RSPH (2017)

1 BACKGROUND

over **half** (54%) of the public have felt stressed from poor sleep

What is sleep?

Sleep forms part of a natural rhythm of life - any single cell taken from our body, and placed in isolation in a laboratory dish, will maintain a stable 24-hour pattern, demonstrating that sleep is a force to be harnessed rather than challenged. Indeed, opposing or disrupting sleep and this rhythm of life can be very harmful.

Our sleep cycle is regulated by two systems in the body: sleep/wake homeostasis and the circadian, or 24 hour body clock.[1] The first tells our bodies when a need for sleep is building.[1] There is no set amount for everyone, and different people need different amounts at different stages of their lives.[2] The second regulates the timing of sleepiness and wakefulness, and is controlled by a group of brain cells that respond to light and dark.[1] Most adults feel some of the strongest urges to sleep between 2-4pm and 1-3am, although again this varies from person to person1 and adolescents often go through 'sleep phase delay', which pushes these timings later into the day.[1]

Our sleep can be broadly divided into five stages – four non-rapid eye movement stages (non-REM) and one rapid eye movement stage (REM). They range from light sleep in stage one to when our dreams occur in the final REM stage of sleep.[3]

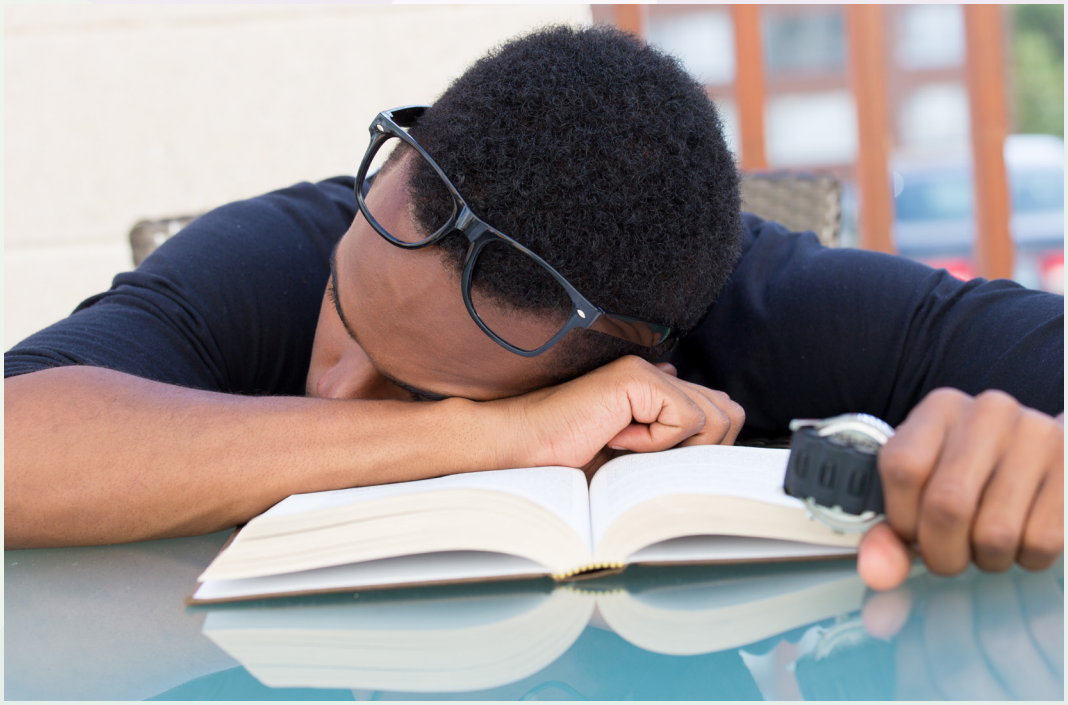
Why does sleep matter?

Sleep seems to be essential for all manner of creatures.[4] Biological drives like hunger and thirst certainly are compelling, yet we are able to make behavioural choices and to choose what, when and even whether to eat and drink. Sleep, however is rather more involuntary, like breathing. Deliberately holding your breath will result in your body over-riding your action, forcing you to breathe out and resuming respiration. Sleep is likewise inevitable. Some studies have kept subjects awake for 40 hours and over.[5] However, we cannot deliberately remain totally awake unassisted for long, extended periods of time.

What happens if we don't sleep?

Sleep deprivation has three consequences. Sleepiness is the first sign of insufficient sleep. Secondly, there is an inevitable intrusion of sleep into our ability to stay awake. When wakefulness is enforced, pressure builds and sleep cannot be avoided, irrespective of stimulation. 'Microsleeps' comprising a few seconds when the person may seem superficially awake become irresistible after continuous wakefulness, especially during the circadian or biological night.[6]

Thirdly, if we have insufficient sleep but remain awake there is marked deterioration in our performance, and are vulnerable to cognitive impairment.[7/8] The term 'local sleep' therefore is now used to denote times when local populations of nerve cells in the brain may fall asleep.[9] As well as indicating that sleep is not always a whole brain phenomenon, such findings suggest that local sleep related cellular repair may occur in regions of the brain which aren't as involved in particular tasks. The brain is always trying to compensate, but sleep loss poses a fundamental challenge.



2 SLEEP AND THE PUBLIC'S HEALTH

"Given sleep's pivotal role in the nation's health and wellbeing, it needs to be a key priority for the public's health."

Does inadequate sleep affect our health?

A wealth of evidence supports the fundamental role sleep plays in protecting us from severe problems with our health and wellbeing: sleep-related accidents are a major cause of injury and death; poor sleep increases the risk of chronic illnesses including: high blood pressure, diabetes, depression, cancer, heart attack and stroke.[10] It is related to obesity in both children and adults[11] and reduced quality of life and early death.[12] In older people it may be related to accelerated cognitive decline.[13] Despite all of this evidence the number of people not getting enough sleep is now around four in ten,[14] while one in five sleep poorly most nights, representing the second most common health complaint after pain,[15] potentially having a significant impact on the nation's health. Given sleep's pivotal role in the nation's health and wellbeing, it needs to be a key priority for the public's health. A structured effort to improve the public's sleep is a missing link in public health strategy, with enormous potential pay-offs.

The purpose of sleep is not yet fully understood; but it likely involves saving energy, restoring the body and brain, and/or organising networks in the brain, for instance for learning and memory. One theory suggests that by reducing the energy used for some of the things our bodies do when we're awake, sleep frees up energy for these much needed brain functions, as well as processes essential to survival such as tissue growth and the function of the immune system.[16] After just a short period of reduced sleep, people are more vulnerable to infection and respond less well to vaccination.[17/18/19] Brain function worsens, in particular attention,[16] drastically increasing the risk of accident and injury. In younger children and older adults, longer periods of sleep loss can significantly impair learning and cognitive processing. Those who consistently fail to get enough sleep face increased risk of high blood pressure, coronary heart disease, incident stroke,[16] and all-cause mortality. [20] The underlying importance of sleep in tackling many of the unhealthy behaviours, chronic conditions and diseases related to lifestyle we are facing needs to be acknowledged. Here we look at the relationship between sleep and some of these.

Physical	Mental	Behavioural	Performance
Risk of…	**Risk of…**	**Risk of…**	
Cancer	Depression	Sleepiness	Impaired attention and concentration
Cardiovascular disease and stroke	Psychiatric relapse	Road traffic accidents	Decreased memory
Disorders of the Hypothalamic-Pituitary-Adrenal (HPA)	Mood fluctuation	Falls and fractures	Reduced multi-tasking
Metabolic abnormalities	Delirium	Repeat prescribing	Impaired decision-making
Weight gain & obesity	Impulsivity	Alcohol and drug dependency	Reduced creativity
Reduced immunity	Anger and frustration	Increased sedative and stimulant use	Reduced communication
Bodily sensations of pain	Higher risk of suicide	Less likely to attend appointments	Reduced socialisation
Thermoregulatory problems	Anxiety and hyperarousal	Longer stay in hospital	Less likely to be employed
Vulnerable seizure threshold	Chronic fatigue	Earlier admission to long-term care	More likely to be on benefits

Table 1: Some of the main consequences to the public's health of poor sleep

BEHAVIOURS

Poor diet and inactive lifestyles

Short sleepers are more likely to be obese; and young children who do not get enough sleep are at greater risk of becoming obese as older children and adults.[21] This may be because shortened sleep affects the hormones that regulate hunger and appetite, resulting in increased food intake.[16/22] Poor sleep alters appetite regulating hormones, leptin and ghrelin,[23] which in turn can influence our food choices.[24] Getting a good night's sleep is an overlooked prescription for good health - including a healthy body weight.[25]

Poor sleep has also been linked to negative eating attitudes and binge eating behaviours.[26] Lower energy levels can make people less likely to exercise,[27] and one survey found this lack of energy led people to avoid stopping to buy healthy foods after work, to avoid cooking, and to opt for more processed and sugary foods and snacks.[26] Together, poor diet and inactvity are contributing to our obesity epidemic, and sleep has a critical underlying role in both of these factors.

Smoking

A similar link has been suggested between sleep and quitting smoking, although the relationship is complex. Insufficient sleep may make it difficult for a smoker to abstain by impairing attention and cognition, changing cravings, affecting mood or increasing the reward 'value' of cigarettes, and is therefore among the factors that make people more likely to relapse in tobacco treatment programmes.[28]

Smokers may expect cigarettes to counter feelings of sleepiness, increasing the temptation to smoke,[27] and this may explain why young adults who sleep for longer seem to have more success at quitting.[29]

The public ranked sleep the 2nd most important activity for health and wellbeing – behind not smoking

Accidents

The biggest killer of children and young people are transport collisions, and one in five crashes on major roads is related to sleep.[30]

Road traffic collisions (RTCs) follow a 24-hour pattern, peaking between 2-7am in the morning and 2-4 pm in the afternoon; times when our circadian arousal signal is low. Sleep-related factors have a role in approximately 20% of all RTCs and sleep-related RTCs are linked to worse outcomes due to eyelid closures and failure to brake prior to collision.[31]

Driving simulators and on-the-road driving experiments reveal impaired driving performance (e.g. lane deviations, variable car position) after restricted or disturbed sleep. [32] Extended shifts, particularly common in junior doctors, are associated with a marked rise in motor vehicle crashes and near-misses,[33] being problematic on the commute home from night-shift.[34]

DISEASE

Cancer

There is considerable evidence that both regular travel across time zones and rotating pattern shiftwork are risk factors for cancer. Night-shift and rotating shift patterns induce circadian misalignment and sleep disturbance. For example, flight attendants, flying for five or more years have about double the risk of breast cancer compared to those flying for shorter periods.[35] The WHO International Agency for Research on Cancer concluded that “shiftwork involving circadian disruption is probably carcinogenic in humans”. [36] The relative risk associated with such occupational factors may lead to this vulnerability being seen as the equivalent to having a first degree relative with cancer.[37]

For women between the age of 34 and 50, breast cancer is the biggest killer, which has been linked to disruption of circadian rhythm.[38] There is an emerging literature that suggests there may be similar links for prostate cancer in men.[39]

Cardiovascular disease

Research indicates that shift work impacts negatively upon blood pressure, lipid profile, metabolic syndrome and, possibly, body mass index.[40/41]

Research has also suggested that prolonged short sleep durations may lead to hypertension through extended exposure to raised 24-hour blood pressure and heart rate, elevated sympathetic nervous system activity, and increased salt retention.[42/43]

Studies also suggest that the combination of insomnia and short sleep is associated with metabolic syndrome and type 2 diabetes.[44/45]

Mental health

Almost 4 in 5 long term poor sleepers suffer from low mood and are seven times more likely to feel helpless.[46] This can be a vicious cycle with stress, anxiety, depression and poor mental health contributing to difficulties sleeping. In the context of interpersonal relations, sleep quality has been linked to greater marital conflict and poorer relationships satisfaction. [47] The repercussions for mental health are particularly severe.

Persistent insomnia increases the risk of developing severe depression and suicidal behaviour. Depending on how severe the insomnia is, will determine how successful psychotherapeutic treatment for depression will be.

Indeed, world authorities who publish diagnostic classifications of mental disorders now recognise that sleep problems may be implicated in the aetiology and maintenance of psychiatric disorder rather than being a mere symptom.[48] Moreover, analysis suggests that sleep disturbance (such as insomnia and nightmares) is associated with an almost threefold increase in completed suicides. [49] Research on the timing of suicidal injuries found that after adjusting for probability of being awake, suicide is four times more likely to occur during the circadian night. Being awake at night may therefore represent vulnerability for completed suicide.

COGNITIVE ABILITY

Reduced performance, decision making and memory

After about 17 hours our alertness sharply declines, to the point where our wakefulness is similar to the effects of a blood alcohol concentration of 0.05%. After 24 hours of not sleeping our alertness is equivalent to a blood alcohol concentration of 0.1% (the legal limit for drink driving [U.S]). [50/51]

Vigilant attention, complex attention and working memory are the cognitive processes most sensitive to sleep loss.[52] Sleep deprivation prior to learning impairs the ability to build new memories [53] - this is true at all ages, but may be a particular vulnerability in older people. Sleep also plays a crucial role in consolidating our memory, which is markedly affected by inadequate sleep.

6 REFERENCES

1. Sleep Foundation. Sleep drive and your body clock https://sleepfoundation.org/sleep-topics/sleep-drive-and-your-body-clock (accessed March 2016).
2. NHS Choices. (2014). What is insomnia and how much sleep do we need? http://www.nhs.uk/Livewell/insomnia/Pages/insomniaover¬view.aspx (accessed March 2016).
3. Robotham, D. Chakkalackal, L. Cyhlarova, E. (2011). Sleep Matters: the impact of sleep on mental health and wellbeing. Mental Health Foundation, London, published Jan 2011. Paper: ISBN 978-1-906162-65-8
4. Cirelli, C. Tononi, G. (2008). Is sleep essential? PLoS Biol 6(8): e216.
5. Adam, M. Reteym J. Khatami, R. Landolt, H.P. (2006). Age-Related Changes in the Time Course of Vigilant Attention During 40 Hours Without Sleep in Men. http://www.journalsleep.org/articles/290110.pdf (accessed March 2016).
6. Cajochen, C. Khalsa, S.B. Wyatt, J.K. Czeisler, C.A. Dijk, D.J. (1999). EEG and ocular correlates or circadian melatonin phase and human performance decrements during sleep loss. Am. J. Physiol. 277, R640-649.
7. Van Dongen, H.P. Maislin, G. Mullington, J.M. Dinges, D.F. (2003). The cumulative cost of additional wakefulness: dose-response effects on neurobehavioural functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep, 26, 117-126.
8. Blenky, G. Wesensten, N.J. Thorne, D.R. Thomas, M.L. Sing, H.C. et al. (2003). Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose response study. J. Sleep Res, 12, 1-12.
9. Vyazovskiy, V.V. Olcese, U. Hanlon, E.C. Nir, Y. Cirelli, C. Tononi, G. (2011). Local sleep in awake rats. Nature, 472, 443-447.
10. Colten, H.R. Altevogt, B.M. (2006). Sleep disorders and sleep deprivation: an unmet public health problem. http://www.ncbi.nlm.nih.gov/pubmed/20669438 (accessed March 2016).
11. Harvard School of Public Health. Obesity prevention source: Sleep. http://www.hsph.harvard.edu/obesity-prevention-source/obesity-causes/sleep-and-obesity/ (accessed March 2016).
12. Centers for Disease Control and Prevention. Insufficient sleep is a public health problem. http://www.cdc.gov/features/dssleep/ (accessed March 2016).
13 Lo JC, Groeger JA, Cheng GH, Dijk DJ, Chee MW. (2015). Self-reported sleep duration and cognitive performance in older adults: a systematic review and meta-analysis. Sleep Med. 2016 Jan;17:87-98. doi: 10.1016/j.sleep.2015.08.021. Epub 2015 Sep 25. Review. PMID:26847980
14. Artis, L. (2013). First ever Great British bedtime report launched. http://www.sleepcouncil.org.uk/2013/03/first-ever-great-british-bedtime-report-launched/ (accessed March 2016).
15. Linton, S. et al. (2015). the effect of the work environment on future sleep disturbances: a systematic review. http://www.sciencedirect. com/science/article/pii/S1087079214001208 (accessed March 2016).
16. Schmidt, M. (2014). The energy allocation function of sleep: a unifying theory of sleep, torpor, and continuous wakefulness. http://www. sciencedirect.com/science/article/pii/S0149763414001997 (accessed March 2016).
17. Czeisler, C. (2015). Duration, timing and quality of sleep are each vital for health, performance and safety. http://www.sciencedirect.com/science/article/pii/S2352721814000138 (accessed March 2016).
18. Lange, T. Perras, B. Fehm, H.L. Born, J. (2003). Sleep enhances the human antibody response to hepatitis A vaccination. http://www.ncbi.nlm.nih.gov/pubmed/14508028 (accessed March 2016).
19. Cohen, S. Doyle, W.J. Alper C.M. Janicki-Deverts, D. Turner R.B. (2009). Sleep habits and susceptability to the common cold. http://www.ncbi.nlm.nih.gov/pubmed/19139325 (accessed March 2016).
20. Irish, L. Kline, C. Gunn, H. Buysse, D. Hall, M. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. http://www.sciencedirect.com/science/article/pii/S1087079214001002 (accessed March 2016).
21. Ruxton, C. Derbyshire, E. (2015). Does sleep affect weight management? Complete Nutrition. Vol 15. No. 1.
22. Hogenkamp, P.S. et al. (2013). Acute sleep deprivation increases portion size and affects food choice in young men. http://www.ncbi. nlm.nih.gov/pubmed/23428257 (accessed March 2016).
23. Van Cauter, E. Spiegel, K. Tasali, E. Leproult, R. (2008). Metabolic consequences of sleep and sleep loss. Sleep Medicine, 9, S23-S28.
24. Greer, S.M. Goldstein, A.M. Walker, M.P. (2013). The impact of sleep deprivation on food desire in the human brain. Nature Communications, 4, 2259.
25. Ruxton, C. Derbyshire, E. (2015). Does sleep affect weight management? Complete Nutrition. Vol 15. No. 1.
26. Quick, V. Shoff, S. Lohse, B. White, A. Horacek, T. Greene, G. (2015). Relationships of eating competence, sleep behaviours and quality, and overweight status among college students. http://www.sciencedirect.com/science/article/pii/S1471015315000811 (accessed March 2016).
27. Turgiss, J. Allen, S. Xiao, S. (2006). Asleep on the job: the causes and consequences of employees' disrupted sleep and how employers can help. http://www.vielife.com/uploads/files/AsleepOnTheJob.pdf (accessed March 2016).
28. Hamidovic, A. de Wit, H. (2009). Sleep deprivation increases cigarette smoking. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2706278/ (accessed March 2016).
29. Rapp, K. Buechele, G. Weiland, S. (2007). Sleep duration and smoking cessation in student nurses. http://www.sciencedirect.com/science/article/pii/S0306460306003388?np=y (accessed March 2016).
30. Department for Transport. Think! Fatigue. http://think.direct.gov.uk/fatigue.html (accessed March 2016).
31. Horne, J.A. Reyner, L.A. (1995). Sleep related vehicle accidents. BMJ, 310, 565-567.
32 Durmer, J.S. Dinges, D.F. (2005). Neurocognitive consequences of sleep deprivation. Seminars in neurology, 25, No. 1.
33. Barger, L.K. Cade, B.E. Ayas, N.T. Cronin, J.W. Rosner, B. et al. (2005). Extended work shifts and the risk of motor vehicle crashes among interns. New England Journal of Medicine, 352, 125-134.
34. Ftouni, S. Sletten, T.L. Howard, M. Anderson, C. Lenne, M.G. et al. (2013). Objective and subjective measures of sleepiness, and their associations with on road driving events in shift workers, Journal of Sleep Research, 22, 58-69.

35. Rafnsson, V. Tulinius, H. Jonasson, J.G. Hrafnkelsson, J. (2001). Risk of breast cancer in female flight attendants: a population-based study (Iceland). Cancer Causes Control, 12, 95-101.
36. International Agency for Research on Cancer. (2010). Monographs on the evaluation of carcinogenic risks to humans; Monograph 98. Painting, firefighting, and shiftwork. Lyon, France: IARC Publication.
37. Megdal, S.P. Kroenke, C.H. Laden, F. Pukkala, E. Schernhammer, E.S. (2005). Night work and breast cancer risk: a systematic review and meta-analysis. European J. Cancer, 41, 2023-2032.
38. David, S. Mirick, D.K. (2006). Circadian disruption, shift work and the risk of cancer: a summary of the evidence and studies in Seattle. http://www.ncbi.nlm.nih.gov/pubmed/16596308 (accessed March 2016).
39. Sigurdardottir, L.G. Valdimarsdottir, U.A. Fall, K. Rider, J.R. et al. (2012). Circadian disruption, sleep loss, and prostate cancer risk: a systematic review of epidemiological studies. Cancer Epidemiol. Biomarkers Prev. 21, 1002-1011.
40. Esquirol, Y., Perret, B., Ruidavets, J.B., Marquie, J.C. et al. (2011) Shift work and cardiovascular risk factors: New knowledge from the past decade. Archives of cardiovascular diseases 104, 636-668.
41. Canuto, R., Garcez, A.S., Olinto, M.T.A. (2013) Metabolic syndrome and shift work: a systematic review. Sleep Medicine Reviews, 17, 425-431.
42. Gangwisch, J.E., Heymsfield, S.B., Boden-Albala, B., Buijs, R.M., et al. (2006) Short Sleep Duration as a Risk Factor for Hypertension: Analyses of the First National Health and Nutrition Examination Survey. Hypertension, 47, 833-839.
43. Vgontzas, A.N., Liao, D., Bixler, E.O., Chrousos, G.P. & Vela-Bueno, A. (2009a). Insomnia with objective short sleep duration is associated with a high risk for hypertension. Sleep, 32, 491-497.
44. Xi, B., He, D., Zhang, M., Xue, J. Zhou, D. (2014) Short sleep duration predicts risk of metabolic syndrome: A systematic review and meta-analysis. Sleep Medicine Reviews, 18, 293-297.
45. Vgontzas, A.N., Liao, D., Pejovic, S., Calhoun, S., Karataraki, M., Bixler, E.O (2009b). Insomnia with Type 2 Diabetes. Diabetes Care, 32, 1980-1985.
46. Sleepio. (2012). The Great British sleep survey. https://www.sleepio.com/2012report/ (accessed March 2016).
47. Gordon, A., Chen, S. (2014). The role of sleep in interpersonal conflict: do sleepless nights mean worse fights? Social Psychological & Personality Science, 5, 168-175.
48. American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing.
49. Pigeon, W.R., Pinquart, M., Conner, K. (2012) Meta-analysis of sleep disturbance and suicidal thoughts and behaviors. Journal of Clinical Psychiatry, 73, e1160-1167
50. Dawson, D. Reid, K. (1997). Fatigue, alcohol and performance impairment. http://www.nature.com/nature/journal/v388/n6639/abs/388235a0.html (accessed March 2016).
51. Williamson, A.M. Feyer, A. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. http://oem.bmj.com/content/57/10/649.short (accessed March 2016).
52. Lim, J., Dinges, D.F. (2010) A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. Psychological Bulletin, 136, 375-389
53 Yoo, S.S., Hu, P.T., Gujar, N., Jol;esz, F.A., Walker, M.P. (2007) A deficit in the ability to form new human memories without sleep. Nature Neuroscience, 10, 385- 392.
54. Foster, R.G., Wulff, K. (2005) The rhythm of rest and excess. Nature reviews: Neuroscience, 2005. 6, 407-414.
55. Colten, H.R., Altevogt, B.M. (2006) Sleep disorders and sleep deprivation: an unmet public health problem. Washington, DC: National Academies Press.
56. Centers for Disease Control and Prevention (CDC: 2011). Effect of short sleep duration on daily activities - United States, 2005-2008. MMWR Morb. Mortal. Wkly. Rep., 60:239-52
57. Singleton N, Bumpstead R, O'Brien M, et al. (2001) Psychiatric morbidity among adults living in private households, 2000. London: The Office for National Statistics, HMSO.
58. Arber, S., Bote, M. and Meadows, R. (2009) Gender and socio-economic patterning of self-reported sleep problems in Britain. Social Science and Medicine, 68, 281-289.
59. Dregan, A. and Armstrong, D. (2009) Age, cohort and period effects in the prevalence of sleep disturbances among older people: The impact of economic downturn. Social Science and Medicine, 69: 1432-38.
60. Green, M.J., Espie, C.A., Benzeval, M. (2014) Social class and gender patterning of insomnia symptoms and psychiatric distress: a 20-year prospective cohort study. BMC Psychiatry, 14, 152
61. Green, M.J., Espie, C.A., Hunt, K., Benzeval, M. (2012) The longitudinal course of insomnia symptoms: inequalities by sex and occupational class among two different age cohorts followed for 20 years in the West of Scotland. Sleep, 35, 815-823.
62. Rajaratnam, S.M.W., Howard, M.E., Grunstein, R.R. (2013) Sleep loss and circadian disruption in shift work: health burden and management. Med. J. Aust., 199, 11-15.
63. Luyster, F.S., Strollo, P.J., Zee, P.C., Walsh, J.K. (2012) Sleep: a health imperative. Sleep, 35, 727-734
64. Kennedy, H. Gardiner, A. Gay, C. Lee, K. (2007). Negotiating sleep: A qualitative study of new mothers. http://journals.lww.com/jpnnjournal/Abstract/2007/04000/Negotiating_Sleep__A_Qualitative_Study_of_New.11.aspx (accessed March 2016).
65. Meltzer, L. Mindell, J. (2007). Relationship between child sleep disturbances and maternal sleep, mood, and parenting stress: A pilot study. http://psycnet.apa.org/journals/fam/21/1/67/ (accessed March 2016).
66. Gay, C. Lee, K. Lee, S. (2004). Sleeping patterns and fatigue in new mothers and fathers. http://brn.sagepub.com/content/5/4/311.short (accessed March 2016).
67. Work Wise UK. http://www.workwiseuk.org/ (accessed March 2016).
68. Hilbrecht, M. Smale, B. Mock, S. 2014. Highway to health? Commute time and wellbeing among Canadian adults. http://www.tandfonline.com/doi/abs/10.1080/16078055.2014.903723 (accessed March 2016).