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Short sleep mediates the association between long work hours and increased body mass index

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Abstract

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ABSTRACT

This study examined whether short sleep duration, physical activity and time spent sitting each day mediated the association between long work hours and body mass index (BMI). Participants included 16,951 middle aged Australian adults who were employed in full time work (i.e. ≥35 h a week). Data on BMI, sleep duration, work hours and other health and demographic variables were obtained through a self-report questionnaire. A multiple mediation model was tested whereby sleep duration, physical activity and amount of time spent sitting were entered as potential mediators between work hours and BMI. The results demonstrated that short sleep partially mediated the association between long work hours and increased BMI in males. In females, long work hours were indirectly related to higher BMI through short sleep. The results provide some support for the hypothesis that long work hours could contribute to obesity via a reduction in sleep duration; this warrants further investigation in prospective studies.

Key Words: obesity, body mass index, sleep, work hours, multiple mediation

INTRODUCTION

Obesity greatly increases the risk of chronic health problems such as type 2 diabetes mellitus, cardiovascular disease, certain metabolic cancers and sleep problems (e.g. obstructive sleep apnoea) (Kopelman 2000). Obesity is also associated with adverse psychosocial outcomes including depression, poor body image, low self-esteem and discrimination (O'Brien et al. 2008; Onyike et al. 2003; Schwartz and Brownell 2004). It is therefore of great concern that obesity has become increasingly common in recent decades (World Health Organization 2000). For example, the prevalence of obesity in Australia more than doubled between 1980 and 2000 (Cameron et al. 2003) and it is currently estimated that 24.8% of Australian adults are obese and a further 36.6% are overweight (Australian Bureau of Statistics 2009). A wide variety of genetic, environmental and psychosocial factors interact to influence body weight and obesity (Kopelman 2000; World Health Organization 2000), but the rapid rise in obesity suggests that environmental and behavioural factors (e.g. high fat diets, sedentary lifestyles) are important underlying causes (Hill et al. 2003).

Several studies conducted in Australia, Hong Kong and Finland have also found that long working hours are associated with an increased risk of obesity (Di Milia and Mummery 2009; Ko et al. 2007; Lallukka et al. 2005, 2008a, b; Ostry et al. 2006). These findings are important in an Australian context given that the proportion of Australian adults working long hours (i.e. >49 h a week) increased between 1985 and 2005 from 22 to 30% in males and 9 to 16% in females (Australian Bureau of Statistics 2006). Interestingly, some studies have identified possible sex differences, indicating an association between long work hours and obesity in males but not in females (Ko et al. 2007; Ostry et al. 2006). Others have found that working overtime (an indicator of long work hours) was associated with obesity and weight gain in both males and females (Lallukka et al. 2008a, b).

These findings suggest that targeting long work hours could play a role in preventing obesity in Australian employees, but studies have not yet clarified how long work contributes to obesity. One novel hypothesis is that long work hours contribute to obesity via a reduction in night-time sleep (Gangwisch 2009). This is based on studies demonstrating that long work hours are associated with shorter sleep durations (Akerstedt et al. 2002a, b; Krueger and Friedman 2009; Magee et al. 2009). For example, a 4-year prospective study of middle aged British Civil Servants indicated that individuals who worked longer hours were more likely to report shorter sleep as well as sleep disturbances such as difficulty falling asleep and waking without feeling refreshed (Virtanen et al. 2009). It is possible that individuals who work long hours voluntarily sacrifice sleep duration in order to meet job demands as well as family and social commitments; longer work hours could also impair sleep because of psychosocial factors relating to stress and a lack of time for relaxation (Gangwisch 2009).

Furthermore, a number of recent cross-sectional studies conducted in Australia, the US, Europe and Asia have found that short sleep is associated with an increased risk of obesity (Cappuccio et al. 2008; Magee et al. 2010b). These cross-sectional findings have been supported by longitudinal studies demonstrating that short sleep at baseline predicts modest weight gain at follow up several years later (Chaput et al. 2008; Gangwisch et al. 2005; Hasler et al. 2004; López-García et al. 2008; Patel et al. 2006). Similar to the associations between long work hours and obesity, a number of studies have found sex differences in the association between sleep duration and obesity. For example, Magee et al. (2010b) found a U shaped association between sleep duration and obesity in males, but a negative linear association in females. Kripke et al. (2002) found the opposite pattern of results with a U shaped association in females and a negative inverse association in males. Ko et al. (2007) found that short sleep was associated with obesity in males, but that there was no association in females. Although these sex differences require further investigation, the associations between short sleep and obesity have potentially important implications given that short sleep is an increasingly common characteristic of modern society (Kripke et al. 1979, 2002).

The observed associations between short sleep, long working hours and obesity raise the possibility that short sleep could mediate the association between work hours and obesity, an idea that has received some preliminary support. In a cross-sectional survey of 346 Australian workers, Di Milia and Mummery (2009) found that obese individuals were more likely to work longer hours and sleep less. It was concluded that longer working hours may contribute to obesity by interfering with sleep duration as well as other factors such as physical activity levels. In a sample of 4,793 Hong Kong adults aged 17–83 years, Ko et al. (2007) found that reduced sleep duration and longer working hours were associated with higher BMIs. It was argued that individuals working long hours and getting less sleep at night may have greater stress levels, which could explain the increased risk of obesity (Ko et al. 2007).

Long working hours may also contribute to obesity by limiting the amount of time available for physical activity (Di Milia and Mummery 2009) or increasing the amount of time spent being sedentary. For example, white collar workers who work long hours could be at an increased risk of obesity because they spend more time sitting (Mummery et al. 2005). Furthermore, individuals who work longer hours may also have an increased risk of obesity because of increased consumption of snacks and fast food resulting from an actual, or perceived, lack of time (Lallukka et al. 2005, 2008a; Nakamura et al. 1998).

Therefore, factors such as short sleep, reduced physical activity and increased sitting time could mediate the association between long work hours and obesity, but to our knowledge this has not yet been tested formally. Mediation is an important concept in behavioural medicine, as it indicates whether an independent variable is related to a dependent variable through another variable (i.e. a mediator) (Baron and Kenny 1986).

Multiple mediation is an extension of simple mediation and allows for an investigation of whether more than one factor mediates the association between an independent and dependent variable (Preacher and Hayes 2008). This is important because it provides further insight into how two variables are associated.

The purpose of this paper was therefore to formally test whether short sleep mediates the relationship between long work hours and BMI in a sample of full-time Australian employees. We also tested physical activity and sitting time as possible mediators given that previous studies have suggested that these variables could be important (Di Milia and Mummery 2009; Mummery et al. 2005). Furthermore, given that previous studies have identified possible sex differences in the relationships between sleep, work hours and obesity, we examined these associations separately in males and females.

METHOD

Participants

This paper utilised data collected through the 45 and Up Study, which is a health survey of adults aged 45 years and over who reside in the state of New South Wales (the most populous state in Australia). The objective of the 45 and Up Study is to develop a long-term collaborative resource to investigate healthy aging in a large sample of Australian adults (Banks et al. 2008). The 45 and Up Study collects a wide variety of health information relating to BMI, sleep duration, psychological distress, physical activity, health status and demographic characteristics. Participants for this study were randomly selected from the Medicare Australia enrolment database (Medicare is Australia's universal health care system) and were invited to participate in this study; the response rate (i.e. individuals who provided consent to participate and completed the questionnaire) was estimated at 18%. A very small percentage (<1% of the final sample) of individuals who were not recruited through this method, independently contacted the 45 and Up Study and volunteered to participate; the data from these participants are also included in this paper. Informed consent was obtained from all participants and the 45 and Up Study was approved by the University of New South Wales Human Research Ethics Committee. Approval to use these data in the present paper was obtained from the University of Wollongong Human Research Ethics Committee.

In this paper, baseline data from the 45 and Up Study collected between 2006 and 2008 were used. This baseline dataset included a total of 103,042 participants aged between 45 and 107 years. We limited this sample to individuals aged 45–65 years who were employed in full-time work (i.e. ≥35 h a week) and for whom complete data were available on all variables. This involved excluding 40,725 individuals aged >65 years, another 35,369 individuals who were not employed or worked <35 h a week and 2,302 individuals who had missing values for BMI or sleep duration. Finally, we excluded another 7,351 individuals who had missing values on the other variables that were also included in this paper. This resulted in a sample size of 17,295 full time employees aged 45–65 years.

Materials

All data were collected through a self-reported questionnaire. Self-reported height and weight were used to calculate BMI (a widely used index of obesity). Participants were asked to estimate the number of hours in each 24 h day they spent sleeping (including at night and naps) and sitting. Sleep duration was coded as ≤6 h (i.e. short sleep) and 7–10 h sleep (i.e. >6, ≤10 h). Work hours were assessed through the open ended question "About how many hours each week do you usually spend doing the following: paid work hours?". As noted above, we only included participants who indicated that they worked a minimum of 35 h a week.

Physical activity levels were assessed using questions from the Active Australia Survey (Australian Institute of Health and Welfare 2003). These questions asked participants to indicate the amount of time they spent each week: walking; engaged in moderate physical activity; and engaged in vigorous physical activity. The total amount of physical activity each week was determined using the following equation: total physical activity (minutes) = (walking) + (moderate activity) + (2 × vigorous activity) (Australian Institute of Health and Welfare 2003). In order to minimise errors due to over-reporting, any responses greater than 1,680 min a week (i.e. >28 h) were recoded as 1,680 min (Australian Institute of Health and Welfare 2003).

Participants were asked to indicate if they had ever been diagnosed with chronic health conditions such as breast cancer (females only), prostate cancer (males only), heart disease, stroke and diabetes. These data were coded as 'no chronic health conditions' and '1 or more chronic health conditions'. Psychological distress was assessed through the Kessler Psychological Distress Scale (K10), which is a 10 item scale scored from 10 to 50 that assesses levels of depression and anxiety (Andrews and Slade 2001; Kessler et al. 2002). There is currently no universal cut-off score for the K10, but many have suggested that a cut-off score of 16 is appropriate (Australian Bureau of Statistics 2003). Thus, we coded the K10 as low (<16) and medium/high (≥16) psychological distress.

Statistical analyses

The objective of this paper was to examine whether short sleep, physical activity and sitting time mediated the association between work hours and BMI. Simple mediation occurs when an independent variable (*X*) influences a dependent variable (*Y*) through a mediator (*M*) (Baron and Kenny 1986; Preacher and Hayes 2004, 2008). The direct effect of *X* on *Y* is usually expressed as path *c*. Path a represents the effect of *X* on *M* and path *b* represents the effect of *M* on *Y* controlling for the effect of *X*. The indirect effect of *X* on *Y* through *M* is the product of *a* and *b* (i.e. *ab*). The total effect of *X* on *Y* is the sum of the direct and indirect effects ($c = c' + ab$). The difference between the total effect and the indirect effect is given as

$c' = c - ab$. When c' is significantly different from 0, it can be concluded that M mediates the association between X and Y.

The most commonly used method for assessing mediation is the causal steps approach as outlined by Baron and Kenny (1986). However, there are a number of limitations of this approach, including a lack of statistical power and the absence of a measure for the strength of the mediated effect (Hayes 2009; MacKinnon and Fairchild 2009). Furthermore, the presence of an indirect effect is not quantified; instead it is inferred from a visual inspection of the magnitude of the c and c' paths (MacKinnon and Fairchild 2009). The causal steps approach also assumes that in order for mediation to exist, there must be a significant total direct effect between an independent and dependent variable; this has since been argued to be a fallible assumption (Hayes 2009; MacKinnon and Fairchild 2009).

There are several modern approaches for testing mediation that overcome these limitations and quantify the indirect effect using procedures such as bootstrapping (e.g. Preacher and Hayes 2004, 2008). Furthermore, these approaches allow for testing of multiple mediation models, whereby the specific indirect effects of X on Y through multiple mediators can be examined; one or more covariates which are not proposed to be mediators can also be controlled (Preacher and Hayes 2008). In this paper, we tested a multiple mediation model whereby we examined whether the association between work hours and BMI was mediated by the following variables: (1) short sleep; (2) physical activity; and (3) sitting time. We also included sex, age, K10 scores and chronic diseases as covariates in the model. We used the multiple mediation macro for SPSS developed by Preacher and Hayes (2008), which involves a bootstrapping procedure to obtain estimates of the indirect effects. Hayes (2009) recommends at least 5,000 resamples; in this paper we performed 10,000 resamples in an attempt to provide more accurate estimates of the indirect effects. Statistical significance for the indirect effect was determined from 99% bias and accelerated confidence intervals. We tested multiple mediation on the whole sample, and then separately for males and females.

RESULTS

Sample Characteristics

The data were checked for missing values and outliers. A small percentage of individuals reported missing data on one or more variables and were excluded from the analysis. Some individuals (1.9%) had extreme values on one or more variables and were excluded so as to not affect the results. For example, although the overwhelming majority of respondents (99.6%) reported sleep durations between 4 and 10 h a night, a very small proportion (0.4%) of respondents reported sleep durations less than 4 h a night or more than 10 h a night; these individuals were excluded from the analysis. Similarly, most participants (99%) had a BMI between 18.5 and 45.0; individuals with values outside this range were also excluded. Finally, most participants reported work hours ranging from 35 to 79 h a week. A very small proportion (<1%) reported that they worked 80 h or more each week; these individuals were removed as outliers from the analyses as they had the potential to confound the results. Removing these extreme values ensured that the results were not skewed by outliers.

The sample size included in the final analysis consisted of 16,951 adults aged 45–65 years. The demographic characteristics of the sample are shown in Table 1; this indicates that the average age of the sample was 53.47 years, the average BMI was 27.16 and the average sleep duration was 7.34 h per night (18.2% reported ≤6 h sleep a night). Furthermore, respondents indicated that they worked an average of 44.70 h per week. ANOVA's and chi-square analyses indicated significant differences between males and females (see Table 1). The effect sizes for ANOVA as indicated by η^2 were weak and ranged from .01 to .05. The chi-square results indicate that males were more likely than females to report <7 h sleep and ≥1 chronic health condition. Females were more likely than males to report medium/high psychological distress.

Table 1. Demographic characteristics for males, females and the total sample

	Males (n = 10,389)	**Females (n = 6,562)**	**Total (n = 16,951)**	***P* value**
Age, mean (SD)	53.91 (4.77)	52.77 (4.50)	53.47 (4.70)	<.001
BMI, mean (SD)	27.44 (3.98)	26.72 (5.08)	27.16 (4.46)	<.001
Sleep duration, mean hours (SD)	7.32 (0.94)	7.37 (0.96)	7.34 (0.95)	<.001
Sleep duration, *n* (%)				.008
≤6 h sleep	1,957 (18.8)	1,125 (17.1)	3,082 (18.2)	
7–10 h sleep	8,432 (81.2)	5,437 (82.9)	13,869 (81.8)	
Work hours, mean (SD)	46.27 (8.94)	42.22 (7.37)	44.70 (5.60)	<.001
Physical activity, mean hours (SD)	8.42 (7.09)	8.08 (6.55)	8.29 (6.89)	.001
Sitting time, mean hours (SD)	6.58 (3.46)	6.40 (3.29)	6.51 (3.40)	.001
Chronic health conditions, *n* (%)				<.001
No chronic conditions	9,118 (87.8)	5,962 (90.9)	15,080 (89)	
≥1 chronic condition	1,271 (12.2)	600 (9.1)	1,871 (11.0)	
Psychological distress, *n* (%)				<.001
Low	8,238 (79.3)	4,888 (74.5)	13,126 (77.4)	
Medium/high	2,151 (20.7)	1,674 (25.5)	3,825 (22.6)	

Multiple Mediation

The multiple mediation model for the total sample is shown in Fig. 1a. This demonstrates that work hours were inversely associated with sleep duration ($\beta = -.004$, $P < .001$). Sleep duration ($\beta = -.615$, P < .001) and physical activity ($\beta = -.001$, $P < .001$) were inversely associated with BMI, whereas sitting time ($\beta = .053$, $P < .001$) was positively associated with BMI. The bootstrap tests of the indirect effects indicated that physical activity ($\beta = -.001$, 99% CI [−.002, .001]) and sitting time ($\beta = .0002$ [−.0003, .001]) did not mediate the association between work hours and BMI. However, short sleep was found to partially mediate the association between long work hours and BMI (β = .002, [.002, .004]). The results indicate partial mediation because the total effect between work hours and BMI (*c* path: β = .022, P < .001) attenuated slightly but remained significant when controlling for the multiple mediators (*c′* path: β = .020, *P* < .001). All of the covariates were significantly associated with BMI.

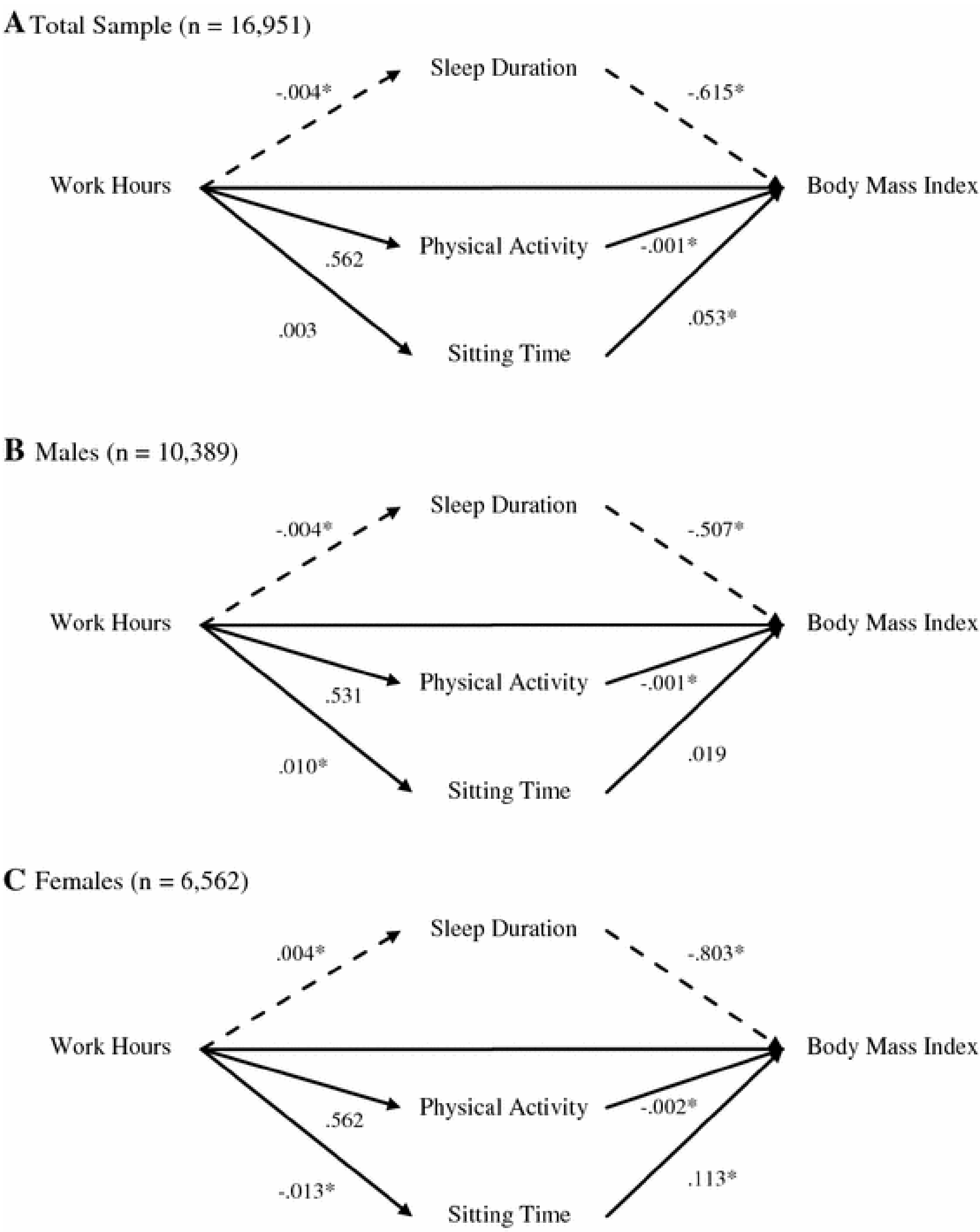

Fig. 1
Multiple mediation models linking work hours to BMI in the total sample (a), males (b) and females (c). coefficients are shown for each path, and a dotted line indicates a significant indirect effect. * $P < .05$

The multiple mediation model linking work hours to BMI in males is shown in Fig. 1b. This indicates that sleep duration ($\beta = -.004$, $P < .001$) was inversely associated with work hours, whereas sitting time ($\beta = .010$, P = .010) was positively associated with work hours. Sleep duration ($\beta = -.507$, P < .001) and physical activity ($\beta = -.001$, $P < .001$) were both inversely associated with BMI. The bootstrap tests of the indirect effects indicated that physical activity ($\beta = -.0004$ [−.002, .001]) and sitting time ($\beta = .0002$ [−.0001, .001]) did not significantly mediate the association between work hours and BMI. However, the indirect effect for sleep duration was significant ($\beta = .002$ [.001, .004]). This indicated partial mediation because the total effect of long work hours on BMI (*c* path: $\beta = .029$, $P < .001$) attenuated slightly but remained significant with the inclusion of the mediators (c' path: $\beta = .027$, $P < .001$). Chronic disease status was also significantly associated with BMI; the associations between the other covariates and BMI were not significant.

The multiple mediation model linking work hours to BMI in females is shown in Fig. 1c. The results indicate that sleep duration ($\beta = -.004$, $P < .001$) and sitting time ($\beta = -.013$, $P = .016$) were inversely associated with work hours. Sleep duration ($\beta = -.803$, $P < .001$) and physical activity ($\beta = -.002$, $P < .001$) were inversely associated with BMI, whereas sitting time ($\beta = .113$, $P < .001$) was positively associated with BMI. The bootstrap results indicated that the indirect effects through physical activity ($\beta = -.001$ [−.005, .002]) and sitting time ($\beta = -.002$ [−.004, .0001]) were not significant. However, the indirect effect through sleep duration was significant ($\beta = .003$ [.001, .006]). Unlike the results for the total sample and males, neither the total effect of long work hours on BMI (*c* path: $\beta = .006$, $P = .486$) nor the direct effect of work hours on BMI (c' path: $\beta = .006$, $P = .502$) were significant. All of the covariates were significantly associated with BMI.

DISCUSSION

This paper examined whether the association between long work hours and obesity as reported in previous studies (Di Milia and Mummery 2009; Ko et al. 2007; Lallukka et al. 2008a, b; Mummery et al. 2005) was mediated by sleep duration, physical activity and/or sitting time. In the entire sample, the results of the multiple mediation model indicated that there was a significant relationship between long work hours and increased BMI, which was partially mediated by short sleep duration. The indirect effects associated with physical activity and sitting time were not significant, indicating that these factors did not mediate the association between long work hours and increased BMI in this study.

When the analyses were broken down by sex, the pattern of the results differed slightly between males and females. In males there was a significant total direct effect between long work hours and higher BMI and this was partially mediated by short sleep. However, in females there was not a significant association between long work hours and BMI. This finding is consistent with previous studies indicating that long work hours are associated with obesity in males but not females (Di Milia and Mummery 2009; Ko et al. 2007; Lallukka et al. 2008b; Mummery et al. 2005). The traditional causal steps approach to mediation (Baron and Kenny 1986) argues that for mediation to exist there must be a significant direct relationship between an independent and dependent variable. However, modern approaches have argued that this is a fallible assumption and that a mediator can causally link an independent and dependent variable even if the two variables are not significantly related (Hayes 2009; MacKinnon and Fairchild 2009). In such a circumstance, the independent variable is proposed to have an indirect effect on the dependent variable through the mediator (Hayes 2009). Therefore, although in this study we found that long work hours were not directly associated with higher BMI in females, the results suggest that they are related indirectly through short sleep. This is a novel finding that has not been previously reported.

These results suggest that long work hours are associated with increased BMI through short sleep duration in both male and female employees. Although it is not possible to determine the direction of causation on the basis of these cross-sectional data, it is possible that long work hours could contribute to obesity via a reduction in night-time sleep. For example, individuals working longer hours may voluntarily restrict the amount they sleep in order to have enough time for other activities such as socialising and spending time with family. It is also possible that longer working hours reflect more stressful and demanding jobs that have the potential to disturb sleep (Gangwisch 2009). For example, increased levels of stress combined with a lack of time for relaxation could make it more difficult to fall asleep and get a sufficient amount of sleep (Gangwisch 2009; Virtanen et al. 2009).

In turn, short sleep could promote higher BMI and obesity via a number of mechanisms. First, individuals who sleep less may have increased opportunity to eat which could contribute to weight gain and this has received some empirical support (Nedeltcheva et al. 2009). Second, short sleep could impact on the physiological regulation of body weight (i.e. energy homeostasis). For example, short-term sleep restriction has been associated with a reduction in levels of the hormone leptin (Spiegel et al. 2004), which plays an important role in the long term regulation of energy stores in the body. Low levels of leptin are implicated in increased food intake and a reduction in energy expenditure, which is a pattern consistent with weight gain. Furthermore, sleep restriction has been shown to increase levels of the hormone ghrelin (Spiegel et al. 2004), which plays an important role in the regulation of hunger and satiety. Other studies have found evidence that short sleep may also contribute to obesity by affecting the regulation of glucose (Boulé et al. 2008; Chaput et al. 2009).

These results therefore suggest that long working hours could be indirectly associated with obesity through short sleep. There are, however, many other pathways through which long work hours could potentially contribute to obesity. For example, individuals who work long hours may have less time to engage in physical activity or may spend more time being sedentary (Di Milia and Mummery 2009; Mummery et al. 2005). Neither of these hypotheses was supported in this paper, but this could reflect the measures used. In particular, the physical activity measure did not assess specific types of activity such as physical activity levels at work, which are important components of overall physical activity. This could partially explain why physical activity or sitting time did not mediate the association between work hours and BMI. A further consideration is that the associations between work hours, physical activity and BMI could differ depending on occupation type. For example, blue collar workers appear to engage in less leisure time physical activity compared to white collar workers (Burton and Turrell 2000), but generally have higher levels of physical activity at work (Steele and Mummery 2003). Unfortunately, we were unable to distinguish between different occupation groups in the present paper, but the possible differences between these groups should be examined in future research.

There are some other limitations of this study that warrant discussion. This paper utilised self-reported data which may be inaccurate particularly for BMI and sleep duration. For example, in both males and females self-reported data can lead to an underestimation of BMI which is most pronounced in females (Connor Gorber et al. 2007). Although this bias may have affected the present results, it is important to note that for most individuals there are strong correlations between self-reported and measured data for both BMI and sleep duration (e.g. Lockley et al. 1999; Stevens et al. 1990). Nevertheless, future research in this area could benefit from the use of more objective measures of sleep duration, BMI and other variables such as physical activity. Furthermore, the cross-sectional nature of the data did not allow us to determine the direction of causation, which is particularly relevant given that the association between sleep duration and obesity could be bi-directional. For example, although it is possible that short sleep contributes to obesity, obesity may also contribute to short sleep via sleep apnoea (a condition characterised by partial or complete collapse of the upper airways during sleep), pain, discomfort or stress (Magee et al. 2010a). A further consideration is that previous studies have demonstrated that other work-related factors such as shift-work, working overtime, work fatigue, high effort and demand, low control and flexibility of work patterns are associated with an increased likelihood of obesity (Di Milia and Mummery 2009; Ko et al. 2007; Lallukka et al. 2005, 2008a, b; Ostry et al. 2006). We relied upon work hours, which although important, may not reflect other aspects of work that could also impact on obesity and sleep in males and females. Thus prospective studies examining multiple aspects of work conditions and utilising more objective measures of sleep and obesity will provide a clearer indication of the associations between variables such as sleep, work and obesity.

However, the key strengths of this study were the large sample size and the contemporary approach to testing mediation. This enabled us to formally test whether short sleep, physical activity and sitting time mediated the association between work hours and BMI. The present study focused specifically on a large sample of middle aged adults, but it is possible that the associations examined in this paper vary with age. Therefore, future research in this area could examine how these associations differ between young, middle aged and elderly adults.

The present paper demonstrates that in males, short sleep duration partially mediated the associated between long work hours and higher BMI. In females, longer work hours were indirectly associated with higher BMI through short sleep. These findings have a number of important implications given that the proportion of Australian adults working long hours (defined in Australia as >49 h a week) has increased in the past 20 years (Australian Bureau of Statistics 2006) and also because short sleep is commonly reported by Australian adults (Magee et al. 2009). These factors could partially account for the rise in obesity in Australia that has been observed in recent decades (Cameron et al. 2003), and could be targeted to prevent obesity. For example, long work hours could make it more difficult to live a healthy balanced lifestyle, reducing the time available for socialising spending time with family, exercising, and getting enough sleep at night (Gangwisch 2009). This in turn could increase the risk of health conditions such as obesity and cardiovascular disease. Thus, in the context of the present results, behavioral interventions promoting a balance between work hours and sleep could prevent the development of obesity and other health problems in full time male and female employees.

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