any income from each income source over time for injured (n=21 639) and comparison (n=596 133) 'participants'

	Injured (n=21 639)			Comparison (n=596 133)		
	n	%	95% CI	n	%	95% CI
<b>Work income received</b>						
Baseline*	21 639	100	(100 to 100)	596 133	100	(100 to 100)
Year 1	21 102	97.5	(97.3 to 97.7)	580 923	97.4	(97.4 to 97.5)
Year 2	20 274	93.7	(93.4 to 94.0)	571 119	95.8	(95.8 to 95.9)
Year 3	19 896	91.9	(91.6 to 92.3)	561 102	94.1	(94.1 to 94.2)
<b>ACC benefit received</b>						
Baseline	1 224	5.7	(5.4 to 6.0)	13 137	2.2	(2.2 to 2.2)
Year 1	11 595	53.6	(52.9 to 54.3)	8 022	1.3	(1.3 to 1.4)
Year 2	2 547	11.8	(11.3 to 12.2)	13 101	2.2	(2.2 to 2.2)
Year 3	1 803	8.3	(8.0 to 8.7)	13 602	2.3	(2.2 to 2.3)
<b>Other benefits received</b>						
Baseline	1 608	7.4	(7.1 to 7.8)	50 733	8.5	(8.4 to 8.6)
Year 1	2 457	11.4	(10.9 to 11.8)	60 624	10.2	(10.1 to 10.2)
Year 2	2 787	12.9	(12.4 to 13.3)	62 448	10.5	(10.4 to 10.6)
Year 3	2 796	12.9	(12.5 to 13.4)	61 398	10.3	(10.2 to 10.4)
<b>Pension received</b>						
Baseline	57	0.3	(0.2 to 0.3)	2 991	0.5	(0.5 to 0.5)
Year 1	735	3.4	(3.2 to 3.6)	19 962	3.3	(0.3 to 0.3)
Year 2	1 410	6.5	(6.2 to 6.9)	38 244	6.4	(6.4 to 6.5)
Year 3	2 247	10.4	(10.0 to 10.8)	59 883	10.0	(10.0 to 10.1)

\*One-sided 97.5% CIs presented for baseline estimates.  
ACC, Accident Compensation Corporation.

a difference of almost \$2000 per annum. The patterns observed for income from work were more extreme. In the first year the geometric mean work income for the

**Table 4** Average annual total income and work income over time for injured (n=21 639) and comparison (n=596 133) 'participants'

	Geometric mean (GM; \$NZ)		Relative difference (injured/comparison)	
	Injured	Comparison	Crude GM ratio	95% CI
<b>Total income</b>				
Baseline	39 950	38 962	1.025	(1.016 to 1.035)
Year 1	38 583	38 812	0.994	(0.985 to 1.004)
Year 2	38 135	39 747	0.959	(0.949 to 0.969)
Year 3	37 262	39 226	0.950	(0.939 to 0.961)
<b>Work income*</b>				
Baseline	37 806	35 939	1.052	(1.041 to 1.063)
Year 1	23 842	28 277	0.843	(0.822 to 0.865)
Year 2	18 371	24 452	0.751	(0.724 to 0.779)
Year 3	15 197	20 282	0.749	(0.719 to 0.780)

\*A small constant (+\$1) was added to each participant's work income so that the GM could be calculated for participants with no work income.

injured group was \$23 842, 16% less than the comparison group's, even though at baseline the injured group's work income was 5% higher. In years 2 and 3, the geometric mean work income for the injured was 25% less than that of the comparison group, a difference of \$5000–\$6000 per annum. The notable increase in receipt of NZ Super over the 3 years for both groups, as seen in table 2, provides explanation for the reducing work income observed in the comparison group over time.

Model estimates ('simple' GMRs) that adjust for the difference between the baseline incomes of the injured and comparison groups are presented in table 5. As can be seen, the 'simple' GMRs that adjust only for baseline income are very similar to the GMRs obtained from models adjusting for baseline income, age group, sex, ethnicity, chronic conditions, deprivation, region and industry.

For total income, the adjusted GMR was 0.970 for the first year, that is, the best estimate of the difference in total income between the groups is that the injured group received on average 3.0% less income. This difference increased to 5.8% in year 2 and 6.7% in year 3. Restricting the outcome to income from work in the first year, the adjusted GMR of 0.767 obtained from the model indicates that those injured received on average 23.3% less

**Table 5** Model estimates for ‘simple’ and adjusted annual total income and work income over time for injured (n=21 639) and comparison (n=596 133) ‘participants’

	Geometric mean ratio (GMR; injured/comparison)			
	‘Simple’ GMR*		Adjusted GMR†	
	GMR	95% CI	GMR	95% CI
<b>Total income</b>				
Year 1	0.973	(0.967 to 0.979)	0.970	(0.964 to 0.976)
Year 2	0.941	(0.934 to 0.948)	0.942	(0.935 to 0.949)
Year 3	0.932	(0.924 to 0.940)	0.933	(0.925 to 0.941)
<b>Work income‡</b>				
Year 1	0.790	(0.774 to 0.806)	0.767	(0.753 to 0.782)
Year 2	0.702	(0.684 to 0.721)	0.700	(0.683 to 0.719)
Year 3	0.699	(0.677 to 0.721)	0.708	(0.686 to 0.730)

\*Estimate obtained from model adjusting for baseline total income only.

†Estimate obtained from model adjusting for baseline total income, age group, sex, ethnicity, chronic conditions, deprivation, region and industry.

‡A small constant was added to each participant’s work income so that the geometric mean could be calculated for participants with no work income.

than the comparison group. The adjusted GMRs for years 2 and 3 indicate that those injured received on average 30.0% less work income than the comparison group in the second year and 29.2% less in the third year.

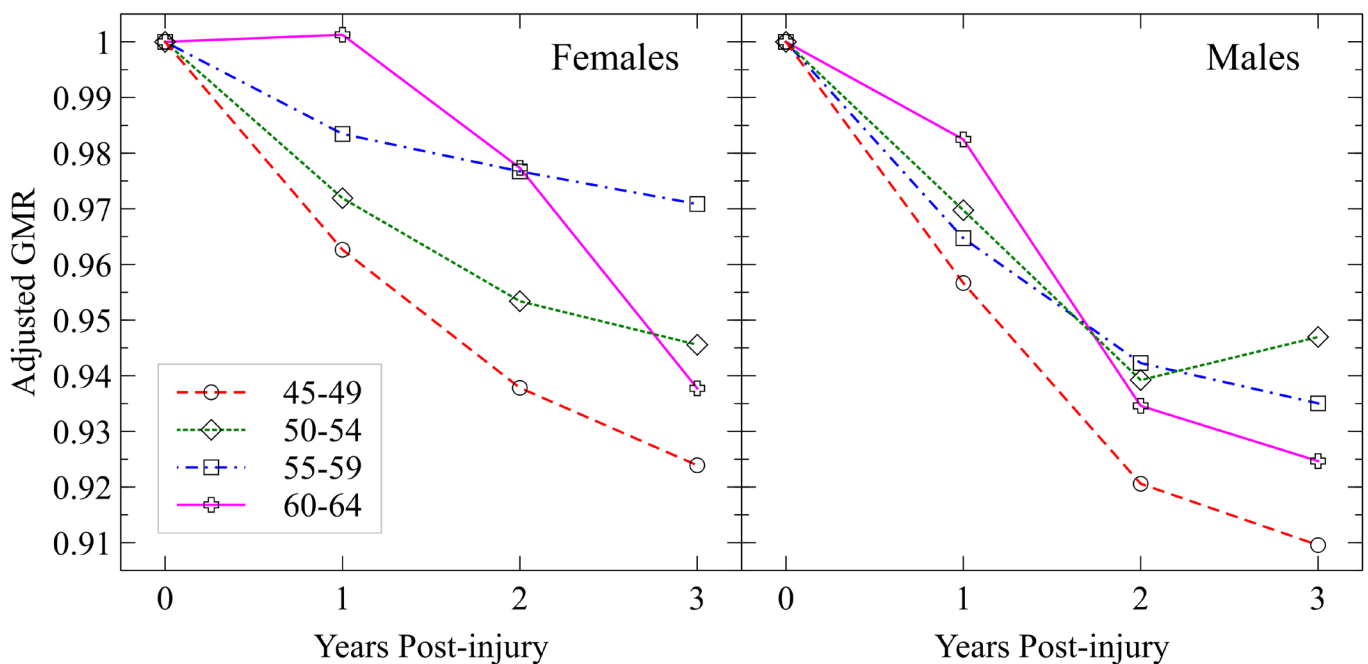
Adjusted GMRs obtained from analyses stratified by baseline total income are presented in online supplementary table 1. Overall the patterns observed for the four

categories of baseline total income of \$25 000 or more were consistent with the estimates presented in table 5. That said, in year 2 the adjusted GMR for those with a total income of \$25 000–\$49 000 was 0.938 compared with adjusted GMRs between 0.957 and 0.961 observed for those with a total income of \$50 000 or more, indicating that those receiving \$25 000–\$49 000 before injury have a greater relative income loss than their injured counterparts whose total income was higher at baseline. For those with a total income less than \$25 000 at baseline, there was no evidence of a difference between the injured group and the comparison group at year 1 or year 2; in the third year the average total income for the injured group was 3.1% less than that of the comparison group.

Adjusted GMRs by age group indicate a different pattern for those aged 60–64 years compared with younger age groups; for women, there was a noticeable drop for an adjusted GMR of 0.977 at 2 years to 0.938 at 3 years, whereas for men the greater drop in this age group was between years 1 and 2 (adjusted GMR 0.982–0.935) (figure 1). For women, the lowest GMRs were observed for those aged 45–49; in the third year their total income was on average 7.6% less for those injured. Despite a small increase in the adjusted GMR from 0.939 to 0.947 for men aged 50–54 years old, the adjusted GMRs for men by age group over time were more similar than those observed for women.

## DISCUSSION

The results of this study provide strong support for our hypothesis that injured older workers have reduced work and total income in the 3 years following injury when



**Figure 1** Relative differences (adjusted geometric mean ratio (GMR); injured/comparison) in total income received between an injured and a comparison group over 3 years by age group and sex.



compared with an 'uninjured' group and that income transfers meet most of the work income losses. There was evidence of significant earnings losses, with adjusted relative losses of income greatest for income derived from work of 23% in year 1, increasing to 30% at year 2 and 29% at year 3. The substantial lost earnings from work income were mitigated by public income transfers provided by ACC, other benefits and NZ Super, so the average total income losses were smaller overall. That said the estimated 7% lower total income 3years following injury equates to an average annual loss of \$2628, or rather a weekly income of \$704 rather than \$754. It is concerning that total losses increased over time, indicating public income transfers are failing to provide total compensation for lost income following injury and injured workers risk falling behind financially over time. We found mixed support for differences by age. While the decline in relative loss of income was steepest in later years for men and women aged 60–64years old, those aged 45–49 years old had the greatest relative loss in total income at all time points. By year 3 the relative income losses for those aged 45–49 years at time of injury were 7.6% for women and 9.0% for men.

This study relies solely on administrative linked data in the IDI, which has both strengths and limitations. The national coverage of the IDI provided a sizeable e-cohort of over 600 000 older workers to be identified, which, combined with the longitudinal nature of the IDI, enabled precise estimates of the financial impacts of injury over time to be determined. Rather than rely on self-reported income, which is prone to recall or social desirability bias, the IDI provides access to taxation records for wage and salary earners, enabling more accurate estimates of the financial impacts of injury. The availability of individual-level data on benefit receipt also enabled examination of costs to the individual and to the social welfare system (including ACC) in terms of income replacement (income transfer). The use of ACC entitlement claims data within the IDI provided an objective measure of injury considered to reflect moderate to severely injured workers, but limits the generalisability of our findings to those with accepted injury claims only; the financial impact of injury may be greatest for those with an unaccepted injury claim. Our study investigated the NZ context; therefore, our results might be less generalisable to other countries with different social security systems and jurisdictions. The use of an upper age limit (aged less than 65 years) in our older worker inclusion criteria removed the effects of universal receipt of NZ Super at baseline but not privately funded planned retirement initiated prior to age 65 years; however, early privately funded retirement is not the norm in NZ.<sup>32</sup> Over the 3years of the study, a large proportion of those aged 60–64 years old in the e-cohort would have become eligible for NZ Super and thus are likely to have reduced their work hours or retired.

Non-governmental researchers are currently not permitted access to IDI taxation records for self-employed

workers, so the generalisability of these results is limited to older salaried workers. Additionally, there may be a healthy worker effect as our e-cohort of older workers may comprise a select group of active and healthy workers as those with early-onset work-limiting disability are more likely to have left the workforce at an earlier age.

Previous examinations of the financial and labour market implications of health shocks in NZ have mainly used an econometric approach.<sup>25 33–35</sup> Direct comparison of our study with this body of work is difficult due to differences in study design, source data and the main focus of previous work being on employment outcomes; however, our findings are broadly similar to the financial impacts identified previously. Our study extends previous knowledge by examining financial losses following injury specifically and by including older workers up to the age of entitlement to universal superannuation (age 65 years) in 5-year age bands. Our finding that work and total income relative losses increase over 3years has not been reported before in NZ. Persistent earnings losses after a work injury have been reported in New Mexico, USA. Using linked federal-level and state-level data from New Mexico to estimate earnings losses, workers with lost-time injuries experienced an estimated 15% loss of earnings 3years after injury.<sup>18</sup> While the average total earnings loss of 7% at 3 years observed in our study is low in comparison, the difference is likely to be explained by workers' compensation benefits not being included in the New Mexican study's earnings estimates.

Age and gender differences in lost earnings have been observed following injury. Women sustained the highest level of lost earnings following work-related injury in the USA,<sup>36</sup> and a Danish study examining the effect of road injuries on income found older men and women experience greater loss of earnings than younger persons in the long term.<sup>37</sup> The relative earnings losses for injury in older workers were greater than those observed in NZ's working population for 'health shocks' due to coronary heart disease, chronic obstructive pulmonary disease, diabetes, melanoma and prostate cancer, and similar to the substantial losses observed for traumatic brain injury and brain cancer.<sup>25</sup>

While the combined social safety nets of ACC earnings-related compensation and the social welfare system protect workers from the substantial decline in work income via income transfers, losses of 7% of total income were still observed for injured older workers 3years following injury. Our findings call into question the adequacy of NZ's income support structure at time when older workers need to prepare financially for retirement to maintain a lifestyle beyond the basics provided by the universal NZ Super, which is set at 66% of the national average wage. The level of financial loss will also be influenced by labour market activity limitations for older workers. Recent reports have highlighted that age discrimination in the workplace is real, and likely to be exacerbated by injury or illness; therefore, there is a need for recognition of older workers' skills and



experience and a need to understand how older workers can be supported in the transition to different careers in later working life.<sup>38</sup> Policies that facilitate older workers' continued participation in work following injury should focus on removing labour market age discrimination, flexible working hours, work with less responsibility or fewer physical demands, job sharing, and age-specific employment assistance.<sup>39</sup> Additionally, stronger measures by government and employers to prevent injury, to support older workers to stay at work, and to promote the timely and appropriate return to work of injured workers are needed to reduce the reliance of injured workers on financial supports and mitigate future earnings losses.

Our study confirms the economic consequences of injury in older workers are not insubstantial with relative financial losses increasing over time. By 45 years of age most workers are in a period of economic stability before beginning a transition to reduced and less active work, where health events can greatly impact on employment choices. The loss of future earnings potential at a time when older workers need to be preparing financially for future retirement is concerning and needs to be understood further. Pathways by which total earnings losses are obtained and sustained, as well as the role of personal and injury characteristics and economic concepts such as incentive behaviour and market forces,<sup>40</sup> need further research. Future research should examine the impact of injury on household income to assess the broader socio-economic impact of injury on households as older workers prepare financially for retirement. Further identification of opportunities for older workers to remain engaged in work following serious injury is also required. Efforts focusing on a higher level of earnings-related financial compensation and early support, such as through the provision of flexible workplaces, vocational and rehabilitation services, to return injured older workers to employment would minimise the economic impact on lifetime earnings of injury to older workers and on lost productivity to society. There is a need to better understand the financial impact of injury on work participation among people approaching the end of their working lives. Efforts to reduce injury and to improve outcomes following injury in older workers can have positive benefits across the working population, including other vulnerable working populations such as younger workers.<sup>41</sup>

## CONCLUSION

Loss of income experienced by older NZ workers following moderate to severe injury is both substantial and appears to increase over time for at least 3 years. Those aged 45–49 years suffered the greatest relative income losses. Although income transfers provided by NZ's universal compensation and rehabilitation scheme, the ACC, and the welfare system mitigate the financial loss, they do not fully compensate older injured workers. Policies focused on providing adequate compensation for injured workers to cover the true financial impact of injury and

on reducing the length of time away from employment will reduce the substantial financial impacts of injury in our rapidly ageing working population.

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**Disclaimer** The results in this paper are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI), managed by Statistics NZ. The opinions, findings, recommendations and conclusions expressed in this paper are those of the authors, not Statistics NZ, Inland Revenue, the Accident Compensation Corporation or the Ministry of Health. Access to the anonymised data used in this study was provided by Statistics NZ under the security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business or organisation, and the results in this paper have been confidentialised to protect these groups from identification and to keep their data safe. Careful consideration has been given to the privacy, security and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the privacy impact assessment for the Integrated Data Infrastructure available from [www.stats.govt.nz](http://www.stats.govt.nz). The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. These tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes. Any person who has had access to the unit record data has certified that they have been shown, have read and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

**Competing interests** None declared.

**Patient consent** Detail has been removed from this case description/these case descriptions to ensure anonymity. The editors and reviewers have seen the detailed information available and are satisfied that the information backs up the case the authors are making.

**Ethics approval** Ethical approval for this study was obtained from the accredited University of Otago Human Ethics Committee.

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**Data sharing statement** Data are available from NZ's Integrated Data Infrastructure, which may be accessed by researchers with permission from Statistics NZ. Technical codes are available from the authors or the Dunedin School of Medicine Administrative Data for Health Research Hub.

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