



2019

The Impact of Shift Work on Health and Wellbeing

Stephanie Gagelin
University of North Dakota

[How does access to this work benefit you? Let us know!](#)

Follow this and additional works at: <https://commons.und.edu/pas-grad-posters>



Part of the [Medicine and Health Sciences Commons](#)

Recommended Citation

Gagelin, Stephanie, "The Impact of Shift Work on Health and Wellbeing" (2019). *Physician Assistant Scholarly Project Posters*. 180.

<https://commons.und.edu/pas-grad-posters/180>

This Poster is brought to you for free and open access by the Department of Physician Studies at UND Scholarly Commons. It has been accepted for inclusion in Physician Assistant Scholarly Project Posters by an authorized administrator of UND Scholarly Commons. For more information, please contact und.common@library.und.edu.

The Impact of Shift Work on Health and Wellbeing

Stephanie M. Gagelin, PA-S

Department of Physician Assistant Studies, University of North Dakota School of Medicine and Health Sciences

Abstract

- Many of today's industries require workers to perform shift work (typically during 1600-0700). If workers are awake during this time period, circadian misalignment occurs. This scholarly project uses research studies and meta-analyses to provide information about increased health risks associated with circadian misalignment, focusing on the categories of glucose metabolism, cardiovascular system, carcinogenesis, and mental health and acuity.
- Shift work has been found to increase BMI and waist circumference of employees, as well as increase blood glucose levels to "prediabetic" levels in previously euglycemic individuals.
- Shift work has been proven to increase high-sensitivity C-reactive protein (hs-CRP), an acute phase reactant that indicates inflammation and has been found to be a precursor to cardiovascular disease. Additionally, shift work has been demonstrated to increase risk for several cardiovascular diseases, including myocardial infarction and ischemic stroke.
- Men who work shift work are at higher risk for developing prostate cancer, and women who have performed shift work for over 30 years are at increased risk for breast cancer development.
- Working a night shift job and its associated sleep deprivation was proven to make medical interns more susceptible to developing depression, as well as more likely to make medical errors due to their sleep deprivation.

Introduction

- Nearly 15% of American workers are employed in a position that requires shift work (Bureau of Labor Statistics, 2005). Shift work commonly occurs in several industries, including healthcare.
- Shift workers often have a very chaotic schedule. They are required to stay awake during their body's circadian "night," which can cause adverse effects on normal body processes such as glucose and fatty acid metabolism, and can influence abnormal processes such as inflammation and oncogenesis.
- While some individuals may be genetically predisposed to depression and other mental illnesses, depression can also be situational in nature. Working long hours, entering and leaving work in darkness, and low amounts of natural light could contribute to this depression. Sleep deprivation and working during circadian misalignment are factors that can contribute to decreased alertness and mental capacity for shift workers.
- In this scholarly project, the assertion that shift workers are at risk for various health problems solely due to the hours they work will be examined, as well as discussing the various mechanisms that may cause this increased risk.

Statement of the Problem

- According to the Centers for Disease Control and Prevention (CDC) (2017), more than 30 million Americans had diabetes mellitus (DM) in 2015, "...Of which 7.2 million (23.8%) were not aware of or did not report having diabetes" (p. 2).
- Nearly 800,000 people have a myocardial infarction (MI) each year in the United States (Benjamin et al., 2017).
- A 2017 report published by the Substance Abuse and Mental Health Services Administration reports, "In 2016, 6.7 percent of adults aged 18 or older (16.2 million adults) had at least one major depressive episode (MDE) in the past year" (2017).

Research Questions

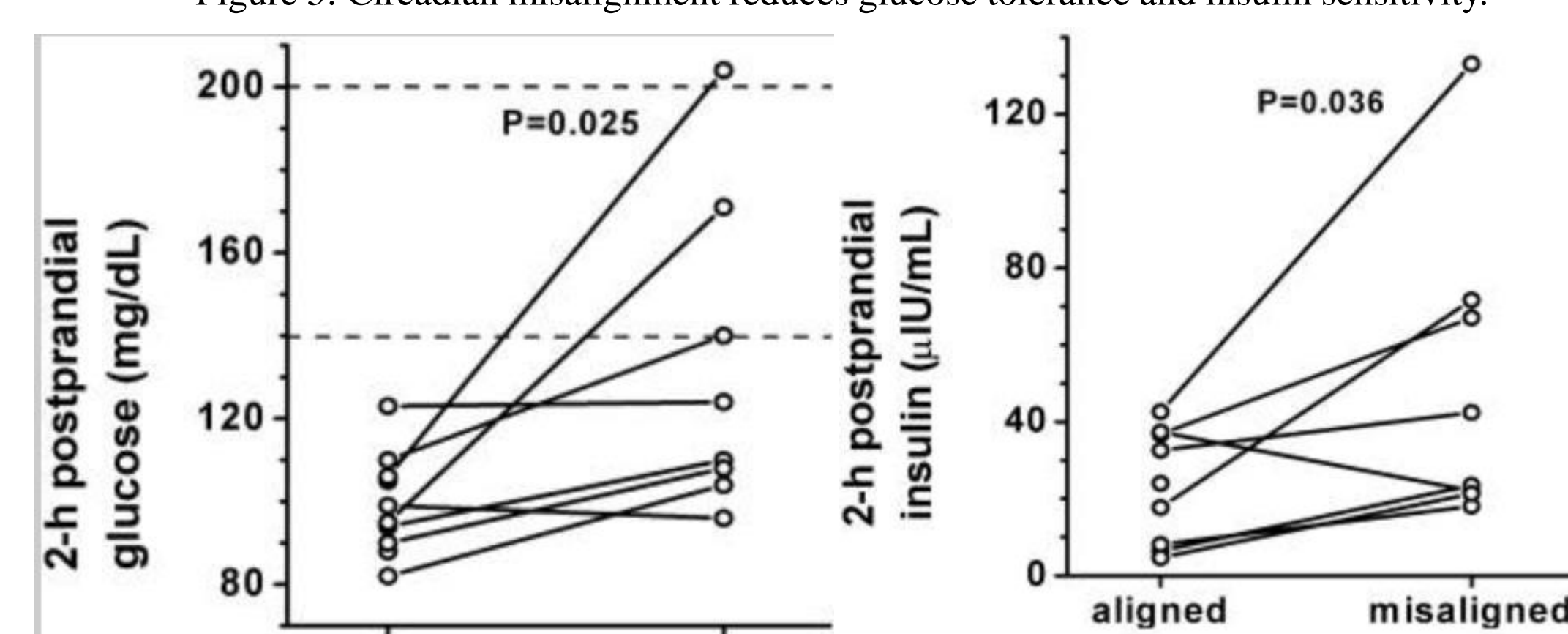
- In adult patients, does working an evening or night shift as compared to day shift increase the risk of developing diabetes mellitus, cardiovascular disease, and various cancers?
- In adult patients, does working an evening or night shift as compared to day shift decrease cognitive functions such as alertness and increase depressive symptoms?

Literature Review

Glucose metabolism and development of diabetes mellitus

- There is a positive association between shift work and increased BMI (p = 0.03) and waist circumference (p = 0.004). The average BMI of the day workers was 23.07 and 29.22 in night workers. The shift worker group had a 16 cm larger average waist circumference than the day workers (Antunes et al., 2010).
- 3 of 8 study participants had 2-hour postprandial glucose response that placed them in the "prediabetic" or "diabetic" stage for glucose metabolism (>140 mg/dL) during a circadian misalignment scenario. The participants had an average blood glucose increase of >30 mg/dL during circadian misalignment vs. circadian alignment (p = 0.025), even with an accompanying increase in insulin (p = 0.036) (Scheer et al., 2009).
- Leptin has a large natural variation of 44%, consisting of a breakfast-time trough leading to a peak at "bedtime" after consuming an evening meal (p <0.001). However, during circadian misalignment, average leptin levels decreased 17% (p <0.001) (Scheer et al., 2009).
- Shift workers had an average HbA1c value of 7.86%, while day workers had HbA1cs of 7.24% and unemployed study participants had HbA1cs of 7.09% (p = 0.044) (Manodpitipong et al., 2017).
- Shift work was associated with a 9% overall increased risk of DM [odds ratio (OR) = 1.09, p = 0.014]. In addition, "rotating shifts, irregular and unshifted shifts and night shifts were associated with an increased risk of DM." (Gan et al., 2015, p. 74).

Figure 5: Circadian misalignment reduces glucose tolerance and insulin sensitivity.



Scheer, F.A., Hilton, M.F., Mantzoros, C.S., & Shea, S.A. (2009). Adverse metabolic and cardiovascular consequences of circadian misalignment. *Proceedings of the National Academy of Sciences of the United States of America*, 106(11), 4453-4458. <http://dx.doi.org/10.1073/pnas.0808180106>

Shift work as a possible carcinogen

- Peplonska et al. (2012) found that while night shift workers did have slightly higher average mammographic density, it was not enough to be statistically significant (p = 0.62). Additionally, it made no statistical difference how long a woman had worked night shifts – participants spanned from 0 to 25+ years of shift work (p = 0.93).
- Grundy et al. (2013) found that women who worked a night shift job for more than 30 years are at increased risk for breast cancer (OR = 2.21) However, there was no increased risk for breast cancer in women who worked night shift less than 30 years (0-14 yrs. shift work OR = 0.95, 15-29 yrs. shift work OR = 0.93).
- Rao et al. (2015) found that there was an increased association of prostate cancer in shift work employees, evidenced by a risk ratio (RR) of 1.24 (p = 0.011). In addition, those who had worked over 5 years of shift work had a 2.8% increased risk of prostate cancer (p = 0.030).

Impact of shift work on mental health and cognitive performance

- Interns and residents on night shift slept an average of 2.19 hrs. per shift, vs. 6.92 hrs. before a day shift. 17.5% of participants had no sleep on an overnight shift. These 17.5% performed the worst on psychomotor tests and had slowed reaction times vs. those who slept on night shift and day shift workers (Basner et al., 2017). Those who did not sleep on night shift performed comparatively to those participants who slept on night shift but took the psychomotor test within an hour of waking (all p >.01).
- Nearly half of interns were sleeping less than 6 hours per night at 3 and 6 months of assessment. Participants who had higher scores of disordered sleep (so-called "poor sleepers") were more likely to be at risk for depression (OR = 2.33, p <0.001). In fact, "Each hour less of sleep correlated to a 59% increase in the odds of developing depression" (OR = 1.59) (Kalmbach et al., 2017, p. 3). Additionally, "Each hour less of sleep correlated to a 27% increase in the odds of reporting medical errors (OR⁻¹ = 1.27, p = .01)" (p. 5).

Discussion

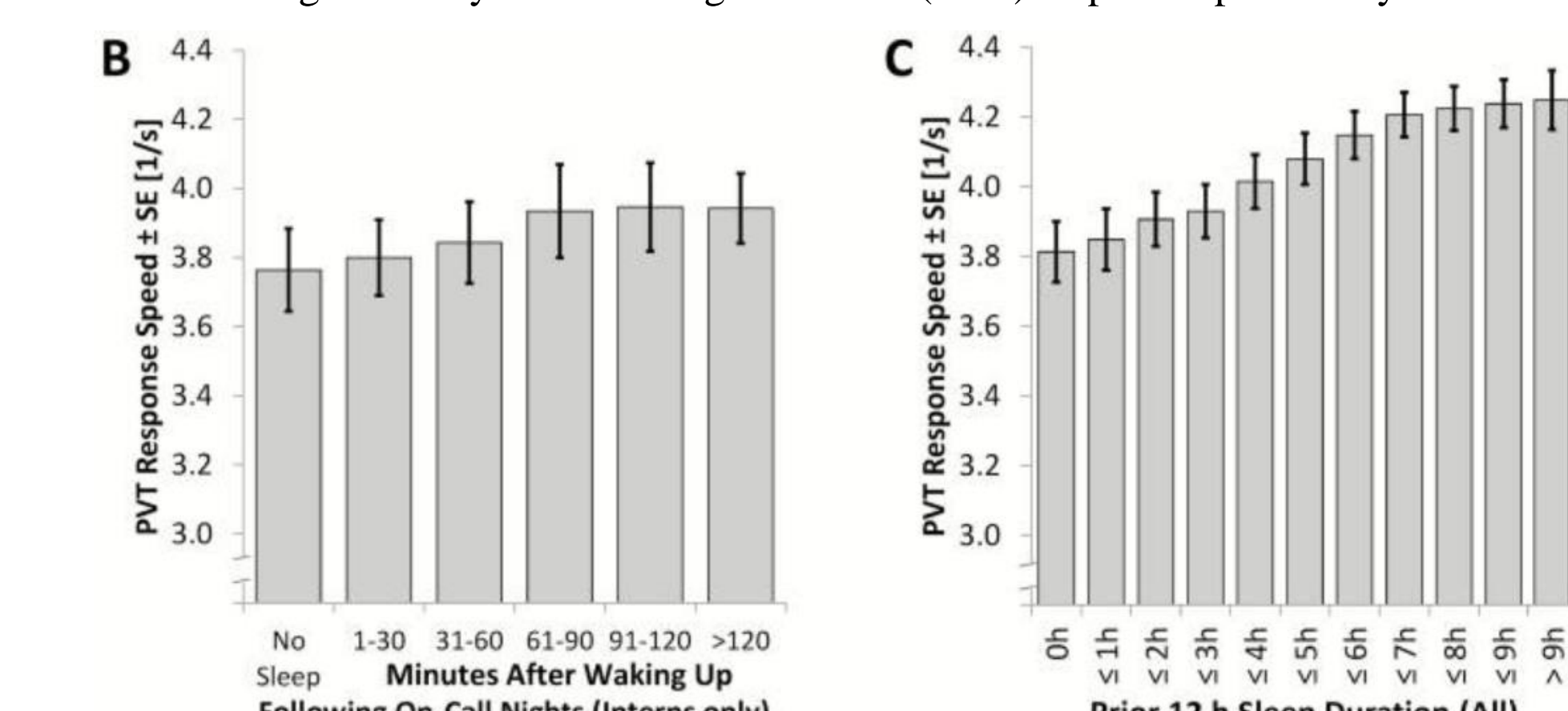
In adult patients, does working an evening or night shift as compared to day shift increase the risk of developing diabetes mellitus, cardiovascular disease, and various cancers?

- Shift workers have increased BMI and waist circumference compared to non-shift workers (Antunes et al., 2010).
- Alarmingly, some participants in a 2009 study were found to have glucose levels that qualified them for "prediabetes" or impaired glucose tolerance after only seven days of circadian misalignment, although they had normal glucose levels days earlier during circadian alignment (Scheer et al., 2009).
- HbA1C levels of diabetic shift workers were higher than diabetics that do not perform shift work (Manodpitipong et al., 2017).
- Subjects had a 17% decrease in leptin levels during circadian misalignment (Scheer et al., 2009).
 - Leptin "Regulate[s] energy balance. It does so by decreasing the appetite or energy intake and by increasing energy expenditure" (Moonishaa et al., 2017, p. 176).
 - Additionally, "Hyperleptinemia may promote atherosclerosis, and dysregulation of leptin signaling in obese individuals results in reduced fatty acid oxidation and glucose uptake" (Welsh et al., 2009, p. 308).
 - Although impaired leptin signaling can lead to reduced glucose uptake, which is itself a mechanism of development of DM, decreased leptin levels can also be contributory to increased DM risk. As mentioned above, leptin helps regulate satiety signals and energy intake and expenditure. If leptin levels are decreased, it could increase appetite in shift workers, which would increase calorie consumption and contribute to increased BMI and waist circumference as observed in studies mentioned previously.
- A meta-analysis asserts that shift workers do have increased risk of developing DM, evidenced by an overall OR of 1.09 (p = 0.014). OR increases to 1.42 in workers performing rotating shifts (p = 0.04) and 1.37 in men performing shift work (p = 0.01) (Gan et al., 2015).
- Subjects in a circadian misalignment scenario had an 11% higher hs-CRP level than their circadian alignment hs-CRP level (Morris et al., 2017).
 - CRP is "A sensitive and dynamic systemic marker of inflammation. Its concentration in the circulation can increase by up to 10,000-fold during acute responses to serious infection or major tissue damage" (Emerging Risk Factors Collaboration (ERFC), 2010, p. 132). In addition, "CRP binds to LDL and is present in atherosclerotic plaques" (p. 132).
 - Furthermore, "Epidemiological studies have shown chronically elevated hs-CRP to predict cardiovascular disease" (Morris et al., 2017, p. 161).
- A 2017 meta-analysis found the RR of a shift worker suffering a MI was 1.21. There was an RR of 1.12 for major adverse cardiovascular events, which includes stroke in addition to MI and cardiovascular death (Barger et al., 2017).
- Men who work night shift have a 24% higher risk of prostate cancer compared to the same man who does not work night shift (Rao et al., 2015).
- A 2012 study concluded there is no statistically significant relationship between shift work and increased mammographic density, a known risk factor for breast cancer (Peplonska et al.). However, Grundy et al. (2013) stated there is increased breast cancer risk for women working a night shift for more than 30 years.

In adult patients, does working an evening or night shift as compared to day shift decrease cognitive functions such as alertness and increase depressive symptoms?

- Night shift workers drove a closed course after a night of work with limited sleep. Night shift workers had an RR of 2.08 for lane excursions, and over half of the drives were ended early due to safety concerns – even on a closed track with no "real-world" obstacles such as pedestrians and other vehicle traffic (Lee et al., 2015).
- Interns and residents who sleep less than 3 hours on overnight on-call shifts have decreased performance on the Psychomotor Vigilance Test (PVT) compared to their scores on the PVT on regular shift days (Basner et al., 2017). In addition, tenured emergency department physicians (avg. duration of employment 8.1 years) have decreased cognition post-night shift, with decreased performance on a word-recall test (Machi et al., 2012).
- Interns and residents who are more sleep deprived have a higher risk of developing depressive symptoms (Kalmbach et al., 2017).

Figure 3: Psychomotor Vigilance Test (PVT) response speed analyses.



Basner, M., Dinges, D.F., Shea, J.A., Small, D.S., Zhu, J., Norton, L., Aldry, K.G. (2017). Sleep and alertness in medical interns and residents: An observational study on the role of extended shifts. *Sleep*, 40(4), zsx027. <http://dx.doi.org/10.1093/sleep/zsx027>

Clinical Applicability

- Anticipation of possible health problems associated with shift work
 - Providers can provide early education and intervention for these health problems in their patients who are employed in shift work positions.
 - For example, if a patient is employed in a shift work position, the provider may be more aggressive with screening for impaired glucose tolerance, and would perform glucose testing once a year as opposed to once every 3 years as suggested by the United States Preventive Services Task Force.
- More awareness of other health risks to the patient
 - Providers can keep a closer eye on screening for cardiac diseases, various cancers such as breast and prostate cancer, and may screen more often for depression.
- Perhaps being aware of the information provided in this scholarly project will make providers more cognizant of the health issues that can plague shift workers and bring more awareness to the fact that these individuals require more preventative care than the average patient who works a day shift position.

Acknowledgements

I would like to thank the faculty and staff of the University of North Dakota Physician Assistant program for their role in providing an excellent education and foundation of skills upon which to build my future career; my academic advisor Daryl Sieg, PA-C for his support, encouragement, and guidance along the way; Marilyn Klug, Ph.D. and Annie Schlecht, MOTL/R for their thoughtful analysis and critique of my scholarly project; my peer review group members Chukwuka Nnoli, PA-S, Ashley Pommer, PA-S, Amy Quinn, PA-S, and Kaitlyn Wirtz, PA-S, for their insightful and constructive criticism of this project; and my family, friends, and classmates for their unwavering support and love over these past two years while I have been working diligently to achieve my dreams.

References

- Antunes, Lda, C., Jorral, M.N., Ramallo, L., & Hidalgo, M.P. (2010). Correlation of shift work and waist circumference, body mass index, chronotype and depressive symptoms. *Aspavros Brasileira de Endocrinologia e Metabolgia*, 54(7), 652-656. <http://dx.doi.org/10.1590/S0004-27302010000700010>
- Basner, L.A., Rajaratnam, M.E., Arehart, C.P., Eastman, A., Lin, K., & Dinges, D.F. (2017). Short sleep duration, obstructive sleep apnea, shiftwork, and the risk of adverse cardiovascular events in patients after an acute coronary syndrome. *Journal of the American Heart Association: Cardiovascular and Cerebrovascular Disease*, 6(10), e006599. <http://dx.doi.org/10.1161/JAHA.117.006599>
- Basner, M., Dinges, D.F., Shea, J.A., Small, D.S., Zhu, J., Norton, L., Aldry, K.G. (2017). Sleep and alertness in medical interns and residents: An observational study on the role of extended shifts. *Sleep*, 40(4), zsx027. <http://dx.doi.org/10.1093/sleep/zsx027>
- Benjamin, E.J., Blaha, M.J., Chiuve, S.E., Cushman, M., Das, S.R., Deo, R., ... Muntner, P. (2017). Heart disease and stroke statistics—2017 update: A report from the American Heart Association. *Circulation*, 135(10), e146-160. <http://dx.doi.org/10.1161/STROKEAHA.117.045811>
- Bureau of Labor Statistics. (2005). *Workers on flexible and shift schedules in May 2004* [PDF]. Retrieved from <https://www.bls.gov/news.release/pdf/flex.pdf>
- Centers for Disease Control and Prevention. (2017). *National diabetes statistics report, 2017* [PDF]. Retrieved from <https://www.cdc.gov/diabetes/pdfs/data/statistics-national-diabetes-statistics-report.pdf>
- Emerging Risk Factors Collaboration. (2010). C-reactive protein concentration and risk of coronary heart disease, stroke, and mortality: an individual participant meta-analysis. *Lancet*, 375(9799), 132-140.
- Gan, Y., Yang, C., Tong, X., Sun, H., Cong, Y., Yin, X., Lu, Z. (2015). Shift work and diabetes mellitus: A meta-analysis of observational studies. *Occupational and Environmental Medicine*, 72(1), 72-78. <http://dx.doi.org/10.1136/sem-2014-102150>
- Grundy, A., Richardson, H., Barsyn, L., Ledwith, C., SenGupta, S.K., Lal, A.S., ... Aronson, K.J. (2013). Increased risk of breast cancer associated with long-term shift work in Canada. *Occupational and Environmental Medicine*, 70(12), 831-838. <http://dx.doi.org/10.1136/oem.2013.101482>
- Kalmbach, D.A., Arendt, J.T., Song, P.X., Guille, C., & Sen, S. (2017). Sleep disturbance and short sleep as risk factors for depression and perceived medical errors in first-year residents. *Sleep*, 40(3), zsw073. <http://dx.doi.org/10.1093/sleep/zsw073>
- Lee, M.L., Howard, M.E., Horew, W.J., Liang, Y., Anderson, C., Shiveeve, M.S., ... Zeisler, C.A. (2015). High risk of near-crash driving events following night-shift work. *Proceedings of the National Academy of Sciences of the United States of America*, 112(1), 176-181. <http://dx.doi.org/10.1073/pnas.1510383112>
- Machi, M.S., Stanton, M., Callaway, C.W., Moore, C., Joong, K., Soyama, J., ... Hondee, D. (2012). The relationship between shift work, sleep, and cognition in career emergency physicians. *Academic Emergency Medicine*, 19(1), 85-91. <http://dx.doi.org/10.1111/j.1553-2712.2011.01254.x>
- Manodpitipong, A., Saetung, S., Nimipong, H., Swasaranond, N., Wongphat, T., Somratwong, C., ... Reatrakul, S. (2017). Night-shift work is associated with poorer glycaemic control in patients with type 2 diabetes. *Journal of Sleep Research*, 26(6):764-772. <http://dx.doi.org/10.1111/jsr.12554>
- Moonesingh, T.M., Sando, S.K., Shamraj, M., Sivas, R., Sivakumar, P., & Ravichandran, K. (2017). Evaluation of leptin as a marker of insulin resistance in type 2 diabetes mellitus. *International Journal of Applied and Basic Medical Research*, 7(3), 176-180. http://dx.doi.org/10.4103/ijabmr.IJABMR_278_16
- Morris, C.J., Navis, T.E., Mistretta, J., Ha, K., & Scheer, F.A. (2017). Circadian misalignment increases C-reactive protein and blood pressure in chronic shift workers. *Journal of Biological Rhythms*, 32(2), 154-164. <http://dx.doi.org/10.1177/0748734116975737>
- Peplonska, B., Bukowska, A., Sobala, W., Reszka, E., Grondzinska, J., Wasowicz, W., ... Urtin, G. (2012). Rotating night shift work and mammographic density. *Cancer Epidemiology, Biomarkers and Prevention*, 21(7), 1028-1037. <http://dx.doi.org/10.1158/1055-9945.EPI12.0406>
- Rao, D., Yu, H., Bai, Y., Zheng, X., & Xie, L. (2015). Does night-shift work increase the risk of prostate cancer? A systematic review and meta-analysis. *Oncotargets and therapy*, 8, 2817-2826. <http://dx.doi.org/10.2147/OTT.S89769>
- Scheer, F.A., Hilton, M.F., Mantzoros, C.S., & Shea, S.A. (2009). Adverse metabolic and cardiovascular consequences of circadian misalignment. *Proceedings of the National Academy of Sciences of the United States of America*, 106(11), 4453-4458. <http://dx.doi.org/10.1073/pnas.0808180106>
- Substance Abuse and Mental Health Services Administration. (2017). *Key substance use and mental health indicators in the United States: Results from the 2016 national survey on drug use and health*. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2016/NSDUH-FRR1-2016.html#find>
- Welsh, P., Murray, H.M., Buckley, B.M., de Craen, A.J.M., Ford, I., Jakoma, J.W., & Sattar, N. (2009). Leptin predicts diabetes but not cardiovascular disease. *Diabetes Care*, 32(2), 308-310. <http://dx.doi.org/10.2337/d018-1458>