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Work-Related Psychological Injury Is Associated with Metabolic Syndrome Components in Apparently Healthy Workers

IS4250 PROJECT ASSIGNMENT

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Executive Summary

The purpose of this study is to examine the relationship between work-place psychological injury and metabolic syndromes. A data set containing 571 workers' psychological score, biological data and lifestyle indicators is chosen for the study. By applying Fisher's Exact Test, Linear Regression and Logistic Regression, following conclusions are obtained. Firstly, workers with a high PIRI score indicating psychological injury had a higher risk of having at least one metabolic syndrome component. Moreover, with higher chance of psychological injury, there was a higher chance of hypertriglyceridemia in male workers and hypertension in female workers. The result of this finding is useful in helping to guide individuals who have exposed to work-place trauma to pay attention to their psychological and metabolic state, and inform employers that psychological injury could occur on apparently healthy workers. Hence, early interventions could be implemented.

Description of the problem

In recent years, the world has witnessed an increasing onset of metabolic syndromes which involves a mix of risk factors such as abdominal obesity, high triglyceride level, low HDL cholesterol level, reduced glucose tolerance and hypertension. The issue pertaining to an increasing population incurring metabolic syndromes has been of great concern, since metabolic syndromes could lead to fatal complications such as cardiovascular diseases, diabetes, even certain types of cancer.

However, the effectiveness of strategies in combating metabolic syndromes could only be considered when the causes are understood. While large amount of literatures has proved the association between work-place trauma and metabolic syndromes, previous studies focused more on first-response occupations such as law enforcement, firefighting and military activities which are renowned for exposure to high intensity trauma where consequences are apparent. It is still questionable whether workers experiencing normal occupational stress who are apparently healthy could also incur metabolic symptoms. Hence, the paper focused on study

the relationship between psychological disorder caused by prevalent occupational stress and metabolic syndromes in apparently healthy workers.

Description of Data

The data set was collected from workers from 20 Italian companies undergoing routine medical examination. Out of 577 requests, 571 workers agreed to participate, and the participation rate is 99%. Hence, the sample comprises of 571 workers who are apparently healthy as worker undergoing sickness absence caused by physical or mental illnesses were automatically excluded from the research.

The dataset consists of 12 variables including self-reported data as well as biological data. Firstly, a questionnaire was given to the participants to acquire the following self-reported information:

1. sex (1=Male, 2=Female): gender
2. age: age
3. smoker (0=non-smoker, 1=current smoker): smoking status
4. alcohol (0= less than 7 alcohol units per week, 1= 8 or more alcohol units per week): alcohol intake
5. exercise (0=regular, 1=none): physical activity
6. sleep (0=regular, 1=disturbed): sleep habit
7. PIRI>25 (0=PIRI less than or equal to 25, 1=PIRI more than 25): Psychological Injury Risk Indicator.

   Psychological Injury Risk Indicator(PIRI) is measurement specifically designed to identify people with higher tendency of incurring psychological injury in the earlier state. It is a self-reported measurement where people under research will answer 26 questions comprising 4 categories on a 0-6 Likert point scale, namely sleep problems (6 items), recovery failure (5 items), post-traumatic stress symptoms (10 items) and chronic fatigue (5 items). The scores

are then transferred to a 0-100 scale. PIRI>25 is defined to be vulnerable to psychological injury while higher score implies higher risk.

Secondly, biological data includes following items:

8. hypercol (1= HDL cholesterol<40 mg/dL in male or < 50 mg/dL in female): reduced HDL cholesterol
9. hypertrig (1= triglyceride>150 mg/dL): elevated triglyceride level
10. hipressure (1= systolic BP > 130): high blood pressure
11. diabetes (1= fasting plasma glucose>100 mg/dL): high fasting plasma glucose
12. obesity (1=BMI>30 kg/m2): central obesity

The biological data serves as indicators for metabolic components, and the diagnosis of metabolic syndrome requires the presence of three or more components.

Methods

There are 3 main experiments in the paper, namely Fisher's Exact Test, Linear Regression Analysis and Logistic Regression Analysis. These methods follow a rational logic process. Firstly, the researchers want to know whether there is relationship between high PIRI score and high prevalence of Metabolic Syndrome, by using Fisher's Exact Test. The contingency table is a 2*2 table which is illustrated below.

	Higher Prevalence of MES Components	Lower Prevalence of MES Components	Total
Higher PIRI Score	6	133	139
Lower PIRI Score	4	428	432
Total	10	561	571

Table 1. Contingency Table

Secondly, after proving the positive relationship between PIRI and MES, they are willing to investigate more on PIRI score related to the number of MES components, by using Linear Regression. As the transitional method between Fisher's Exact Test and Logistic Regression, Linear Regression helps to complete the top-down approach to investigate the association between work-related psychological injury and metabolic syndrome components in apparently healthy workers.

After determining higher PIRI scores have positive correlation with number of MES components, Logistic Regression is used to analyse whether psychological injury is significantly related to the presence of at least 1 MES component. Comparing to Linear Regression which gives infinite number of possible continuous values, the outcome of Logistic Regression has only a limited number of possible values. In this case, it is to determine whether psychological injury is related to at least 1 MES component. There are only 2 outcomes, simply yes or no. In the end, Logistic Regression completes the whole investigation.

Replication of Experiment

We choose to replicate experiment of logistic regression analysis with the data provided, by using R. The reason why we choose this experiment is that Fisher's Exact Test and Linear Regression Analysis give us only a rough idea about the association between psychological injury and metabolic syndrome, although they are clear enough to understand. Only the Logistic Regression Analysis can provide us a more profound understanding of the topic.

Basically this experiment is to investigate whether there is significant relationship between high PIRI score and at least 1 MES syndrome as well between combining high PIRI score and biographic data and at least 1 MES syndrome, called model1 and model2 respectively. In both situations, we focus more on the following 3 index, namely p-value, odds ratio and R-square. Those 3 measures are the main ways to quantify how strongly the presence or absence of

independent variables is associated with the presence or absence of dependent variables in a given population.

In R, we use *glm()* function to build logistic regression model. Both models use at least 1 MES syndrome as dependent variables. For model1, only high PIRI score (whether greater than 25) is used as independent variables. For model 2, high PIRI score and biological data (sex, age, smoker, alcohol, exercise and sleep) are treated as independent variables. *summary()* function is used to check the p-value of each independent variables. From Table 2, we can see in model1, high PIRI score is significant as p-value is much smaller than 0.05. In model 2, besides high PIRI score, although there are 6 more independent variables, only age is significant with p-value smaller than 0.001. That shows only high PIRI score and age are the main factors which are statistically significant to MES syndrome.

	model1				**model2**			
	OR	**95% CI(L&U)**		**p-value**	**OR**	**95% CI(L&U)**		**p-value**
High PIRI	1.779	1.194	2.641	**0.004**	1.596	1.023	2.481	**0.038**
Sex	-	-	-	-	0.710	0.478	1.056	0.090
Age	-	-	-	-	1.057	1.037	1.078	**0.000**
Smoke	-	-	-	-	0.868	0.589	1.272	0.470
Alcohol	-	-	-	-	1.227	0.638	2.320	0.533
Exercise	-	-	-	-	1.056	0.710	1.582	0.788
Sleep	-	-	-	-	1.020	0.571	1.794	0.945
C&U R^2	**0.019**				**0.111**			

Table 2: Replicated Experiment Result by R

For odds ratio, we use R function exp(cbind(OR=coef(model), confint(model))) to calculate, subjected to different model names. Before biographic data added in the model, High PIRI has OR of 1.779 with 95% confidence interval (1.194-2.641). After biographic data added, High PIRI has OR of 1.596 with 95% C.I. (1.023-2.481) instead. For R-squared value which determines the fitness of the model, model after biographic data added has greater value 0.111 than model before biographic data added (0.019). Here, Cragg and Uhler's Pseudo R-square is used which can be found in *pR2()* function in library(pscl). However, although R-squared value has improved more than 5 times after biographic data introduced to the model, it is still a relatively low value. In order words, the current model is not perfect as the small R-squared value does not explain too much variation of the model. The experimental plot of at least 1 MES component against PIRI standard value is shown in Figure 1.

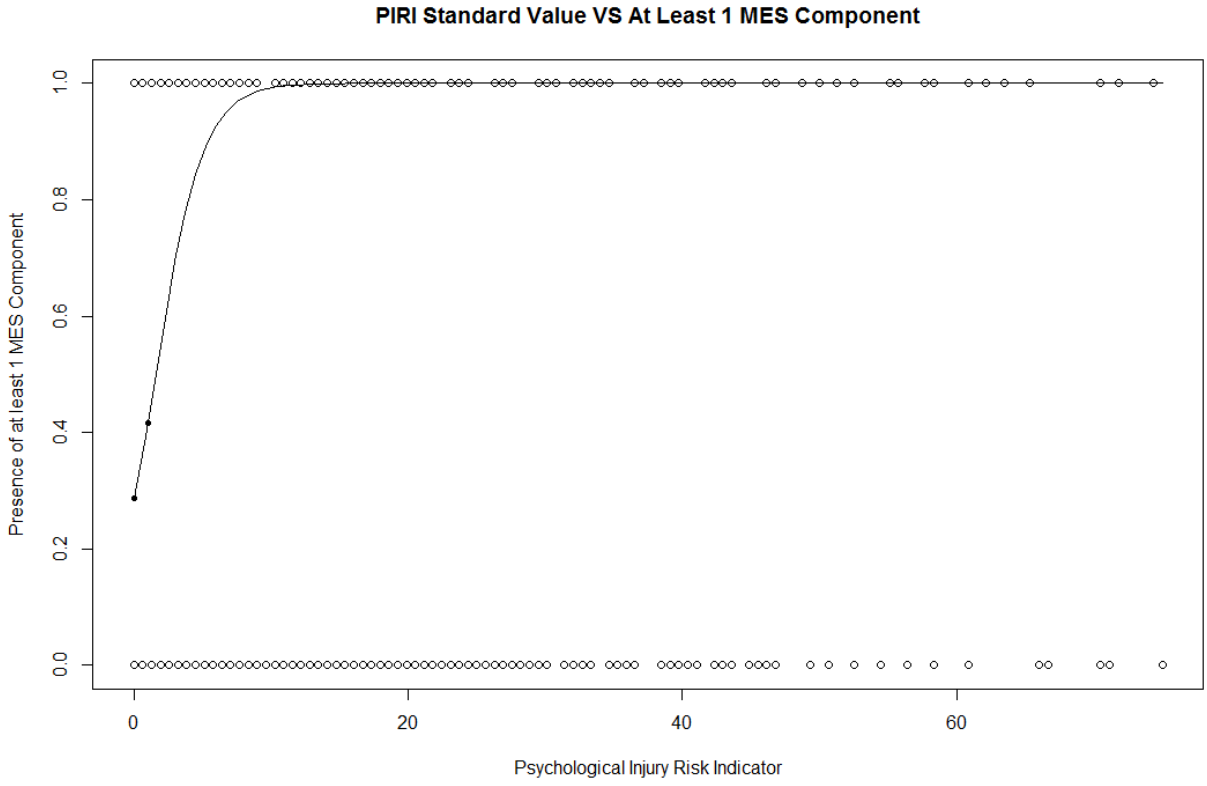

Figure 1. Experimental Plot of at least 1 MES Component against PIRI Standard Value

Contributions

While previous studies did not give a concrete prove on the relationship between occupational stress and MES, this research focused on ordinary everyday work situations and demonstrated that there is indeed a relationship between work stress and MES. By publishing the result, it raised the awareness that not only people from high strain jobs can incur mental and physical illnesses, people from ordinary jobs are also at risk. Hence, individuals should pay more attention on his own health conditions. And from employers' side, it is important to provide a healthy work environment and early interventions should be implemented to look after the mental and physical health of their workers to render higher productivity. For example, medical surveillance could be conducted annually by occupational physicians to achieve early intervention at a low cost and high benefit ratio.

The topic targeting every working personnel worth attention and further analysis to improve on. Published on 2015-07-07, the dataset has been downloaded 49 times for further analysis.

Limitations

1. *Cross-sectional design prevents from drawing conclusions about causality*

   Panel data is needed to find out the causal relationship between PIRI and MES. However, the researchers only managed to obtain a one-time cross sectional data from the workers. It means that only association between variables could be obtained but we are unable to draw the conclusion that the work-place trauma causes metabolic syndromes since the causal relationship could be other way round. This limitation could lead to less insights on the final result.

2. *Limited number of observations may lead to more Type II error, failing to detect real associations*

   In statistical analysis, if we do not reject the null hypothesis when in fact there is a difference between the groups we make is known as a type II error. And such a case

usually happens when the dataset is small. In this study, out of 571 observations, only 182 have at least on MES components and 10 are identified for incurring MES. Even if there is a correlation worth identifying, the confidence interval of the two groups could overlay zero resulting in the correlation undetected, affecting the accuracy of the final result.

3. *Low percentage of variance is explained by logistic regression model*

   In this study, the association between PIRI and MES is weak and the percentage of variance explained by the logistic regression model is low. It means that the model fails to consider other variables that could potentially lead to MES in apparently healthy workers. This limitation implies that the current model is incomprehensive.

4. *Bias in self-reported data*

   Firstly, the responders could have different interpretations on the same set of questions. Secondly, using Likert Point Scales can bring problems as people interpret and use scales differently, resulting in people with the same opinion giving different ratings. Thirdly, some people may lack of the introspective ability, resulting in inaccurate of the responses. Moreover, honesty of the responders could also be an issue if some workers purposely hide their true information.

Further Work

1. Data should be collected on a yearly basis from the group of workers to from a panel dataset for further analysis. Auto-regression could be used to examine the effect of psychological factors with time-lag to find out the causal relationship between worker's psychology state(PIRI) and their physical state(MES).

2. A larger sample should be collected from different hospitals to reduce the inaccuracy caused by type II error. Moreover, the study should not be restricted to companies in Italy, data could be acquired from other countries for a more holistic analysis.

3. A small percentage of variance explained by the logistic model implies that the independent variables chosen in the study only explain part of the causes towards MES. To fully understand MES among workers, the group could take into considerations other variables such as their diet habit, heredity factors etc. to provide a more effective model.

4. Instead of giving questions on Likert scale, simple black-or-white questions could be asked to improve accuracy of the responses. The honesty issue could be reduced if the confidentiality of the information is guaranteed.

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