Original research

Trends in fatal occupational injury rates among older workers before and after the Great Recession of 2008

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ABSTRACT

Background Older workers experience higher rates of fatal occupational injury than younger workers worldwide. In North Carolina, the population of older workers more than doubled between 2000 and 2017. In 2008, the Great Recession changed occupational patterns among all age groups. We examined annual rates and distribution of fatal occupational injuries experienced by older workers, comparing the pre-recession period (2000–2007) to the post-recession period (2009–2017).

Methods Detailed information on all fatal occupational injuries during the period between 1 January 2000 and 31 December 2017 were abstracted from the records of the North Carolina Office of the Chief Medical Examiner and the office of vital records. The decennial Census and American Community Survey were used to estimate the population at risk and derive annual rates of fatal occupational injury.

Results During the study period, 537 occupational fatalities occurred among workers 55+ years of age. The rate of fatal occupational injury among older workers declined 2.8% per year, with a 7.7% yearly decline in the pre-recession period compared with a 1.4% increase per year in the post-recession period. Workers 65+ years of age experienced rate increases in both periods. The highest rates of unintentional fatal occupational injury (injuries that were not purposefully inflicted) were observed in forestry, fishing hunting and trapping, and wood building manufacturing. Intentional fatal occupational injury rates (homicide, suicide) were highest in transportation, gas/service stations and grocery/food stores.

Conclusions Older workers have persistently high rates of fatal occupational injury in North Carolina before and after the Great Recession.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Fatal occupational injury has historically been more common among older workers than younger workers. In many countries, the post-World War II generation is remaining in the workforce longer than previous generations. The impact of economic downturn on rates of fatal occupational injury is not well understood in this population.

WHAT THIS STUDY ADDS

⇒ This study identifies workers 55 years of age and older as experiencing the highest rates of fatal occupational injury both before and after the Great Recession of 2008 in the state of North Carolina. In the post-recession period, workers >65 years of age experienced the highest rates, as well as the fastest rate increase.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study focuses on the state of North Carolina, USA, and presents evidence that older workers are both a rapidly growing age group in the workforce and continue to experience high rates of fatal occupational injury. These results may inform aetiological research, interventions, or policy approaches to reduce these rates.

INTRODUCTION

Older workers in many settings experience higher rates of fatal occupational injury than younger workers.[1–5] Changes in proprioception, balance and visual acuity that are normal parts of the ageing process may predispose older workers to injury, and an injury that would have been severe but survivable for a younger worker may be fatal to an older worker.[6 7] Technology has also altered the work environment, with increasing usage of heavy equipment, computer-controlled industrial machinery, and power tools that may present unfamiliar risks to older workers trained prior to the advent of these newer technologies.[8] High rates of fatal occupational injury in this group are of particular concern not only from an occupational safety perspective but also because of the social role played by older adults; older workers make valuable contributions to the economy and society and are often deeply embedded within their community.[9 10]

In this study, we examine fatal occupational injury rates among older workers, defined as employed persons 55 years of age or older, in the state of North Carolina, USA, during an 18-year period, centred on the Great Recession of 2008, during which many workers experienced employment changes.[11–13] The great recession had varying impacts on groups of workers; we hypothesised that older workers experienced different stresses that affected their employment patterns compared with younger workers (eg, deterioration of retirement savings).[14] We hypothesised that these stressors may result in a larger number of workers delaying retirement, resulting

Table 1 Characteristics of workers 55 year of age and older who experienced a fatal occupational injury in North Carolina (2000–2017)

	Number	Percentage
Male	512	95.3
Female	25	4.7
Age		
55–64	351	65.4
65–74	137	25.5
75+	49	9.1
Latino/a ethnicity		
Latino/a	20	3.7
Not Latino/a	517	96.3
Race		
White	438	81.60
Black	81	15.10
Other	18	3.40
Means of death		
Motor vehicle	142	26.4
Fall/jump	91	16.9
Machinery	64	11.9
Blunt instrument	60	11.2
Firearm	54	10.1
Transportation (not motor vehicle)	11	2.0
Asphyxia	10	1.9
Electrocution	10	1.9
Fire/burns	9	1.7
Poisoning	8	1.5
Other	78	14.5
Intentionality		
Unintentional injury	428	79.7
Intentional injury (suicide, homicide)	71	13.2
Undetermined	38	7.1

Intentional deaths denote purposeful intent to cause harm or death such as homicide and suicide.

in increases in aggregate fatal occupational injury rates due to more workers ageing into higher rate strata. We estimate yearly rates of fatal occupational injury among groups of workers, as well as describe the distribution of deaths and death rates among industries.

METHODS

Study setting

North Carolina is the ninth most populous state in the USA and the third most populous state in the southeast. Since the 1980s, the state's urban population has grown rapidly, and the economy has transitioned from agricultural and manufacturing dominance to service sector and technology industries.[15–17]

Fatal occupational injury

All fatal occupational injuries in the state of North Carolina are required by law to be investigated by a medical examiner,[18] overseen by the chief medical examiner in the state capital of Raleigh. Medical examiners are required to determine the cause of death, the circumstances that lead to each fatal injury, and the location of injury, including whether the injury occurred at work,[18] and complete a death certificate. Reports on all fatal injuries from local medical examiners are transmitted to the Office of the Chief Medical Examiner (OCME), Department of Health and Human Services, which maintains a statewide reporting, coding, and data retrieval system. Two data sources were used to identify potential cases of fatal occupational injury; the OCME data system and the North Carolina State Center for Health Statistics (SCHS) death certificate data system. All deaths occurring between 1 January 2000 to 31 December 2017, that were flagged as 'at work' in the SCHS data system or 'on the job' in the OCME data system were eligible for study inclusion. For the purposes of this study, a fatal occupational injury is defined as any injury resulting in death within 30 days of the injury event, whether intentional (homicide, suicide) or unintentional (not purposefully inflicted), determined by a medical examiner to have been sustained while in North Carolina while working for legal pay (ie, excluding illegal income-generating activities), and regardless of immigration status.

Trained investigators abstracted demographic and occupational data from the records of the OCME, including the official death certificate, autopsy results, family interviews and witness and police statements. Investigators reviewed all case reports, which included information from the physical death records as well as supplemental sources including news reports and obituaries. Information on the industry that corresponds with the activity that decedents were engaged in at the time of fatal injury was abstracted from the medical examiner report and coded to the U.S. Census year 2000 guidelines.[19] Decedents were classified based on age in 10-year age groups (beginning at age 55), 3 race groups (white, black, other), manner of death (intentional, unintentional) and ethnicity (Latino/a or non-Latino/a: gender-neutral terms denoting persons with Central American, South American, and Caribbean heritage) derived from the death certificate, medical examiner report, with validation from supplemental sources when available.

Population at risk

Yearly estimates of the North Carolina work force were cross classified by age, sex, race, ethnicity and industry (in 51 groups defined by census codes) categories obtained from the 2000 decennial US Census and the 2004—2017 American Community Survey (ACS). The ACS was deployed in 2004 and replaces the long-form decennial census, providing yearly estimates of the demographic and employment characteristics of the population of the USA. Linear interpolation between the 2000 decennial Census and the 2004 ACS was used to estimate the population at risk between 2001 and 2003. These yearly census estimates of the working population were used to estimate the number of person years at risk in each stratum in that calendar year.

Statistical methods

Yearly rates of fatal occupational injury were modelled as a Poisson distributed variable, and the natural logarithm of the yearly estimate of the population at risk as the regression model offset. The overall unadjusted model for a crude trend in rates is expressed as: $\log(\text{annual rate}) = \beta 0 + \beta 1\ (\text{Year} - 2000)$. Calendar year was entered as a continuous variable to estimate the average change in rate per year. Sex-adjusted estimates of fatal occupational injury rates were calculated by including a binary indicator variable for sex in the regression model. All analyses were conducted using SAS V.9.4 (SAS Institute).

To estimate the trend in rates in the pre-recession period, this model was fitted to the study data restricted to the period 2000–2007. To estimate the trend in rates in the post-recession period, this model was fitted to the study data restricted to the period 2009–2017. We report estimates of the yearly per cent change in

Table 2 Change in distribution of workforce by industry: pre-recession (2000–2007) versus post recession (2009–2017), North Carolina

Largest absolute increase		Largest percentage increase		Largest percentage decline or smallest percentage Increase*	
Industry	Change in workforce (%)	Industry	Change in workforce (%)	Industry	Change in workforce (%)
Professional services	1 313 138 (108%)	Paper and Allied Product Mfg	2411 (1512%)	Furniture and Fixtures Mfg	−11 380 (−883%)
Finance, insurance, real estate	224 537 (149%)	Agriculture	12 562 (703%)	Wood Buildings and Mobile Homes Mfg	−542 (−675%)
Retail	221 769 (186%)	Sawmills and Wood Mfg	6957 (406%)	Textile Mill Product Mfg	−34 405 (−373%)
Business and repair services	167 363 (90%)	Printing and publishing	12 397 (394%)	Apparel and Finished Textiles Mfg	−14 185 (−347%)
Construction	152 444 (204%)	Fishing/hunting/trapping	707 (318%)	Food and Associated Product Mfg	58 396 (67%)
Public administration	130 485 (137%)	Misc manufacturing	16 462 (302%)	Chemicals and Petroleum Mfg	65 104 (71%)
Machinery and transport equipment Mfg	107 556 (89%)	Forestry	3881 (255%)	Transport/taxi	5784 (73%)
Wholesale	78 940 (227%)	Wholesale	78 940 (227%)	Personnel supply services	27 155 (77%)
Eating and drinking places	78 796 (127%)	Detective/protective services	15 224 (204%)	Electric Gas/pipeline/ other utility	36 451 (84%)
Transport bus/truck	72 291 (150%)	Construction	152 444 (204%)	Mining and oil	5168 (85%)

Data are presented as difference in number of employees (% difference) between the pre-recession and post-recession periods.
*Strong economic growth during the study period resulted in only four industries with declining employment.
Mfg, manufacturing.

fatality rate in each period derived from the fitted Poison regression model as 100 [exp(β1)–1].

To evaluate our hypothesis that the rates in the two periods would be different, we included a binary variable for the post-recession period (1 if post, else 0) as well as an interaction term between this variable and calendar year. The contrast in rate between the two periods is estimated using the Wald test statistic for the interaction term between the post-period variable and calendar year, evaluated at the $\alpha=0.05$ level. To evaluate the difference in trends of occupational fatality between the two study periods, a model was fit to the data for the entire period 2000–2017 of the form $\log(AnnualRate) = \beta_0 + \beta_1(Year - 2000) + \beta_2(Y2008) + \beta_3(PostRecession) + \beta_4(Y2009)$, where the variable Y2008 is a binary variable that takes a value of 1 in 2008, else 0, the variable 'post-recession' is a binary variable that takes a value of 1 if year≥2009, else 0; and the variable Y2009 is a variable that takes a value of (year-2008) if year≥2009, else 0. The contrast in rate trend between the pre-period and post period is estimated by exponentiating the β_4 coefficient, and a test of the null hypothesis that the trends are equal was evaluated using a Wald test statistic at the $\alpha=0.05$ level. We also report a dispersion parameter (ϕ), defined as the ratio of the residual deviance to df as a diagnostic indicator of overdispersion, with a value greater than 1 indication potential overdispersion. All models had dispersion parameters less than 1.0.

RESULTS

Between 2000 and 2017, 537 occupational fatalities were observed in North Carolina among those 55 years of age or older. Among these older deceased workers, 512 decedents (95.3%) were male, 438 (81.6%) were white, 81 (15.1%) were black, and 20 (3.7%) were identified as Latino/a (table 1).

During the years between 2000 and 2017, there was a doubling of the number of older workers from 506 000 workers to 1 055 000. The proportion of older workers in the workforce increased from 13.5% of the workforce in 2000 to 22.0% of the workforce in 2017. During this period, the number of workers 55–65 years of age increased by more than 65%, the number of workers 65–75 increased by more than 83%, and the number of workers 75 years of age or greater increased by more than 54% (online supplemental table 1). The change in the workforce among selected industries is detailed in table 2, stratified by greatest absolute and percentage change, as well as greatest decline.

The industries with the highest counts of fatalities among older workers are detailed in table 3, along with the distribution of manner of death in each industry. Older workers employed in construction, agriculture and transportation died in the largest numbers, while the rates of fatal occupational injury were highest in forestry, hunting fishing and trapping, and transportation (table 4). Disaggregating fatal occupational injury counts and rates into intentional and unintentional injuries reveals an overlap between the highest number and highest rate industries. For example, grocery stores and gas stations were among the highest three industries for both rate and number of intentional occupational fatalities.

During the entire study period, the estimated annual rate of fatal occupational injury declined among older workers by an estimated 2.8 percentage points per year (95% CI −4.5% to −1.0%, $\phi=0.19$). The average rate of fatal occupational injury was 1.4 deaths per 100 000 worker years lower in the post-recession period (4.8 vs 3.3, $\phi=0.19$) and the interaction term between year and post-recession period was significant (Wald $\chi^2=5.1$, $p=0.02$).

After estimating the rate during the entire study period and comparing the average rate in the pre-recession and post-recession period, we examined whether annual trends in fatal occupational injury rate among older workers increased in the post-recession period. In the pre-recession period, spanning the years 2000–2007, the fatal occupational injury rate among older workers decreased by an estimated 7.7 percentage points per year (−11.7%, −2.2%, $\phi=0.31$). In the post-recession period, fatal occupational injury rates among older workers were lower, but trended upwards by an estimated 1.4 percentage points per year (−3.8%, 5.9%, $\phi=0.14$, table 5). Rate trends were significantly different between the two periods, with older workers

Table 3 Leading industries by number of fatal occupational injuries and intentionality among older workers (age 55+ years), North Carolina (2000–2017)

Unintentional			Intentional		
Industry	Deaths	Rate/10^5 person years	Industry	Deaths	Rate/10^5 person years
Construction	81	9.9 (7.9, 12.2)	Retail	8	0.7 (0.4, 1.4)
Agriculture	72	23.7 (18.8, 29.8)	Grocery/food	8	3.3 (1.6, 6.5)
Transport bus/truck	66	21.4 (16.8, 27.2)	Gas/service stations	6	18.5 (8.3, 41.2)
Retail	19	1.7 (1.1, 2.7)	Construction	4	0.5 (0.2, 1.3)
Wholesale	18	3.9 (2.4, 6.1)	Eating/drinking places	4	1.4 (0.5, 3.6)
Forestry	17	65.6 (40.8, 105.6)	Justice/public safety	4	0.3 (0.2, 0.5)
Professional services	14	0.3 (0.2, 0.5)	Transport/taxi	3	20.1 (6.5, 62.3)
Automotive sales/service repair	10	1.9 (2.8, 8.4)	Transport/bus/truck	3	1.0 (0.3, 3.0)
Warehouse storage/transport	8	7.5 (3.8, 15.0)	Automotive sales/service repair	3	0.6 (0.2, 1.8)

Data are presented as rates per 100 000 worker years (95% CI).
Intentional deaths denote purposeful intent to cause harm or death, that is, homicide and suicide.

experiencing estimated rate increases in the post-recession period compared with the pre-recession period. Workers 65 years and older experienced different trends, with annual rate increases observed in both periods, increasing by 1.4 percentage points per year (−9.0%, 12.9%, ϕ=0.34) in the preperiod and 4.4 percentage points per year (−3.9%, 13.5% ϕ=0.13) in the post period.

DISCUSSION

In North Carolina, the proportion of the workforce composed of older workers increased steadily during the early years of the millennium. During the years immediately following 2008, the workforce participation among older workers declined, likely due to a variety of recession-related outcomes including job loss, acceptance of early retirement offers and inability to find work. By 2011, workforce participation among older workers recovered and continued to increase throughout the post-recession period. A strong economic climate in the first half of the study period may have fuelled the increase in pre-recession employment of older workers, as previous studies have suggested an association between economic improvement and increased employment among older workers.[20] We hypothesised that the great recession of 2008 would further increase this participation by delaying the retirement of the oldest workers via loss of value of retirement investments.[14 21] Distance to retirement has been identified as a significant driver of employment patterns among older workers, especially in competitive labour markets.[22–24] Increased participation rates during economic downturn can relate to fatal occupational injury rates via a variety of mechanisms, including (but not limited to): (1) older workers entering dangerous or unfamiliar professions after loss of their primary job, (2) decreased spending by organisations on new machinery, equipment, and safety training and (3) a decrease in the number of available workers for dangerous tasks, potentially increasing the requirements for overtime and probability of fatal incident.

We found that the rate of fatal occupational injury among older workers declined from a mean 4.8 deaths per 100 000 worker years in the pre-recession period to 3.3 deaths in the post-recession period. We hypothesised that the rate of occupational injury in the period following the recession of 2008 would increase. While we did identify a trend towards an increase in the fatal occupational injury rate during the post period (1.4 percentage points), the sharp decline observed in the pre-recession period was followed by relatively stable rates. In contrast to this apparent stabilisation among the older worker group, workers over 65 experienced increasing annual rates of fatal occupational injury in both the preperiod and post period (1.4 percentage points, 4.4 percentage points, respectively) that may signal a trend towards reversion to the pre-recession rate.

Table 4 Leading industries by rate of fatal occupational injury and Intentionality among older workers (age 55+ years), North Carolina (2000–2017)

Unintentional		Intentional	
Industry	Rate/10^5 Person years	Industry	Rate/10^5 Person years
Forestry	65.6 (40.8, 105.6)	Transport/taxi	20.1 (6.5, 62.3)
Fishing/hunting/trapping	55.8 (18.0, 172.8)	Gas/service stations	18.5 (8.3, 41.2)
Wood buildings/mobile home manufacturing	26.6 (6.7, 106.2)	Grocery/food stores	3.3 (1.6, 6.5)
Agriculture	23.7 (18.8, 29.8)	Justice/public safety	2.1 (0.8, 5.6)
Transport/bus/truck	21.4 (16.8, 27.2)	Automotive sales/service repair	1.9 (0.8, 4.5)
Transport/taxi	13.4 (3.4, 53.5)	Warehouse storage/transport	1.9 (0.5, 7.5)
Stone/clay/glass/concrete manufacturing	10.3 (4.6, 23.0)	Stone/clay/glass/concrete manufacturing	1.7 (0.2, 12.2)
Construction	9.8 (7.9, 12.2)	Eating/drinking places	1.4 (0.5, 3.6)
Warehouse storage/transport	7.5 (3.8, 15.0)	Lodging	1.1 (0.2, 7.8)

Data are presented as rates per 100 000 worker years (95% CI).
Intentional deaths denote purposeful intent to cause harm or death, that is, homicide and suicide.

Table 5 Rates of fatal occupational injury among age groups, by study period, North Carolina (2000–2017)

	Full study period 2000–2017		2000–2007		2009–2017	
Age group	Rate /10^5 (95% CI)*	Annual rate change (95% CI)†	Rate /10^5 (95% CI)*	Annual rate change (95% CI)†	Rate /10^5 (95% CI)*	Annual rate change (95% CI)†
(55+)	3.4 (3.1 to 3.7)	−2.8% (−4.5% to −1.0%)	4.0 (3.5 to 4.6)	−7.7% (−11.7% to −2.2%)	3.0 (2.7 to 3.4)	1.4% (−3.8% to 5.9%)
55–64	2.9 (2.6 to 3.2)	−3.5% (−5.6 to −1.4)	3.4 (2.9 to 4.1)	−11.5% (−17.9 to 4.6)	2.6 (2.2 to 3.1)	−1.3% (−7.0 to 4.8)
65+	6.1 (4.7 to 7.7)	−1.7% (−4.6 to 1.5)	6.0 (4.8 to 7.6)	1.4% (−9.0% to 12.9%)	4.5 (3.7 to 5.6)	4.4% (−3.9% to 13.5%)

*Data are presented as: Average rate of fatal occupational injuries per 100 000 worker years during time period indicated (95% CI).
†Yearly change in rate during period indicated (95% CI).

The ageing of the post-WW2 generation is receiving greater attention as a significant public health concern. Older workers have historically experienced high rates of fatal occupational injury, and our results suggest that contrary to our hypothesis, the recession of 2008 was associated with a decline and stabilisation of fatal occupational injury rates among older workers. However, we identify a concerning signal among all age groups of workers, especially those over 65, of increasing fatal occupational injury rates in the post-recession period. If these trends continue, we hypothesise further increases in the fatal occupational injury rate as well as years of potential life lost as workforce participation continues to increase, resulting in a large group of workers ageing into higher rate strata.

Older workers may be uniquely vulnerable to occupational fatality as rapid technological advances remodel the workplace.[25] Age-related changes may also contribute to the relationship between age and fatal occupational injury, as declines in proprioception, balance, vision and hearing may increase the likelihood of falls or collisions, while impairing a worker's ability to see a hazard or hear a warning signal.[6 7 26] Older workers may also experience elevated levels of financial uncertainty, especially during the period surrounding the great recession, that combined with ageism in hiring may make changing jobs more difficult than for their younger colleagues.[27 28] Physical limitations are also a factor in employment transition for older workers, as the accumulated burden of musculoskeletal injuries from a lifetime of work,[29] the challenges inherent in requesting ergonomic or other accommodations,[30] and reductions in their ability to endure extreme environmental or strenuous labour conditions may reduce competitiveness in the job market.[31 32] Companies may also perceive, sometimes correctly, that older workers may have higher health insurance costs, greater rates of absenteeism, and take longer to recover from injuries.[33] While the rate of intentional fatal occupational injury (homicide, suicide) did decrease during the study period, overall 13% of all deaths among older workers during the study period were intentional fatal occupational injuries.

The loss of older workers is of great concern to public health, as well as the companies that employ them. Older workers are often charged with training employees and may have extensive experience in safely completing hazardous tasks. The death of these employees also represents a loss of institutional memory functions, including those that identify policies that will increase hazards. Older workers may also play a mediating role as organisations seek to improve their profitability (or stem their losses) during a downturn, by pushing back against austerity initiatives that could increase hazards, such as reducing training/onboarding time, decreasing the frequency of maintenance, or assigning inexperienced employees to hazardous jobs. The presence of older workers may also exert a stabilising effect in some industries, decreasing bullying, horseplay, risk taking and posturing among younger workers. While older workers themselves may have high rates of occupational fatality, the loss of older workers in the workplace may have unexpected effects on the occupational fatality rates of their colleagues.

Our study has three primary strengths, the first involves a robust system of medical examiners in North Carolina who are empowered to seek administrative search warrants as needed to investigate both accidental and intentional deaths. Second, we identified fatal occupational injuries using two state databases, including the OCME, and the State Center for Health Statistics, to identify potential occupational fatalities. Finally, we conducted thorough reviews of multiple sources of information to validate the demographic information of decedents and the circumstances that resulted in fatal occupational injury, a more sensitive approach than using the death certificate alone. Limitations to our study include generalisability, while North Carolina is considered a 'sentinel state' for the American South (trends observed in North Carolina suggest similar trends are incipient in other southern states) the relationship between the Great Recession of 2008 may be different in different states and countries. As the post-World War II population increase was experienced in many countries, we hypothesise that these trends may be similar in other countries, especially those in which long work careers are common. For example, we hypothesise that delayed retirement initiatives adopted by several European countries[34 35] may result in a larger proportion of older workers remaining in the workforce with concomitant increases in the number of fatal occupational injuries. Another limitation involves potential bias in our denominator due to sampling limitations of the decennial and ACS population estimates. We hypothesise that potential misspecification of the denominator would involve overestimates of the population at risk, resulting in underestimation of the rate of fatal occupational injury. While misspecification of the denominator may result in bias in yearly estimates of the fatal occupational injury rate, we note that estimates of trend are robust to misclassification of the population at risk, provided that misspecification of the workforce is consistent over time. We also did not examine the number of hours worked (part time, full time) due to the highly stratified nature of our data, which has been found in some settings to underestimate the rate of injury among older workers.[36] Finally, we did not evaluate the type of injuries sustained by workers (eg, falls, machinery) beyond their intentionality, which may provide important information to inform interventions aimed at reducing these events. Our aim in conducting statistical analysis of these observational data is summarisation, smoothing and pattern recognition,[37] and we therefore focus on reporting events, rates and trends, rather than statistical null hypothesis testing and p values.

CONCLUSION

As demographics continue to shift in the USA and worldwide, and the post-World War II generation continues to age, we present evidence confirming previous research identifying older workers as experiencing high rates of fatal occupational injury as a significant public health concern. We also identify a post-recession trend towards increasing fatality rates among older workers, especially among those 65 years of age and older. While fatality rates declined from their highest levels in the year 2000, driven primarily by the rapid drop during the Great Recession of 2008, this trend stalls or reverses in the years following the recession. In the setting of an ageing global population and worldwide economic uncertainty, insights from previous economic shocks may be useful to inform efforts to limit the impact on vulnerable groups.

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Contributors MMR is the guarantor of this work, accepts full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish. MMR conceived the study aim, assisted with data acquisition, built the study data set, led the analysis, and wrote the manuscript. MMR is accountable for the integrity and accuracy of the work. DBR provided intellectual andmethodological guidance on developing the study aim and analysis, was the leader of the data acquisition process, and assisted with intellectual and editorial development of the manuscript. YG, SWM, WN and AK provided methodological and editorial guidance during the study development, manuscript writing and editing process. MN lead the data acquisition team, managed data quality efforts, and provided methodological and editorial guidance during the study development, manuscript writing and editing process.

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