

Promoting Sleep Among Medical Trainees

Cam Clayton, UBC, Class of 2022
Renee Reimer, UBC, Class of 2022
Ola Lemanowicz, UBC, Class of 2023
Emily Yang, UBC, Class of 2023
Michael Minkley, UBC, Class of 2022
**order does not denote contribution*

Type of Paper: Position Paper

Approved: Date

Revised: Date(s)



CFMS
Canadian Federation
of Medical Students

FEMC

Fédération des étudiants et des
étudiantes en médecine du Canada



Promoting Sleep Among Medical Trainees

Date 2021-10-04

POSITION PAPER

Summary

Proper sleep is a biological necessity (1,2). However, sleep deprivation is pervasive throughout medical training, commonly seen as unavoidable for both staff and trainees, and featuring prominently in popular culture depictions of medical settings. Though exact studies of sleep timing at Canadian Medical Schools are sparse, more general studies (5-10) and the anecdotal fact that most medical students report being sleep deprived highlight this reality. Recent research has created a robust set of evidence that clearly demonstrates both short and long-term consequences of sleep deprivation. These consequences affect both the mental and physical well-being of medical learners and raise concerns for the safety of patients who are being cared for by sleep-deprived students (See Tables 1-3).

Numerous factors contribute to the normalization of sleep deprivation amongst medical learners. Most prominent are the need to provide sufficient duty hours for coverage of medical services, the additional long study hours required adequate exposure during medical training, and medicine's culture of selflessness and competitive excellence. However, by setting educational schedules and policies that mandate sleep deprivation, medical schools demand medical learners and patients to bear the brunt of the consequences. Recent efforts have begun to address working hours during training, but we believe special attention needs to be paid to sleep, as the majority of health consequences are more directly related to lack of proper sleep as opposed to long working hours.

Given the pervasiveness of sleep deprivation and its associated consequences within our medical system, stakeholders at every level of medicine including hospital administration, medical staff, learners, and patients serve to benefit from systematic change. The main objectives of this position paper are to highlight the evidence around the consequences of sleep deprivation, discuss the reasons for its prevalence in medical training, and provide recommendations for potential strategies that may begin to mitigate it.

RECOMMENDATIONS

- 1) Canadian medical schools should collect and make publicly available data regarding the quality and quantity of sleep, sleep-related behaviours (i.e. sleep hygiene), and their determinants among medical students and trainees. Furthermore, associated parameters of well-being and academic performance among their medical trainees across years of training should also be collected and published.
- 2) Canadian medical schools should leverage existing evidence to develop clear and explicit policy statements around minimum sleep requirements of 7-9 hours for medical trainees that are consistent with the above noted principles.
- 3) Canadian medical schools should develop and evaluate interventions to promote sleep among sleep-deprived medical trainees, including education programs, alternative scheduling strategies, and, most importantly, duty hour policies aimed to optimize sleep for medical trainees.
- 4) Canadian medical schools should implement culture-change interventions that aim to shift the prevailing discourse from

devaluing the need for sleep towards upholding it as a basic physiological requirement.

SUPPORTING EVIDENCE & RATIONALE

1. The evidence of the short term and long-term consequences of sleep deprivation has grown substantially (Tables 1-3).
2. Very little published Canadian data exists to quantify the degree of sleep deprivation experienced by medical trainees.
3. Despite robust evidence of the implications of less than 7-9 hours of sleep per night among medical staff and students, and despite the Quebec Supreme Court upholding that 26-hour shifts violate worker's rights (14), duty hour reform in the rest of Canada fails to protect sleep time in medical training.
4. Currently, very few interventions have been documented that support medical learners' wellness through optimal sleep in Canada.
5. Medical culture celebrates sleep deprivation as an inevitable rite of passage, as opposed to the hazard to learner and patient health that it represents (11, 18).

INTRODUCTION & BACKGROUND

Sleep is an essential biological process. It plays a critical role in proper functioning of the brain and multiple bodily systems including metabolism, appetite regulation, the immune, hormonal, and cardiovascular systems. A substantial body of evidence demonstrates the importance of sleep for human physiological and psychological functioning (1,2). However, medical education is well-known to be a time of chronic sleep deprivation. For pre-clinical years, this lack of sleep is due to long days spent in lectures and laboratories; for clinical clerks, long workdays and frequent overnight call shifts are at fault. This is on top of the heavy study burden present throughout medical school. Unfortunately, this is often seen as part of the reality of learning and practicing medicine. As a profession that fundamentally strives to improve health and well-being, mandated sleep deprivation during training is, at best, a large oversight to these goals. In this position paper, we explore the reality of sleep deprivation and its consequences among medical trainees; urging action to mitigate sleep deprivation and its negative consequences.

How Much Sleep do Medical Students Get?

Healthy sleep is described as sleep of sufficient duration, quality, and regularity of timing without sleep disturbances or disruptions. Evidence suggests the vast majority of humans require 7-9 hours per night to support optimal health and functioning (3,4). Data from the US and other countries indicate a majority of medical students report suboptimal sleep patterns (5), getting an average of 6.45 hours per night (6). However, this average poorly captures the sleep irregularity that occurs during clinical rotations especially during call shifts as well as stressful study periods: trainees on call average less than three hours of sleep per night, and often go sleepless (7,8). Student self-reporting shows that 70% of students felt the amount of time they slept was less than what they need for good health (9,10). As medical students advance through their training, they sleep less than in pre-clinical years and score higher on sleepiness indices (9,11,12).

What causes poor sleep in medical training and beyond?

The prevailing rationale is that long hours during medical training offer a valuable educational experience, supporting continuity of care and high-quality training. Such schedules are seen to be necessary to provide sufficient time to be prepared for the demands of clinical practice (13). It is also often seen as the reality of our medical system that long work hours from trainees are required to run services. Upon entering medical school, students deal with an increased workload and stress from progressively increasing clinical and academic requirements, all of which erode their sleep (5,14,15). During clinical years, with the exception of Quebec (16), Canadian medical schools regularly schedule interns for 26 or more hour call shifts an average of 1 in 4 days (17).

Indeed, sleep deprivation can be seen to be part of the hidden curriculum of medicine. The culture of medicine devalues physicians' and trainees' need for sleep. Whereas fatigue is seen as a collective hazard in other industries, residents see fatigue as an inescapable part of their training; a personal challenge to be managed and overcome (18). This intensive training schedule has been called a rite of passage at teaching hospitals (13). While it would be deemed prohibitively dangerous for sleep deprived pilots to fly in Canada, it is the norm among those providing medical care across the country.

Tables 1 and 2 below highlight some of the well-established short and long-term consequences of sleep deprivation, while Table 3 includes a review of the evidence of consequences of sleep deprivation within the medical profession specifically.

Table 1. Short-Term Consequences of Sleep Deprivation

Increased autonomic stress response (19,20)	Emotional dysregulation (21)
Low mood (22,23)	Decreased quality of life (27)
Headache and abdominal pain (28)	Poor physical performance (29–31)
Decreased driving ability and increased risk of collision (32–34)	Impaired cognitive performance (24–26)

Table 2. Long-Term Consequences of Sleep Deprivation

Diabetes (36)	Hypertension (37–39)
Cardiovascular disease (39,40)	Obesity (41–43)
Alzheimer's disease (44)	Cancer (45,46)
Increased Suicide (48) and overall mortality (35,48)	Depression and anxiety (47)

Table 3. Documented Consequences of Sleep Deprivation in the Medical Profession

Lower academic achievement and worse study concentration (49,50)	Decline in clinical expertise and increased medical errors (51, 65,71)
Decreased cognitive performance and decreased performance on clinical tasks (52)	Impaired technical performance of surgeries and intubations (53–58)
Impaired language and math (59)	Decreased ECG interpretation skills (60)
Less empathy (61,62)	Increased ICU errors (63)
More motor vehicle accidents (64)	More exposures to blood-borne pathogens (67)
More workplace (e.g. needle stick) injuries (66)	Family and marital stress (69,70)
Anxiety, stress, and negative mood (68)	Increased burnout and job dissatisfaction (71)

How can we improve sleep among medical trainees?

Several strategies have been undertaken in different locations to ensure sufficient sleep among medical trainees. These interventions include sleep education programs (72) and protected sleep times (three-hour naps) during call shifts (73). Duty hour caps were instituted in Quebec as of 2011 after the Quebec Supreme Court ruled that 24 hour shifts violated the Quebec Charter Rights of resident doctors, capping duty hours to a maximum of 16 consecutive work hours (74). Similarly, the Accreditation Council for Graduate Medical Education (ACGME) capped duty hours to 80 hours per week and 16 hours per shift for first year residents in 2011 in an effort to bolster resident wellness and patient safety. The EU has been the most progressive with duty hour reform. There, medical trainees fall under the European Working Time Directive (EWTD), established in 2003. Worker duty hours are capped at 48 hours per week, at least 11 hours of rest per 24 hours period, one day off per week, and 20 minutes rest every 6 hours. Though these policies focus most on workload hours, inherent to being able to achieve a reasonable amount of sleep is having a work schedule that provides sufficient time to do so. Because the time demand of clinical medical training is so great, duty hours restrictions are the most common strategy cited to increase sleep and well-being among medical trainees. Indeed, the 2019 CFMS position statement on workload policies across Canadian medical schools recommended weekly maximum hours, including and excluding call, while also recommending that students should not be scheduled for more than 12 out of 14 days, which would limit the number of weekend calls to two days every two weeks (75).

There is mixed evidence in regard to the success of these interventions (76). In the face of extended work hours, education alone may not be sufficient (72). Protected sleep time, however, supported increased sleep duration and improvements in attention in some situations (74). Indeed, with respect to the EWTD, a survey of UK medical graduates suggested the majority of MD's felt it benefited work-life balance (77). Additionally, there was a reported decrease in fatigue-related complaints,

suggesting an increase in overall sleep as a result of the reforms (82). However, there is general uncertainty whether this is always the case. In 2017, the ACGME duty hour cap was reversed as the hope for benefits associated with the policy were not realized. In this case, it was unclear if the duty hour cap was truly reflected in reduced hours worked by residents. Behaviours among trainees such as not taking their post call days off were not reflected in official documents. Further, it was also noted that some residents may have been pressured to underreport their hours, or administration may have disclosed schedules which did not reflect the true hours worked (78).

Even in the case of truly reduced scheduled hours, workplace performance demands, educational requirements, and career competitiveness have not changed. These are ultimately drivers of greater work hours and concurrently reduced sleep. It is worth noting that in regard to the previous ACGME and EWTD, concerns were raised, particularly by procedural specialties, about the duty hour restriction and its impact on being able to acquire the necessary skills to perform in their specialty. Also, it is a common concern that a reduction in work hours and protected sleep time would negatively impact hospital care by limiting service availability. Unfortunately, with the EWTD as well as other interventions, there are few studies indicating the impact of such reductions in duty hours on sleep specifically. However, given the growing evidence of the consequences of poor sleep on both medical outcomes and physician and trainee health, these studies are currently our best insight in how to approach this serious problem.

KEY PRINCIPLES

1. Sufficient sleep is fundamental for optimal physical and mental health in the short and long-term for medical students.
2. Optimal sleep is important for the medical trainee given its fundamental role in learning and assimilation of information as well as bolstering mental health. Canadian medical students require sufficient sleep to manage the cognitive, emotional, and physical toll of medical training.
3. The best evidence indicates that at least 7-9 hours of sleep opportunity per night is necessary for optimal functioning of most individuals, including medical students. Such sleep is most ideally undertaken in a consistent, circadian fashion.
4. Medical education institutions should adopt work, education, and training practices consistent with best evidence for the health and well-being of their trainees.
5. Policies, in general, ought to be implemented and enforced in a consistent and transparent manner.

RECOMMENDATIONS

The CFMS has compiled a list of recommendations for Canadian medical institutions to support greater sleep as a key component of wellness among medical students.

1. Collecting and Publishing Data Regarding Sleep in Medical Training

Concern 1: Medical students in general are shown to be chronically sleep-deprived, which can have short- and long-term deleterious effects on students' learning, and mental and physical health.

Concern 2: There is a paucity of data specific to Canadian Medical Schools available in regard to trainee sleep duration, timing, and consistency during training and possible associated performance and health effects

Recommendation 1: Canadian medical schools should collect and make publicly available data regarding the quality and quantity of sleep, sleep-related behaviours (i.e. sleep hygiene), and their determinants among medical students and trainees.

Recommendation 2: Furthermore, associated parameters of well-being and academic performance among their medical trainees across years of training should also be collected and published.

Supporting Evidence & Rationale

Despite the increasingly recognized importance of sleep for wellness and nearly all aspects of mental and physical performance, very little data exist quantifying sleep among medical students. Anecdotally, no Canadian Medical student escapes their training without enduring extended periods of sleep disruption; however, little published Canadian data was found in our search. As an emerging foundation of health that is relatively undervalued within the medical profession, an evidence base is required to further clarify at regional and national levels the nature and extent of sleep deprivation across training years and services. Publicly available data will allow researchers to undertake analyses that facilitate a present understanding of sleep among medical trainees, as well as to quantify the impacts of future interventions to improve sleep.

2. Implementing Specific Sleep Policy Goals

Concern 1: There is a clear lack of policy statements around sleep for medical trainees from existing medical educational institutions in Canada.

Concern 2: Duty hour policies frequently mandate, at an institutional level, medical trainees forgo sleep for 24+ hours to meet educational requirements. This has been challenged and upheld in court as a violation of the Canadian Charter of Rights and Freedoms in Quebec (2011).

Recommendation 1: Canadian medical schools should leverage existing evidence to develop clear and explicit policy statements around minimum sleep requirements.

Recommendation 2: These requirements should be targeted towards achieving a minimum of at least 6 hours and ideally 7-9 hours daily for medical trainees that are consistent with the above noted principles.

Recommendation 3: In situations where this is not possible due to clinical workloads, the maximum practical amount of rest/sleep should be given (e.g. 1-2 hours of protected break or sleep time during an overnight call shift).

Supporting Evidence & Rationale

A previous CFMS paper from 2019 highlights the need for duty hour reform amongst medical trainees. We applaud and uphold this effort, and further point to the additional medical school-related obligations that increasingly impinge on time for basic personal health activities such as sleep. Post-duty study is a basic expectation to achieve satisfactory clinical evaluations, and intense competition for residency programs leads most medical students to engage with a wide variety of scholarly and extra-curricular activities. These engagements - now a basic expectation among medical students - in combination with heavy duty hours, impinge heavily on sleep and other health-related behaviours.

While we recognize that sleep deprivation among medical trainees is fundamentally a complex systems-level issue, leadership and policy statements are required to chart a corrected course towards greater trainee wellness, balancing the simultaneous needs of educating medical students and residents while providing appropriate care to the Canadian public. We advocate for Canadian medical undergraduate programs moving beyond generalized statements of support for medical trainee “wellness” in favor of making explicit, quantified target statements of ideal hours of sleep per night. At this time, a recommendation of 7-9 hours per night would be in keeping with current best evidence. This, in combination with greater data collection, will allow for accurate benchmarking and indicators of success. Policy statements should also include advocating for programs to undertake scheduling policies that explicitly strive to maximize unbroken sleep in a given 24-hour cycle, and minimize disruption of circadian rhythms.

3. Interventions for Sleep Promotion

Concern 1: The National Steering Committee on Resident Duty Hours recommended “duty periods of 24+ consecutive hours without restorative sleep should be avoided and only undertaken in rare or exceptional circumstances”. However, this remains the norm for clerks and residents across Canada.

Concern 2: Due to the compromise in mental and physical functioning, there are concerns for patient safety after extended periods of sleeplessness (18+ hours).

Recommendation 1: Canadian medical schools should develop and evaluate interventions to promote sleep among sleep-deprived medical trainees, including education programs, alternative scheduling strategies, and, most importantly, duty hour policies aimed to optimize sleep for medical trainees.

Recommendation 2: Given the limited number of published studies, interventions should be individualized to the setup of each specific program

Recommendation 3: Interventions that have previously shown some success in some studies should be considered as a starting point (72-78). These include sleep education programs, protected sleep time and duty hour caps.

Recommendation 4: We would also recommend consideration of other interventions with anecdotal evidence of possible usefulness. These include ensuring comfortable and available call rooms. Providing additional staff, resident, or student evening coverage to allow rest periods for students on overnight call. Implementing triage protocols that allow non-urgent consults and ward issues to be delayed during certain overnight periods to optimize the chance of rest.

Recommendation 5: That strategies that are trialed by programs be documented and published in order to improve the available knowledge base.

Supporting Evidence & Rationale

Despite the relatively limited knowledge of current sleep among Canadian medical trainees as discussed above, the negative health outcomes of sleep disruption are well-documented. Therefore,

current understanding of sleep deprivation is such that there is no longer a reasonable excuse to continue ignoring this aspect of medical training. Additionally, the 2011 ruling from the Quebec Supreme Court suggests mandated 26-hour shifts violate workers' rights, and medical trainees should not *de facto* absolve themselves from workers' rights enjoyed in every other industry by entering the medical profession. Indeed, as a leading health profession in society, medical professionals ought to engender the best ideals of health promotion. Workers should not be subject to health-compromising work conditions (i.e. sleepless nights) except in extreme circumstances. Despite this, there appear to be very little documented reports of interventions to ensure optimal sleep among Canadian medical trainees.

Based on our review of the literature, a few possible avenues to enhance sleep may exist. Education programs on the primary importance of sleep, sleep requirements, and sleep hygiene should be employed to ensure medical students have sufficient knowledge and skills to sleep optimally. As discussed above, a policy framework to guide decisions about sleep and duty hours should be made. Based on these policies, efforts should be made to ensure 7-9 hours of unbroken sleep opportunity for medical trainees across years wherever possible. Where this is not possible, such as in overnight or call rotations, medical schools should explore alternate scheduling strategies, such as evening or night shifts or call-protected sleep breaks or rest periods to allow students to mitigate the consequences of sleep disruption. The incongruence between these known harms but lack of interventions demonstrates a critical need for Canadian medical institutions to act. Research and evaluation of reasonable methods to improve scheduling and protect sleep during prolonged shifts are needed.

4. Shifting The Medical Sleep Culture

Concern 1: The culture of medicine systematically devalues the need for sleep and often celebrates it as a rite of passage despite its dangerous consequences.

Concern 2: Due to this culture in medicine, students feel unable to ask for help when they are sleep-deprived to a degree that is dangerous to their health or to the health of the patients they are treating.

Recommendation 1: The information presented here should be further disseminated amongst medical learners and staff in order to highlight that current attitudes in medicine towards sleep are not based on reasonable health science and are not without consequences for learners and patients.

Recommendation 2: Canadian medical schools should prioritize implementing culture-change interventions that aim to shift the prevailing discourse from devaluing the need for sleep towards upholding it as a basic physiological requirement.

Supporting Evidence & Rationale

As discussed, sleep deprivation is woven into the fabric of medicine and is a key part of the curriculum. Indeed, the ability to work tirelessly for 26 or more hours, multiple days per week, is accepted, embraced, and valorized. The drive to learn more, achieve more, and gain mastery (and employment) in one's chosen area of medicine drives medical trainees to constant work. While there can be a sense of increased confidence and accomplishment that comes from such commitment to one's career, sacrifice of basic personal health requirements should not be seen as noble. Sleep deprivation in particular should not be celebrated. Rather, it should be seen for what it is - a noxious stimulus and risk

factor for multiple poor health outcomes. Canadian medical institutions, including residency programs, ought to undertake culture-change interventions to shift the narrative on the acceptability of sleep deprivation among medical trainees as part of the larger ongoing narrative shift of promoting trainee and physician wellness.

ADVOCACY PLAN & FOLLOW-UP STRATEGY

We recognize the multifaceted nature of this issue, and its requirement for efforts over time to improve the well-being of medical trainees. An issue which is central to our medical culture and how our medical system currently functions is unlikely to change rapidly. Immediate efforts should focus on a few key areas, which we advocate to be taken up by the CFMS.

The first is to raise awareness that sleep deprivation, though central to medicine, is not without its consequences. This is an important factor in shifting medical culture and attitudes towards sleep. We believe that the creation of this position paper is an important early step in this process, and further dissemination of this information should be prioritized. The second is to improve understanding of sleep amongst medical trainees. The ideal method would be to design and release a sleep survey. For practical reasons, inclusion of more sleep-related questions amongst existing surveys of medical students may be more reasonable. Finally, we strongly advocate for the inclusion of a mandated Sleep Portfolio or a combination of work hours and sleep portfolio within CFMS Student Affairs to continue to advocate on behalf of this issue and work on these tasks.

CONCLUSION

Despite its biological necessity, sleep deprivation is common in medical training. It is encountered throughout the training years but is most pronounced during clinical rotations. It is often cited as necessary in order to gain the required clinical expertise to function as a good doctor. A more pertinent reality is that our medical system is currently dependent on learners forgoing sleep in order to provide coverage on various medical services, particularly overnight and on weekends. Learners who are sleep-deprived are at increased risk of serious mental health consequences as well as numerous chronic health conditions. Patients being treated by sleep-deprived learners are at increased risk of suffering serious medical errors. Given the relationship of this problem to hospital service coverage, medical learner health as well as patient health, this is an issue with stakeholders at every level of medicine.

The complexity of this issue and the lack of studies in this area means that data on the best approach to improving sleep is limited. Ultimately, it is likely that broad recommendations will need to be taken by each individual program and adjusted in a manner that best suits their health system. Efforts to better understand and survey sleep amongst medical students as well as to shift prevailing cultural attitudes towards sleep are good early goals to begin to combat this issue.

We cannot continue to let our learners and patients bear the brunt of the now well-documented consequences of sleep deprivation without undertaking reasonable efforts to change it. Significant work is needed in order to change something as entrenched in our medical system as sleep deprivation. This position paper and associated advocacy for the recommendations outlined herein are an important first step towards mitigating these serious consequences.

REFERENCES

1. PhD MW. Why We Sleep: Unlocking the Power of Sleep and Dreams. Illustrated edition. New

York: Scribner; 2017. 368 p.

2. Medic G, Wille M, Hemels ME. Short- and long-term health consequences of sleep disruption. *Nat Sci Sleep*. 2017;9:151–61.
3. Consensus Conference Panel, Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, et al. Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society on the Recommended Amount of Sleep for a Healthy Adult: Methodology and Discussion. *Sleep*. 2015 Aug 1;38(8):1161–83.
4. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health*. 2015 Dec;1(4):233–43.
5. Azad Muhammad Chanchal, Fraser Kristin, Rumana Nahid, Abdullah Ahmad Faris, Shahana Nahid, Hanly Patrick J., et al. Sleep Disturbances among Medical Students: A Global Perspective. *Journal of Clinical Sleep Medicine*. 11(01):69–74.
6. Rao W-W, Li W, Qi H, Hong L, Chen C, Li C-Y, et al. Sleep quality in medical students: a comprehensive meta-analysis of observational studies. *Sleep Breath*. 2020 Sep 1;24(3):1151–65.
7. Basner M, Dinges DF, Shea JA, Small DS, Zhu J, Norton L, et al. Sleep and Alertness in Medical Interns and Residents: An Observational Study on the Role of Extended Shifts. *Sleep* [Internet]. 2017 Feb 24 [cited 2021 Jan 12];40(4). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5806581/>
8. Defoe DM, Power ML, Holzman GB, Carpentieri A, Schulkin J. Long hours and little sleep: work schedules of residents in obstetrics and gynecology. *Obstetrics & Gynecology*. 2001 Jun 1;97(6):1015–8.
9. Ahmed N, Sadat M, Cukor D. Sleep Knowledge and Behaviors in Medical Students: Results of a Single Center Survey. *Acad Psychiatry*. 2017 Oct 1;41(5):674–8.
10. Johnson KM, Simon N, Wicks M, Barr K, O'Connor K, Schaad D. Amount of Sleep, Daytime Sleepiness, Hazardous Driving, and Quality of Life of Second Year Medical Students. *Acad Psychiatry*. 2017 Oct 1;41(5):669–73.
11. Brick CA, Seely DL, Palermo TM. Association Between Sleep Hygiene and Sleep Quality in Medical Students. *Behavioral Sleep Medicine*. 2010 Mar 26;8(2):113–21.
12. Ayala EE, Berry R, Winseman JS, Mason HR. A Cross-Sectional Snapshot of Sleep Quality and Quantity Among US Medical Students. *Acad Psychiatry*. 2017 Oct 1;41(5):664–8.
13. Howard SK. Sleep deprivation and physician performance: Why should I care? *Proc (Bayl Univ Med Cent)*. 2005 Apr;18(2):108–12.
14. Huen L-LE, Chan T-WG, Yu W-MM, Wing Y-K. Do medical students in Hong Kong have enough sleep? *Sleep Biol Rhythms*. 2007 Jul 1;5(3):226–30.
15. Almojali AI, Almalki SA, Alothman AS, Masuadi EM, Alaqeel MK. The prevalence and association of stress with sleep quality among medical students. *J Epidemiol Glob Health*. 2017 Sep;7(3):169–74.
16. Lajoie M-RB. End of 24-hour institutional on-call duty in Quebec. *Can Fam Physician*. 2012 May;58(5):e296–7.
17. Wong K, Jin S, Roncière L, Sarkis B, Cohen A, Major S. Workload Policies across Canadian Medical Schools. :13.
18. Taylor TS, Watling CJ, Teunissen PW, Dornan T, Lingard L. Principles of fatigue in residency education: a qualitative study. *CMAJ Open*. 2016 Jun;4(2):E200-204.
19. Meerlo P, Sgoifo A, Suchecki D. Restricted and disrupted sleep: effects on autonomic function, neuroendocrine stress systems and stress responsivity. *Sleep Med Rev*. 2008 Jun;12(3):197–210.
20. Irwin M, Thompson J, Miller C, Gillin JC, Ziegler M. Effects of sleep and sleep deprivation on catecholamine and interleukin-2 levels in humans: clinical implications. *J Clin Endocrinol Metab*.

1999 Jun;84(6):1979–85.

21. Yoo S, Gujar N, Hu P, Jolesz F, Walker M. The human emotional brain without sleep — a prefrontal amygdala disconnect. *Current Biology*. 2007;
22. Meerlo P, Havekes R, Steiger A. Chronically restricted or disrupted sleep as a causal factor in the development of depression. *Curr Top Behav Neurosci*. 2015;25:459–81.
23. Finan PH, Quartana PJ, Smith MT. The Effects of Sleep Continuity Disruption on Positive Mood and Sleep Architecture in Healthy Adults. *Sleep*. 2015 Nov 1;38(11):1735–42.
24. Lim J, Dinges DF. A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. *Psychol Bull*. 2010 May;136(3):375–89.
25. Thomas M, Sing H, Belenky G, Holcomb H, Mayberg H, Dannals R, et al. Neural basis of alertness and cognitive performance impairments during sleepiness. I. Effects of 24 h of sleep deprivation on waking human regional brain activity. *Journal of sleep research*. 2000;
26. Alhola P, Polo-Kantola P. Sleep deprivation: Impact on cognitive performance. *Neuropsychiatr Dis Treat*. 2007 Oct;3(5):553–67.
27. Feeley CA, Turner-Henson A, Christian BJ, Avis KT, Heaton K, Lozano D, et al. Sleep quality, stress, caregiver burden, and quality of life in maternal caregivers of young children with bronchopulmonary dysplasia. *J Pediatr Nurs*. 2014 Feb;29(1):29–38.
28. Luntamo T, Sourander A, Rihko M, Aromaa M, Helenius H, Koskelainen M, et al. Psychosocial determinants of headache, abdominal pain, and sleep problems in a community sample of Finnish adolescents. *Eur Child Adolesc Psychiatry*. 2012 Jun;21(6):301–13.
29. Reyner LA, Horne JA. Sleep restriction and serving accuracy in performance tennis players, and effects of caffeine. *Physiol Behav*. 2013 Aug 15;120:93–6.
30. Azboy O, Kaygisiz Z. Effects of sleep deprivation on cardiorespiratory functions of the runners and volleyball players during rest and exercise. *Acta Physiol Hung*. 2009 Mar;96(1):29–36.
31. Skein M, Duffield R, Edge J, Short MJ, Mündel T. Intermittent-sprint performance and muscle glycogen after 30 h of sleep deprivation. *Med Sci Sports Exerc*. 2011 Jul;43(7):1301–11.
32. Moradi A, Nazari SSH, Rahmani K. Sleepiness and the risk of road traffic accidents: A systematic review and meta-analysis of previous studies. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2019 Aug 1;65:620–9.
33. Williamson A, Feyer A. Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occup Environ Med*. 2000 Oct;57(10):649–55.
34. Bioulac S, Micoulaud-Franchi J-A, Arnaud M, Sagaspe P, Moore N, Salvo F, et al. Risk of Motor Vehicle Accidents Related to Sleepiness at the Wheel: A Systematic Review and Meta-Analysis. *Sleep* [Internet]. 2017 Oct 1 [cited 2021 Mar 20];40(zsx134). Available from: <https://doi.org/10.1093/sleep/zsx134>
35. Itani O, Jike M, Watanabe N, Kaneita Y. Short sleep duration and health outcomes: a systematic review, meta-analysis, and meta-regression. *Sleep Med*. 2017 Apr;32:246–56.
36. Tasali E, Leproult R, Ehrmann DA, Van Cauter E. Slow-wave sleep and the risk of type 2 diabetes in humans. *Proc Natl Acad Sci U S A*. 2008 Jan 22;105(3):1044–9.
37. Meng L, Zheng Y, Hui R. The relationship of sleep duration and insomnia to risk of hypertension incidence: a meta-analysis of prospective cohort studies. *Hypertens Res*. 2013 Nov;36(11):985–95.
38. Rod NH, Vahtera J, Westerlund H, Kivimäki M, Zins M, Goldberg M, et al. Sleep disturbances and cause-specific mortality: Results from the GAZEL cohort study. *Am J Epidemiol*. 2011 Feb 1;173(3):300–9.
39. Phillips B, Mannino DM. Do insomnia complaints cause hypertension or cardiovascular disease? *J Clin Sleep Med*. 2007 Aug 15;3(5):489–94.
40. Meisinger C, Heier M, Löwel H, Schneider A, Döring A. Sleep duration and sleep complaints and

- risk of myocardial infarction in middle-aged men and women from the general population: the MONICA/KORA Augsburg cohort study. *Sleep*. 2007 Sep;30(9):1121–7.
41. Lauderdale DS, Knutson KL, Rathouz PJ, Yan LL, Hulley SB, Liu K. Cross-sectional and longitudinal associations between objectively measured sleep duration and body mass index: the CARDIA Sleep Study. *Am J Epidemiol*. 2009 Oct 1;170(7):805–13.
 42. Suwazono Y, Dochi M, Sakata K, Okubo Y, Oishi M, Tanaka K, et al. A longitudinal study on the effect of shift work on weight gain in male Japanese workers. *Obesity (Silver Spring)*. 2008 Aug;16(8):1887–93.
 43. Narang I, Manlhiot C, Davies-Shaw J, Gibson D, Chahal N, Stearne K, et al. Sleep disturbance and cardiovascular risk in adolescents. *CMAJ*. 2012 Nov 20;184(17):E913–920.
 44. Bubu OM, Brannick M, Mortimer J, Umasabor-Bubu O, Sebastião YV, Wen Y, et al. Sleep, Cognitive impairment, and Alzheimer’s disease: A Systematic Review and Meta-Analysis. *Sleep* [Internet]. 2017 Jan 1 [cited 2021 Mar 20];40(zsw032). Available from: <https://doi.org/10.1093/sleep/zsw032>
 45. Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, et al. Night-shift work and risk of colorectal cancer in the nurses’ health study. *J Natl Cancer Inst*. 2003 Jun 4;95(11):825–8.
 46. Ali T, Choe J, Awab A, Wagener TL, Orr WC. Sleep, immunity and inflammation in gastrointestinal disorders. *World J Gastroenterol*. 2013 Dec 28;19(48):9231–9.
 47. Tkachenko O, Olson EA, Weber M, Preer LA, Gogel H, Killgore WDS. Sleep difficulties are associated with increased symptoms of psychopathology. *Exp Brain Res*. 2014 May;232(5):1567–74.
 48. Bernert RA, Hom MA, Iwata NG, Joiner TE. Objectively Assessed Sleep Variability as an Acute Warning Sign of Suicidal Ideation in a Longitudinal Evaluation of Young Adults at High Suicide Risk. *J Clin Psychiatry*. 2017 Jun;78(6):e678–87.
 49. van der Heijden KB, Vermeulen MCM, Donjacour CEHM, Gordijn MCM, Hamburger HL, Meijer AM, et al. Chronic sleep reduction is associated with academic achievement and study concentration in higher education students. *J Sleep Res*. 2018 Apr;27(2):165–74.
 50. Maheshwari G, Shaukat F. Impact of Poor Sleep Quality on the Academic Performance of Medical Students. *Cureus* [Internet]. 2019 Apr 1 [cited 2021 Mar 20];11(4). Available from: <https://www.cureus.com/articles/19016-impact-of-poor-sleep-quality-on-the-academic-performance-of-medical-students>
 51. Jacques CHM, Lynch JC, Samkoff JS. The effects of sleep loss on cognitive performance of resident physicians. *Journal of Family Practice*. 1990 Feb 1;30(2):223–30.
 52. Philibert I. Sleep Loss and Performance in Residents and Nonphysicians: A Meta-Analytic Examination. *Sleep*. 2005 Nov 1;28(11):1392–402.
 53. Taffinder NJ, McManus IC, Gul Y, Russell RCG, Darzi A. Effect of sleep deprivation on surgeons’ dexterity on laparoscopy simulator. *The Lancet*. 1998 Oct 10;352(9135):1191.
 54. Leff DR, Aggarwal R, Rana M, Nakhjavani B, Purkayastha S, Khullar V, et al. Laparoscopic Skills Suffer on The First Shift of Sequential Night Shifts: Program Directors Beware and Residents Prepare. *Annals of Surgery*. 2008 Mar;247(3):530–9.
 55. Grantcharov TP, Bardram L, Peter F-J, Rosenberg J. Laparoscopic performance after one night on call in a surgical department: prospective study. *BMJ*. 2001 Nov 24;323(7323):1222–3.
 56. Eastridge BJ, Hamilton EC, O’Keefe GE, Rege RV, Valentine RJ, Jones DJ, et al. Effect of sleep deprivation on the performance of simulated laparoscopic surgical skill. *The American Journal of Surgery*. 2003 Aug 1;186(2):169–74.
 57. Tsafrir Z, Korianski J, Almog B, Many A, Wiesel O, Levin I. Effects of Fatigue on Residents’ Performance in Laparoscopy. *Journal of the American College of Surgeons*. 2015 Aug

- 1;221(2):564-570.e3.
58. Smith-Coggins R, Rosekind MR, Hurd S, Buccino KR. Relationship of day versus night sleep to physician performance and mood. *Ann Emerg Med*. 1994 Nov;24(5):928–34.
59. Hawkins MR, And Others. Sleep and Nutritional Deprivation and Performance of House Officers. *Journal of Medical Education*. 1985;60(7):530–5.
60. Friedman RC, Bigger JT, Kornfeld DS. The Intern and Sleep Loss. *New England Journal of Medicine*. 1971 Jul 22;285(4):201–3.
61. Groopman LC. Medical internship as moral education: an essay on the system of training physicians. *Cult Med Psychiatry*. 1987 Jun;11(2):207–27.
62. Mizrahi T. *Getting Rid of Patients: Contradictions in the Socialization of Physicians*. Rutgers University Press; 1986. 240 p.
63. Landrigan CP, Rothschild JM, Cronin JW, Kaushal R, Burdick E, Katz JT, et al. Effect of Reducing Interns' Work Hours on Serious Medical Errors in Intensive Care Units. *New England Journal of Medicine*. 2004 Oct 28;351(18):1838–48.
64. Kowalenko null, Kowalenko null, Gryzbowski null, Rabinovich null. Emergency medicine resident related auto accidents-Is sleep deprivation a risk factor? *Acad Emerg Med*. 2000 Oct;7(10):1171.
65. Medicine I of, Safety C on OGMT (Resident) H and WS to IP. *Resident Duty Hours: Enhancing Sleep, Supervision, and Safety*. National Academies Press; 2009. 427 p.
66. Ayas NT, Barger LK, Cade BE, Hashimoto DM, Rosner B, Cronin JW, et al. Extended Work Duration and the Risk of Self-reported Percutaneous Injuries in Interns. *JAMA*. 2006 Sep 6;296(9):1055.
67. Parks DK, Yetman RJ, McNeese MC, Burau K, Smolensky MH. Day-Night Pattern in Accidental Exposures to Blood-Borne Pathogens Among Medical Students and Residents. *Chronobiology International*. 2000 Jan 1;17(1):61–70.
68. Berkoff K, Rusin W. Pediatric house staff's psychological response to call duty. *J Dev Behav Pediatr*. 1991 Feb;12(1):6–10.
69. Kancherla BS, Upender R, Collen JF, Rishi MA, Sullivan SS, Ahmed O, et al. What is the role of sleep in physician burnout? *J Clin Sleep Med*. 2020 May 15;16(5):807–10.
70. Wolf MR, Rosenstock JB. Inadequate Sleep and Exercise Associated with Burnout and Depression Among Medical Students. *Acad Psychiatry*. 2017 Apr;41(2):174–9.
71. Trockel MT, Menon NK, Rowe SG, Stewart MT, Smith R, Lu M, et al. Assessment of Physician Sleep and Wellness, Burnout, and Clinically Significant Medical Errors. *JAMA Network Open*. 2020 Dec 7;3(12):e2028111–e2028111.
72. Arora VM. Improving Sleep Hygiene of Medical InternsCan the Sleep, Alertness, and Fatigue Education in Residency Program Help? *Arch Intern Med*. 2007 Sep 10;167(16):173
73. Shea JA, Dinges DF, Small DS, Basner M, Zhu J, Norton L, et al. A randomized trial of a three-hour protected nap period in a medicine training program: sleep, alertness, and patient outcomes. *Acad Med*. 2014 Mar;89(3):452–9.
74. Macleans. No more 24-hour shifts for Quebec residents [Internet]. 2011. [cited 2021 Mar 24]. Available from: <https://www.macleans.ca/education/uniandcollege/no-more-24-hour-shifts-for-quebec-medical-students/>
75. Wong K, Jin S, Ronciere L, Sarkis B, Cohen A, Major S. *Workload Policies across Canadian Medical Schools*. Canadian Federation of Medical Students 2019.
76. Redeker NS, Caruso CC, Hashmi SD, Mullington JM, Grandner M, Morgenthaler TI. Workplace Interventions to Promote Sleep Health and an Alert, Healthy Workforce. *J Clin Sleep Med*. 2019

Apr 15;15(4):649–57.

77. Lambert TW, Smith F, Goldacre MJ. The impact of the European Working Time Directive 10 years on: views of the UK medical graduates of 2002 surveyed in 2013-2014. *JRSM Open*. 2016 Mar;7(3):2054270416632703.
78. Maisonneuve JJ, Lambert TW, Goldacre MJ. UK doctors' views on the implementation of the European Working Time Directive as applied to medical practice: a quantitative analysis. *BMJ Open*. 2014 Feb 6;4(2):e004391.