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Fatal occupational injuries in North Carolina, 1992–2017

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Abstract

Objectives: After declining for several decades, fatal occupational injury rates have stagnated in the United States since 2009. To revive advancements in workplace safety, interventions targeting at-risk worker groups must be implemented. Our study aims to identify these at-risk populations by evaluating disparities in unintentional occupational fatalities occurring in North Carolina (NC) from 1992–2017.

Methods: Our retrospective cohort study drew upon both the NC Office of the Chief Medical Examiner system and the NC death certificate data system to identify unintentional fatal occupational injuries occurring from 1992–2017. Unintentional fatal occupational injury rates were reported across industries, occupations, and demographic groups, and rate ratios were calculated to assess disparities.

Results: Among those aged 18 and older, 2645 unintentional fatal occupational injuries were identified. Fatal occupational injury rates declined by 0.82 injuries/ 100,000 person-years over this period, falling consistently from 2004–2009 and increasing from 2009–2017. Fatal injury rates were highest among Hispanic workers, who experienced 2.75 times the fatal injury rate of non-Hispanic White workers (95%CI: 2.42, 3.11) and self-employed workers, who experienced 1.44 times the fatal injury rate of private workers (95%CI: 1.29, 1.60). We also observed that fatal injury rates increased with age-group and were higher among male relative to female workers even after adjustment for differential distributions across occupations.

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RESEARCH ETHICS APPROVAL: This study was reviewed by the University of North Carolina Office of Human Research Ethics and was determined to not constitute human subjects research.

Conclusions: The decline in unintentional fatal occupational injury rates over this period is encouraging, but the increase in injury rate after 2009 and the large disparities between occupations, industries, and demographic groups highlight the need for additional targeted safety interventions.

Occupational injuries place a substantial burden on public health in the United States (US). According to the Bureau of Labor Statistics (BLS), about 2.8 million occupational injuries were reported among US workers in 2021, of which 5,190 were fatal [1,2]. While the rate of non-fatal occupational injury in the US has declined steadily over the last 10 years, the rate of fatal occupational injury has remained relatively consistent since 2009, suggesting that the efficacy of occupational safety initiatives may have stagnated in recent years [1–7]. For example, this lack of progress may indicate that current safety efforts do not adequately address the needs of older workers, who have been shown to be at high risk for fatal injury and who make up an increasing portion of the US workforce [8–10]. Fatal injury trends within the construction and agriculture industries are also of particular concern, as workers in these fields have been found to be at high risk for fatal injury both globally and in the US [11–16]. In the US, self-employed and Hispanic workers have also been shown to be at increased risk for occupational fatal injury [8,12,17]. As the US' economy transitions and workforce expands, ages, and diversifies, it is vital to benchmark fatal occupational injury rates and document the disparities therein to identify high-risk populations and facilitate the allocation of resources towards at-risk workforce groups.

We focus on unintentional fatal occupational injury rates in North Carolina (NC), which in 2021 had the 9th largest workforce and the 6th highest number of occupational fatal injuries in the nation [18,19]. This study reports on the epidemiology of fatal occupational injury in NC from 1992–2017, focusing on unintentional injury deaths, with the goal of identifying areas for research and injury prevention. This study builds upon a prior study carried out by our team, examining occupational fatal injury disparities and trends in NC from 1977–1991 [20].

METHODS

The NC Medical Examiner system retrieves, codes, and reports data maintained by the Office of the Chief Medical Examiner (OCME). The OCME obtains fatal injury data from local medical examiners (MEs) in each of the counties in NC. All injury-related deaths in NC are investigated by the OCME. Each ME determines the causes of and circumstances surrounding deaths in their jurisdiction, including whether the injuries that led to death occurred at work. The NC ME system has previously been shown to be a reliable source of occupational injury and fatality data for epidemiological studies [21–24].

Data on occupational deaths occurring in NC between January 1, 1992 and December 31, 2017 were collected using the NC ME system and the NC State Center for Health Statistics (SCHS) death certificate data system. An occupational fatal injury was defined as any injury leading to death within 30 days that was sustained by an individual in NC engaged in legal work for pay or engaged in work for their personal or family-owned business. Military deaths were excluded from this analysis as these deaths are incompletely reported to the

OCME. This report is restricted to unintentional fatal injuries, meaning that the manner of death was determined to be an “accident”. Homicides, suicides, and fatalities for which the manner of death was undetermined, were not included.

Deaths during the study period that were flagged as “at work” in the SCHS death certificate data system or “on the job” in the OCME data system were eligible for inclusion. Data were abstracted from the OCME records, including the ME reports, official death certificates, autopsy results, and toxicology results. A review of the circumstances surrounding each death was then conducted. Complex cases, defined as cases in which there was discordance between the “at work” flag on the death certificate and the “on the job” flag in the OCME record, were adjudicated by trained investigators using information abstracted from supplemental sources, such as family interviews, witness and police statements, news clippings, court transcripts, and crime scene reports, to make a final determination of “at work status” for purposes of inclusion.

Information on the means of death, age, sex, race, and ethnicity of decedents was abstracted from the death certificate and the ME report. Race was coded as “White”, “Black”, “American Indian or Alaska Native” (AI/AN), “Asian and Pacific Islander” (API), and “other race”, and ethnicity was categorized as “Hispanic” or “non-Hispanic”. In analyses stratified by race and ethnicity, decedents were grouped as “Hispanic”, “non-Hispanic White”, and “non-Hispanic Black”. Non-Hispanic decedents who were classified as “AI/AN”, “API”, and “other race” were excluded from race and ethnicity-stratified analyses due to limitations in workforce-estimate data. Causes of injury were examined using information on the means of death, which was assigned by the ME using ICD-9 and ICD-10 codes. Information on occupation and industry at time of fatal injury was abstracted from the ME report and coded to align with US Census industry and occupation groups using the NIOSH Industry and Occupation Computerized Coding System [25].

Estimates of workforce size stratified by age, sex, race/ethnicity, class of worker, occupation, and industry were derived from the 1990, 2000, and 2010 decennial US censuses of the population; worker populations in intercensal years were estimated by linear interpolation and extrapolation methods that assumed within-stratum linear changes in labor force participation between each decennial census [26]. The observed deaths and population data were used to estimate rates of fatal occupational injury per 100,000 person-years.

We calculated and plotted the overall fatal injury rate for each year in the study period and smoothed the data using a Locally Weighted Scatterplot Smoothing (LOWESS) curve. We examined fatal occupational injury rates by age, sex, race/ethnicity, class of worker, occupation, and industry, calculating crude, occupation-adjusted, and age-adjusted fatal injury rates for each of these groups. Occupation-adjusted rates were calculated to determine to what extent disparities were attributable to differential workforce distribution in high-risk occupations. Occupation-adjusted rates were derived by standardizing rates to the occupation distribution of the total NC workforce over the study period. Age-adjusted rates were derived by standardizing rates to the age distribution of the total NC workforce over the study period. Rate Ratios (RRs) and 95% confidence intervals (95% CIs) were calculated to compare rates between different demographic groups. Population attributable risks (PARs)

for each occupation and industry were calculated to determine the absolute fatal injury burden contributed by each occupation and industry respectively [27].

RESULTS

During the study period, 2,663 civilian deaths from unintentional occupational injuries were identified. 18 of these fatal injuries occurred among workers younger than 18 years of age, with the youngest decedent being 14 years of age. For fatal injuries among these younger workers, the leading industries were agriculture and construction, and the leading occupations were farmworker and construction worker. The leading means of death were machinery-related accidents, followed by falls/jumps and motor vehicle (MV) accidents. The remainder of this analysis focuses on the 2645 decedents aged 18 years and older, due to a lack of workforce-estimate data for workers under 18 years of age (Table 1).

The average NC fatal injury rate for workers aged 18+ years over the period 1992–2017 was 2.42 injuries/100,000 person-years. From 1992–2017, the overall fatal injury rate declined by 0.82 injuries/100,000 person-years. Over this period, the average annual fatal injury rate remained relatively stable from 1992–2004, declined from 2004–2009, and subsequently increased from 2009–2017 (Figure 1). Over the study period, the estimated size of the NC workforce increased by 64% (Supplementary Table 3). Fatal occupational injury rates increased consistently with age (Table 2). Relative to 18–24 year-old individuals, the fatal injury rate among those aged 65–74 was 3.41 times as high (95% CI: 2.79, 4.17), and the rate among those aged 75+ was 6.06 times as high (95% CI: 4.68, 7.85).

The largest number of fatal injuries occurred in the construction occupation, followed by the MV transport and farmworker occupations (Table 3, Supplementary Table 1). The occupations with the highest fatal injury rates were the forestry and logging, fishing, hunting, and trapping, extractive, rail transport, and farmworker occupations (Table 3). Fatal injury rates were low in the precision woodworking, food preparation and services, health services, other services, and sales and administrative support occupations.

The MV transport occupation had the highest population attributable risk (PAR) (17.34%), reflecting the moderately high fatal injury rate and large number of workers in this occupation (Table 3). Additionally, high PARs were associated with the construction (17.01%), farmworker (6.40%), other agricultural (5.06%), and forestry and logging (5.00%) occupations. The managerial and professional specialty occupation had the lowest PAR (−29.55%), followed by the sales and administrative support occupation (−25.76%), indicating that the low fatal injury rates in these occupations contributed to reducing the state’s overall average fatal injury rate.

When examined by industry, the largest number of unintentional fatal injuries occurred in the construction industry, followed by the bus, trolley, and truck transport industry and agriculture industry (Table 4, Supplementary Table 2). The highest crude unintentional fatal injury rates were observed in the forestry and logging, fishing, hunting, and trapping, agriculture, agricultural services, and bus, trolley, and truck transport industries.

The construction industry had the highest PAR (20.44%), reflecting the moderately high death rate and large number of workers in this industry (Table 4). Additionally, high PARs were associated with the bus, trolley, and truck transport (8.83%), agriculture (7.06%), agricultural services (5.22%), and forestry and logging (5.11%) industries. The professional and related services industry had the lowest PAR (−29.28%), indicating that the low fatal injury rate in this industry contributed to reducing the state's overall average fatal injury rate.

Most unintentional occupational fatal injuries occurred among workers employed in the private sector (Table 1). However, the average fatal injury rate was highest among self-employed workers relative to private and civilian government workers (Table 2). Relative to private workers, the fatal injury rate among self-employed workers was 1.44 times as high (95% CI: 1.29, 1.60) and the rate among government workers was 0.51 times as high (95% CI: 0.44, 0.59). The age-adjusted fatal injury rate among self-employed workers was 1.13 times that among private workers (95% CI: 1.00, 1.27), and the occupation-adjusted fatal injury rate among self-employed workers was 0.95 times that among private workers (95% CI: 0.82, 1.09). While age and occupation-adjustment substantially shifted injury rates among self-employed workers, crude and adjusted rates for private and government workers remained relatively consistent.

Among men, the crude fatal injury rate was 4.36/ 100,000 person-years; among women, the crude fatal injury rate was 0.20/ 100,000 person-years (Table 2). After adjusting for age, the relative rate comparing men to women was 21.26 (95% CI: 17.47, 25.87). After adjusting for occupation, the fatal injury rate among men was 7.66 times the rate of women (95% CI: 5.69, 10.33).

Most fatal occupational injuries occurred among non-Hispanic White workers (1840 deaths), followed by non-Hispanic Black workers (466 deaths) and Hispanic workers (280 deaths) (Table 1). The crude fatal injury rate was 6.33/ 100,000 person-years among Hispanic workers, 2.31/ 100,000 person-years among non-Hispanic Black workers, and 2.30/ 100,000 person-years among non-Hispanic White workers (Table 2). The crude fatal injury rate among Hispanic workers was 2.75 times that of non-Hispanic White workers (95% CI: 2.42, 3.11) and the crude fatal injury rate among non-Hispanic Black workers was 1.00 times that of non-Hispanic White workers (95% CI: 0.91, 1.11). The age-adjusted fatal injury rate among Hispanic workers was 3.96 times that of non-Hispanic White workers (95% CI: 3.36, 4.66) and the occupation-adjusted fatal injury rate among Hispanic workers was 1.40 times that of non-Hispanic White workers (95% CI: 1.15, 1.71). While age and occupation-adjustment substantially shifted injury rates among Hispanic workers, crude and adjusted rates for non-Hispanic White and Black workers remained relatively consistent.

The overall decline in fatal injury rate from 2004–2009 and increase from 2009–2017 corresponded closely to trends within high-PAR occupations and industries, specifically the construction occupation and industry, the forestry and logging occupation and industry, the MV transport occupation, and the bus, trolley, and truck transport industry (Supplementary Table 5). We also found that the overall fatal injury rate decline and subsequent increase paralleled trends within every race/ethnicity group, with the decline from 2004–2009 being most pronounce within the Hispanic workforce, and the increase after 2009 being pronounce

within both the Hispanic and non-Hispanic Black workforces (Supplementary Table 6). Similar trends were also observed within all age groups and among all worker classes, most apparently among privately-employed workers. These trends were not observed when we restricted to female workers.

Overall, MV accident was the most common means of unintentional occupational fatal injury, accounting for one third of all injuries. Other leading means of fatal occupational injury included falling/jumping, machinery-related accident, blunt force, and electrocution (Supplementary Table 4). Rates of fatal MV accidents, machinery-related accidents, and electrocutions fell consistently between about 2000 and 2009. Rates of electrocution then stagnated, while fatal MV and machinery-related accident rates increased consistently until 2017. Rates of accidents involving blunt force fell sharply between 2003 and 2006, and then remained relatively consistent until 2017. Rates of fatal injury resulting from falling/jumping did not show substantial change over the period of study.

DISCUSSION

In this surveillance of fatal occupational injuries in NC from 1992–2017, we found that the overall fatal injury rate among those aged 18 and older declined by 0.82 injuries/100,000 person-years over this period, but that the fatal injury rate increased from 2009–2017. This is consistent with data from the BLS, which show that national fatal occupational injury rates declined steadily between the early 1980s and early 2000s, but have either stagnated or increased since 2009 [2,6,7,28–30]. While this recent increase was only observed among men in our study, it was observed consistently across race/ethnicity, class, and age groups, suggesting that this trend reversal is indicative of industry and occupation-wide shortcomings in safety that impact a wide range of workers. Rates of fatal injury due to MV and machinery-related accidents increased consistently after 2009, as did fatal injury rates within the construction, forestry and logging, and MV transport industries and occupations. These findings align with literature reporting that, globally, road accidents are the leading means of occupational fatality, and that little progress has been made in recent years to reduce MV transport and machinery-related accidents or to reduce injury rates in the construction industry [8,11,22,31–34].

We found that fatal injury rates were higher among men than among women and that this disparity was attenuated, but not eliminated, after adjustment for occupation. This may suggest that men are more likely to be employed in high-risk industries and occupations and that, within the same occupations, men generally carry out more dangerous tasks compared to women. This is consistent with literature that indicates that occupation and job-activity segregation remained commonplace over our period of study, with men working in more physically strenuous and dangerous jobs on average compared to women [35–37]. Additionally, this disparity may be indicative of differences between men and women regarding how occupational safety is generally perceived and approached.

In this study, fatal injury rates in all age groups from 1992–2017 were lower than those reported in NC during the 1977–1991 period [20]. We found that older workers experienced substantially higher fatal injury rates than younger workers, and that the youngest workers

had the lowest fatal injury rates. This contrasts our prior finding that middle-age workers experienced the lowest fatal injury rates in NC during the 1977–1991 period [20]. These results are notable given prior findings that, from 2012–2018, US workers younger than 25 had the highest rates of non-fatal occupational injury [38]. These findings taken together may indicate that, while younger workers in general are still prone to non-fatal injuries due to a lack of workplace experience, they may be less likely to pursue work within highly hazardous industries and occupations relative to younger workers in prior decades and relative to workers in older age-groups. While the overall decline in fatal injury rate within all age groups since the 1977–1991 period is encouraging, assessing the drivers of the substantially elevated fatal injury rates among older workers in NC is vital due to NC's rapidly aging workforce.

We found that Hispanic workers had the highest fatal injury rates during the period of study. This is consistent with earlier findings, which showed that, in the Southern US, the fatal occupational injury rate among Hispanic workers overtook that among non-Hispanic Black workers in the mid-1990s [17]. Fatal injury rates among Hispanic workers are important to assess as the Hispanic workforce of NC has grown at a rapid pace, and these fatal injury trends demonstrate that this growing population is being placed at undue risk for occupational injury. After standardizing rates to the age-distribution of the total NC workforce, the fatal injury rate among Hispanic workers became greater relative to the crude rate, indicating that Hispanic workers were younger on average relative to the overall NC workforce and that, had the Hispanic workforce had the age-distribution of the overall NC workforce, its average fatal injury rate would be even higher than observed. Additionally, occupation-adjustment reduced the fatal injury rate among Hispanic workers, suggesting that occupational segregation contributes substantially to fatal injury disparities between Hispanic and non-Hispanic workers, with Hispanic workers on average working in more dangerous industries and occupations. Additional research examining employment segregation in NC relative to health outcomes among Hispanic workers is needed.

This study found that self-employed workers had higher fatal injury rates than private and civilian government workers. However, when adjusted for occupation, the difference between the fatal injury rates of self-employed and private workers fully disappeared. This suggests that the heightened fatal injury rate among self-employed workers is largely driven by these workers being employed in more dangerous occupations relative to private workers. These findings support those of a study examining NC workers from 1978–1994, which found that, while self-employed workers had higher overall fatal injury rates relative to private workers, self-employed workers had fatal injury rates that were lower than or comparable to those among private workers within many high-PAR industries, including the construction, agriculture, and forestry and logging industries [23]. Additionally, after adjusting for age, the fatal injury rate among self-employed workers was attenuated. This indicates that self-employed workers tend to continue working into older age relative to private and government workers. Workers may also become self-employed after leaving private and government work due to retirement or employment loss. Fatal injury rates were consistently higher among self-employed and private workers relative to government workers, even after adjusting for age and occupation. This suggests that the occupational

safety oversight and regulation of workplace conditions for self-employed and private workers may be inadequate relative to those in place for government workers.

The greatest fatal injury burdens were attributable to the construction industry, bus, trolley, and truck transport industry, agriculture and agricultural services industries, and forestry and logging industry. These industries and occupations have also been found to have high fatal injury rates both in the overall US and globally [13,14,16,32,39,40]. These findings are consistent with those reported during the 1977–1991 period, during which these industries, with the exception of the agricultural services industry, were found to contribute most substantially to the overall fatal injury burden in NC [20]. The average fatal injury rate in each of these hazardous industries fell substantially between the 1977–1991 and 1992–2017 periods [20]. Based on these findings, it appears that progress has been made over these periods to improve safety within these hazardous industries, but that additional safety measures and policies are necessary to fully protect workers, who continue to be placed at heightened risk for fatal injury relative to the overall NC workforce.

This study has several limitations. Our analyses rely on rate denominator estimates that are derived from census data and reflect estimates of number of persons employed. This may imply that a person is constantly at-risk for fatal occupational injury, which is often not the case. Alternatives include the use of estimates of full-time equivalent units. However, we utilized census-based estimates when calculating persons at-risk because it allowed us to derive analyses cross-classified by age, sex, race/ethnicity, class of worker, occupation, and industry. The use of census data facilitated the calculation of more highly stratified estimates than would be possible using Current Population Survey and American Community Survey data. However, the use of this census data hinders our ability to calculate fatal injury rates for workers who do not belong to the “Hispanic”, “non-Hispanic White”, and “non-Hispanic Black” categories of race/ethnicity, and, for “self-employed” workers, the use of census data may result in an underestimation of time spent employed. Finally, this study is limited to the analyses of unintentional fatal occupational injuries. Additional research on occupational homicides and suicides is necessary to fully describe the state of occupational fatalities in NC.

In conclusion, we found that fatal occupational injury rates in NC declined throughout the first decade of the 21st century, but that these improvements have stagnated in recent years and are inequitably distributed. Further exploration of racial and sex-based differences in fatal occupational injuries by occupation and industry is warranted to allow targeting of worker safety interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Occupational Injuries and Illnesses Industry Data (2014 forward). Accessed March 23, 2023. https://data.bls.gov/cgi-bin/dsrv?is
2. National Census of Fatal Occupational Injuries in 2021. Bureau of Labor Statistics, U.S. Department of Labor; 2022. https://www.bls.gov/news.release/pdf/cfoi.pdf
3. Table SNR05. Incidence rate and number of nonfatal occupational injuries by industry and ownership, 2011. Bureau of Labor Statistics, U.S. Department of Labor; 2012. https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/soii-summary-historical/ostb3183.pdf
4. Table SNR05. Incidence rate and number of nonfatal occupational injuries by industry and ownership, 2012. Bureau of Labor Statistics, U.S. Department of Labor; 2013. https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/soii-summary-historical/ostb3573.pdf
5. Table SNR05. Incidence rate and number of nonfatal occupational injuries by industry and ownership, 2013. Bureau of Labor Statistics, U.S. Department of Labor; 2014. https://www.bls.gov/iif/nonfatal-injuries-and-illnesses-tables/soii-summary-historical/ostb3966.pdf
6. 2017 Census of Fatal Occupational Injuries Charts. Bureau of Labor Statistics, U.S. Department of Labor; 2018. https://www.bls.gov/iif/fatal-injuries-tables/archive/census-of-fatal-occupational-injuries-charts-1992-2017.pdf
7. National Census of Fatal Occupational Injuries in 2018. Bureau of Labor Statistics, U.S. Department of Labor; 2019. https://www.bls.gov/news.release/archives/cfoi_12172019.pdf
8. Marsh SM, Fosbroke DE. Trends of occupational fatalities involving machines, United States, 1992–2010. American Journal of Industrial Medicine. 2015/11/01 2015;58(11):1160–1173. doi:10.1002/ajim.22532 [PubMed: 26358658]
9. Morgan Miller R, Yvonne G, Stephen William M, et al. Trends in fatal occupational injury rates among older workers before and after the Great Recession of 2008. Occupational and Environmental Medicine. 2023;80(3):154. doi:10.1136/oemed-2022-108587 [PubMed: 36717256]
10. Smith SM, Pegula SM. Fatal occupational injuries to older workers. U.S. Bureau of Labor Statistics. 10.21916/mlr.2020.2
11. Konda S, Tiesman HM, Reichard AA. Fatal traumatic brain injuries in the construction industry, 2003−2010. American Journal of Industrial Medicine. 2016/03/01 2016;59(3):212–220. doi:10.1002/ajim.22557 [PubMed: 26765167]
12. Gubernot DM, Anderson GB, Hunting KL. Characterizing occupational heat-related mortality in the United States, 2000–2010: An analysis using the census of fatal occupational injuries database. American Journal of Industrial Medicine. 2015/02/01 2015;58(2):203–211. doi:10.1002/ajim.22381 [PubMed: 25603942]
13. Ahn YS, Bena JF, Bailer AJ. Comparison of unintentional fatal occupational injuries in the Republic of Korea and the United States. Inj Prev. Aug 2004;10(4):199–205. doi:10.1136/ip.2003.004895 [PubMed: 15314045]
14. Shim Y, Jeong J, Jeong J, Lee J, Kim Y. Comparative Analysis of the National Fatality Rate in Construction Industry Using Time-Series Approach and Equivalent Evaluation Conditions. International Journal of Environmental Research and Public Health. 2022;19(4):2312. [PubMed: 35206494]
15. Gonzalez-Delgado M, Gómez-Dantés H, Fernández-Niño JA, Robles E, Borja VH, Aguilar M. Factors Associated with Fatal Occupational Accidents among Mexican Workers: A National Analysis. PLOS ONE. 2015;10(3):e0121490. doi:10.1371/journal.pone.0121490 [PubMed: 25790063]

16. Cavlak N, Turkoglu A, Kiliccioglu D, Tokdemir M. Fatal occupational injuries in eastern Turkey between 2000 and 2016. Medicine Science | International Medical Journal. 2022;11(2)doi:10.5455/medscience.2021.12.387
17. Richardson DB, Loomis D, Bena J, Bailer AJ. Fatal Occupational Injury Rates in Southern and Non-Southern States, by Race and Hispanic Ethnicity. American Journal of Public Health. 2004;94(10):1756–1761. doi:10.2105/AJPH.94.10.1756 [PubMed: 15451746]
18. Table 1. Civilian labor force and unemployment by state and selected area, seasonally adjusted. Bureau of Labor Statistics, U.S. Department of Labor; 2021. Accessed March 12, 2023. https://www.bls.gov/news.release/laus.t01.htm
19. Number of fatal work injuries by state, 2021. Bureau of Labor Statistics, U.S. Department of Labor; 2022. https://www.bls.gov/charts/census-of-fatal-occupational-injuries/state-fatal-work-injuries-map.htm
20. Loomis DP, Richardson DB, Wolf SH, Runyan CW, Butts JD. Fatal Occupational Injuries in a Southern State. American Journal of Epidemiology. 1997;145(12):1089–1099. doi:10.1093/oxfordjournals.aje.a009071 [PubMed: 9199538]
21. Sniezek JE, Horiagon TM. Medical-examiner-reported fatal occupational injuries, North Carolina, 1978–1984. American Journal of Industrial Medicine. 1989;15(6):669–678. doi:10.1002/ajim.4700150606 [PubMed: 2750742]
22. Jackson SA, Loomis D. Fatal Occupational Injuries in the North Carolina Construction Industry, 1978–1994. Applied Occupational and Environmental Hygiene. 2002;17(1):27–33. doi:10.1080/104732202753306122 [PubMed: 11800403]
23. Mirabelli MC, Loomis D, Richardson DB. Fatal occupational injuries among self-employed workers in North Carolina. American Journal of Industrial Medicine. 2003;44(2):182–190. doi:10.1002/ajim.10244 [PubMed: 12874851]
24. Richardson DB, Cole SR, Martin AT, et al. Disparities in fatal occupational injury rates in North Carolina, 1978–2017: comparing non-managerial employees to managers. Epidemiology. / 2023;ePub(ePub):ePub–ePub.
25. NIOSH Industry and Occupation Computerized Coding System (NIOCCS). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Field Studies & Engineering, Health Informatics Branch; 2023.
26. Richardson D, Loomis D, Bailer AJ, Bena J. The effect of rate denominator source on US fatal occupational injury rate estimates. American Journal of Industrial Medicine. 2004;
27. Population Attributable Risk (PAR). In: Kirch W, ed. Encyclopedia of Public Health. Springer Netherlands; 2008:1117–1118.
28. Morbidity and Mortality Weekly Report: Fatal Occupational Injuries -- United States, 1980–1994. Centers for Disease Control and Prevention; 1998. https://www.cdc.gov/mmwr/PDF/wk/mm4715.pdf
29. Morbidity and Mortality Weekly Report: Fatal occupational injuries--United States, 1980–1997. Centers for Disease Control and Prevention; 2001. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5016a4.htm
30. National Census of Fatal Occupational Injuries in 2002 Bureau of Labor Statistics, U.S. Department of Labor; 2003. https://www.bls.gov/news.release/archives/cfoi_09172003.pdf
31. Bureau of Labor Statistics USDoL. Construction deaths due to falls, slips, and trips increased 5.9 percent in 2021. The Economics Daily: U.S. Bureau of Labor Statistics; 2023.
32. WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury, 2000–2016. World Health Organization and the International Labour Organization; 2021.
33. Smith SM. Workplace hazards of truck drivers. Monthly Labor Review. U.S. Bureau of Labor Statistics; 2015. 10.21916/mlr.2015.8
34. Jung S, Kim TK, Kim YJ, Kim YK, Kang D, Kim SY. Epidemiology of occupational injuries in construction workers between 2009 and 2018 in South Korea. American Journal of Industrial Medicine. Feb 2023;66(2):155–166. doi:10.1002/ajim.23448 [PubMed: 36433706]
35. Stier H, Yaish M. Occupational segregation and gender inequality in job quality: a multi-level approach. Work, Employment and Society. 2014;28(2):225–246. doi:10.1177/0950017013510758

36. Levanon A, Grusky DB. The Persistence of Extreme Gender Segregation in the Twenty-first Century. American Journal of Sociology. 2016;122(2):573–619. doi:10.1086/688628

37. Cohen PN. The Persistence of Workplace Gender Segregation in the US. Sociology Compass. 2013;7(11):889–899. doi:10.1111/soc4.12083

38. Guerin RJ, Reichard AA, Derk S, Hendricks KJ, Menger-Ogle LM, Okun AH. Nonfatal Occupational Injuries to Younger Workers - United States, 2012–2018. MMWR Morb Mortal Wkly Rep. 2020;(1545–861X (Electronic))

39. Shafique M, Rafiq M. An Overview of Construction Occupational Accidents in Hong Kong: A Recent Trend and Future Perspectives. Applied Sciences. 2019;9(10). doi:10.3390/app9102069

40. Ganesh CS, Krishnan R. A Review of Occupational Injury Research In Malaysia. Med J Malaysia. Jun 2016;71(Suppl 1):100–104. [PubMed: 27801392]

What is already known on this topic –

North Carolina has experienced dramatic economic and demographic transitions over the last 25 years, and it is not known how these transitions have impacted fatal occupational injury distributions across industries, occupations, and populations, hindering the implementation of targeted safety interventions.

What this study adds –

This study found that in North Carolina unintentional fatal occupational injury rates were highest within the Hispanic workforce relative to both the non-Hispanic White and non-Hispanic Black workforces, even after adjustment for differential age and occupational distributions. Self-employed workers were found to be at higher risk for occupational fatal injury relative to private and government workers, in part because self-employed workers were on average older and employed in more dangerous occupations than the overall workforce. Additionally, the greatest fatal injury burden was attributable to the construction, transport, agriculture, and forestry and logging industries and occupations.

How this study might affect research, practice or policy –

The results of this study can be used to efficiently implement safety interventions targeting workforce groups at high risk for occupational fatal injury, thereby reducing occupational mortality and improving worker health.

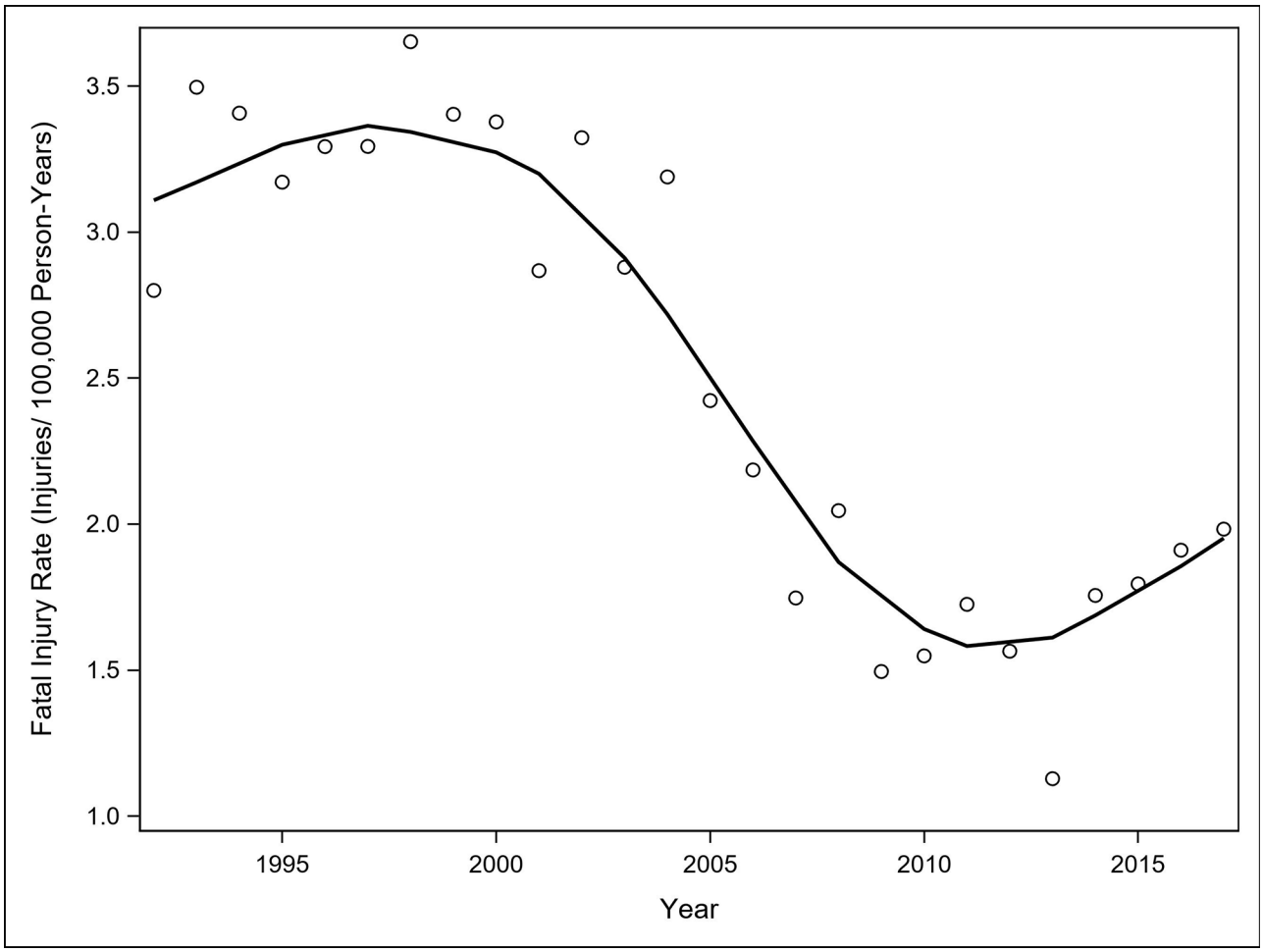

Figure 1.

Overall fatal injury rate trend in North Carolina (1992–2017). Fatal injury rates in North Carolina were calculated for each year between 1992 and 2017. The data were smoothed using a LOWESS curve.

Table 1.

Descriptive Characteristics of Occupational Fatality Decedents in NC (1992–2017)

	Fatal Injuries	%	Person-years
Sex			
Male	2541	96.07	58257437
Female	104	3.93	51207119
Age			
18–24 Years	217	8.20	13575204
25–34 Years	531	20.08	25579317
35–44 Years	623	23.55	29157885
45–54 Years	583	22.04	25436534
55–64 Years	439	16.60	11720011
65–74 Years	174	6.58	3190334
75+ Years	78	2.95	805271
Race and Ethnicity			
Hispanic	280	10.59	4424999
NH* White	1840	69.57	79850325
NH Black	466	17.62	20170017
NH American Indian or Alaska Native	34	1.29	
NH Asian and Pacific Islander	23	.87	
NH Other Race	2	.08	
Class of Work			
Self employed	399	15.09	11185004
Privately Employed	2044	77.28	82352858
Government Employed	202	7.64	15926694
Total	2645		109464556

* non-Hispanic

Table 2.

Occupational Fatal Injury Rates by Demographic Groups (NC, 1992–2017)

	N	Crude Rate*	Age-adj. Rate*	Occ.-adj. Rate*	Crude RR (95%CI) †	Age-adj. RR (95%CI) †	Occ.-adj. RR (95%CI) †
Overall	2645	2.42					
Sex							
Male	2541	4.36	4.34	3.05	21.48 (17.65, 26.13)	21.26 (17.47, 25.87)	7.66 (5.69 10.33)
Female	104	0.20	0.20	0.40	Ref.	Ref.	Ref.
Race/Ethnicity							
Hispanic	280	6.33	8.93	3.40	2.75 (2.42, 3.11)	3.96 (3.36, 4.66)	1.40 (1.15 1.71)
NH ǂ White	1840	2.30	2.26	2.43	Ref.	Ref.	Ref.
NH Black	466	2.31	2.42	2.38	1.00 (0.91, 1.11)	1.07 (0.97, 1.19)	0.98 (0.88 1.10)
Class of Work							
Self Employed	399	3.57	2.87	2.44	1.44 (1.29, 1.60)	1.13 (1.00, 1.27)	0.95 (0.82, 1.09)
Privately Employed	2044	2.48	2.54	2.58	Ref.	Ref.	Ref.
Government Employed	202	1.27	1.31	1.46	0.51 (0.44, 0.59)	0.52 (0.45, 0.60)	0.57 (0.47, 0.69)
Age Group							
18–24	217	1.60		1.56	Ref.		Ref.
25–34	531	2.08		2.00	1.30 (1.11, 1.52)		1.28 (1.09, 1.51)
35–44	623	2.14		2.13	1.34 (1.15, 1.56)		1.36 (1.16, 1.60)
45–54	583	2.29		2.52	1.43 (1.23, 1.68)		1.61 (1.37, 1.90)
55–64	439	3.75		3.86	2.34 (1.99, 2.76)		2.47 (2.09, 2.94)
65–74	174	5.45		4.78	3.41 (2.79, 4.17)		3.06 (2.46, 3.81)
75+	78	9.69		8.89	6.06 (4.68, 7.85)		5.70 (4.09, 7.94)

*Fatal injuries/100,000 person-years

†Rate ratio and 95% confidence interval

ǂNon-Hispanic

Table 3.

Occupational Fatal Injury Rates by Occupation (NC, 1992–2017)

Occupation	Fatal Injuries	Crude Rate*	Age-adj. Rate*	PAR (%)†
Forestry and Logging	137	67.56	70.66	5.00
Fishing, Hunting & Trapping	40	58.55	61.20	1.45
Extractive	5	23.86	38.54	0.17
Rail Transport	10	21.15	21.94	0.34
Farm Worker	192	19.05	15.76	6.40
Other Material Moving Equipment Operator	61	14.28	14.63	1.92
Other Agricultural	162	13.23	14.06	5.06
Motor Vehicle Transport	545	12.59	12.16	17.34
Water Transport	<5	9.76	8.21	0.11
Construction	603	7.90	8.32	17.01
Protective Services	96	4.92	4.93	1.88
Material Moving Equipment (Nontruck) Operator	<5	4.63	4.85	0.07
Material Handlers, Helpers, and Laborers	100	4.22	4.48	1.65
Nonauto Machinery Mechanic/Repairer	45	3.51	3.44	0.54
Auto Mechanic/Repairer	47	3.22	3.47	0.45
Other Mechanic/Repairer	51	2.92	2.90	0.34
Other Machine Operator	114	1.84	1.85	−1.43
Woodworking Machine Operator	18	1.53	1.55	−0.40
Private Household & Building Services	34	1.36	1.27	−1.02
Technicians & Related Support	40	0.97	0.99	−2.33
Precision Metalworking	17	0.86	0.91	−1.19
Other Precision Production	12	0.80	0.85	−0.92
Managerial & Professional Specialty	162	0.54	0.56	−29.55
Textile Machine Operator	10	0.49	0.49	−1.52
Sales and Administrative Support	118	0.45	0.44	−25.76
Other Services	8	0.29	0.31	−2.25
Health Services	6	0.24	0.23	−2.08
Food Preparation and Service	<5	0.09	0.10	−3.86
Precision Woodworking	0	0.00	0.00	−0.16
Overall	2645	2.42		

*Fatal injuries/100,000 person-years

†Population attributable risk percentage

Table 4.

Occupational Fatal Injury Rates by Industry (NC, 1992–2017)

Industry	Fatal Injuries	Crude Rate*	Age Adj-Rate*	PAR (%)†
Forestry & Logging- Manufacturing	140	65.52	64.31	5.11
Fishing, Hunting & Trapping	40	46.21	51.37	1.43
Agriculture	214	17.56	14.78	7.06
Agricultural Services	162	15.51	18.08	5.22
Transport- Bus, Trolley, Truck	282	12.79	12.54	8.83
Transport- Taxi	9	11.91	12.05	0.27
Water Supply & Sanitation Utilities	57	9.56	10.73	1.62
Mining & Oil	11	7.88	10.04	0.29
Construction	719	7.74	8.05	20.44
Electric, Gas Pipelines & Nonspecialized Utilities	49	5.80	6.23	1.09
Stone, Clay, Glass & Concrete Products- Manufacturing	34	5.52	5.86	0.73
Warehouse Storage & Transport Services	43	5.27	5.30	0.89
Transport- Railroad, Water, Air	29	4.78	8.09	0.54
Sawmills, Planing & Miscellaneous Wood Products- Manufacturing	29	4.53	4.42	0.51
Justice, Public Order, & Safety	84	4.34	4.72	1.43
Food & Kindred Products- Manufacturing	49	3.67	3.86	0.64
Miscellaneous- Manufacturing	37	3.60	3.76	0.46
Paper & Allied Products- Manufacturing	19	3.28	3.21	0.19
Wholesale Trade	95	2.64	2.60	0.32
Wood Buildings & Mobile Homes- Manufacturing	6	2.63	2.97	0.02
Primary Metal- Manufacturing	7	2.28	2.20	−0.02
Auto Sales & Services- Retail & Repair	50	2.21	2.27	−0.18
Fabricated Metal Products- Manufacturing	20	1.90	2.28	−0.21
Detective & Protective Services	7	1.81	1.53	−0.09
Radio, TV, Phone & Miscellaneous Communications	26	1.81	1.73	−0.34
Entertainment & Recreation Services	18	1.53	1.80	−0.40
Rubber, Leather & Miscellaneous Plastic Products- Manufacturing	15	1.39	1.32	−0.42
Business & Repair Services	56	1.39	1.45	−1.62
Chemicals & Petroleum Products- Manufacturing	19	1.35	1.33	−0.58
Public Administration	41	1.28	1.18	−1.41
Gasoline Service Stations- Retail	3	1.26	1.60	−0.10
Textile Mill Products- Manufacturing	26	1.07	1.07	−1.26
General Retail Trade	77	0.96	0.93	−4.76
Printing & Publishing	10	0.94	0.91	−0.60
Tobacco Manufactures	<5	0.90	1.31	−0.19
Machinery & Transport Equipment- Manufacturing	20	0.69	0.75	−1.94

Industry	Fatal Injuries	Crude Rate*	Age Adj-Rate*	PAR (%)†
Lodging Services	<5	0.42	0.29	−0.72
Personal Services	8	0.38	0.36	−1.64
Furniture & Fixtures- Manufacturing	8	0.37	0.34	−1.73
Grocery, Dairy & Food Stores - Retail	7	0.32	0.31	−1.79
Eating & Drinking Places- Retail	13	0.28	0.34	−4.00
Computer, Medical, Etc. Equipment- Manufacturing	7	0.27	0.24	−2.15
Professional & Related Services	73	0.27	0.26	−29.28
Finance, Insurance & Real Estate	17	0.27	0.26	−5.50
Personnel Supply Services	<5	0.13	0.09	−0.67
Apparel & Finished Textile Product- Manufacturing	<5	0.07	0.05	−1.38
Drug Stores- Retail	0	0.00	0.00	−0.49
Overall	2645	2.42		

*Fatal injuries/100,000 person-years

†Population attributable risk percentage