

© thinkstock
BY GETTY IMAGES

Does sleep affect weight management?



Dr Carrie Ruxton, PhD, RD, Freelance Dietitian, Nutrition Communications @DrCarrieRuxton, and **Dr Emma Derbyshire**, PhD, RNutr (Public Health), Freelance Nutritionist, Nutritional Insight, @DrDerbyshire

Sleep is tightly regulated by homeostatic processes (those which seek equilibrium), which demonstrates the importance of sleep for survival. However, modern day stresses such as shift work, irregular working hours and general worries can lead to poor quality or insufficient sleep. This may have wider implications for health, such as increased risk of mental health problems, heart disease, type II diabetes and obesity. Given that 42 per cent UK adults are now overweight and more than 25 per cent are obese,¹ this review will consider the role of sleep in weight management. Although we think of sleep as 'shutting down' it is actually an active physiological process where the metabolism slows but organ and regulatory systems continue to function.² There are two main types of sleep: rapid eye movement (REM) and non REM sleep.

Introduction

The rise in obesity appears to parallel a reduction in self-reported sleep duration while, in contrast, weight loss, reductions in body mass index (BMI) and body fat are associated with improved sleep duration.³ Findings from the Great British Sleep Survey (n=20,814, mean age 41 y) revealed that average sleep score was 5.1 out of 10 with most respondents being kept awake by a 'racing mind'.⁴ In addition, findings from the Sleep Council project, comprised of 5000 Britons, showed that 40 per cent were not getting the NHS recommended six to nine hours of sleep.⁵

Insufficient sleep seems to interfere with the crosstalk between physiological and circadian rhythms, contributing to metabolic disorders.⁶ For example, the expression and secretion of leptin, an

important satiety regulating hormone, peaks at night. Leptin and ghrelin are two of several hormones implicated in metabolism and energy balance that work alongside circadian rhythms.⁶ It is thought that disrupted sleep may affect these natural biorhythms, leading to a process known as 'circadian misalignment'⁷ which may impact on weight control.

The purpose of sleep

Sleep is essential to life and contributes to cognitive function by supporting normal speech, memory and thinking processes. Experts believe that we need around six to nine hours sleep every 24-hour period,⁸ while having less than six hours sleep daily over the long-term can have adverse effects on health.

Findings from a Scottish cohort study found that habitual short sleep duration (i.e. less than 7 hours per 24 hours) increased risk of overall mortality over a 25-year period.⁹ Equally, a Japanese cohort study, comprised of 104,010 subjects aged 40 to 79 years, found that sleep duration of at least seven hours was associated with the lowest mortality risk.¹⁰

In terms of specific health outcomes, results from the cross-sectional Sleep Heart Health Study found that sleep duration with a median of less than eight hours per night was associated with increased hypertension risk, especially when sleep was less than six hours per night.¹¹ Furthermore, a cohort study found that men sleeping less than six hours or more than eight hours nightly increased their risk of Type 2 diabetes over the follow-up period.¹² While this needs to be confirmed, it seems that too little, as well as too much, sleep could adversely affect health.

Sleep and weight control

Studies show that the amount and quality of sleep we are able to enjoy can affect body weight and the healthiness of our diets. Sleep problems tend to increase with age with women being more vulnerable than men,¹³ and shift workers having a greater risk of obesity and metabolic disorders than workers with daytime hours.¹⁴ Several observational studies have considered links between sleep and weight control. A meta-analysis pooling data from nine cohort studies found that longer sleeping times were associated with reduced body mass index (BMI) and more favourable dietary behaviours, such as lower saturated fat intakes and higher polyunsaturated fatty acid intakes.¹⁵

A recent US study measured sleep duration and quality using seven nights of wrist actigraphy on a sample of 441 adults. It was found that both self-reported and measured sleep were inversely associated with BMI. Poor quality sleep was also linked with higher BMI and waist circumference amongst women.¹⁶ A longitudinal study, conducted in the US using diaries and wrist actigraphy, found that shorter sleep duration was associated with increased BMI, with one hour less of sleep each night increasing BMI by 1.22 kg/m².¹⁷ A Japanese retrospective cohort study (n=21,148) used a questionnaire to determine sleep duration finding that mean sleep duration was 6.2 hours daily and that greater variability in sleep duration was independently associated with increased BMI.¹⁸ In terms of body composition, a longitudinal study looking at 43 adults with short sleep durations, i.e. ≤6 hours daily, found that over 6 years short periods of sleep were associated with a significantly higher BMI (+1.1 kg/m²) and fat mass (+2.4 kg) when compared with those sleeping seven to eight hours daily.¹⁹ These findings emphasise the need to have regular sleeping patterns to help maintain a healthy body weight and composition.

Other studies have looked at the impact of daytime sleepiness on obesity, such as a

longitudinal survey on osteoporosis which involved 1066 women and 911 men. After data adjustments, excessive daytime sleepiness was associated with a 1.5-1.6 fold increased odds of being overweight or having a larger waist circumference (women only) and greater BMI (both sexes).²⁰ Equally, a smaller study on physicians (n=72) found that a high percentage (65 per cent) were overweight or obese. Poor diets were common in this group as were a high incidence of low-quality sleep and excessive daytime sleepiness.²¹

Late nights and shift work also appear to impact on body weight. An Iranian study of 226 adults found that overweight or obese participants slept around an hour less each night and displayed a 'late to bed late to rise' pattern compared with normal weight participants. Indeed, for each hour later to bed at night, risk of obesity increased 2.6-fold. Shorter sleep duration was associated with higher intakes of energy, carbohydrates and fats.²² Furthermore, a cross-sectional survey of shift and day workers showed that mean BMI was significantly higher in shift workers than in day workers. Obese workers reported working for significantly longer hours and slept around 18 minutes less per day compared with individuals with a healthy BMI.²³

Five main intervention studies have investigated links between body weight and sleep. An intervention study consisting of 98 overweight or obese subjects (20-50 years) following a two-month very-low-energy diet followed by a 10-month weight maintenance period showed that daytime sleepiness and time taken to fall asleep reduced during the weight-loss period. Sleep duration also increased in short (≤7 h) and average (>7 to <9 h) sleepers indicating that weight loss improved sleep duration and vice versa.²⁴ A randomised weight-loss trial also looked at subjective sleep quality in overweight and obese women (n=245) which was measured using the Pittsburgh Sleep Quality Index. Better subjective sleep quality increased the chance of weight loss success by 33 per cent (relative risk 0.67), indicating that quantity and quality of sleep could contribute to weight loss.²⁵

Several randomised crossover studies (RCS) have also been carried out. In one, the sleep physiology of 15 males was monitored during fragmented sleep (FS) or non-FS, showing that FS compared with non-FS led to reductions in slow-wave sleep, REM sleep and total sleep time. Respiratory quotient and carbohydrate oxidation were elevated during FS (indicating less fat burning), which may predispose to obesity.²⁶ In a two-phase crossover study, 30 subjects were allocated to restricted sleep (4 hours per night) or habitual sleep (9 hours per night) and neuronal activity measured using magnetic resonance imaging for each. Results showed that neuronal activity was greater in response to food stimuli after restricted sleep, indicating that this may lead to a greater tendency to overeat.²⁷

...a cross-sectional survey of shift and day workers showed that mean BMI was significantly higher in shift workers than in day workers.

References: 1. NICE [National Institute for health and Care Excellence] (2014). Adults who are obese can improve their health by losing even a small amount of weight. Accessed online: www.nice.org.uk/news/press-and-media/adults-who-are-obese-can-improve-their-health-by-losing-even-a-small-amount-of-weight (20th December 2014). 2. National Sleep Foundation (2006). Sleep-Wake Cycle: Its Physiology and Impact on Health. Accessed online: <http://sleepfoundation.org/sites/default/files/SleepWakeCycle.pdf> (18th December 2014). 3. Gonissen HK, et al. (2013). Sleep duration, sleep quality and body weight: parallel developments. *Physiol Behav*; 121: 112-6. 4. Sleepio (2012). The Great British Sleep Survey. Accessed online: www.sleepio.com/2012_report/#respondents1 (18th December 2014). 5. The Sleep Council (2013). First Ever Great British Bedtime Report Launched. Accessed online: www.sleepcouncil.org.uk/2013/03/first-ever-great-british-bedtime-report-launched/ (18th December 2014). 6. Joutet J (2013). Interlinks between sleep and metabolism. *Lancet Diabetes Endocrinol*; 1(1): 16-7. 7. Baron KG, Reid KJ (2014). Circadian misalignment and health. *Int Rev Psychiatry*; 26(2): 139-54. 8. NHS (2014). How to get to sleep. Accessed online: www.nhs.uk/Livewell/insomnia/Pages/bedtimeritual.aspx (accessed 20th December 2014). 9. Heslop P, et al. (2002). Sleep duration and mortality: The effect of short or long sleep duration on cardiovascular and all-cause mortality in working men and women. *Sleep Med*; 3(4): 305-14. 10. Takakoshi A, et al. (2004). Self-reported sleep duration as a predictor of all-cause mortality: results from the JACC study, Japan. *Sleep*; 27(1): 51-4. 11. Gottlieb DJ, et al. (2006). Association of usual sleep duration with hypertension: the Sleep Heart Health Study. *Sleep*; 29(8): 1009-14. 12. Yaggi HK, et al. (2006). Sleep duration as a risk factor for the development of type 2 diabetes. *Diabetes Care*; 29(3): 657-61. 13. Polo-Kantola P (2011). Sleep problems in midlife and beyond. *Maturitas*; 68(3): 224-32. 14. Zimberg IZ, et al. (2012). Metabolic impact of shift work. *Work Suppl*; 1: 4376-83. 15. Dashti HS, et al. (2015). Habitual sleep duration is associated with BMI and macronutrient intake and may be modified by CLOCK genetic variant. *Am J Clin Nutr*; 101(1): 135-43. 16. Mezick EJ, et al. (2014). Associations of self-reported and actigraphy-assessed sleep characteristics with body mass index and waist circumference in adults: moderation by gender. *Sleep Med*; 15: 64-70. 17. Appelhans BM, et al. (2013). Sleep duration and weight change in midlife women: the SWAN sleep study. *Obesity*; 21: 77-84. 18. Kobayashi D, et al. (2013). High sleep duration variability is an independent risk factor for weight gain. *Sleep Breath*; 17(1): 167-72. 19. Chaput JP, et al. (2012). Longer sleep duration associates with lower adiposity gain in adult short sleepers. *Int J Obes*; 36: 752-6. 20. Hayley AC, et al. (2014). Excessive daytime sleepiness and body composition: a population-based study of adults. *PLoS One*; 9: e112238. 21. Mota MC, et al. (2013). Dietary patterns, metabolic markers and subjective sleep measures in resident physicians. *Chronobiol Int*; 30(8): 1032-41. 22. Parvaneh K, et al. (2014). Sleep deprivation is related to obesity and low intake of energy and carbohydrates among working Iranian adults: a cross sectional study. *Asia Pac J Clin Nutr*; 23: 84-90. 23. Di Milia L, Mummery K (2009). The association between job related factors, short sleep and obesity. *Ind Health*; 47(4): 363-8. 24. Verhoeve SP, et al. (2013). Concomitant changes in sleep duration and body weight and body composition during weight loss and 3-month weight maintenance. *Am J Clin Nutr*; 98(1): 25-31. 25. Thomson CA, et al. (2012). Relationship between sleep quality and quantity and weight loss in women participating in a weight-loss intervention trial. *Obesity (Silver Spring)*; 20(7): 1419-25. 26. Hursel R, et al. (2011). Effects of sleep fragmentation in healthy men on energy expenditure, substrate oxidation, physical activity, and exhaustion measured over 48 h in a respiratory chamber. *Am J Clin Nutr*; 94(3): 804-8. 27. St-Onge MP, et al. (2012). Sleep restriction leads to increased activation of brain regions sensitive to food stimuli. *Am J Clin Nutr*; 95(4): 818-24. 28. Wu Y et al. (2014). Sleep duration and obesity among adults: a meta-analysis of prospective studies. *Sleep Med*; 15(12): 1456-62. 29. McHill AW, et al. (2014). Impact of circadian misalignment on energy metabolism during simulated nightshift work. *Proc Natl Acad Sci U S A*; 111(48): 17302-7. 30. Mota MC, et al. (2014). Sleep pattern is associated with adipokine levels and nutritional markers in resident physicians. *Chronobiol Int*; 31(10): 1130-8. 31. Copsinchi G, et al. (2014). The important role of sleep in metabolism. *Front Horm Res*; 42: 59-72. 32. Chaput JP (2014). Sleep patterns, diet quality and energy balance. *Physiol Behav*; 134: 86-91. 33. Chapman CD, et al. (2013). Acute sleep deprivation increases food purchasing in men. *Obesity (Silver Spring)*; 21(12): E555-60. 34. Chapman CD, et al. (2014). Watching TV and food intake: the role of content. *PLoS One*; 9(7): e100602. 35. Bayon V, et al. (2014). Sleep debt and obesity. *Ann Med*; 46(5): 264-72. 36. Leinum CJ, et al. (2009). Sleep-disordered breathing and obesity: pathophysiology, complications, and treatment. *Nutr Clin Pract*; 24(6): 675-87. 37. Roehrs T, et al. (2006). Sex differences in the polysomnographic sleep of young adults: a community-based study. *Sleep Med*; 7(1): 49-53.

Discussion

Overall, lack of sleep and broken sleep can impact significantly on health and life quality. However, similar trends are not apparent for long sleep durations. For example, a recent meta-analysis of 11 studies concluded that long sleep duration was not associated with obesity risk.²⁸ This suggests that most of the risk relates to short sleep duration.

Working and eating when the circadian clock is programmed to sleep may promote the risk of weight gain and obesity.⁶ For example, a study of 14 adults monitored during a six-day simulated shift showed that total daily energy expenditure reduced by 3 per cent during nightshifts and energy expenditure at dinnertime was also reduced.²⁹ Equally, insufficient sleep can alter hormone levels in the body, including those with a role in appetite regulation.⁶ Fasting hormone measurements taken from 72 resident physicians showed that women with excessive daytime sleepiness had significantly lower levels of leptin than those not feeling sleepy. Mean ghrelin levels (a hormone that leads to hunger) were significantly higher amongst resident physicians with poor sleep quality.³⁰

In terms of other mechanisms, sleep restriction is thought to create a permissive environment for the activation of genes promoting obesity.³¹ It also creates more opportunities for eating, along with the stimulation of hedonic 'reward' behaviours in the brain, so there is increased desire to seek out tempting foods.³² Interestingly, findings from one study found that when a sample of men (n=14) experienced a night of total sleep deprivation they tended to purchase significantly more calories (+9%) and grams of food (+18%) in a mock

supermarket environment the next day, compared with having a good night's sleep.³³ Overall, these combined effects suggest that sleep loss may stimulate the desire for high-calorie foods.

Finally, it should be considered that spending time in sedentary pursuits, such as watching TV, provides opportunities for extra snacking,³⁴ while multimedia, such as TV, computer and internet use, may contribute to sleep deprivation, sedentary behaviour and increased calorie intakes.³⁵ Once people become overweight or obese this can affect the quality of sleep, typically through a condition known as sleep apnoea which causes interruptions to breathing during sleep leading to regular waking and daytime tiredness.³⁶ Thus, lack of sleep may help cause obesity while obesity tends to compound sleeping problems leading to a vicious cycle. Research suggests that men are more likely to experience sleep disturbances, although they seem to sleep more lightly and have less efficient sleep even after accounting for such conditions.³⁷ Subsequently, weight loss strategies, including diet and exercise, could have an important role in improving sleep quality and duration. Some tips to help support individuals struggling with their sleep and body weight are suggested in **Table One**.

Conclusions

In summary, getting a good night's sleep is a basic, but often overlooked, prescription for good health; including a healthy body weight. Encouraging people to sleep for six to nine hours daily, ideally seven to eight hours, and to reflect on their sleep quality could have the additional benefit of helping to regulate their body weight.

Table One: Tips for Patients with Sleeping Problems

	Questions to patients
How well do you sleep?	Is anything preventing them getting off to sleep at night? Do snoring or active family members, or neighbours wake them frequently? What is stopping them getting a good sleep?
Sound barrier	Discuss ideas to help, such as ear plugs or even sleeping in the spare room a couple of nights a week. Can family members or neighbours be encouraged to be quieter? This is particularly important when a shift worker is attempting to sleep during the day. If chronic sleep deprivation is becoming an issue, it is worth suggesting that the patient talks to their GP.
Technology transfer	Regular use of smart phones, tablets, computers and TVs activate the brain and make it harder for someone to drop off to sleep. Stopping technology use at least an hour before bedtime and reading a book or listening to music instead helps to promote sleep.
Drink less to dream	Alcohol causes drowsiness but has the downside of inhibiting higher quality deep sleep later in the night. This is why having several alcohol-free days a week, and sticking to official guidelines on how much should be consumed, are better for sleep.
Beating drowsiness	Day time drowsiness affects energy levels and leads to hunger, especially for shift workers. Research shows that novel interventions, such as use of light boxes at waking, or supplements of tryptophan (5HT) help for some people better regulate their periods of sleeping and waking.
How much is enough?	Studies show that most people do well on 7-9 hours of sleep daily but this depends on age, gender and health status. Conversely, too much sleep may also have a detrimental effect so a lie in at the weekend may not be any better for health.
Active lifestyle	Taking regular exercise not only helps us to sleep better but makes us feel more energetic during the day. An evening walk, or a dance class, could be a good way to promote better sleeping habits. Again, shift workers may need extra advice to get the balance right between sleeping, leisure time and working but planning ahead can help.

Acknowledgements

This review was funded by Slimming World. The views expressed are those of the authors alone and Slimming World had no role in writing the review.