Analysis of Australian Mental Health Within The FIFO Industry

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Introduction: While FIFO occupations are recognised for their high wages, it is also known that psychological mental distress is highly prevalent within this sub-group of the population. To determine the extent of this psychological distress, a survey known as the Kessler 10 questions were utilised among 1275 FIFO workers. These questions concern the subject matter of the worker's mental health such as stress relating to children, family and work rosters ("1 = none of the time", "2 = A little of the time", "3 = Some of the time", "4 = Most of the time" or "5 = All of the time"). The values are summed up out of 50 to determine the extent of psychological distress. This analysis concerns a random sample of 1000 using demographics and family related questions where blank responses have been omitted (final sample, n = 680).

Objectives: To assess psychological distress within the Australian FIFO community and determine how factors of demographics and family-related issues correlate with psychological distress.

Methodology: Binary logistics regression will be used to determine if a subject is stressed or not with regard to the k10 two level classification. Furthermore, chi-squared tests will be utilised to determine dependence of demographic and family related issues against the k10 four level classifications. Models are assessed with leave one out cross validation and the main selection criteria considered will be the AICc, among others.

Statistical Analysis: The statistical software package R, has been used to generate table data and figures for analysis. Latex was used to make the tables and then they were converted and imported to word format.

The summary statistics for the categorical demographic variables can be tabulated as shown below.

Variable	**Level (* = mode)**	**Count**	**%(2 decimals)**
Sex	Male*:	645	94.9%
	Female:	35	5.1%
Age Group	16-24:	51	7.5%
	25-34*:	244	35.9%
	35-44:	182	26.8%
	45-54:	154	22.6%
	55+:	49	7.2%
Relationship	Single:	153	22.5%
	Married/De Facto*:	489	71.9%
	Divorced/Widowed/Separated:	38	5.6%
Education	Year 10*:	254	37.4%
	Year 12:	131	19.3%
	Cert/Trade Diploma:	247	36.3%
	University Degree	48	7%
Dependants	No Children*:	323	47.5%
	One Child:	141	20.7%
	Two Or More:	216	31.9%
Occupation	Management:	72	10.6%
	Contractor*:	608	89.4%
Sector	Construction:	257	37.8%
	Underground*:	285	41.9%
	Open Pit:	138	20.3%
Roster (weeks on/ weeks off)	1/1:	113	16.6%
	2/1*:	313	46%
	4/1:	223	32.8%
	Other:	31	4.6%

Explanation of figure 1.0: For gender, FIFO workers appear to be nearly entirely men (94.9%). The data shows that there are very few women working in the resource/FIFO sector. In terms of age, most FIFO workers are young adults (35.9%) and middle aged people. The distribution shows slight symmetry and very few people of young (7.5%) and older ages (7.2%). Relationship wise, majority of FIFO workers are married (71.9%), while a considerable amount are single (22.5%). Very few workers fall into another status. For education, it appears majority of FIFO workers are not highly educated as majority did not surpass year 10 (37.4%). Only 7% have university education. For dependants roughly half of the FIFO workers have children (20.7% and 31.9%), while the other half do not have children at all (47.5%). For occupations, there are very few in management roles (10.6%) compared to actual contractors (89.4%). Between the sectors there are not many workers in open pit (20.3%) when compared to other sectors. Nearly half of FIFO workers have a 2/1 schedule (46%) while a considerable amount have a heavy workload on 4/1 (32.8%).

Figure 1.0: Summary statistics for demographic variables and explanation

The Chi-Squared test for independence can then be used to test for independence between the K10 four level classification and each of the eight demographics. i.e if there is some sort of relationship between the variables. Eight individual tests will need to be run. The following is the hypotheses for each of the individual tests (α = 5%).

H(0): Independence between K10 four level classification and demographic variable (no association).

H(1): Dependence between K10 four level classification and demographic variable (there is an association).

Chi-Squared test results: For gender, p = 0.2314 which is > α thus we cannot reject the hypothesis and we assume independence between gender and k10 2 level psychological distress. The cross tabulation indicates no relationship between the two as both genders have similar stress levels with regard to their proportions. For Age, p =0.0996 which is > α thus we assume independence between stress and age. The cross tabulation supports this relationship as all levels of age have similar stress levels with regard to their proportions (high % not stressed which lowers as the level of stress becomes higher). For relationship status, p = 0.1215 which is > α thus we cannot reject the null hypothesis as we assume independence. The cross tabulation results show no relationship between the different levels of variables. For dependants, p = 0.1935, thus we cannot reject the null hypothesis and assume independence between stress and dependants. The cross tabulation shows high levels of not stressed and low levels of not stressed for all levels of dependants. For education, p=0.9125 which is > α, thus we cannot reject the null hypotheses and independence holds. The cross tabulation shows no relationship as all levels of education experience similar stress levels with regard to their respective proportions. For occupation, p=0.04303 which is < α, thus we can reject the null hypothesis and conclude stress is dependent of occupation. The cross tabulation shows elevated stress levels of contractors when compared to managers. For Roster, p < 0.01 thus we can reject the null hypothesis and assume dependence between stress and roster. For the 4/1 roster it appear to be less stressed with regard to their proportion which contradicts the common consensus. For sector, p < 0.01 thus we can reject the null hypothesis and conclude stress level is dependent on roster. There appears to be a relationship as construction and underground appear less stress than open pit when compared to their proportions. While demographics show there is a relationship between some demographics and stress, the magnitude is not clear. To get a better insight, backward selection can be employed against K10 two level classification to build a logistic regression model. The backward model, forward model and null model will be considered (AICc mainly used for selection).

Model	**Predictors**	**AICc**	**Deviance**	**Pseudo R^2**	**Delta AIC**
Full Model	All Demographics	786.115	746.96	0.066	15.47
Null Model	-	801.9154	799.9	0	31.27
Backward Model	Dependants, Occupation, Roster	770.6315	756.47	0.054	0

Figure 1.1: Candidate model summaries (Backwards model is the best as AICc is lowest, Delta AIC does not support other models (> 10) and there is not much change in pseudo R squared for an increase in predictors.)

The Backward model is summarised in the following table (CI = confidence interval for odds ratio. * = statistically significant, OR= odds ratio).

Variable	**Level**	**Beta**	**OR(P-value)**	**95% CI**
Intercept	-	-2.219	0.11(<0.01*)	0.05~0.23
Dependants	No Children:	0	1	-
	One Child:	0.148	1.16(0.54)	0.72~1.85
	Two Or More:	0.5261	1.69(0.009*)	1.43~2.51
Occupation	Management:	0	1	-
	Contractor:	0.9867	2.68(0.007*)	1.35~5.79
Roster	1/1:	0	1	-
	2/1:	0.5632	1.76(0.03*)	1.04~2.94
	4/1:	-0.5611	0.57(0.053)	0.32~1.01
	Other:	0.3554	1.43(0.49)	0.5~3.8

Figure 1.2: Summary of chosen model and cross validation explanation (model evaluation)

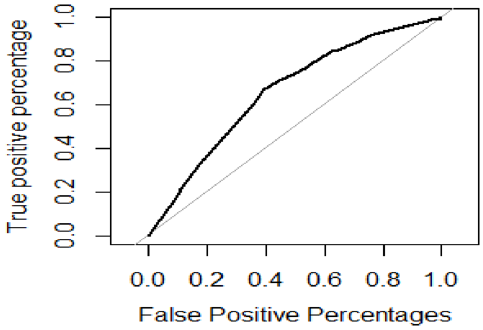

Figure 1.3: ROC curve for backwards model

Figure 1.3 displays a ROC curve for the chosen model to describe psychological distress in FIFO workers. For the figure, the AUC is only 0.66, thus we can conclude the model is not ideal, additional predictors should be used to improve this.

Explanation of figure 1.2: Having one child increases odds of psychological stress by 16% while having 2+ children increases the odds by 69% when compared to having no children. Being a contractor increases odds of psychological stress by 168% when compared to those in management positions. Having a 2/1 week on/off roster increases odds of psychological stress by 76%, while having a 4/1 roster decreases odds of psychological stress by 43%; this is inconsistent with what is known. Having another roster increases odds of psychological stress by 43% compared to a 1/1 roster.

The pseudo R squared for the model is low, furthermore, at a threshold of 0.45, while the sensitivity is 89%. The specificity is only 20%. i.e bad at predicting non-stressed subjects correctly.

Cross validation was employed and had a prediction rate of 72.5%. The bias was -2 and the standard deviation was 0.497. Predicated sum of squares was 3044.8 and root mean square error was 4.48. While the model can be useful, these values are higher than what is desirable, thus more predictors should be added to understand FIFO stress.

As shown previously, while the model may be useful, it is not ideal. To improve the effectiveness of the model, family related issues can be used to predict psychological stress among FIFO workers. The questions asked were, Events: rate your stress level from missing family events. Relationship: rate your stress level regarding your partner. Children: rate your stress level in regards to your children. Parents: rate your stress level regarding your parents. Finance: rate your stress level regarding your financial situation.

Variable	**Level (* = mode)**	**Count**	**%(2 decimals)**
Events	Not Stressed:	98	14.4%
	Slightly Stress*:	209	30.7%
	Stressed:	185	27.3%
	Very Stressed:	188	27.6%
Partner	Not Stressed*:	220	32.3%
	Slightly Stress:	188	27.6%
	Stressed:	151	22.2%
	Very Stressed:	121	17.8%
Children	Not Stressed*:	309	45.4%
	Slightly Stressed:	153	22.5%
	Stressed:	116	17.1%
	Very Stressed:	102	15%
Parents	Not Stressed*:	351	51.6%
	Slightly Stressed:	177	26%
	Stressed:	91	13.4%
	Very Stressed:	61	9%
Finance	Not Stressed*:	252	37%
	Slightly Stressed:	195	28.7%
	Stressed:	135	19.9%
	Very Stressed:	98	14.4%

Figure 2.0: Summary statistics for family related variables and explanation

Explanation of figure 2.0: For missing family events, a higher amount of workers are either stressed (27.3%) or very stressed (27.6%) when compared to the lower levels. However, most participants are only slightly stressed (30.7%). For partner related stress, the distribution seems relatively uniform with the exception of a significantly higher number of unstressed workers (32.3%). With stress relating to children, almost half (45.4%) are not stressed. The higher the level of stress, the lower number of workers are involved. E.g very stressed only has 15%. Stress relating to parents has a similar trend where over half (51.6%) are not stressed, which decreases as the level of stress becomes higher until the count percentage is very low (9% for very stressed). For finance most workers are not financially stressed (37%) while only 19.9% are stressed or 14.4% as very stressed. This could have correlation with the high pay for FIFO workers.

Just as before, a chi-squared test can be conducted with each family variable against the K10 four level classification. The hypotheses for each individual test and α value are the same as previously.

For stress related to missing family events, $p < 0.01$ which is $< \alpha$, thus we reject the null hypothesis and conclude independence does not hold and there is an association between missing events related to missing events and psychological distress. The cross tabulations indicate greatly that workers who are either slightly stress or stressed have a low classification of stress on the K10 classification (with respect to their proportions). For stress relating to a partner, $p < 0.01$ which $< \alpha$ thus we reject the null hypothesis and conclude stress relating to a partner is not independent of their k10 four level classification (there is an association). The cross tabulation makes the relationship very clear. Having a high level of stress relating to a partner, has a high association with being classified as stressed or very stressed. For stress regarding children, $p < 0.01$ which is $< \alpha$ thus we reject the null hypothesis and conclude independence does not hold for stress regarding children against the K10 four level classification (association present). It appears regarding children, not being stressed or only slightly has a correlation with being considered only stressed or slightly stress on the K10 four level classification, while being considered stressed with regards to children has a correlation with being considered stressed on the K10 four level classification (with respect to their proportions). For stress related to parents, $p < 0.01$ which is $< \alpha$, thus we reject the null hypothesis and conclude independence does not hold for stress relating to parents and their K10 four level classification (there is an association). The cross tabulation produces some peculiar results. It appears, with regard to their proportions, being very stressed in regards to parents is associated with low levels of the K10 four level classification for psychological distress. The other levels remain similar where a low level of stress with regards to parents is associated with a low stress classification on the K10 four level classification. In regards to stress relating to finance, $p < 0.01$ which is $< \alpha$, thus we reject the null hypothesis and conclude there is dependence against stress relating to health and K10 four level classification. The cross tabulations show that workers that are stressed or very stressed in regards to finance, associate with being classified as stressed or very stressed on the K10 four level classification.

These variables can be used in conjunction with the demographics to create a logistics regression model (In other words, the full model is the previous chosen model plus the family related issues variables).

For model selection, once again the backward model, full model and null model will be contrasted. Once again the K10 two level classification will be used as response and AICc will be the main selection criteria.

Model	**Predictors**	**AICc**	**Deviance**	**Pseudo R^2**	**Delta AIC**
Full Model	All Demographics, All Family Issues	700.8256	746.9635	0.06619	7.79
Null Model	-	801.9154	799.9	0	108.8842
Backward Model	Occupation, Roster, Events, Partner, Finance	693	664.3997	0.169	0

Figure 2.1: Candidate model summaries (Backwards model is the best as AICc & deviance is lowest, Delta AIC does not support other models (> 7) and pseudo R squared is the highest)

The backwards model can be summarised in the following table, notice dependants was eliminated in the backward selection from the full model (All demographics and family issues). The selection criteria stated above proves this model is most parsimonious (K10 two level classification as response).

Variable	**Level**	**Beta**	**OR(P-value)**	**95% CI**
Intercept	-	-2.25	0.11(<0.01*)	0.04~0.26
Occupation	Management:	0	1	-
	Contractor:	0.6351	1.89(0.10)	0.91~4.22
Roster	1/1:	0	1	-
	2/1:	0.363	1.44(0.19)	0.84~2.50
	4/1:	-0.3281	0.72(0.30)	0.39~1.34
	Other:	0.4424	1.56(0.42)	0.51~4.45
Events	Not Stressed:	0	1	-
	Slightly Stressed:	-0.7867	0.46(0.02*)	0.23~0.91
	Stressed:	-0.9369	0.39(0.01*)	0.19~0.82
	Very Stressed:	-0.5370	0.58(0.17)	0.27~1.26
Partner	Not Stressed:	0	1	-
	Slightly Stressed:	0.2819	1.33(0.34)	0.74~2.39
	Stressed:	0.8646	2.37(<0.01*)	1.3~4.39
	Very Stressed:	1.3912	4.02(<0.01*)	2.02~8.16
Finance	Not Stressed:	0	1	-
	Slightly Stressed:	0.3166	1.37(0.26)	0.79-2.40
	Stressed:	1.2955	3.65(<0.01*)	2.05~6.59
	Very Stressed:	1.3155	3.73(<0.01*)	1.93~7.28

Figure 2.2: Summary of chosen model and cross validation explanation (model evaluation)

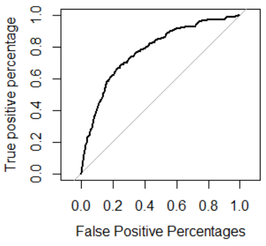

Figure 2.3 Displays a ROC curve for the chosen model, for the ROC curve, the AUC is 0.78. While this is still not ideal, it is still much better than the demographic model. However, the bias, standard deviation, sum of squares and root mean square error are still relatively high for the cross validation and not ideal. Thus, while family-related issues are a useful predictor for psychological distress, more could be considered.

Figure 2.3: ROC curve for model

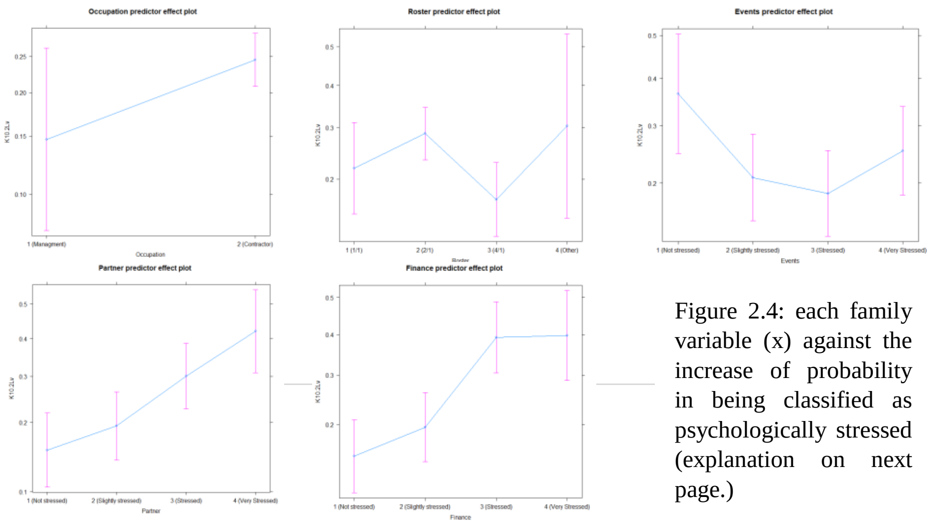

Figure 2.4: each family variable (x) against the increase of probability in being classified as psychologically stressed (explanation on next page.)

Explanation of figure 2.2: Being a contractor increases odds of stress by 89%, when compared to managers. Having a 2/1 week on/week off schedule increases the odds of stress by 44% when compared to having a 1/1 schedule. Being on 4/1 schedule decreases the odds of stress by 28% when compared to the reference level, however, being on any other roster increases the odds of stress by 56% when compared to the reference level. Being slightly stressed with regards to missing events decreases odds of being classified as stressed by 54% when compared to those who are not stressed. Being stressed from missing events reduces odds of being classified as psychological distressed by 61% while being very stressed from missing events reduces the odds of being classified as psychologically distressed by 42% when compared to workers who are not stressed. Workers who were slightly stressed with regards to their partner had increased the odds of psychological distress by 33%. Those who considered themselves stressed with regard to their partner had a very high 137% increase in the odds of being classified as psychologically stressed compared to those who were not stressed. Those who considered themselves very stressed in relation to their partner had an increase odds of being stressed by a massive 302% compared to the reference. Workers who were slightly stressed in regards to finance had an increased 37% in odds of being psychologically stressed when compared to those who were not stressed financially. However, those who were financially stressed and financially very stressed had a massive increase in odds of being classified as stressed by a great 265% and 273% respectively.

The pseudo R squared for the model is still pretty low, furthermore, at a threshold of 0.5, while the sensitivity is 91.3%. The specificity is only 36.9%. i.e it is still bad at predicting non-stressed subjects correctly.

Cross validation was employed and had a prediction rate of 74.2%. The bias was -2.2 and the standard deviation was 1. Predicated sum of squares was 4019.471 and root mean square error was 5.9.

Figure 2.4 represents the probability increase/decrease associated with changing levels for each of the predictors; these plots support the model in figure 2.4 as it shows how changing different levels of a variable effect the probability and hence odds for being classified as psychologically distressed. Figure 2.4 shows being a contractor significantly increases the chances of being classified as stressed. The second plot shows relatively consistent probabilities across all levels of roster; however having a 4/1 weeks on/off schedule decreases the probability of being classified as psychologically stressed. This is not consistent with known knowledge as it has been reported workers with long hours suffer from stress. This inconsistency could be due the unlikeliness associated with small sample size, confounding variables or the subjects represented (such as those from open pit which might show different distress levels related to weekly schedule). Being stressed in the context of finance and partner shows a higher probability of being classified as psychologically stressed on the K10 two level classification. This is all consistent with the odds ratios of the chosen regression model.

Results: The results showed that psychological distress is very prevalent in the FIFO community. The results also showed in the context of demographics and family related issues, the most significant predictors for understanding psychological distress in FIFO workers was their occupation, roster, stress from missing events, stress in the context of their partner and stress related to finance. Furthermore, the statistically significant levels were slightly stressed from events ($p = 0.02$), stressed from events ($p=0.01$), being stressed in relations to a partner ($p<0.01$), being very stressed related to a partner ($p<0.01$), being financially stressed ($p<0.01$) and being very financially stressed ($p<0.01$). This model has proven usefulness in determining psychological distress and which individual variables in demographics and family issues are useful predictors of K10 two level psychological distress. However, the specificity of the model is still poor (36.9%). The results from the cross validation (74.2% accuracy) and high bias, predicted sum of squares, and root mean square error are higher than what is desirable; additionally the pseudo R squared is low. While the model may be somewhat useful, it is clear that better and more predictors could be used to build an ideal model for predicting psychological distress.

Discussion: This study has a select few limitations. Bias could be introduced as the form of gathering data is a survey, in other words workers could lie or over/under estimate their stress and thus produce inaccurate data in the collection. A solution to this is to use a continuous and medically collected form of measuring stress. Another limitation is once again the accuracy; the sample size is small so it is possible the data could not be an accurate representation of the population. This can be fixed by taking the time to collect more subjects/samples as certain sub groups seem under represented (for example, open pit workers could be under represented). Another limitation of the study is that there is no control group. In other words, the K10 questions have been asked to FIFO workers but for comparison, the same questions relating to stress should be asked to randomly selected members of the general population, this will provide a control so the true difference between mental health in FIFO workers and the general Australian population can be observed. These findings have very useful practical implications and could be very useful in practice. For example, the findings in this paper could be used to identify those in the workforce currently who are most at risk of psychological distress and provide attention to mentally aid them and potentially prevent self-harm situations. The findings may be useful in the hiring process as well. Industry could selectively hire candidates who exhibit criteria (in the context of demographics) for having low odds of being classified as psychologically stressed. In addition, this data could potentially evoke change to help create a less stressful FIFO environment. For example, being financially stressed associates high with being classified as psychologically distressed. Thus, to create a less stressful work environment, financial aid could be provided to workers or improved pay rates, to reduce the level of financial stress and therefore reduce the probability of a FIFO worker being categorised as psychologically stressed.

Conclusion: This study has found that mental health issues are prevalent within the FIFO community. Furthermore, in the context of demographic and family related issues, the best predictors of psychological stress for FIFO workers are occupation, roster, stress related to missing events, stress related to partners and financial stress. Understanding these indicators of stress can be very useful in practice and has the ability to improve the FIFO work environment and also potentially prevent FIFO self-harm cases in advanced.