

# **Stress, Anxiety, and Depression: Prevalence and Associations to Electroencephalography and Cognitive Performance in Healthcare Professionals**

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## I. Declaration

I declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy (Science) in the School of Life Sciences at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.

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### III. Publications and Presentations

#### Publications

1. Maharaj, S., Lees, T., & Lal, S. (2018). Negative mental states and their association to the cognitive function of nurses. *Journal of Psychophysiology*, 33(3), 207–218. <https://doi.org/10.1027/0269-8803/a000223>
2. Maharaj, S., Lees, T., & Lal, S. (2019). Prevalence and Risk Factors of Depression, Anxiety, and Stress in a Cohort of Australian Nurses. *International Journal of Environmental Research and Public Health*, 16(1), 61. <https://doi.org/10.3390/ijerph16010061>
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4. Ferreira, B., Maharaj, S., Simpson, A., Nassif, N., & Lal, S., (2020), The metabolic role of depression and burnout in nurses. *Translational Metabolic Syndrome Research*, 3, 9-11. <https://doi.org/10.1016/j.tmsr.2020.03.002>
5. Beehan-Quirk, C., Jarman, L., Maharaj, S., Simpson, A., Nassif, N., & Lal, S., (2020), Investigating the effects of fatigue on blood glucose levels – Implications for diabetes. *Translational Metabolic Syndrome Research*, 3, 17-20. <https://doi.org/10.1016/j.tmsr.2020.03.001>
6. Lees, T., Maharaj, S., Kalatzis, G., Nassif, N., Newton, P., & Lal, S. (2020) Electroencephalographic prediction of global and domain specific cognitive performance of clinically active Australian Nurses (*Accepted for publication, Journal: Physiological Measurement*)

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1. Lees, T, Maharaj, S and Lal, S. (2015). Electroencephalographic markers of subjective cognitive performance: implications towards electrophysiological prediction of early cognitive decline. Frontiers in Human Neuroscience Conference Abstract: ASP2015 - 25th Annual Conference of the Australasian Society for Psychophysiology

2. Maharaj, S, T, Lees, C, Zaslowski, K, Fatima-Shad, Lal, S. (2017), 'Assessing the link between negative mental states and cognitive performance in health professionals.' Conference Abstract: The 4th Annual Conference of the Australasian Cognitive Neuroscience Society

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13. Beehan-Quirk, C, Jarman, L, Maharaj, S, Simpson, A, Nassif, N, Lal, S., (2019), The effects of fatigue on blood glucose levels – implications for diabetes. The 36th Combined Health Science Conference - New Horizons 2019, Sydney, November 14-15

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2. Lees T, Maharaj S, Kalatzis G, Nassif N, Newton P, Lal S., Anxiety and its relationship to the neurocognitive performance of Australian Nurses
3. Leong D, Akella A, Kumar Singh A, Lal S, Newton P, Clifton-Bligh R, McLachlan C, Gustin S, Maharaj S, Lees T, Cao J, Lin CT., Classifying the Level of Lab-induced Stress in a combined sample of nurses and non-health professionals using Auto-Encoder
4. Chalmers T, Maharaj S, Lal S., Assessing associations between workplace factors and Depression and Anxiety in Australian heavy vehicle truck drivers

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## VII. Abbreviations

|                           |   |
|---------------------------|---|
| <b>ABS</b>                | = Australian Bureau of Statistics                     |
| <b>ACTH</b>               | = Adrenocorticotrophic Hormone                        |
| <b>AIHW</b>               | = Australian Institute of Health and Welfare          |
| <b>AIN</b>                | = Assistant in Nursing                                |
| <b>ANOVA</b>              | = Analysis of Variance                                |
| <b>ANS</b>                | = Autonomic Nervous System                            |
| <b><math>\beta</math></b> | = Beta  |
| <b>B</b>                  | = Regression Coefficient                              |
| <b>BMI</b>                | = Body Mass Index                                     |
| <b>BP</b>                 | = Blood Pressure                                      |
| <b>Bpm</b>                | = beats per minute                                    |
| <b>CANTAB</b>             | = Cambridge Neuropsychological Test Automated Battery |
| <b>CBT</b>                | = Cognitive Behavioural Therapy                       |
| <b>CRH</b>                | = Corticotropin Releasing Hormone                     |
| <b>°C</b>                 | = Degrees Celsius                                     |
| <b>DASS</b>               | = Depression Anxiety Stress Scale                     |
| <b>DC</b>                 | = Direct Current Value                                |
| <b>EEG</b>                | = Electroencephalography                              |
| <b>ELISA</b>              | = Enzyme-linked Immunosorbent Assay                   |
| <b>EOG</b>                | = Electro-oculogram                                   |

|                 |  |
|-----------------|--|
| <b>ESS</b>      | = Epworth Sleepiness Scale                       |
| <b>fMRI</b>     | = Functional Magnetic Resonance Imaging          |
| <b>g('s)</b>    | = Relative Centrifugal Force (RCF)               |
| <b>GHQ</b>      | = General Health Questionnaire                   |
| <b>GP</b>       | = General Practitioner                           |
| <b>HPA axis</b> | = Hypothalamic Pituitary Adrenal Axis            |
| <b>HR</b>       | = Heart Rate                                     |
| <b>HREC</b>     | = Human Research Ethics Committee                |
| <b>Hz</b>       | = Hertz  |
| <b>IQ</b>       | = Intelligence Quotient                          |
| <b>LC-MS/MS</b> | = Liquid Chromatography Tandem Mass Spectrometry |
| <b>MANCOVA</b>  | = Multiple Analysis of Covariance                |
| <b>MCI</b>      | = Mild Cognitive Impairment                      |
| <b>MEG</b>      | = Magnetoencephalography                         |
| <b>mmHg</b>     | = Millimetres Mercury                            |
| <b>MMSE</b>     | = Mini Mental State Examination                  |
| <b>MRI</b>      | = Magnetic Resonance Imaging                     |
| <b>NC</b>       | = No Change                                      |
| <b>NHC</b>      | = Non-Healthcare comparative group               |
| <b>NS</b>       | = Non-Significant                                |
| <b>NSW</b>      | = New South Wales                                |
| <b>OMS</b>      | = Ohms   |

|                         |                                       |
|-------------------------|---------------------------------------|
| <b>PET</b>              | = Positron Emission Tomography        |
| <b>qEEG</b>             | = Quantitative Electroencephalography |
| <b>R</b>                | = Correlation Coefficient             |
| <b>r</b>                | = Rho value                           |
| <b>R<sup>2</sup></b>    | = Coefficient of determination        |
| <b>RN</b>               | = Registered Nurse                    |
| <b>SD</b>               | = Standard Deviation                  |
| <b>SE</b>               | = Standard Error                      |
| <b>μV</b>               | = Microvolts                          |
| <b>ug/dL</b>            | = Micrograms per Decilitre            |
| <b>USA</b>              | = United States of America            |
| <b>UTS</b>              | = University of Technology Sydney     |
| <b>WAIS</b>             | = Wechsler Adult Intelligence Scale   |
| <b>μV/s<sup>2</sup></b> | = Microvolts per second squared       |

## VIII. Abstract

Healthcare remains one of the most demanding careers available. Psychological distress is widespread among healthcare professionals. However, few studies have investigated the prevalence of stress and common mental health issues such as anxiety, and depression in Australian healthcare professionals, and their associations with electroencephalography (EEG) and cognitive performance. The present study assessed the prevalence of stress, anxiety and depression, and the relationships between these mental states and cognitive performance in healthcare professionals. It also investigated associations between cortisol and mental health/cognitive performance measures.

Data was obtained from 154 participants divided into four groups: nurses (n=81), allied health professionals (n=31), doctors (n=20), and non-healthcare professionals (n=22). The experimental protocol involved pre-study and post-study blood pressure measurements and the collection of salivary cortisol. A questionnaire battery obtained lifestyle, demographic, and work-related data. Mental health data was obtained using the Depression, Anxiety, Stress Scale, and the General Health Questionnaire. A 32-lead monopolar EEG was recorded over two five-minute phases (a resting baseline phase followed by an active phase involving the Stroop task). Finally, cognitive performance was assessed using the Mini-Mental State Examination and the Cognistat.

Prevalence rates in healthcare providers ranged between 26-60% for depression, 26-44% for anxiety, and 29-60% for stress. Stress was associated with decreases in repetition ( $r=-0.46$ ,  $p=0.039$ ), memory ( $r=-0.49$ ,  $p=0.029$ ), and attention ( $r=-0.51$ ,  $p=0.021$ ) in doctors, while anxiety was linked to decreased memory ( $r=-0.23$ ,  $p=0.047$ ) in nurses and global cognition ( $r=-0.36$ ,  $p=0.049$ ) in allied health professionals. Depression was also related to declines in memory ( $r=-0.27$ ,  $p=0.019$ ) in nurses. Conversely, stress was associated with better judgement ( $r=0.61$ ,  $p=0.004$ ) in doctors. Stress, anxiety, and depression were also associated with mixed findings in both high and low-frequency brain activities (decreased theta, increased delta, decreased alpha, increased beta, decreased gamma). No associations were found between cortisol and mental health/cognitive performance measures.



These findings provide insight into the prevalence of mental health symptomology in Australian health professionals and suggest that negative mental states are associated with both improvements and impairments in cognitive performance. Unique variations in electroencephalographic changes were also linked to stress, anxiety, and depression; giving insight into what brain rhythms may underlie stress, anxiety, and depression, and how they may relate to various cognitive processes. Further research exploring the effects of negative mental states on personal wellbeing and cognition could enable the development of industry-specific management, monitoring, and/or intervention strategies aimed at preserving the health and performance of health professionals.