

2020

Factors associated with patterns of psychological distress, alcohol use and social network among Australian mineworkers

Carole L. James

University of Newcastle, carole.james@newcastle.edu.au

Mijanur Rahman

University of Wollongong, mmrahman@uow.edu.au

Aaron Bezzina

University of Newcastle

Brian Kelly

University of Newcastle

Follow this and additional works at: <https://ro.uow.edu.au/ahsri>

Factors associated with patterns of psychological distress, alcohol use and social network among Australian mineworkers

Abstract

Objective: To investigate the convergence of individual findings relating to psychological distress, alcohol use and social network (SN) to identify their associated clusters within Australian mineworkers. **Methods:** This study used cross-sectional survey data from 3,056 participants across 12 Australian mines. Latent class analysis used the scores of Kessler Psychological Distress Scale, Alcohol Use Disorders Identification Test (AUDIT) and Social Network Index. **Results:** Class 1 (moderate to very high psychological distress, low SN score and low to moderate AUDIT) included 39% (n=1,178) participants and class 2 (low to moderate psychological distress and AUDIT and very high SN) composed of 61% (n=1,873) participants. Class 1 was associated with younger age (OR=0.65, 95%CI=0.53-0.81), being a current smoker (OR=1.45, 95%CI=1.18-1.79), and reporting a history of anxiety (OR=3.00, 95%CI=2.23-4.05) and/or depression (OR=2.18, 95%CI=1.65-2.90). **Conclusions:** These findings highlight the challenges the mining sector faces regarding the welfare of its employees. Implications for public health: Modifiable work factors associated with lower social networks and higher psychological distress need addressing at an individual and industry level through targeted and specifically tailored multi-component interventions.

Keywords

patterns, network, among, australian, mineworkers, social, alcohol, distress, psychological, factors, associated

Publication Details

C. L. James, M. Rahman, A. Bezzina & B. Kelly, "Factors associated with patterns of psychological distress, alcohol use and social network among Australian mineworkers", *Australian and New Zealand Journal of Public Health Online First* (2020)

Factors associated with patterns of psychological distress, alcohol use and social network among Australian mineworkers

Carole James,^{1,3} Mijanur Rahman,^{2,4} Aaron Bezzina,^{1,3} Brian Kelly^{3,5}

Mental disorders, including mood, anxiety and substance use, are extensive throughout the world with one in three people affected by such disorders in their lifetime.¹ In 2010, the global cost of mental disorders was estimated at \$US2.5 trillion, including indirect costs such as lost productivity and income. As most adults spend one-third or more of their waking time at work, mental disorders present as a considerable challenge for workplaces and industry. Mental disorders have substantial economic and productivity ramifications for industry, with higher absenteeism, presenteeism (people who attend work despite being sick whereby their productivity is reduced),² and higher injury rates in those suffering from mental disorders.³

In Australia, in 2013–2014, the estimated cost of mental disorders to the public and private sectors and individuals was \$974 million.⁴ The annual cost as a result of lost productivity was \$11.8 billion, illustrating the importance of actions needed to address mental disorders in industry and society.⁴ Workplaces provide an opportune setting to implement policies and practices targeting mental disorders due to the importance of employment to mental health and the prevalence of modifiable risk-factors related to mental disorders in the workplace.⁵ Interventions designed to be delivered in the workplace and address mental disorders, such as that of the *MATES in Mining* program,⁵ have been shown to

Abstract

Objective: To investigate the convergence of individual findings relating to psychological distress, alcohol use and social network (SN) to identify their associated clusters within Australian mineworkers.

Methods: This study used cross-sectional survey data from 3,056 participants across 12 Australian mines. Latent class analysis used the scores of Kessler Psychological Distress Scale, Alcohol Use Disorders Identification Test (AUDIT) and Social Network Index.

Results: Class 1 (moderate to very high psychological distress, low SN score and low to moderate AUDIT) included 39% (n=1,178) participants and class 2 (low to moderate psychological distress and AUDIT and very high SN) composed of 61% (n=1,873) participants. Class 1 was associated with younger age (OR=0.65, 95%CI=0.53–0.81), being a current smoker (OR=1.45, 95%CI=1.18–1.79), and reporting a history of anxiety (OR=3.00, 95%CI=2.23–4.05) and/or depression (OR=2.18, 95%CI=1.65–2.90).

Conclusions: These findings highlight the challenges the mining sector faces regarding the welfare of its employees.

Implications for public health: Modifiable work factors associated with lower social networks and higher psychological distress need addressing at an individual and industry level through targeted and specifically tailored multi-component interventions.

Key words: latent class analysis, mineworkers, psychological distress, alcohol use, social network

provide an economic return on investment for industry.⁶ Interventions implemented in the workplace that address mental disorders can target rates of absenteeism and presenteeism,⁶ and depression.⁷ Understanding the demographic, health and workplace characteristics associated with mental disorders can assist to improve industry response and investment. For example, identification of factors contributing

to suicide in construction workers has resulted in successful industry investment into suicide prevention,⁸ with resulting economic benefit of \$4.60 for every \$1 invested.⁷

As one of Australia's largest industries, with 234,000 employees, the mining sector contributed significant export earnings of \$226 billion in the 2017–2018 financial year, approximately 7% of Gross Domestic

1. School of Health Sciences, University of Newcastle, New South Wales

2. Priority Research Centre for Generational Health and Ageing, School of Medicine and Public Health, University of Newcastle, New South Wales

3. Centre for Resources Health and Safety, Faculty of Health and Medicine, University of Newcastle, New South Wales

4. Department of Statistics, Comilla University, Bangladesh

5. School of Medicine and Public Health, University of Newcastle, New South Wales

Correspondence to: Dr Carole L. James; University of Newcastle, Callaghan Drive, Callaghan NSW 2308; e-mail: carole.james@newcastle.edu.au

Submitted: March 2020; Revision requested: July 2020; Accepted: July 2020

The authors have stated they have no conflict of interest.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

Aust NZ J Public Health. 2020; Online; doi: 10.1111/1753-6405.13037

Product.⁹ The mining industry plays a significant role in rural and remote areas by generating jobs and infrastructure and contributes to both local and national economies.

Psychological distress (a criterion of the likelihood of suffering a mental disorder) within the Australian mining industry is well documented, with miners experiencing significantly higher levels of psychological distress when compared to representative Australian data.^{10,11} A combined 44.4% of a mining sample reported moderate, high or very high levels of psychological distress.¹¹ This proportion is significantly greater than the 27.2% reporting the same levels in a gender- and age-weighted sample of employed Australians.¹² Furthermore, evidence suggests that there is a connection between suicide rates and occupation, with 'blue-collar' workers being more represented in suicide statistics.¹³ This notion is further ratified within the mining industry, where higher suicide rates have been reported.¹³

Male-dominated industries such as mining are susceptible to a wide range of challenges with workplace factors recognised as a contributing aspect to the development of mental disorders.¹⁴ Mines typically operate 24 hours a day, seven days a week, with employees working 12 hours or more on rotating shifts. The Australian mining sector has witnessed a trend toward remote access employment, often requiring workers to 'fly in and fly out' (FIFO) or 'drive in and drive out' (DIDO), which sees them regularly separated from family and social networks.¹⁵ This disconnection has been associated with increased rates of mental disorders and is further compounded by the abnormal work hours, long rosters and block shifts.¹⁶

Barriers to help-seeking for healthcare and the stigmatisation of mental disorders is also a problem for rural and remote communities, as well as workers of FIFO settings.^{17,18}

Previous research has highlighted that within rural and remote settings, the significance of social support and networks in regards to mental disorders cannot be dismissed. This is pertinent to the mining industry as research by Considine et al. has shown that workers who report lower social network scores were significantly more likely to have higher levels of psychological distress.¹⁰ Mining workers and similar populations have identified factors or personal characteristics indicative of a greater burden of personal mental disorders, including higher levels

of psychological distress and alcohol use and low social connection/networks.^{16,19} This study took a pragmatic approach to investigate the convergence of the individual findings relating to psychological distress, alcohol use and social networks, acknowledging that these individual factors do not exist in isolation. The aim was to identify clusters or combinations of these characteristics and associated factors of such profiles in this workforce. Identifying the assimilation of these factors that contribute to psychosocial distress is important for understanding specific and distinct industry needs and modifiable risk factors. This information is vital for guiding tailored workplace policy and practices that can support prevention and intervention initiatives.

Methods

Ethics approval for the study was provided by the University of Newcastle's Human Research Ethics Committee (HREC) (Approval Number H-2013-0135).

Study sample and recruitment

This study used cross-sectional survey data from 3,256 employees across 12 Australian mines. The total number of surveyed participants varied across sites with the following range: 97, 104, 112, 118, 163, 207, 246, 248, 316, 324, 624 and 679. The final sample included 3,056 participants, after excluding 181 employees who had a missing social network score and 19 participants who had a missing K10 score. Data was collected between December 2013 and May 2017. Metalliferous and coal mines across Australia were recruited through Australia's peak national mining industry body, the Minerals Council of Australia. Non-probability quota sampling was selected to ensure a representative cross-section of the industry.

Mine site recruitment

For each site, the general managers were contacted to gain consent for individual mines. The research team then worked with the health and safety managers at each site to determine the logistical arrangements for data collection.

Participant recruitment

To raise awareness for the project, promotional materials for the study were distributed to each site before data collection.

Subsequently, all workers at participating mines (including contractors and subcontractors) were invited to participate in the study.

Data collection

To limit disruptions to workplace productivity and to facilitate the unique logistical considerations of each site, data collection procedures were crafted to account for these factors. At routine pre-shift meetings or scheduled training during shifts, the research team delivered a brief presentation outlining: the voluntary nature of the research; that the survey contained no identifiable information; and that there would be no ramifications concerning employment, regardless of whether participants completed the survey or not. Paper-based surveys and information statements were distributed after the presentation and either completed immediately or returned to a designated 'post box' at the mine site in a sealed envelope. Survey duration was between 10 and 15 minutes, with completion implying informed consent.

Differences in response rates were observed between the contrasting data collection procedures. Of the nine sites where data was collected during pre-shift meetings, this yielded a 95% response rate (2,728 of 2,871 completed the survey). When training days were unavailable at three sites, collection took place either during the shift or during participants' pre-start inductions and yielded a 22% response rate (528 of 2,386 completed the survey).

Indicator variables

The current study included three indicator variables: alcohol use, psychological distress and social networks, which are described below.

Alcohol use

Participants' recent alcohol use and alcohol-related behaviour (past 12 months) were measured by the Alcohol Use Disorders Identification Test (AUDIT), a 10-item instrument developed by the World Health Organization.²⁰ Initially, the total score was calculated based on the participants' response on a 5-point Likert-scale (1 to 5) for each of the 10 AUDIT questions and then stratified into four categories: scores <8 indicating 'no known risk'; scores 8–14 indicating 'risky or hazardous drinking'; scores 15–19 indicating 'high risk or harmful

drinking'; and scores >19 indicating 'alcohol dependence is likely'.

Psychological distress

Participants' current level of psychological distress was measured by the Kessler Psychological Distress Scale (K10),²¹ a 10-item instrument relating to negative emotional states over the preceding four weeks. The total score was calculated by adding participants' responses to each of the questions, which were recorded on a 5-point Likert scale ranging from 1 (none of the time) to 5 (all of the time). The total score was stratified into four levels of psychological distress: low (10–15), moderate (16–21), high (22–29) and very high (30–50).

Social network scale

The social network (SN) scale was measured by the Berkman Social Network Index,²² based on the combination of four questions relating to 'number of friends, colleagues, relatives, and others', six questions on membership of different social groups, and participants' relationship/marital status. It measures the strength of social and community connectedness. The scores were stratified into four categories Low (1), Moderate (2–5), Medium high (6–7) and Very high (8–12). Low SN scores reflected few or infrequent contacts and low group participation.

Predictor variables

The current study included a range of demographic, health behaviour and workplace characteristics as predictors for the membership of different latent groups.

Demographic variables

Self-reported demographic variables were recorded, including participant age (categorical), gender (male or female), relationship status (categorical), having dependent children (continuous) and level of education (categorical).

Behaviours and health history

Participants reported their current smoking status, and any previous diagnosis of mental disorders including depression, anxiety, or drug or alcohol problems (categorical variables). Illicit drug use was gauged via a five-response tick box question (responses ranging from 'No, have never tried it' to 'Yes, daily') in the past month. Overall health, both physical and mental, relationships and the

ability to perform tasks were recorded in the form of a 5-response matrix questionnaire relating to the past month. Alcohol and psychological distress were assessed using the AUDIT and K10 tools, respectively.

Workplace characteristics

Participants were asked to report their current employment category (a seven-response tick box question); commute type (FIFO, DIDO, residential); and work schedule (a five-response tick box question; responses included 'Regular day shift' and 'Rotating shift'). Other attitudinal characteristics were measured including: reasons for working in mining (a five-point Likert scale ranging from strongly disagree to strongly agree to assess participants feelings towards working in the mines, pay, roster schedules and financial commitments); and perception of workplace culture in relation to mental health (a five-point Likert scale ranging from strongly disagree to strongly agree assessed participants feelings towards statements concerning people who experience mental illness would be treated differently by their friends, colleagues and in their current workplace). Social connectedness was assessed via SNI (described above).

Statistical analysis

We used latent class analysis (LCA) to identify distinct clusters of mine employees based on their levels of psychological distress, alcohol use and social network.²³

LCA is a multivariable classification model that assigns participants into mutually exclusive latent classes based on the probability of class membership. In our analysis, the observation of psychosocial distress would typically be unobservable (latent), although by using LCA and our observed factors (SNI, AUDIT, K10) we can group individuals into classes to observe the latent variable. Parameters of the model were estimated using the maximum likelihood method.²³ We performed two to six class LCA models, starting with two classes and then adding another class for each subsequent model. A model with the optimum number of classes was selected based on the fit indices, including Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC).²⁴ AIC and BIC are statistical model selection criteria, with lower values representing a better fit of the model. The item response probabilities (the conditional probabilities of responding to an item given membership within a latent

class) were graphically presented for better interpretability of the resultant latent classes. The model generates a latent class variable 'best' where the participants were classified to mutually exclusive latent classes based on the maximum posterior probability. This latent variable was considered as the outcome variable for further analysis.

The latent classes were then explored by participants' characteristics using unadjusted binary logistic regression modelling to assess their association with the obtained classes. A multi-variable binary logistic regression was conducted to estimate odds ratios (OR) and 95% confidence intervals (CI) for membership of different latent classes. The variables that were significant in the unadjusted model were simultaneously entered into the model to adjust for independent effects of participants' demographics, history of health behaviour and workplace-related factors. Participants' marital status was not included in the model as this variable was used to determine SN scores, which was one outcome of the model. The multivariable model only included participants who had complete information with regard to covariates. Analyses were performed using SAS 9.4 utilising the LCA procedure.^{25,26}

Results

Of the 3,056 participants, more than two-fifths (41.8%) were aged less than 35 years, most were male (88.3%), half were single (50.5%) or were in households described as couples with children (48.3%) and had a trade/apprenticeship/diploma qualification (49.3%), see Table 1. The majority had low psychological distress (57.8%), low levels of alcohol use (no known risk of alcohol misuse on audit scores; 53.4%), and low or moderate social networks (64%). Most of the participants did not have a history of anxiety (88.8%) or depression (87.7%) and were not a current smoker, including never smoked (47.5%) or ex-smoker (28.5%). Most participants were FIFO (79.8%) and had a permanent or ongoing employment contact (80.44%). The major employment categories were professional (35.7%), labourer (31.2%) and trade worker (12.7%).

Six LCA models using two to seven classes were compared. Based on the model fit criteria and clinical meaningfulness of the classes, a two-class model was considered as the preferred model. The average posterior probability for belonging to each of the

assigned classes was ≥ 0.8 , demonstrating that women were appropriately classified into the latent classes.²³ Patterns of levels of psychological distress, AUDIT and SN were depicted for both of the latent classes (Figure 1).

'Class 1' included 39% (n=1,178) of the participants who were most likely to have moderate to very high psychological distress, low SN scores and low to moderate AUDIT. 'Class 2' was composed of 61% (n=1,873) of participants who were most likely to have low to moderate psychological distress and AUDIT and a high probability of moderate to very high SN.

Table 2 presents both unadjusted and adjusted odds ratios (OR) and 95% confidence intervals (CI) of participants characteristics for belonging to class 1 (i.e. likely moderate to very high psychological distress, low SN,

low to moderate AUDIT) compared to class 2 (likely low to moderate psychological distress and AUDIT and high probability of having moderate to very high SN). It reveals that participants' demographics (except for gender and education), history of health behaviour, and workplace characteristics (except employment category and contract) were significantly associated with class membership. After adjusting for other demographic, health behaviour and workplace characteristics, membership of class 1 was associated with younger age (OR=0.65, 95%CI=0.53–0.81) and living in a one-person household, as compared with living as a couple with children (OR=1.63, 95%CI=1.16–2.30).

Class 1 membership was also significantly associated with being a current smoker (OR=1.45, 95%CI=1.18–1.79) and reporting

a history of anxiety (OR=3.00, 95%CI=2.23–4.05) and/or depression (OR=2.18, 95%CI=1.65–2.90).

Regarding work structure, rotating shift structures were associated with class 1 membership compared with fixed shifts (OR=1.25, 95%CI=1.02–1.54). In the unadjusted model, participants with FIFO commute type had significantly increased odds (OR=1.37, 95%CI=1.11–1.68) of being in class 1 rather than class 2, but in the adjusted model the association was not statistically significant (OR=1.21, 95%CI=0.97–1.51).

Discussion

This study aimed to assess factors that contribute to the development of mental disorders – alcohol use, psychological distress and social networks – within a pooled sample from 12 Australian mines to identify the convergence of these factors within this workforce. A two-class latent model was used to best describe relationships between the three variables within this sample. Class 1 was associated with moderate to very high psychological distress, low SN scores and low to moderate AUDIT scores and class 2 with having low to moderate psychological distress and AUDIT with a high probability of having moderate to very high SN. Within the different factors assessed by the analysis, it is noteworthy that almost half of the study population (45.6%) recorded either: 'Risky or Hazardous'; 'High Risk or Harmful'; or 'Dependence is likely' on the AUDIT scale. While alarming, these results are not surprising and have been documented in previous studies within this population.¹⁹

Age

Increasing age was associated with decreased odds (OR=0.65, 95%CI=0.53–0.81) of being a member of class 1 after adjusting for other characteristics. This is significant as a large portion of the sample occupies the <35 years age bracket (nearly 42%), which is representative of the mining industry.²⁷ Australian Bureau of Statistics data report median ages for marriage (males 32.4 yrs; females 30.5 yrs) and becoming parents (father 33.1 yrs; mother 31.0 yrs).²⁸ Such significant life events may increase demands at home and contribute to the greater incidence of lower social networks in workers under 35 years.

Table 1: Distribution of the sample by participants' demographic, behavioural and workplace characteristics.

Characteristics	n (%)	Characteristics	n (%)
Age group	3,046 (100)	Alcohol use	3,051 (100)
<35	1,274 (41.8)	No known risk	1,629 (53.4)
35-44	863 (28.3)	Risky or Hazardous	1,043 (34.2)
45+	909 (29.9)	High Risk or Harmful	241 (7.9)
		Dependence is likely	138 (3.5)
Gender	3,029 (100)	Smoking status	3,034 (100)
Male	2,673 (88.3)	Never smoked	1,441 (47.5)
Female	356 (11.7)	Ex-smoker	864 (28.5)
Relationship status^a	2,771 (100)	Current smoker	729 (24.0)
Single	1,399 (50.5)	History of Anxiety	3,051 (100)
Married	710 (25.6)	No	2,710 (88.8)
In relation & living with partner	445 (16.1)	Yes	341 (11.2)
In relation not living with partner	217 (7.8)	History of Depression	3,051 (100)
Household type	3,039 (100)	No	2,675 (87.7)
Couple with children	1,469 (48.3)	Yes	376 (12.3)
Couple only	704 (23.2)	Employment category	3,047 (100)
Lone person	347 (11.4)	Trade worker	388 (12.7)
Others ^b	519 (17.1)	MO/other	192 (6.3)
Education	3,043 (100)	Manager	198 (6.5)
No education	420 (13.8)	Labour	951 (31.2)
10 years/12 years	684 (22.5)	Admin	231 (7.5)
Trade/apprenticeship/diploma	1,500 (49.3)	Professional	1,087 (35.7)
University/higher	439 (14.4)	Commute type	3,046 (100)
Social network	3,051 (100)	FIFO	2,432 (79.8)
Low	691 (22.7)	DIDO	542 (17.8)
Moderate	1,262 (41.3)	Local	72 (2.4)
Medium high	803 (26.3)	Work schedule	3,007 (100)
Very high	295 (9.7)	Fixed shift	1,287 (42.8)
Psychological distress	3,051 (100)	Rotating shift	1,454 (48.4)
Low	1,764 (57.8)	Other	266 (8.9)
Moderate	818 (26.8)	Employment contact	3,042 (100)
High	361 (11.8)	Permanent/ongoing	2,567 (84.4)
Very high	108 (3.5)	Casual/fixed-term ^c	475 (15.6)

Notes:

a: information of 248 participants is missing, and 'In relation not living' category also included widowed, divorced and separated.

b: included multiple family household, one parent family with children, group household, and other one family household

c: included contractor/sub-contractor and others

MO: Machine operator, FIFO: Fly-in Fly-out, and DIDO: Drive-in drive out

History of anxiety and depression

Psychological distress within the Australian mining industry is well documented.^{10,11,13,29} Previous research has shown that metalliferous mining workers experience significantly greater levels of psychological distress when compared to a gender- and age-weighted sample of employed Australians.¹¹ Our sample illustrated a significant association with participants reporting a history of anxiety (OR: 3.00, 95%CI=2.23–4.05) and depression (OR: 2.18, 95%CI=1.65–2.90) and being associated with class 1 of the latent model.

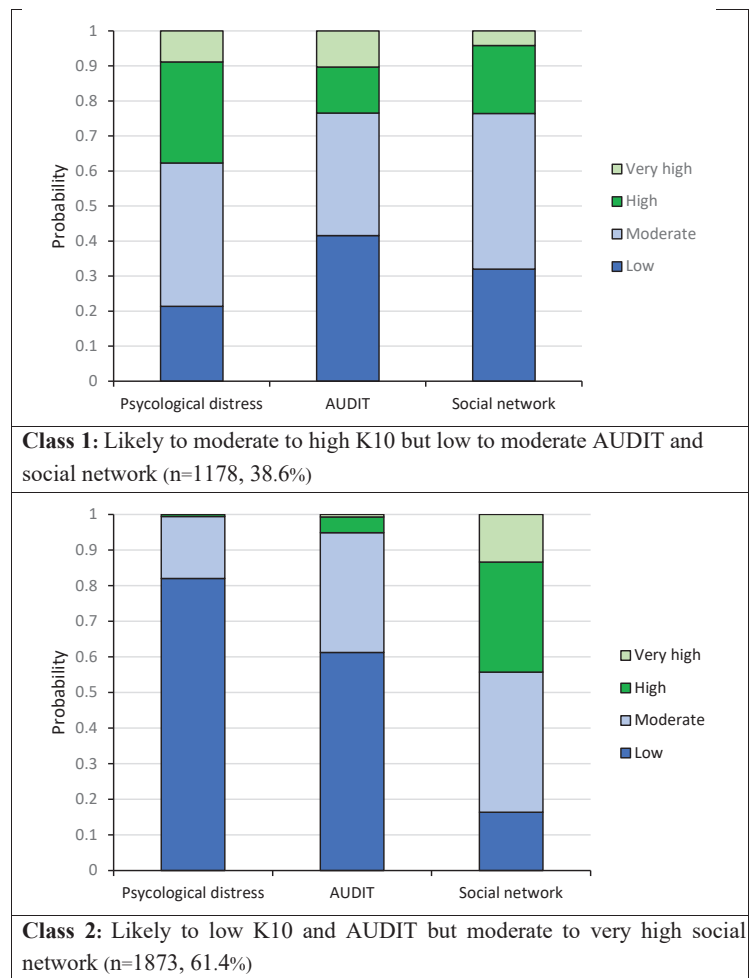
Regarding mental and physical health outcomes, the literature is suggestive that social networks and relationships have a role in the development of mental disorders.³⁰ Poor social networks and social isolation have been linked with a variety of unfavourable outcomes including both depression and suicide.³¹ A systematic review by Santini et al. (2015) re-affirms that those who experience depression tend to have limited social networks and lower satisfaction with social support.³¹

Not surprising, those who have a history of depression or anxiety in this sample were significantly associated with class 1. Extended periods of not seeing loved ones, missing out on special events due to work commitments and long working hours all culminate in increased social isolation, which is prevalent in this demographic.

Living arrangements

In our sample, those living in a one-person household rather than as a couple with children were 63% more likely to belong to class 1 compared to class 2 (OR: 1.63 95%CI: 1.16–2.30 $p < 0.01$). This is significant considering half of the sample were single (50%) and under the age of 35 (42%). Living alone and not being in a relationship with a partner are substantial risk factors for loneliness.³² Relationship separation tends to result in increased loneliness across ages and genders, with men having a greater susceptibility compared to women. Men who are recently separated are 13 times more likely to develop loneliness than married men.³³ Considering the demographics of the mining sector and the male-dominated nature of the industry, this is alarming due to the increased vulnerability of psychological distress experienced by this group. Furthermore, in a recent systematic review by Holt-Lunstad et al. (2015), it was found

Figure 1: Latent patterns of psychological distress (K10), alcohol use (AUDIT) and social network (SN) among Australian mining workers.



that social isolation was associated with: an array of detrimental health effects including a range of mental disorders, suicide and premature death; poor health behaviours including smoking, physical inactivity and poor sleep; and biological effects including high blood pressure and poorer immune function.³⁴

Commute type

Many studies examining psychological distress within rural and remote mining communities have often attributed FIFO commuting as one of the main contributing factors to the abnormally high levels of mental disorders experienced by these workers.^{29,35,36} In 2013, the House of Representatives in Australia tabled its findings on the use of FIFO workforce practices in regional Australia.¹⁸ Many reports have been damning of the practice and the effects on psychological distress. This paper is not disputing the effects of FIFO work practices

in the development of mental disorders, although it offers an alternative opinion of the narrative that poor social networks and social isolation also contribute to psychological distress and FIFO work practices affect social networks. In our sample, FIFO commute type had significantly increased odds (OR=1.37, 95%CI=1.11–1.68) of being in class 1 rather than class 2, but in the adjusted model the association was not found to be significant at $p < 0.05$. Additionally, working rotating shifts was associated with increased odds (OR=1.25, 95%CI=1.02–1.54) of being a member of class 1 rather than class 2.

Limitations

This paper uses a pooled sample of twelve mines and provides evidence regarding the effects of poor social networks in the Australian mining industry. Some areas of potential bias should be noted. Firstly, this paper uses a latent class model to assess three different indicator variables and their

relationship within the model. As with any latent class model, the issue of ambiguity should be noted. LCA provides a useful method for representing heterogeneity across the model, rather than the classes representing actual types of individuals in a population.

Secondly, recruitment for data was conducted using two types of methods.¹⁰ This methodological considerations of different mine

sites. However, it should be noted that despite variation in participation rate according to the recruitment methods, there were no method-related statistical differences in study outcomes used in the analysis of this combined dataset. Additionally, the data collection period of three and a half years should be acknowledged as during this period the minerals industry in Australia shifted its production systems due of

changing economic fortunes, which may have affected participant scores.

Lastly, it should be noted that indicator variables had varying timeframes and were not all consistent. The AUDIT scale assesses alcohol use over the past 12 months; whereas, the K10 looks at the previous four weeks. This might explain the less consistent associations with AUDIT scores.

Table 2: Odds ratio and 95% confidence intervals of participants' characteristics for being the membership of class 1 compared to class 2.

Characteristics	Unadjusted OR (95%CI)	Adjusted OR 95%CI)
Age group		
<35	Referent	Referent
35-44	0.88 (0.74–1.07)	0.90 (0.72–1.11)
45+	0.65 (0.54–0.79)**	0.65 (0.53–0.81)**
Gender		
Male	Referent	–
Female	1.21 (0.94–1.54)	
Household type		
Couple with children	Referent	Referent
Couple only	0.93 (0.77–1.13)	0.87 (0.70–1.07)
Lone person	2.00 (1.50–2.67)**	1.63 (1.16–2.30)**
Others ^a	1.51 (1.20–1.90)**	1.23 (0.95–1.63)
Education		
No education	Referent	–
10 years/12 years	1.24 (0.99–1.56)	
Trade/apprenticeship/diploma	0.98 (0.80–1.20)	
University/higher	0.98 (0.77–1.24)	
Smoking status		
Never smoked	Referent	Referent
Ex-smoker	1.25 (1.03–1.50)**	1.23 (1.00–1.50)
Current smoker	1.69 (1.39–2.06)**	1.45 (1.18–1.79)**
History of Anxiety		
No	Referent	Referent
Yes	4.41 (3.38–5.73)**	3.00 (2.23–4.05)**
History of Depression		
No	Referent	Referent
Yes	3.60 (2.83–4.60)**	2.18 (1.65–2.90)**
Employment category		
Professional	Referent	Referent
Trade worker	0.81 (0.63–1.04)	0.91 (0.66–1.25)
Machine operator/other	0.93 (0.66–1.29)	0.93 (0.64–1.34)
Manager	0.74 (0.53–1.04)	0.89 (0.61–1.29)
Labour	0.79 (0.64–0.95)*	0.84 (0.68–1.04)
Admin	1.07 (0.78–1.45)	1.02 (0.73–1.41)
Commute type		
DIDO/local	Referent	Referent
FIFO	1.37 (1.11–1.68)**	1.21 (0.97–1.51)
Work schedule		
Fixed shift	Referent	Referent
Rotating shift	1.36 (1.15–1.60)**	1.25 (1.02–1.54)*
Other	1.03 (0.75–1.40)	1.19 (0.85–1.67)
Employment contact		
Permanent/ongoing	Referent	–
Casual/fixed-term†	0.92 (0.73–1.14)	

Note:

*indicates significant at $p < 0.05$; **indicates significant at $p < 0.01$

a: included multiple family household, one parent family with children, group household, and other one family household.

Conclusions

This study found several participant factors associated with belonging to class 1 of the latent model (moderate to very high psychological distress, but low to moderate AUDIT and SN) including age, history of depression or anxiety, living arrangements and commute type (FIFO). This paper had a particular focus on social networks and the interplay between the aforementioned factors. Poor social networks and psychological distress are increasing challenges for the mining sector and highlight opportunities for the industry to address and respond within the context of health and social welfare for their employees. Modifiable factors such as fewer social networks and higher psychological distress could be targeted through strategies to engage employees with peer-related support programs such as MATES program⁵ or through steps to strengthen the connection with home and family support networks. Multi-component interventions that tackle the issues around personal, social and work characteristics are likely to be advantageous at both the individual and industry level.

Acknowledgements

The team would like to acknowledge Australian Coal Association Research Program (ACARP) and the Minerals Council of Australia (MCA) for funding this research, the mining companies for their engagement in this study and the individual mineworkers who took the time to complete the survey.

Funding

This work was supported by the Australian Coal Association Research Program (ACARP) Grant Number G1200745 and the Minerals Council of Australia (MCA) Grant Number: G1401530. The funders were involved in the recruitment of participants (approaching interested mine sites across Australia). The

fundlers had no role in data collection and analysis, decision to publish or preparation of the manuscript.

References

- Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, et al. The global prevalence of common mental disorders: A systematic review and meta-analysis 1980-2013. *Int J Epidemiol*. 2014;43(2):476-93.
- Johns G. Presenteeism in the workplace: A review and research agenda. *J Organ Behav*. 2010;31(4):519-42.
- Dewa CS, Thompson AH, Jacobs P. The association of treatment of depressive episodes and work productivity. *Can J Psychiatry*. 2011;56(12):743-50.
- Lee YC, Chatterton ML, Magnus A, Mohebbi M, Le LK, Mihalopoulos C. Cost of high prevalence mental disorders: Findings from the 2007 Australian National Survey of Mental Health and Wellbeing. *Aust N Z J Psychiatry*. 2017;51(12):1198-211.
- Tynan RJ, James C, Considine R, Skehan J, Gullestrup J, Lewin TJ, et al. Feasibility and acceptability of strategies to address mental health and mental ill-health in the Australian coal mining industry. *Int J Ment Health Syst*. 2018;12(1):66.
- Wang PS, Simon GE, Avorn J, Azocar F, Ludman EJ, McCulloch J, et al. Telephone screening, outreach, and care management for depressed workers and impact on clinical and work productivity outcomes a randomized controlled trial. *JAMA*. 2007;298(12):1401-11.
- Callander EJ, Lindsay DB, Scuffham PA. Employer benefits from an early intervention program for depression: A cost-benefit analysis. *Int J Occup Environ Med*. 2017;59(3):246-9.
- Gullestrup J, Lequertier B, Martin G. MATES in construction: Impact of a multimodal, community-based program for suicide prevention in the construction industry. *Int J Environ Res Public Health*. 2011;8(11):4180-96.
- Office of the Chief Economist. *Resources and Energy Quarterly - June 2018*. Canberra (AUST): Australian Department of Industry, Science, Energy and Resources; 2018.
- Considine R, Tynan R, James C, Wiggers J, Lewin T, Inder K, et al. The contribution of individual, social and work characteristics to employee mental health in a coal mining industry population. *PLoS One*. 2017;12(1):e0168445-e.
- James C, Tynan R, Roach D, Leigh L, Oldmeadow C, Rahman M, et al. Correlates of psychological distress among workers in the mining industry in remote Australia: Evidence from a multi-site cross-sectional survey. *PLoS One*. 2018;13(12):e0209377-e.
- Australian Bureau of Statistics. *National Survey of Mental Health and Wellbeing 2007: Summary of Results*. Canberra (AUST): ABS; 2008.
- McPhedran S, De Leo D. Suicide among miners in Queensland, Australia: A comparative analysis of demographics, psychiatric history, and stressful life events. *SAGE Open*. 2013;3(4):2158244013511262.
- Bowers J. *Submission to the Education and Health Standing Committee (Western Australian Legislative Assembly) Inquiry into Mental Health Impacts of FIFO Work Arrangements*. Perth (AUST): Australian Association of Social Workers; 2015.
- Ling R, Kelly B, Considine R, Tynan R, Searles A, Doran CM. The economic impact of psychological distress in the Australian coal mining industry. *J Occup Environ Med*. 2016;58(5):e171-6.
- Tynan RJ, Considine R, Rich JL, Skehan J, Wiggers J, Lewin TJ, et al. Help-seeking for mental health problems by employees in the Australian mining industry. *BMC Health Serv Res*. 2016;16(1):498.
- Handley TE, Kay-Lambkin FJ, Inder KJ, Lewin TJ, Attia JR, Fuller J, et al. Self-reported contacts for mental health problems by rural residents: Predicted service needs, facilitators and barriers. *BMC Psychiatry*. 2014;14(1):249.
- The House of Representatives Standing Committee on Regional Australia. *Cancer of the Bush or Salvation for Our Cities? Fly-in, Fly-out and Drive-in, Drive-out Workforce Practices in Regional Australia*. Canberra (AUST): The Parliament of Australia; 2013.
- Tynan RJ, Considine R, Wiggers J, Lewin TJ, James C, Inder K, et al. Alcohol consumption in the Australian coal mining industry. *Occup Environ Med*. 2017;74(4):259.
- Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M. Development of the alcohol use disorders identification test (audit): WHO collaborative project on early detection of persons with harmful alcohol consumption—II. *Addiction*. 1993;88(6):791-804.
- Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SL, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med*. 2002;32(6):959-76.
- Berkman LF, Syme SL. Social networks, host resistance, and mortality: A nine-year follow-up study of Alameda County residents. *Am J Epidemiol*. 1979;109(2):186-204.
- Collins LM, Lanza ST. *Latent Class and Latent Transition Analysis with Applications in Social, Behavioral and Health Sciences*. Hoboken (NJ): John Wiley & Sons; 2010.
- Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modelling: A Monte Carlo simulation study. *Struct Equ Modeling*. 2007;14(4):535-69.
- SAS/ACCESS – Statistical software. Version 9.4. Cary (NC): SAS Institute; 2013.
- Lanza ST, Dziak JJ, Huang L, Wagner AT, Collins LM. *Proc LCA & Proc LTA Users' Guide*. Version 1.3.2. Abington (PA): The Pennsylvania State University College of Health and Human Development University Park The Methodology Center; 2015.
- Chapman P, James C, Rich J. *Obesity and NSW Coal Mining*. Newcastle (AUST): University of Newcastle; 2018.
- Australian Bureau of Statistics. *Marriages and Divorces, Australia, 2018*. Canberra (AUST): ABS; 2018.
- Bowers J, Lo J, Miller P, Mawren D, Jones B. Psychological distress in remote mining and construction workers in Australia. *Med J Aust*. 2018;208:1.
- Leigh-Hunt N, Bagguley D, Bash K, Turner V, Turnbull S, Valtorta N, et al. An overview of systematic reviews on the public health consequences of social isolation and loneliness. *Public Health*. 2017;152:157-71.
- Santini ZI, Koyanagi A, Tyrovolas S, Mason C, Haro JM. The association between social relationships and depression: A systematic review. *J Affect Disord*. 2015;175:53-65.
- Lauder W, Sharkey S, Mummery K. A community survey of loneliness. *J Adv Nurs*. 2004;46(1):88-94.
- Franklin AS, Tranter B. *Loneliness in Australia*. Occasional Paper 13. Hobart (AUST): University of Tasmania Housing and Community Research Unit; 2008.
- Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspect Psychol Sci*. 2015;10(2):227-37.
- Vojnovic P, Michelson G, Jackson D, Bahn S. Adjustment, well-being and help-seeking: Among Australian FIFO Mining employees. *Aust Bull Labour*. 2014;40(2):242-61.
- Torkington AM, Larkins S, Gupta TS. The psychosocial impacts of fly-in fly-out and drive-in drive-out mining on mining employees: A qualitative study. *Aust J Rural Health*. 2011;19(3):135-41.

Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Fit information for the models with two to seven latent classes.