Citation
Carey, R.N. and El-Zaemey, S. and Daly, A. and Fritschi, L. and Glass, D.C. and Reid, A. 2021. Are There Ethnic Disparities in Exposure to Workplace Hazards Among New Zealand Migrants to Australia? Asia-Pacific Journal of Public Health. 33 (8): pp. 870-879. http://doi.org/10.1177/10105395211007648

Abstract

Disparities in exposure to workplace hazards exist between Māori and non-Māori workers in New Zealand, with Māori workers generally incurring poorer conditions. This study aimed to determine if these ethnic disparities are similar after migration to Australia. A national cross-sectional telephone survey asked participants what tasks they undertook in their job to assess exposure to carcinogens as well as whether they experienced ethnic discrimination, bullying, job precariousness, or job strain. A total of 389 New Zealand Caucasians and 152 Māori/Pasifika workers were recruited. After adjustment, 79% of Māori/Pasifika compared with 67% of New Zealand Caucasian workers were assessed as being exposed to at least one carcinogen at work (adjusted prevalence ratio (aPR)=1.2, 95% CI 1.1-1.4). Māori/Pasifika workers were also more likely to report ethnic discrimination (aPR=6.9, 95% CI 2.6-18.3) and fair or poor current health (aPR=1.9, 95% CI 1.1-3.2) than New Zealand Caucasians. Some ethnic disparities in exposure to workplace hazards in New Zealand are apparent after migration to Australia.

Keywords: discrimination; ethnicity; health; New Zealand; occupational carcinogens; psychosocial job hazards

What we already know:

- Around one-quarter of New Zealand-born migrants to Australia identify as Māori or Pasifika; this is similar to proportions of those living in New Zealand who identify as Māori/Pasifika.
- In New Zealand, Māori workers generally incur poorer working conditions than non- Māori workers, including higher injury rates and exposure to various physical and psychosocial hazards.
- These differences in workplace exposures may contribute to health disparities between Māori and non-Māori workers.

What this article adds:

- Results suggest that some ethnic disparities are apparent after migration to Australia, with Māori/Pasifika workers more likely to report exposure to carcinogens and in particular environmental tobacco smoke.
- Māori/Pasifika workers were also more likely to report ethnic discrimination and to experience fair or poor current health.
- These findings suggest that further investigation is needed to identify possible reasons for identified differences among New Zealand-born workers in Australia.

Introduction

More than one-quarter of Australia's resident population was born outside of Australia (over 7.5million people).[1] One of the largest migrant groups is those born in New Zealand, with 2.2% of Australia's population (570,000 people) being New Zealand-born. According to the 2016 Census, Australian residents who were born in New Zealand were more likely to be of working age (20 to 69) and to be employed than their Australian-born counterparts.[1] However, they were also more likely to work in jobs at the lower end of the socio-economic scale, such as labourers and machinery operators, than Australian-born workers.[1]

Around one-quarter of the New Zealand-born population living in Australia identify as Māori/Pasifika.[1] While Māori/Pasifika migrants have similar labour force participation to other New Zealand-born migrants, Census data shows that they are more likely to be younger (65% aged <40 versus 39% other New Zealand-born), to have no tertiary education (63% versus 43% other New Zealand-born), and to be in a lower income bracket (65% earn < $1,250/week versus 46% other New Zealand-born).[1] Occupational profiles also differ, with 52% of all Māori/Pasifika migrants working as community and personal service workers, machinery operators, and labourers, compared with 27% of other New Zealand-born migrants.

Historically, rates of fatal and non-fatal work-related injuries have been higher in New Zealand than similar countries, including Australia and the United Kingdom, with industry distribution accounting for a large proportion of the difference.[2] From 2005 to 2014, the work-related fatality rate in New Zealand was 4.8/100,000 workers,[3] compared with 2.3/100,000 workers over approximately the same period (2003 to 2016) in Australia.[4] An examination of work-related injuries in Australia found New Zealand-born workers to have higher rates of fatalities and hospital admissions than Australian-born workers,[5] in line with research from other countries which has shown higher rates of fatal and non-fatal work-related injuries among migrant compared with native-born workers.[6]

Within New Zealand, there are also disparities in work-related injuries and exposure to workplace hazards between workers of Māori/Pasifika and European ethnicity. For example, the work-related fatality rate from 2005 to 2014 was estimated to be 4.8/100,000 workers in New Zealanders of European ethnicity, and 7.7/100,000 workers in Māori workers.[3] It is not clear whether these disparities are due, at least in part, to

differences in occupation between ethnicities, with the highest work-related injury rates reported in labourers and machinery operators,[3] occupations in which Māori/Pasifika workers are highly represented.[7]

Māori workers are also more likely to be employed in jobs involving lifting, loud noise, awkward positions, repetitive tasks, and tight deadlines.[8, 9] Male Māori workers are more likely to be exposed to dusts than non-Māori workers in the same job, while female Māori workers are more likely to report work stress than non-Māori workers in the same job.[9] In addition, 5.6% of Māori workers report experiencing work-related racial discrimination, compared with 2.1% of New Zealanders of European ethnicity.[10]

These differences may contribute to health disparities between Māori/Pasifika and New Zealand Caucasian workers,[8, 9] with Māori/Pasifika populations known to have poorer health outcomes in general, including lower life expectancy and higher rates of many chronic and infectious diseases.[10] Past research has found experiences of racial discrimination contribute to health inequalities between those of Māori and European ethnicity, with the association between discrimination and poor health stronger for Māoris.[10] These associations can be understood within the framework of cumulative risk assessment, which investigates the interactions between exposures to multiple agents or stressors and their impact on health.[11]

While differences in the relationship between work-related exposures and health outcomes by ethnicity have been found in New Zealand, it is unclear whether similar disparities are apparent after migration to Australia. This study aimed to investigate exposure to workplace hazards (carcinogens and psychosocial hazards) among New Zealand-born workers in Australia; differences in exposure by ethnicity; and the contribution of these exposures to health outcomes.

Methods

Study sample, recruitment, and data collection

In 2017/2018, we conducted a national survey of workers living in Australia and born in New Zealand, India, or the Philippines. New Zealand-born workers were asked if they were of Caucasian, Māori, Pacific Island, or 'other' ethnic background. This study focuses on New Zealand-born migrants who identified as being of Caucasian, Māori, or Pacific Island (Pasifika) ethnicity and therefore those who reported 'other' ethnic

background were excluded. Ethics approval was obtained from the Human Research Ethics Committee of [redacted for review] (HREC RDHS-55-16).

Detailed study methodology has been published previously.[12] In brief, four sampling strategies were used. The first strategy used random sampling of the Electronic White Pages stratified by State and filtered by the most common surnames for the migrant groups (49.5% of total New Zealand sample). The second strategy refined this sample frame by selecting suburbs with a high proportion of migrants (24.7% of New Zealand sample). The third strategy used mobile phone numbers purchased from a commercial survey sampling firm which was able to identify migrants by country of birth; the source of these numbers is unknown (21.6% of New Zealand sample). The final strategy used non-probability techniques including advertising and snowball sampling (4.2% of New Zealand sample).

Data collection used computer-assisted telephone interviews. After obtaining verbal informed consent, workers were asked about sociodemographic (sex, age, country of birth, year of arrival in Australia, highest level of education attained) and occupational factors (job title, main tasks, type of employment contract, company size). Each job title was coded to one-digit codes (Managers, Professionals, Technicians/trades workers, Community/personal workers, Clerical/administrative workers, Sales workers, Machinery operators/drivers, and Labourers) according to the Australian and New Zealand Standard Classification of Occupations.[13] Participants' postcodes of residence were obtained from sample lists and classified into either metropolitan or rest of state according to the Australian Statistical Geography Standard Remoteness Structure.[14]

Measures

Exposure to carcinogens

We assessed exposure to the 10 most common carcinogens encountered in Australian workplaces according to past research (benzene, diesel engine exhaust, environmental tobacco smoke, ionising radiation, lead, polycyclic aromatic hydrocarbons other than vehicle exhausts, graveyard shiftwork, silica, solar ultraviolet radiation, wood dust).[15]

Based on job title and main tasks, participants were assigned to a job module administered using OccIDEAS, an online program that automates exposure assessment.[16] Each job module comprised questions about specific tasks performed and protective measures taken. Modules were developed by a team of epidemiologists and occupational hygienists and tailored to Australian workplace conditions.[15]

Answers to task questions in OccIDEAS automatically triggered predetermined exposure rules developed based on expert opinion and the scientific literature.[16] These rules provided an automatic assessment of the probability of exposure ('none', 'possible' or 'probable') to each carcinogen. All 'possible' assessments were reviewed and recategorized into either 'probable' or 'no' exposure. Participants were classified as exposed to occupational carcinogens if they were assessed as being exposed to at least one of the 10 carcinogens.

Exposure to psychosocial hazards

Ethnic discrimination at work. Four items from the General Ethnic Discrimination Scale assessed ethnic discrimination at work.[17] Discrimination by employers and supervisors and by co-workers was measured in the last year and over the lifetime on a six-point scale (*never* to *almost all of the time*). Scores were summed and collapsed to a dichotomous variable, whereby any reported experience of discrimination at work (at any time, by anyone) was classified as exposure to ethnic discrimination.

Bullying in the past year. Participants were asked if they had ever been bullied, and if so, whether they had ever been sexually harassed, verbally abused, or intimidated at work (three separate questions; response options from *never* to *all of the time*). They were then asked when they were most recently bullied in one of those ways (*last week* to *more than 12 months ago*). All participants indicating that they had been bullied in the last 12 months were also asked whether they felt their health or safety at work was at risk as a result of bullying (*yes, no, unsure*). All 'unsure' responses were recoded as missing.

Job precariousness. Job precariousness was assessed using two dimensions, vulnerability and job insecurity, in line with a previous factor analysis of the nine items used which confirmed the existence of a two-factor structure aligning with these dimensions.[18] Vulnerability was measured using five items adapted from the Employment Precariousness Scale.[19] These items measured feelings of being replaceable at work; fear of being fired; being treated in a discriminatory or unjust way; inability to voice concerns about unsafe work practices; and feeling defenceless towards unfair treatment. High vulnerability was defined as those reporting three or more indicators of vulnerability.

Job insecurity was measured using four items. Three items (whether participants felt they had a secure future in their job, whether they worry about the future of their job,

and whether the company they work for will be in business in five years) were adapted from a measure of job quality [20] with responses on a seven-point Likert scale ranging from '*strongly agree*' to '*strongly disagree'*. A fourth item assessed employment contract preference. This preference was compared to participants' current contract status, with responses categorised as '0' (preference from more to less secure), '1' (no difference between current and preferred), or '2' (preference from less to more secure). Job quality items and preferred status score were summed, and scores were dichotomised for analysis using the 25th percentile.

Job strain. Job strain was assessed using 11 items measuring job complexity (eight items) and job control (three items).[20] Job complexity items assessed how stressful the job was; whether the job required the participant to work fast, hard, or excessively (three questions); whether the participant had enough time to finish their work; how complex and difficult the job was; whether new skills were required; and whether the participant was able to use their existing skills. Job control items comprised whether the participant had freedom to decide how and when to do their work (two items) and how much input into the job they had. Each was measured on a seven-point Likert scale ranging from '*strongly agree'* to '*strongly disagree'*. Scores on each scale were summed and dichotomised using the 75th (high complexity) or 25th (low control) percentiles. High strain jobs were classified as those with high complexity and low control. All other jobs were classified as low strain.

General health

Two items from the Medical Outcomes Study Short Form 36 scale assessed physical health.[21] Using five-point Likert scales, participants rated their current health ('*excellent*' to '*poor*') and their current health compared with the previous year ('*much better'* to '*much worse'*). Two levels of health were used in analysis: good/better health (scores from 1-3) and poor/worse health (scores of 4-5).

Analysis

Iterative proportional fitting [22] was used to weight data by age, sex, education, and area of residence within each State (metropolitan vs rest of State), using proportions for employed persons born in New Zealand obtained from the 2016 Census.[1] Univariate descriptive analysis produced weighted point estimates and 95% confidence intervals (CIs) for sociodemographic and occupational variables, exposure to occupational carcinogens and psychosocial hazards, and health measures. Pearson's Chi-square test

with adjusted Pearson residuals were used to compare proportions between New Zealand Caucasian and Māori/Pasifika workers.

Unweighted modified Poisson regression models with robust error variance [23] estimated whether the likelihood of exposure to workplace hazards (carcinogens and psychosocial hazards) differed among New Zealand Caucasian (reference) and Māori/Pasifika workers, as well as whether health measures differed by sociodemographic and occupational factors, exposure to workplace hazards, and ethnicity. Models were bootstrapped [24] with 100 replicates. Backward stepwise elimination was used to determine which variables to enter as covariates.

Results

Demographic and occupational characteristics of workers

Of 566 interviews conducted with New Zealand-born workers, 68.7% (n=389) self-identified as Caucasian, 23.1% (n=131) as Māori, and 3.2% (n=21) as Pacific Islander. Māori and Pacific Islander workers were combined for analysis (Māori/Pasifika). Those identifying as 'other' (4.2%, n=24) or 'unsure' (0.2%, n=1) were excluded from analysis, resulting in a final sample of 541 workers.

New Zealand Caucasian workers were more likely to be male, older, to have achieved a higher education, to have resided in Australia for longer, and to be employed as Professionals than Māori/Pasifika workers (Table 1).

[Insert Table 1 about here]

Exposure to carcinogens

A total of 337 New Zealand-born workers (62.3%) were assessed as being exposed to at least one carcinogen at work. The majority of exposed workers (n=246, 73.0%) were exposed to more than one carcinogen, with the number of carcinogens individual workers were exposed to ranging from one to eight (median=2, interquartile range (IQR)=1-3). The median number of carcinogens workers were exposed to did not differ between Māori/Pasifika (median=2, IQR=1-3) and New Zealand Caucasian (median=2, IQR=2-3) workers (p=.3084).

After adjusting for occupation and demographic characteristics, exposure was more likely among Māori/Pasifika than New Zealand Caucasian workers (Table 2). This is likely attributable to Māori/Pasifika workers being significantly more likely to be

exposed to environmental tobacco smoke than New Zealand Caucasian workers; there was no significant difference in prevalence of exposure when excluding environmental tobacco smoke (aPR=1.1, 95% CI 0.9-1.3). Exposure to ionising radiation was more common among New Zealand Caucasian (3.6%, 95% CI 1.8-7.0) than Māori/Pasifika workers (0.2%, 95% CI 0.0-1.1) ($\chi^2(1)=6.1$, $p<.001$); due to low numbers exposed (n=18), no regression analysis was performed.

[Insert Table 2 about here]

Exposure to psychosocial hazards

Overall, 6.6% of New Zealand-born workers reported experiencing ethnic discrimination, while 15.0% reported having been bullied in the last year. Māori/Pasifika workers were significantly more likely to report experiencing ethnic discrimination than New Zealand Caucasian workers (Table 3). Reports of bullying or feeling that one's safety at work was threatened due to bullying did not significantly differ by ethnicity.

Around one-quarter of New Zealand-born workers (25.9%) reported being in a high-strain job, 9.8% reported high job vulnerability, and 14.9% reported high job insecurity. There was no difference in these psychosocial hazards by ethnicity (Table 3).

[Insert Table 3 about here]

General health

Māori/Pasifika workers were more likely to report fair or poor current health than New Zealand Caucasian workers (Table 4). Those perceiving a threat to their safety at work due to bullying were also more likely to report fair or poor current health.

Māori/Pasifika workers were more likely than New Zealand Caucasian workers to report worse or much worse health compared with the previous year ($p=0.036$). After controlling for occupational and exposure variables, however, there was no difference in worsening health by ethnicity (Table 4). Those reporting exposure to high job strain, high job insecurity, and wood dust were more likely to report experiencing worse or much worse health (Table 4). Those with a casual contract were less likely than those with a permanent contract to report worsening health.

[Insert Table 4 about here]

Discussion

These results suggest that Māori/Pasifika workers have a higher risk of exposure to some hazardous working conditions in Australia than New Zealand Caucasian workers. Māori/Pasifika workers were more likely than New Zealand Caucasian workers to be exposed to at least one of ten workplace carcinogens in Australia. Further, the prevalence of exposure to occupational carcinogens found in the current study (62% overall) was much higher than that previously found among Australian-born workers (30%) [25] and among all workers in Australia (38%).[15] The reasons for this difference are unknown; it may be at least partially a function of the jobs and industries in which New Zealand migrants to Australia are employed, but further research is needed. To our knowledge, no other studies have examined the prevalence of exposure to occupational carcinogens among New Zealand-born workers in Australia. However, studies conducted in New Zealand have found that Māori workers are more likely than non-Māori workers to be exposed to dusts and smoke at work,[8, 9] in line with our findings.

Māori/Pasifika workers were also more likely than New Zealand Caucasian workers in Australia to report experiencing ethnic discrimination at work. Overall, around 3% of New Zealand Caucasians reported experiencing workplace ethnic discrimination, compared with 12% of Māori/Pasifika workers. These estimates are similar to those reported in a study conducted in New Zealand, where ethnic discrimination was more common among those of Pacific Islander (12%) and Māori (10%) ethnicity than among those of European ethnicity (4%).[26] Overall, around 6% of New Zealand-born workers reported experiencing ethnic discrimination at work in our study, similar to previous estimates in New Zealand.[26] This number is somewhat lower than a previous Australian study, however, which found that 26% of New Zealand-born migrants to Australia reported racial discrimination at work, compared with 7% of third-generation Australians.[27] However, this study included discrimination encountered while trying to find employment in their definition of workplace discrimination, while our study referred specifically to discrimination from supervisors and co-workers. It may be that the true experience of discrimination at work may be somewhat higher than our estimates if other forms of discrimination (e.g. from potential employers and customers/clients) were considered.

We did not find any difference between Māori/Pasifika and New Zealand Caucasians working in Australia in terms of job vulnerability, job strain, and job insecurity. In New

Zealand, past research has found Māori women to be more likely to experience high work stress than non-Māori women, [8, 9] although another study found no differences between workers of Māori and European ethnicity in terms of psychological work strain.[28] Other research in New Zealand has found Māori workers to report lower job security than those of European ethnicity.[29] However, that study defined job security objectively, in terms of the probability of losing and finding employment, while our study investigated individuals' perceptions of their job security.

There was also no significant difference between New Zealand Caucasian and Māori/Pasifika workers in terms of their reports of being bullied, in contrast to our findings for ethnic discrimination. Ethnic discrimination, being specifically linked to one's race or ethnicity,[30] is conceptually distinct from bullying, which may occur as a result of a number of reasons.[31] Thus it does not necessarily follow that those experiencing one would also report the other, as seen here in our results. Our overall estimate of 15% of New Zealand-born workers reporting bullying at work is similar to that reported in New Zealand, where 13% reported experiencing harassment or bullying at work in the last year.[32] These estimates are also in line with a recent Australian study in which 16.6% of workers reported a previous experience of bullying at work.[33] That study found that workplace bullying was likely to occur in conjunction with other psychosocial work hazards, and particularly jobs characterised by high job strain.

This is in line with the cumulative risk assessment model, which examines the combined impact on health from exposures to multiple agents or stressors.[11] We found that reporting exposure to high job strain, high job insecurity, and wood dust were independently associated with reporting worse health compared with the previous year. Māori/Pasifika workers were also more likely than New Zealand Caucasians to report worse health, although this association was not significant when controlling for exposures. This suggests that some of the variation in health by ethnicity could be explained by differences in workplace exposures. However, ethnicity was found to be independently related to fair or poor current health, and so further investigation of the interaction between psychosocial workplace conditions, ethnicity, and health is needed.

Our study has some limitations and strengths. We used four sampling strategies to achieve the required number of workers, due to the lack of an established sampling frame from which to randomly sample New Zealand-born workers, a common challenge in research in ethnic minority populations.[34] To address this, we used

weighted prevalence estimates and bootstrapped regression models. We also combined Māori and Pasifika workers into a single group for analyses, given the small number (n=21) of those who identified as being of Pasifika ethnicity. While there are diversities in cultural values and beliefs between Māori and Pasifika workers, these two groups are similar in terms of their labour force participation and educational and occupational profiles. We used self-report measures, the validity of which may vary between the different ethnic groups. However, the impact of this is unknown. Our assessment of occupational exposures was based on automated expert assessment rather than self-report of exposures, and so these estimates are less likely to be biased. Our study is the first to investigate New Zealand-born workers in Australia at a population level, rather than the more usual occupation- or industry-level investigations, allowing for generalisations to the New Zealand-born working population across Australia.

Conclusion

Our findings highlight that some disparities in exposure to workplace hazards among Māori/Pasifika and New Zealand Caucasian workers are apparent after migration to Australia. This is to our knowledge the only population-based study investigating differences in exposure to workplace hazards among Māori/Pasifika and New Zealand Caucasian workers in Australia. Our findings, taken together with past research, suggest further investigation is necessary to identify possible reasons for the noted differences, including cultural attitudes towards work and possible ethnic discrimination in hiring and/or workplace policies and practices.

References

1. Australian Bureau of Statistics. *Census of Population and Housing 2016*. Canberra: ABS; 2016

2. Feyer AM, Williamson AM, Stout N, Driscoll T, Usher H, Langley JD. Comparison of work related fatal injuries in the United States, Australia, and New Zealand: Method and overall findings. *Inj Prev*. 2001;7(1):22-8. doi:10.1136/ip.7.1.22

3. Lilley R, Maclennan B, McNoe BM, Davie G, Horsburgh S, Driscoll T. Decade of fatal injuries in workers in New Zealand: Insights from a comprehensive national observational study. *Inj Prev*. 2020;doi:10.1136/injuryprev-2020-043643

4. Safe Work Australia. *Work-related traumatic injury fatalities, Australia 2016*. Canberra: Safe Work Australia; 2016

5. Reid A, Peters S, Felipe N, Lenguerrand E, Harding S. The impact of migration on deaths and hospital admissions from work-related injuries in Australia. *Aust N Z J Public Health*. 2016;40(1):49-54. doi:10.1111/1753-6405.12407

6. Smith PM, Mustard CA. Comparing the risk of work-related injuries between immigrants to Canada and Canadian-born labour market participants. *Occup Environ Med*. 2009;66(6):361-367. doi:10.1136/oem.2007.038646

7. Ministry of Business Innovation and Employment. *Maori in the labour market - December 2019 year*. Wellington: Ministry of Business, Innovation and Employment; 2020

8. Denison HJ, Eng A, Barnes LA, et al. Inequities in exposure to occupational risk factors between Maori and non-Maori workers in Aotearoa New Zealand. *J Epidemiol Community Health*. 2018;72(9):809-816. doi:10.1136/jech-2018-210438

9. Eng A, t Mannetje A, Ellison-Loschmann L, McLean D, Cheng S, Pearce N. Ethnic differences in patterns of occupational exposure in New Zealand. *Am J Ind Med*. 2011;54(5):410-8. doi:10.1002/ajim.20934

10. Harris R, Tobias M, Jeffreys M, Waldegrave K, Karlsen S, Nazroo J. Effects of self-reported racial discrimination and deprivation on Maori health and inequalities in New Zealand: Cross-sectional study. *Lancet*. 2006;367(9527):2005-9. doi:10.1016/S0140-6736(06)68890-9

11. Fox MA, Spicer K, Chosewood LC, Susi P, Johns DO, Dotson GS. Implications of applying cumulative risk assessment to the workplace. *Environ Int*. 2018;115:230-238. doi:10.1016/j.envint.2018.03.026

12. Daly A, Carey RN, Darcey E, et al. Using three cross-sectional surveys to compare workplace psychosocial stressors and associated mental health status in six migrant groups working in Australia compared with Australian-born workers. *Int J Environ Res Public Health*. 2019;16(5):735. doi:10.3390/ijerph16050735
13. Australian Bureau of Statistics. *Australian and New Zealand Standard Classification of Occupations (ANZSCO)*. Canberra: ABS; 2006
14. Australian Bureau of Statistics. *Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, July 2016*. Canberra: ABS; 2018
15. Carey RN, Driscoll TR, Peters S, et al. Estimated prevalence of exposure to occupational carcinogens in Australia (2011-2012). *Occup Environ Med*. 2014;71(1):55-62. doi:10.1136/oemed-2013-101651
16. Fritschi L. OccIDEAS - Occupational exposure assessment in community-based studies. *Occup Med*. 2019;69(3):156-157. doi:10.1093/occmed/kqy126
17. Landrine H, Klonoff EA, Corral I, Fernandez S, Roesch S. Conceptualizing and measuring ethnic discrimination in health research. *J Behav Med*. 2006;29(1):79-94. doi:10.1007/s10865-005-9029-0
18. Daly A, Schenker MB, Ronda-Perez E, Reid A. Examining the impact of two dimensions of precarious employment, vulnerability and insecurity on the self-reported health of men, women and migrants in Australia. *Int J Environ Res Public Health*. 2020;17(20)doi:10.3390/ijerph17207540
19. Vives A, Amable M, Ferrer M, et al. The Employment Precariousness Scale (EPRES): Psychometric properties of a new tool for epidemiological studies among waged and salaried workers. *Occup Environ Med*. 2010;67(8):548-55. doi:10.1136/oem.2009.048967
20. Leach L, Butterworth P, Rodgers B, Strazdins L. Deriving an evidence-based measure of job quality from the HILDA survey. *Australian Social Policy Journal*. 2010;9:67-86.
21. Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30(6):473-83.
22. Kolenikov S. Calibrating survey data using iterative proportional fitting (raking). *Stata Journal*. 2014;14(1):22-59. doi:10.1177/1536867x1401400104
23. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159(7):702-6. doi:10.1093/aje/kwh090

24. Efron B. Second thoughts on the bootstrap. *Stat Sci*. 2003;18(2):135-140. doi:10.1214/ss/1063994968

25. Boyle T, Carey RN, Glass DC, Peters S, Fritschi L, Reid A. Prevalence of occupational exposure to carcinogens among workers of Arabic, Chinese and Vietnamese ancestry in Australia. *Am J Ind Med*. 2015;58(9):923-32. doi:10.1002/ajim.22428

26. Daldy B, Poot J, Roskruge M. Perception of workplace discrimination among immigrants and native born New Zealanders. *Australian Journal of Labour Economics*. 2013;16(1):137-154.

27. Markus A. *Australians Today: The Australia@2015 Scanlon Foundation Survey*. Melbourne: Monash University; 2016

28. Gardner D, Bentley T, Catley B, Cooper-Thomas H, O'Driscoll M, Trenberth L. Ethnicity, workplace bullying, social support and psychological strain in Aotearoa/New Zealand. *NZ J Psychol*. 2013;42(2):123-130.

29. Gibson J, Watane C. Why is job security lower for Maori and Pacific Island workers? The role of employer-provided training. *New Zealand Economic Papers*. 2001;35(1):1-24. doi:10.1080/00779950109544330

30. Harris R, Cormack D, Tobias M, et al. The pervasive effects of racism: Experiences of racial discrimination in New Zealand over time and associations with multiple health domains. *Social Science & Medicine*. 2012;74(3):408-415. doi:10.1016/j.socscimed.2011.11.004

31. Einarsen S, Nielsen MB. Workplace bullying as an antecedent of mental health problems: A five-year prospective and representative study. *International Archives of Occupational and Environmental Health*. 2015;88(2):131-142. doi:10.1007/s00420-014-0944-7

32. Statistics New Zealand. *Labour market statistics (working life): December 2018 quarter*. Wellington: Statistics NZ; 2019

33. Leach LS, Too LS, Batterham PJ, Kiely KM, Christensen H, Butterworth P. Workplace bullying and suicidal ideation: Findings from an Australian longitudinal cohort study of mid-aged workers. *Int J Environ Res Public Health*. 2020;17(4):1448. doi:10.3390/ijerph17041448

34. Small R, Yelland J, Lumley J, Rice PL. Cross-cultural research: Trying to do it better. 1. Issues in study design. *Aust N Z J Public Health*. 1999;23(4):385-9. doi:10.1111/j.1467-842x.1999.tb01279.x

Table 1. Weighted demographic and occupational characteristics of New Zealand-born workers in Australia by ethnicity

	NZ Caucasian (n=389) % (95% CI) [residual[b]]	Māori/Pasifika (n=152) % (95% CI) [residual[b]]	*p* value [a]
Sex			.0024
Male	69.0 (63.5-74.0) [2.6]	51.4 (41.1-61.6) [-2.6]	
Female	31.0 (26.0-36.5) [-2.6]	48.6 (38.4-58.9) [2.6]	
Age group			<.001
18-25	9.2 (5.2-15.6) [-2.0]	11.6 (6.1-20.9) [2.0]	
26-35	15.5 (9.7-23.8) [-4.1]	32.7 (22.9-44.4) [4.1]	
36-45	22.2 (17.2-28.3) [-4.1]	30.3 (22.2-39.9) [-4.1]	
46-55	29.1 (23.9-34.9) [2.1]	17.9 (11.9-26.1) [-2.1]	
56+	24.1 (19.6-29.1) [5.0]	7.5 (4.7-11.9) [-5.0]	
Highest level of education			.001
High school or lower	35.9 (28.9-43.6) [-3.9]	57.3 (47.3-66.7) [3.9]	
Trade/diploma	34.2 (28.3-40.5) [0.2]	26.3 (19.3-34.8) [-0.2]	
Bachelor degree or higher	30.0 (24.6-35.9) [3.7]	16.4 (10.6-24.4) [-3.7]	
Area of residence			.747
Metropolitan	69.2 (61.8-75.7) [1.2]	67.2 (56.9-76.1) [-1.2]	
Rest of state	30.8 (24.3-38.2) [-1.2]	32.8 (23.9-43.1) [1.2]	
Length of stay in Australia			<.001
≤10 years	16.6 (11.0-24.3) [-5.4]	35.2 (25.7-46.0) [5.4]	

11-20 years	35.5 (29.1-42.5) [-2.6]	44.6 (34.4-55.2) [2.6]	
>20 years	47.9 (41.1-54.7) [6.6]	20.2 (13.8-28.7) [-6.6]	
Occupational group			.004
Managers	10.5 (7.2-15.1) [0.7]	10.1 (5.3-18.3) [0.7]	
Professionals	24.1 (19.1-29.9) [3.4]	10.9 (6.6-17.5) [-3.4]	
Technicians/trades workers	17.7 (12.0-25.4) [0.9]	7.6 (3.6-15.4) [-0.9]	
Community/ personal service	7.6 (5.0-11.3) [-0.6]	9.4 (5.5-15.6) [0.6]	
Clerical/ administrative	18.2 (14.0-23.4) [-0.1]	22.8 (14.6-33.7) [0.1]	
Sales workers	4.0 (2.3-6.9) [-1.8]	10.4 (5.3-19.2) [1.8]	
Machinery operators/drivers	11.0 (7.4-16.0) [-1.7]	13.8 (8.3-22.1) [1.7]	
Labourers	7.0 (4.0-12.0) [-3.0]	15.1 (8.7-24.8) [3.0]	
Type of employment contract			.494
Casual	17.0 (12.2-23.2) [-1.8]	22.3 (14.9-32.1) [1.8]	
Fixed term	6.1 (3.8-9.6) [-0.1]	5.6 (2.8-10.7) [0.1]	
Permanent	76.9 (70.5-82.3) [1.6]	72.1 (62.2-80.2) [-1.6]	
Self-employed			.426
Yes	16.7 (12.4-22.0) [-2.0]	12.9 (7.2-22.2) [2.0]	
No	83.3 (78.0-87.6) [2.0]	87.1 (77.8-92.8) [-2.0]	
Size of company			.147
<19 people	32.0 (25.9-38.7) [1.3]	27.7 (19.2-38.2) [-1.3]	
20-199 people	21.6 (17.0-27.1) [-1.0]	32.5 (23.2-43.4) [1.0]	
≥200 people	46.4 (39.5-53.5) [-0.3]	39.8 (30.3-50.3) [0.3]	

NZ: New Zealand

[a] *p* value derived from Chi Square goodness of fit test

[b] Adjusted Pearson residuals appear in square parentheses

Table 2. Weighted prevalence of occupational exposure to all and specific carcinogens with unweighted bootstrapped adjusted prevalence ratios (aPR) and 95% confidence intervals (CI) for New Zealand-born workers in Australia, by ethnicity

	NZ Caucasian (n=389)	**Māori/Pasifika (n=152)**
Any exposure		
% (95% CI)	67.4 (61.3-72.9)	79.1 (70.5-85.8)
Model 1[a] aPR (95% CI)	1.0	**1.3 (1.1-1.4)**
Model 2[b] aPR (95% CI)	1.0	**1.2 (1.1-1.4)**
Exposure to benzene		
% (95% CI)	51.1 (44.4-57.9)	48.5 (38.2-58.9)
Model 1[a] aPR (95% CI)	1.0	1.2 (0.9-1.5)
Model 2[b] aPR (95% CI)	1.0	1.1 (0.8-1.3)
Exposure to diesel engine exhaust		
% (95% CI)	50.0 (43.2-56.8)	50.9 (40.6-61.2)
Model 1[a] aPR (95% CI)	1.0	1.2 (0.9-1.5)
Model 2[b] aPR (95% CI)	1.0	1.1 (0.9-1.4)
Exposure to ETS		
% (95% CI)	21.4 (15.4-28.8)	44.6 (34.4-55.3)
Model 1[a] aPR (95% CI)	1.0	**2.0 (1.5-2.7)**
Model 2[b] aPR (95% CI)	1.0	**1.8 (1.3-2.5)**
Exposure to lead		
% (95% CI)	2.1 (0.7-5.7)	3.9 (1.1-12.7)
Model 1[a] aPR (95% CI)	1.0	2.6 (0.8-9.1)
Model 2[b] aPR (95% CI)	1.0	3.3 (0.9-12.0)
Exposure to PAHs		
% (95% CI)	5.2 (3.0-8.7)	4.1 (1.8-8.9)
Model 1[a] aPR (95% CI)	1.0	0.8 (0.3-1.9)
Model 2[b] aPR (95% CI)	1.0	0.8 (0.3-2.0)
Exposure to graveyard shift work		
% (95% CI)	9.8 (5.2-17.7)	4.4 (1.7-10.6)
Model 1[a] aPR (95% CI)	1.0	0.7 (0.0-18.1)
Model 2[b] aPR (95% CI)	1.0	0.5 (0.0-14.8)

Exposure to silica		
% (95% CI)	13.4 (8.2-21.3)	7.1 (3.4-14.4)
Model 1[a] aPR (95% CI)	1.0	0.8 (0.4-1.9)
Model 2[b] aPR (95% CI)	1.0	0.7 (0.3-1.4)
Exposure to solar UV radiation		
% (95% CI)	32.2 (25.9-39.2)	25.2 (17.4-34.9)
Model 1[a] aPR (95% CI)	1.0	1.1 (0.7-1.6)
Model 2[b] aPR (95% CI)	1.0	1.0 (0.7-1.5)
Exposure to wood dust		
% (95% CI)	5.3 (2.9-9.8)	7.5 (3.2-16.5)
Model 1[a] aPR (95% CI)	1.0	1.6 (0.5-4.7)
Model 2[b] aPR (95% CI)	1.0	2.2 (0.6-8.3)

aPR: Adjusted Prevalence Ratio; CI: Confidence Interval; ETS: Environmental Tobacco Smoke; NZ: New Zealand; PAHs: Polycyclic Aromatic Hydrocarbons (other than vehicle exhausts); UV: Ultraviolet

[a] Model 1 adjusted for sex, age, and company size

[b] Model 2 adjusted for sex, age, company size, and occupational group

Table 3. Weighted prevalence of exposure to psychosocial work hazards with unweighted bootstrapped adjusted prevalence ratios (aPR) and 95% confidence intervals (CI) for New Zealand-born workers in Australia, by ethnicity

	NZ Caucasian (n=389)	**Māori/Pasifika (n=152)**
Ethnic discrimination		
% (95% CI)	3.2 (1.5-7.1)	12.2 (6.9-20.7)
Model 1[a] aPR (95% CI)	1.0	**6.6 (2.8-15.5)**
Model 2[b] aPR (95% CI)	1.0	**6.9 (2.6-18.3)**
Bullying in last year		
% (95% CI)	16.5 (11.9-22.4)	12.0 (6.4-21.2)
Model 1[a] aPR (95% CI)	1.0	0.7 (0.4-1.2)
Model 2[b] aPR (95% CI)	1.0	0.7 (0.4-1.2)
Perceived threat to safety at work from bullying		
% (95% CI)	7.6 (4.8-11.9)	2.6 (1.0-6.5)
Model 1[a] aPR (95% CI)	1.0	0.5 (0.2-1.4)
Model 2[b] aPR (95% CI)	1.0	0.5 (0.2-1.4)
High job vulnerability		
% (95% CI)	11.0 (7.5-15.7)	7.7 (4.0-14.4)
Model 1[a] aPR (95% CI)	1.0	0.6 (0.3-1.2)
Model 2[b] aPR (95% CI)	1.0	0.6 (0.3-1.1)
High job insecurity		
% (95% CI)	14.2 (10.4-19.1)	16.1 (9.8-25.5)
Model 1[a] aPR (95% CI)	1.0	1.1 (0.7-1.7)
Model 2[b] aPR (95% CI)	1.0	1.0 (0.7-1.6)
High job strain		
% (95% CI)	23.9 (18.6-30.2)	29.6 (20.6-40.6)
Model 1[a] aPR (95% CI)	1.0	1.1 (0.8-1.5)
Model 2[b] aPR (95% CI)	1.0	1.1 (0.8-1.5)

aPR: Adjusted Prevalence Ratio; CI: Confidence Interval; NZ: New Zealand

[a] Model 1 adjusted for age and company size

[b] Model 2 adjusted for age, company size, and occupational group

Table 4. Weighted prevalence of reported health outcomes with unweighted bootstrapped adjusted prevalence ratios (aPR) and 95% confidence intervals (CI) for measures of physical health among New Zealand-born workers in Australia, by sociodemographic, occupational and exposure variables, and ethnicity

	Poor or fair current health		**Worse health compared with previous year**	
	% (95% CI)	**aPR[a] (95% CI)**	**% (95% CI)**	**aPR[b] (95% CI)**
Ethnicity				
New Zealand Caucasian	10.3 (7.1-14.9)	1.0	13.1 (9.1-18.4)	1.0
Māori/Pasifika	19.3 (13.1-27.5)	**2.1 (1.3-3.4)**	23.7 (15.2-35.1)	1.4 (0.9-2.2)
Highest level of education				
High school or lower	11.6 (7.0-18.5)	1.0	-	-
Trade/diploma	20.5 (14.3-28.5)	1.2 (0.7-2.1)	-	-
Bachelor degree or higher	7.9 (4.5-13.5)	0.6 (0.3-1.5)	-	-
Length of stay in Australia				
≤10 years	16.5 (9.6-26.8)	1.0	-	-
11-20 years	14.7 (9.4-22.2)	0.8 (0.5-1.3)	-	-
>20 years	10.6 (6.9-16.0)	0.6 (0.4-1.1)	-	-
Type of employment contract				
Permanent	13.7 (9.9-18.5)	1.0	16.9 (11.9-23.4)	1.0
Fixed term	28.2 (13.8-48.9)	1.8 (1.0-3.1)	37.7 (20.5-58.7)	1.3 (0.7-2.6)
Casual	9.2 (4.4-18.4)	0.6 (0.3-1.1)	11.2 (4.7-24.4)	**0.4 (0.2-0.8)**

Threat to safety at work from bullying				
No	12.3 (9.1-16.4)	1.0	-	-
Yes	41.3 (22.3-63.2)	**2.3 (1.3-4.0)**	-	-
High job strain				
No	-	-	13.6 (9.3-19.3)	1.0
Yes	-	-	26.7 (17.0-39.2)	**2.1 (1.3-3.6)**
High job insecurity				
No	-	-	14.4 (10.2-20.0)	1.0
Yes	-	-	30.5 (18.5-45.9)	**2.1 (1.2-3.6)**
Exposure to ETS				
No	-	-	14.9 (10.7-20.5)	1.0
Yes	-	-	21.3 (12.4-34.1)	1.5 (0.9-2.4)
Exposure to wood dust				
No	-	-	15.2 (11.2-20.4)	1.0
Yes	-	-	40.4 (18.5-67.0)	**2.4 (1.1-5.2)**

aPR: Adjusted Prevalence Ratio; CI: Confidence Interval; ETS: Environmental Tobacco Smoke

[a] Adjusted for ethnicity, occupation, education level, years in Australia, contract type, and perception of threat to safety at work from bullying

[b] Adjusted for ethnicity, occupation, contract type, job strain, job insecurity, exposure to environmental tobacco smoke, and exposure to wood dust