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The relationship between chronic sleep restriction, poor sleep quality and obesity in adults

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THE RELATIONSHIP BETWEEN CHRONIC SLEEP RESTRICTION, POOR SLEEP QUALITY AND OBESITY IN ADULTS

A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

DOCTOR OF PHILOSOPHY

FROM

UNIVERSITY OF WOLLONGONG

BY

CHRISTOPHER MAGEE, B. PSYC (HONS)

SCHOOL OF PSYCHOLOGY

2008

CERTIFICATION

I, Christopher Magee, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Psychology, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Christopher Magee

14 April 2008

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Finally, to my family and friends for always keeping things in perspective.

ABSTRACT

This thesis consists of two literature reviews followed by three empirical chapters that examined the relationship between chronic sleep restriction and obesity. Chapter 2 reviewed available research data and presented a theoretical model linking chronic sleep restriction to obesity. This model hypothesises that chronic sleep restriction contributes to obesity by altering energy regulatory hormones such as ghrelin and leptin. It was also argued that factors such as poor mental health, medication use and long work hours contribute to chronic sleep restriction at a population level, and could have implications for improving sleep. This model provides a sound theoretical framework, which was used to guide the subsequent empirical chapters. In chapter 3, the key methodological limitations of previous studies examining the relationship between chronic sleep restriction and obesity were outlined. Methodological recommendations for future research were then provided to facilitate a more complete understanding of how chronic sleep restriction and obesity are linked in the general population.

Chapter 4 tested a path model linking chronic sleep restriction to obesity in 325 adults aged 18 to 87 years, based on the theoretical framework provided in chapter 2 and the methodological recommendations listed in chapter 3. The results indicated that short sleep durations and age were associated with obesity, whilst age, uncomfortable sleep environments, irregular sleep/wake cycles and poor mental health were associated with short sleep durations. However, the results also identified potential environmental, behavioural and psychological determinants of chronic sleep restriction that could be targeted in the future treatment and prevention of obesity.

Chapter 5 examined the relationship between three dimensions of sleep quality as assessed by the Pittsburgh Sleep Quality Index and obesity in 262 adults aged 18 to 35 years. Short sleep durations and increased levels of daytime dysfunction (e.g., sleepiness) were associated with obesity, whilst irregular bedtimes, noisy environments, discomfort and depression were the major factors associated with poor sleep quality. These factors could play a role in obesity interventions that target sleeping patterns and need to be further investigated.

Finally, chapter 6 examined the effects of two nights of seep restriction on energy expenditure and neuroendocrine hormones involved in energy balance regulation in ten healthy male adults. The results indicated that sleep restriction led to an increase in ghrelin and a reduction in PYY, which corresponded with increased hunger and reduced satiety. The results also suggested that energy expenditure declined with sleep restriction. These results suggest that sleep restriction could contribute to obesity by altering energy expenditure and the hormonal regulation of food intake.

The findings from this thesis therefore suggest that chronic sleep restriction contributes to the development of obesity by altering key pathways identified in chapter 2. The identification of possible determinants of chronic sleep restriction has potential applications for the treatment and prevention of obesity. For example, the factors identified in chapters 4 and 5 could be targeted as a way to promote healthy sleep durations, and could be effective in improving the efficacy of existing interventions for obesity.

PUBLICATIONS FROM THE THESIS

Published Manuscripts

Magee, C.A., Iverson, D.C., Huang, X., & Caputi, P. (In Press). A Link between Chronic Sleep Restriction and Obesity: Methodological Considerations. *Public Health, 10.1016/j.puhe.2008.05.010.*

Manuscripts under Review

Magee, C.A., Caputi, P., Iverson, D.C., Huang, X., & Humpel, N. (Submitted). A Path Model linking Short Sleep Durations and Obesity in Adults. *Journal of Psychosomatic Research.*

Magee, C.A., Caputi, P., Iverson, D.C., & Huang, X. (Submitted). The Relationship between Multiple Dimensions of Sleep Quality and Obesity. *Journal of Behavioral Medicine*.

Magee, C.A., Iverson, D.C., Caputi, P., & Huang, X.F. (Submitted). A Preliminary Investigation of the Effects of Short-Term Sleep Restriction on Energy Regulatory Hormones and Metabolic Rate. *Journal of Clinical Endocrinology and Metabolism.*

Magee, C.A., Huang, X., Iverson, D.C., & Caputi, P. (Submitted). The Link between

Chronic Sleep Restriction and Obesity: A review of the underlying causal mechanisms. *Journal of Behavioral Medicine.*

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- Journal of Behavioral Medicine (2007)
- Journal of Clinical Endocrinology and Metabolism (2008)
- Journal of Sleep Research (2007)
- Preventive Medicine (2007)
- Public Health (2007)
- Sleep (2007)
- Sleep Medicine (2007)

DEFINITION OF KEY TERMS

BASAL METABOLIC RATE: The energy that is expended when an individual is at rest. It is recommended that this measurement is taken in the morning between 6:00am and 9:00am after a minimum of nine hours fasting (Levine, 2005). In this thesis, basal metabolic rate was estimated using indirect calorimetry, which is also defined in this list.

CHRONIC SLEEP RESTRICTION: Habitual sleep durations that are less than seven hours but more than four hours per night (Dinges, Rogers, & Baynard, 2005). This is in contrast to total sleep restriction or total sleep deprivation, which refers to a complete absence of sleep over a period of at least 24 hours.

INDIRECT CALORIMETRY: A method to estimate energy expenditure which involves the measurement of oxygen consumption and carbon dioxide production (Levine, 2005). In the present thesis, a whole room calorimeter was used to obtain these measurements.

OVERWEIGHT AND OBESITY: An excess of body fat (particularly visceral fat) that is associated with increased mortality risk. Most relevant literature has defined overweight by a body mass index (BMI) between 25.0 and 29.9, with obesity defined by a BMI of 30.0 and over. In this thesis, overweight and obesity are defined on the basis of a combination of BMI and waist circumference (WC) using cut-offs suggested by the World Health Organization (WHO, 2000).

PARTIAL LEAST SQUARES: A statistical method of estimating parameters in path models. This method of estimation is used in a technique that allows the complex relationships between multiple variables to be examined simultaneously in a path model. This technique is the non-parametric equivalent to structural equation modelling and is suitable for exploratory data analyses (Chin, 1998).

SLEEP QUALITY: A construct that encompasses multiple aspects of sleep such as subjective sleep satisfaction, sleep disturbances, sleep disorders, excessive daytime sleepiness and sleep duration. In this thesis, subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index.

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