XXIV International Symposium on Shiftwork & Working Time - Shiftwork2019

Keynotes

When Can You Start Trusting an Awakening Brain?

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The awakening period is often characterized by grogginess and impaired performance. These effects, referred to as *sleep inertia*, have been reported to last everything from a few minutes up up to several hours. It is at present a poor understanding of how fast one can expect an awakening person to make swift and accurate decisions. The presentation will focus of how fast the brain wakes up, and factors affecting the awakening process. The audience can expet a review of the literature, and to see data from a series of recent experimental and field studies that have determined how different cognitive functions return to normal in abrubtly awakened individauls. The results are important since on-call duty is common in the modern society, and staff is often expected to make safety critical decisions immediately upon awakening.

Health and Safety Risks Related to Specific Characteristics of Shift Work Scheduling

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It is well documented that shift work particularly when including night shifts is associated with shorter and disturbed sleep, increased fatigue, poorer work performance, and higher work-life interference. Furthermore, many studies suggest that shift workers have increased risk of cardiovascular disease, breast and prostate cancer, diabetes, and gastrointestinal disorders, although the causal relationship between night work and adverse health outcomes remains to be established. Night work can be organised in many ways e.g. as part of a rotating or permanent schedule, few or many consecutive night shifts (speed of rotation) and short or long time between shifts. The choices have consequences

for health and safety risk, but what is known about the risk associated with the different characteristics? E.g. how does number of consecutive night shift affect circadian rhythms of melatonin, cortisol and testosterone? What is the association between time between shifts and risk of injuries? And how does specific characteristics of shift work scheduling affect pregnant women? That is the focus of this presentation, where results from large epidemiological as well as mechanistic studies on health and safety risks associated with specific shift work schedule characteristics will be presented. The knowledge will be linked to current theories about possible mechanisms such as light at night (melatonin), sleep and fatigue, and circadian disruption. The motivation is increase the knowledge about shift work and health and safety and if the association is causal, and also to provide knowledge on how to reduce health and safety risks in relation to shift work. This knowledge may be used occupational health and safety professionals, employers and employees to make an optimal organization of night work, as well as in the authorities risk assessment of various forms of shift work schedules.

Symposia

Costs and Consequences of 12-Hour Shifts in Nursing: Perspectives from England's National Health Service

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Introduction: The introduction of long shifts (i.e. shifts of 12 hours or more) in nursing was based on presumed efficiency savings, predicated on the assumption that the reduction in overlaps removes unproductive time which does not "add value" to the delivery of care. However, the move to long shifts remains controversial, and this symposium aims to report the effect of long shifts on indicators of nurse fatigue through the presentation of a collection of the author's studies. **Methods:** Studies used different methodologies, ranging from a cross-sectional multi-country survey to longitudinal studies using routinely collected data within a single hospital in England. **Results:** There is insufficient evidence to conclusively say that 12-hour shifts are safe and lead to more productivity. Large multi-site multi-country surveys report that working 12-hour shifts is associated with decreased quality of care, patient safety, job satisfaction, educational opportunities for nurses; and increased burnout and intention to leave. Studies using objective measures of shift work and fatigue outcomes found that long shifts are associated with increased sickness absence for the nursing workforce, and with increased staffing costs. **Discussion:** Long shifts have been associated with higher levels of fatigue, suggesting that fatigue may play a mediating role between long shifts and adverse outcomes for nurses and patients. In the current context of austerity, it is essential for healthcare organisations to have good evidence on which to base decisions on hospital nurse work hours, to ensure that staff wellbeing and quality of care are maintained, and nurses are retained in practice. The move to long shifts based on a more cost-effective resource use should be questioned; our findings suggest that savings are not achieved. Increases in resource use could result in additional costs or loss of productivity for hospitals, especially when taking into account the costs of nurses' sickness absence.

Shift-work, Diurnal Preference, Sleep and Parkinson's Disease

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Introduction: Parkinson's disease (PD) is the second most common neurodegenerative movement disorder with a tendency of increasing incidence. Sleep problems is a common nonmotor part of the disease. Further, it has been suggested that lack of sleep earlier in life may be a risk factor for PD. Further, night shift work has been proposed as associated with PD. The aim of this study is exploring interactions between sleep pattern before disease, night shift work and diurnal preference in relation to PD. **Methods**: We conducted a nested case control study of 1,808 Danish cases idiopathic PD cases and 1,876 randomly selected age and sex matched controls. Information on demographics, use of medication, lifestyle habits and life-long work history, including night shift work, sleep patterns before and after diagnosis and diurnal preferences was obtained by structured questionnaires and telephone interviews. **Results:** Overall, no associations between night shiftwork and PD was observed. Low duration of sleep was associated with increased risk of PD. No differences in risks were observed in relation to diurnal preference. **Discussion:** Short sleep duration may be associated with increased risk of PD. Differential recall bias, however, cannot be excluded. Prospective studies of PD and sleep are warranted.

Eating, Sleeping, and Working in Different Environments: Does it Make a Difference?

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Introduction: Increasing industrialization and urbanization are processes of global scale bringing changes in social life, work hours, and life style that can affect health, as well as quality of life. New trends on work hours are happening rapidly without proper planning. It includes not only night work, but also flexible working time arrangements, early morning starts, weekend work, remote work, among others. Exposure factors as natural and artificial light, and environmental temperature might vary according to work hours leading to changes on eating and sleeping timing. Here I will present a field study conducted in four places with different levels of urbanization (rural; town; city-dayworkers; city-night workers) to investigate eating behavior and its association with sleep and work hours. **Methods:** Food consumption was determined using three 24-hour food recalls. Eating duration was calculated considering the period from the first caloric intake after wake-up to the last caloric intake before sleep onset, which has been calculated by actigraphy and sleep logs. **Results:** 24-hour food recalls revealed that fat intake varied according to the study groups, with highest consumption by the city-day workers. By contrast, the city-day workers had the lowest intake of carbohydrate, whereas the rural group had the highest. Surprisingly, eating duration was negatively correlated with total energy intake, fat and protein consumption in the rural and town groups. There was a positive correlation, however, between body mass index and eating duration in both city groups. The rural group had the earliest start time of eating, where this was associated with lower body mass index. **Discussion:** This study revealed that food content and timing, as well as eating duration, differed according to different levels of urbanization. Timing of eating appears to be more relevant for body mass index than eating duration.

A Mathematical Framework for Understanding Sleep Disturbances in a Rodent Model of Shift Work

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Introduction: Millions of people worldwide are required to work when their physiology is tuned for sleep. By forcing wakefulness out of the body's normal schedule, shift workers face numerous health challenges, including gastrointestinal problems, sleep problems, and higher rates of some diseases, including cancers. Recent studies have developed protocols to simulate shift work in rodents. These rodent shift work models have been used to assess the effects of nightshift work on subsequent sleep and understand the metabolic consequences of shift work. However, our understanding of the circuit level neurobiological mechanisms underlying night-shift-related sleep disturbances is still limited. **Methods:** In order to advance toward a mechanistic understanding of sleep disruption in shift work, we developed a simple and novel mathematical model of rodent sleep and used it to investigate the timing of sleep in a 4-day simulated shift work protocol. This mathematical framework includes the circadian and homeostatic processes of the two-process model, but additionally incorporates a stochastic process, (a modified Markov decision process) to model the polyphasic nature of rodent sleep. **Results:** By changing only the time at which the rodents are forced to be awake, the model reproduces some key experimental results, including correct proportions of time spent in each stage of sleep as a function of circadian time and the differences in total wake time and SWS bout durations in the rodents representing night-shift workers and those representing day-shift workers. **Discussion:** The model allows for deeper insight into circadian and homeostatic influences on sleep timing, as it demonstrates that the differences in SWS bout duration between rodents in the two shifts is largely a circadian effect. Our study shows the importance of mathematical modeling in uncovering mechanisms behind shift work sleep disturbances and it begins to lay a foundation for future mathematical modeling of sleep in rodents.

Transportation Safety Board of Canada (TSB) Fatigue Investigation Methodology and Recent Recommendations

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Introduction: Fatigue can impair human performance in ways that can lead to accidents. As many transportation industries operate around the clock, fatigue and its effects cannot be eliminated completely; however, they must be managed. A first step is to document the prevalence and role of fatigue in accidents that occur. The TSB routinely investigates if fatigue was present in an occurrence, if it played a role, and if the operator had practices in place to manage the associated risks effectively. **TSB's fatigue investigation methodology:** Investigators consider 6 risk factors to determine whether fatigue existed in an occurrence (test of existence): sleep disruptions (acute and chronic), continuous wakefulness, circadian effects, sleep disorders, and individual factors, such as illness, drugs or medication, and characteristics, such as one's capacity to nap. To determine whether fatigue played a role in an occurrence (test of *influence*), investigators compare performance (in terms of information processing, decision-making, attention, mood, and reaction time) to known, scientifically proven, effects of fatigue, and to other potential contributing factors. To determine whether an operator or organization involved in an occurrence is able to manage the risks of fatigue effectively, company policies and practices are investigated. A company that adopts a proactive approach to fatigue management that includes, as a minimum, compliance with regulations and an education program to help employees identify fatigue, and that takes proactive, preventative measures, will be more likely to successfully mitigate the risk of fatigue than one that does not. **Results:** between 1990 and 2018, fatigue 93 TSB investigations (31 in the railway industry, 28 in the marine sector, and 34 in aviation) cited fatigue as a causal or contributing factor, or as a source of risk. Therefore, the issue of fatigue management in rail, marine and air transportation is on the TSB's 2018 Watchlist of key safety issues.

Shiftwork and Prescription Medication Use

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Introduction: We examined prospective associations between specific types of shiftwork schedule and purchases of prescription medication for depression, hypertension, type 2 diabetes, dyslipidemia and sleep disorders. **Methods:** Data from two national multi-occupation surveys (Swedish Longitudinal Occupational Survey of Health - SLOSH, N=8643; and two cohorts of the Finnish Public Sector Study - FPSS, N=42846 and 24046) were linked to register data on medication purchases. In SLOSH, we examined associations between 8 categories of work schedule and purchase of anti-depressants, with 2 years of follow-up. In FPSS, we examined associations between 3 categories of work schedule and purchase of medications for hypertension, type 2 diabetes, dyslipidemia and sleep disorders, with up to 11 years of follow-up. **Results:** In SLOSH, among females, flexible/non-regulated schedules predicted greater antidepressant use (adjusted OR=2.01, 95% CI=1.08-3.76). There were no associations with shiftwork (with or without nightwork). In the larger FPSS cohort, among participants aged 40-49, shiftwork without nightshifts predicted greater use of type 2 diabetes medication (adjusted HR 1.28, 95% CI = 1.01-1.62), while shiftwork with nightshifts predicted greater use of dyslipidemia medication (adjusted HR 1.33, 95% CI = 1.12-1.57). There were no such associations among younger and older shiftworkers. Among participants aged <50, both types of shiftwork predicted greater use of hypertension medication (adjusted HRs up to 1.20, 95% CI = 1.05-1.37). Shiftwork predicted greater use of sleep medication (with nightwork, all age groups, adjusted HR up to 1.42, 95% CI = 1.18-1.73; without nightwork, ≥50 years, adjusted HR 1.17, 95% CI = 1.01-1.36). In the smaller FPSS cohort, the only positive associations were between shiftwork with nightwork and sleep medication use (≥40 years, adjusted HRs up to 1.21, 95% CI = 1.02-1.44). **Conclusions:** Evidence that work schedules predict medication use is mixed, likely reflecting issues around individual differences, selection, disease mechanisms and statistical power.

Oral Presentations

The Relationships between Coping Styles and Food Intake in Shiftworking Nurses and Midwives

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Introduction: Shiftwork presents several challenges such as insufficient and poor sleep quality, emotion regulation concerns, and increased stress. Shiftworkers adopt different methods of coping to deal with these challenges. Engaged coping styles such as problem solving and cognitive restructuring are suggested to be more effective than disengaged coping styles such as wishful thinking and withdrawal. Further, shiftworkers typically have an unhealthier diet than the general population and are more likely to suffer from gastrointestinal discomfort and disease. However, the relationships between coping styles and food intake have not been widely researched in shiftworking populations. This study aimed to investigate the relationship between coping style and food consumption in shiftworkers. **Methods:** The Standard Shiftwork Index and Food Frequency Questionnaire were completed by South Australian hospital nurses and midwives working forward rotating shifts (N=27, female=24, age=38.4±13.1 y). **Results:** Average engaged coping score was 45.0 (±11.2), while average disengaged coping score was 35.3 (±12.5), with higher scores indicating greater use of these strategies. Average daily consumption of saturated fat was 25.2g (±8.8), carbohydrate was 146.7g (±54.0), sugars was 67.6g (±30.8), and sodium was 1954.1mg (±753.3). Higher engaged coping was associated with lower daily saturated fat (rho=-.299), carbohydrate (rho=-.131), and sugar (rho=.202) consumption, and higher daily sodium (rho=.065) consumption. Higher disengaged coping was associated with higher daily saturated fat (rho=.192), carbohydrate (rho=.297), sugar (rho=.207), and sodium (rho=.379) consumption. **Discussion:** Daily consumption of saturated fat, sugar, and sodium were higher than recommended intakes (20g, 25g, and 460mg, respectively). The use of different coping strategies has previously been shown to impact several aspects of life, including stress management and relationships. This study shows that more purposeful and engaged coping strategies may contribute to healthier dietary choices. A greater focus on coping styles in the workplace may contribute to improving the health of shiftworkers.

Working Time Variability and Flexibility in Europe Revisited: A Typological Approach

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Introduction: Working time variability is a double edged sword. If it is an outcome of the employees' possibility to arrange their working time to fit to their personal demands and private life, variability in terms of employee oriented flexibility serves as a resource. However, if working time is determined by market requirements or the employer, working times become unpredictable and variability might be stressful since it collides with personal demands. In order to give an overview about different regimes of working time variability in Europe, a typological approach is used to describe two aspects, employer- and employee-oriented determination, as well as the variability of working times. **Methods:** Based on the data of the European Working Conditions Survey 2015 (EWCS, n = 28'749), four clusters of employees are compared: Those with low variability and employer-driven respectively employee-driven working time arrangements as well as those with high variability and employer-driven respectively employee-driven working time arrangements. The analysis aims to assess differences across Europe and different groups of employees. Outcomes for health-related aspects and work-life balance are focused in a multilevel analysis controlling for socio-demographic and job characteristics. **Results:** Working time variability differs between European countries. In the Northern countries, high working time variability determined by the employees is most prevalent, whereas in the other countries low variability and working times set by the employers are widely spread. The multilevel analyses suggest that high working time variability is consistently associated with adverse health outcomes, lower well-being (e.g., number of health symptoms, sleep quality, general health status) as well as more work-family conflicts. However, when employees determine working time variability, the negative relationship is slightly lower as

compared to employees with working times determined by the employer. **Discussion:** The analysis supports the two-sided view on variability and flexibility. In general, variable working times are related to adverse health aspects. However, the negative aspects may be cushioned by the employee's autonomy to determine this flexibility.

A Randomized Trial on the Effects of Standard and Flexible Duty-Hour Rules on Intern Sleep and Alertness

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Introduction: Duty hour regulations affect resident sleep, education, and patient care in complex ways. We performed a national cluster-randomized trial (iCOMPARE) in 63 internal medicine residency programs comparing the effects of the 2011 duty-hour standards to a more flexible set of duty hour rules characterized by maintaining an 80-hour workweek but without limits on shift length or mandatory time off between shifts, relative to patient mortality, intern educational outcomes, and intern sleep and alertness. **Methods:** In the sleep and alertness sub-study, sleep duration and morning sleepiness and alertness were assessed with actigraphy, the Karolinska Sleepiness Scale, and a 3-minute Psychomotor Vigilance Test (PVT-B) for 14 days in 193 interns from 6 standard programs and 205 interns from 6 flexible programs. **Results:** During the 14-day study periods, interns in standard and flexible programs averaged 7.03h sleep/24h (95% confidence interval [CI] 6.78h, 7.27h) and 6.85h sleep/24h (95% CI 6.61h, 7.10h), respectively. Sleep duration (difference between arms of -0.17h/24h; 1-sided lower 95% confidence limit -0.45h; NIM -0.5h; $p=0.02$ for noninferiority) and KSS sleepiness (difference 0.12 points; 1-sided upper 95% confidence limit 0.31 points; NIM 1 point; $p<0.001$) were noninferior in flexible versus standard programs. We could not establish noninferiority for PVT-B alertness (difference -0.3 lapses; 1-sided upper 95% confidence limit 1.6 lapses; NIM 1 lapse; $p=0.10$). Based on analyses by shift type, sleep duration was 1.77h shorter on days when interns in flexible programs finished an overnight shift relative to a regular day shift ($p<.001$), with significant decreases in subjective and objective alertness, and frequent reports of excessive sleepiness, especially between 12am and 6am. **Conclusion:** There were no signs of relevant chronic sleep loss across shifts in interns in flexible programs relative to their standard program counterparts. Interns were able to compensate for the sleep lost during extended overnight shifts by increasing sleep duration on nights prior to day shifts, night shifts, and days off. Increased sleepiness and reduced alertness of interns following extended overnight shifts need to be mitigated and suggest a role for fatigue-risk management programs.

Health and Work-Life Balance across Types of Work Schedules: A Latent Class Analysis

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Introduction: Duration and timing of work play an important role for employees' wellbeing. Drawing on the demand-control model (Karasek, 1979), this study aims at exploring how shift work, weekend work, overtime, overlong working hours, changes in working time, control over begin and end of workday, and control over taking hours off can be classified into distinct types of work schedules and how these types are differentially associated with health and work-life balance. **Methods:** Data of 13,540 full-time employees from the BAuA-Working Time Survey 2015 - a representative survey of the German working population - was included in the present study. Distinct types of work schedules were extracted by means of latent class analysis. Relationships with satisfaction with work-life balance and subjective health status were examined using ANOVAS and Wald-tests. **Results:** Analyses pointed towards a 6-class-solution (flexible extended, extended shift, rigid standard, flexible standard, rigid all-week, and rigid extended). Classes characterized by high working time demands and low work time control (extended shift, rigid extended, rigid all-week) showed the strongest impairments of health and satisfaction with work-life balance. **Discussion:** This classification approach based on a representative sample may help researchers and practitioners evaluate work schedules with regard to their effects on health and work-life balance. Thereby, this study allows the identification of risk groups concerning work schedules, namely the extended shift, rigid extended and rigid all-week schedule. A limitation of this study is the use of cross-sectional self-report measures with data collected exclusively among full-time employees in Germany.

Disseminating Policy Recommendations to Reduce Fatigue in Nurses

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Introduction: Society needs critical nursing services around the clock, which leads nurses to have shift work schedules and long hours. These work hours are associated with circadian rhythm disruption and sleep deficiency, which in turn are associated with health and safety risks to the nurse and safety risks to the public. Nurses and health care managers may not fully understand these risks and the available evidence-based strategies to reduce these risks. Evidence shows that it is possible to limit or modify the adverse impact of shift work and long hours by improving sleep, correcting disturbances to circadian rhythms, and reducing fatigue. Strategic dissemination of this information to the nursing community and health care leaders is needed. **Methods:** To promote knowledge of this workplace hazard across the nursing community, the authors are leveraging the American Academy of Nursing dissemination channels. The Academy's 2500 members consist of nursing's most respected and accomplished leaders in education, practice, and research from the United States and other countries. Strategies include an Academy position statement and policy brief published in Nursing Outlook, the official journal of the Academy. **Results:** In the November-December 2017 issue of *Nursing Outlook*, the authors published the Academy's first position statement on nurse fatigue titled, *Reducing fatigue associated with sleep deficiency and work hours in nurses.* As of March 2019, ten journal articles and at least three organizations' websites have cited it. The authors have drafted a policy brief, which succinctly argues the importance of addressing nurse fatigue. It recommends policies that health care service and standard-setting organizations could implement to reduce the health and safety risks of fatigue in nurses and thereby promote nurses' health and safety along with public safety. **Discussion:** Targeted dissemination strategies can promote better uptake of scientific findings by the nursing community and health care leaders.

Risk-Taking and Circadian Misalignment in Night Shift Workers

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Introduction: Circadian misalignment is of particular concern for shift workers as it impacts cognitive performance, such as decision making and risk-taking. Research in non-shift workers have demonstrated that sleep loss can lead to increased appetitive and risk-taking behaviors; however, fewer studies have examined this in night shift workers despite the high prevalence of excessive sleepiness and sleep disruption. This study examined the relationship between risk-taking behavior and circadian misalignment in a sample of permanent night shift workers. **Methods:** Thirty permanent night shift workers participated in a larger study examining the health consequences of circadian misalignment. Circadian phase was evaluated using dim-light salivary melatonin onset (DLMO). Risk-taking behavior was evaluated using a computerized Stop-Light paradigm, which was completed at 7am. This paradigm mimics the context of a traffic light, where a go/no-go decision must be made at onset of the yellow light. Successful go trials were rewarded with 25 points, and a percentage of unsuccessful trials were punished with loss of 25 points. **Results:** Results revealed that workers

with greater circadian misalignment earned less total points (r=.46, *p*<.05). While participants were more conservative on higher risk trials, this effect was not moderated by degree of circadian misalignment. However, risk-taking behavior did decrease with sleepiness prior to the task (r=-.51, *p*<.01), perhaps due to increased risk aversion or decreased appetitive drive. Finally, workers with better circadian alignment achieved higher success rates on go trials (r=.42, *p*<.05), suggesting that circadian alignment is associated with improved ability for decision making in the context of risk. **Discussion:** Results indicate that greater circadian alignment in shift work may be associated with improved performance in decisions involving risk. This offers further insight into the cognitive vulnerabilities related to circadian misalignment that may impact risk for errors, accidents, and injuries in night shift workers.

Teaching Strategies for Sleep and Recuperation to New Nurses Who are Starting Shiftwork: Can it Mitigate Fatigue and Ill-health? Results From a Randomized Controlled Trial

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Introduction: Entering working life as a newly graduated nurse is stressful and for many it is an introduction to shiftwork. This study examines whether an intervention targeting strategies for sleep and recuperation in relation to work related stress and shiftwork could prevent development of symptoms of burnout, insomnia and ill-health. **Methods:** 209 newly graduated nurses were recruited at five Swedish hospitals and randomly assigned into experiment (intervention) and control groups. The intervention involved attending group education on strategies for sleep and recuperation, based on cognitive behavioural therapy techniques for sleep but modified for shiftworkers (three 2.5h sessions). Participants completed a questionnaire at baseline, one- and six months after the intervention, comprising the Shirom Melamed Burnout Questionnaire (SMBQ), Insomnia Severity Index (ISI), Somatic Symptom Scale-8 (SSS8) and the Work Home Interference scale (WHI). After dropouts the experiment and control groups consisted of 82 and 110 nurses respectively, at baseline. Group by time interactions were examined in multilevel analyses. **Results:** There was a group

by time interaction in SMBQ global scores and in the SMBQ indexes of listlessness, physical fatigue and cognitive weariness, but not tension. Symptom levels were similar in both groups at baseline, becoming lower in the experiment group relative to the control group at first follow-up, then returning to approximate parity at six months follow-up. Similar patterns were found for WHI. There was a group by time interaction in the SSS8 ratings, with the control group reporting more symptoms at baseline, then approaching the intervention group's levels at the last follow-up. ISI showed no interaction. **Discussion:** Supporting nurses' strategies for sleep and recuperation when starting shiftwork may be more beneficial for preventing development of burnout symptoms and achieving a full work-life balance than for health or sleep problems. Such interventions may need to be followed up with booster sessions.

Sleep Quantity and Quality, PVT-B Performance, and Subjective Sleepiness, Fatigue, and Stress in Commercial Motor Vehicle (CMV) Drivers: On-Duty Days vs. Restart (Off-Duty) Days

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Introduction: A US congressionally-mandated naturalistic study of CMV drivers was conducted to evaluate operational, safety, fatigue, and health impacts of US restart provisions in Sections 395.3(c) & 395.3(d) of Title 49, Code of Federal Regulations. **Methods:** N=235 CMV drivers (95% male, 20-69y) from diverse trucking operations participated in an observational study, contributed data for up to 5 months while working their normal schedules. N=181 (77%) completed 5 months of study. At recruitment they reported driving "mostly in daytime" (10.2%), "mostly at night" (14.9%), or "both day and night" (74.9%). They wore electronic logging devices to track (1) driving/working hours; (2) safety-critical events (i.e., crashes, near-crashes); (3) sleep-wake times; and (4) their subjective fatigue, sleepiness, stress, sleep quality, caffeine intake, and PVT-B performance. The N=26,964 days of data acquired included 17,628 duty days, 9,336 restart days; 3,287 restarts (N=426 1-night restarts; N=1,577 2-night restarts; N=1,284 >2-night restarts); and N=1,482 restarts <168 hours; N=1,592 restarts ≥168 hours). Statistical analyses included linear and non-linear mixed-effects modeling to ensure results were free of selection bias. **Results:**

26,964 days of data were acquired. During on-duty days, drivers slept an average of 6.6h/day, compared to 8.7h/day during restarts (off-duty) days ($p<0.0001$). Analyses of safety-critical events revealed no differences in performance. During restart (off-duty) days versus on-duty days, drivers rated sleepiness higher ($p<0.0001$), sleep quality higher ($p<0.0001$), stress lower ($p<0.0001$), and they had slower PVT-B performance, regardless of provision used. Fatigue ratings were higher and sleep quality ratings were lower during 1-night vs. 2-night restarts. They had more PVT-B lapses during restart periods than during on-duty periods ($p<0.0001$). **Discussion:** Although there were no safety critical events, there was clear evidence that drivers were in need of extended sleep time during restarts, as they slept an average of 2h longer during restarts than when they were working.

Effects of Fatigue on Officer Performance in Deadly Force Simulations

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Introduction: Law enforcement officers are expected to function under fatigued conditions as a result of job strains and shift requirements. While in a fatigued condition, officers may be required to use deadly force. It is critical to assess officer performance in deadly force simulations to gain a better understanding of the effects of fatigue on deadly force judgement and decision making. The purpose of this study was to assess the effects of fatigue and shift work on a series of performance measures in simulated deadly force scenarios. **Methods:** Participants were experienced patrol officers recruited from a medium-sized law enforcement agency (N=80). Subjects participated in two to four separate sessions in the lab, at least one directly following the last patrol shift of the work week (fatigued condition) and at least one at the same time of day after a three day rest period (control condition). Each five-hour session included six deadly force scenarios, a variety of cognitive tasks, and multiple driving simulations. **Results:** Mixed effects analysis of variance found fatigued officers scored higher than rested officers on a series of performance metrics, $F (1, 1124) = 6.53$, $p = 0.01$. Follow up Pearson chi-square analysis and nonlinear mixed effect regression analysis showed fatigued officers to perform significantly better on several distinct measures of performance. These performance items were primarily associated with measures of the officers' immersion and engagement within the simulated deadly force scenario. **Discussion:** Fatigue appears to lower the suspension of disbelief barrier seen within simulation-based training. This would explain why our fatigued law enforcement officers outperformed rested officers on the measures of performance which are associated with immersion and engagement with the simulated scenario. A more complete understanding of the physiological differences of these officers within the simulation would provide a clearer picture of participant engagement and immersion.

The Impact of Day and Night Shifts on Sleep and Patient Care Skills in Registered Nurses

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Introduction: Around 2/3rds of all registered nurses in the US are currently working 12-hour day and night shifts. Although several studies have linked 12-hour night shifts to sleep deprivation and more errors in patient care, no study has yet to specifically quantify the effect of shift type and nurses' sleep behavior on their patient care skills. In the present study, we tested nurses in a nursing simulation laboratory and collected subjective and objective measures of their sleep from the prior week. **Methods:** 50 day shift and 50 night shift nurses working at a local hospital were tested on two separate occasions: once following a third consecutive shift, and once following a third day off work. Nurses' skills were evaluated in patient care simulation scenarios using the Creighton Competency Evaluation Instrument (C-CEI). To obtain information about their sleep, nurses provided sleep diary and actigraphy data during the week prior to each test session. **Results:** Preliminary analyses found that C-CEI scores were comparable between day and night shift nurses, $F(1,22.12) = 0.315$, $p = .58$. However, for night shift but not day shift nurses, C-CEI scores were negatively correlated with both sleep diary and actigraphy measures of awakenings during sleep in the week prior to their test session, $Fs > 6.067$, $ps < .015$. In general, night shift nurses did not have worse sleep quality than day shift nurses, $F(1,22.671) = 2.152$, $p = .156$, but they were significantly less alert on average, $F(1,10.939) = 42.382 = 42.382$, $p < .001$. **Discussion:** The results of this study provide evidence for the risks

to patient care posed by individual differences in the sleep habits of nurses. These findings could help inform the development of interventions or policies that target specific sleep behaviors in nurses on the night shift.

Characterizing the Distribution of Shift Domains by Demographics and Shift Schedule in the American Manufacturing Cohort

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Introduction: The American Manufacturing Cohort is the largest source of time-registry data on American workers available for research. In this cohort of 23,096 workers with over 23 million shifts, between 2003-2013, we describe the distribution of shift work domains relevant for circadian rhythm disruption by demographics and shift schedules. **Methods:** We defined the prevalence of shift domains using algorithms for shift type (e.g. day vs. night), shift duration (e.g. shift ≥13 hours), shift intensity (e.g. quick return (<11 hours between shifts) and consecutive work), rotational direction (forward, backward, flipped), and social aspects (e.g. weekend work). Person-years with ≥150 shifts/year were classified into shift schedules by combinations of permanent and rotating day, evening, and night. Shift domains distributions were examined by shift schedules and demographics, and were cross-classified in a matrix to examine co-occurrence. **Results:** Shifts were classified into morning (6%), day (50%), evening (16%), and night (28%). Approximately 60% of shifts may cause circadian rhythm disruption as they were non-day shifts or day shifts with a quick return, a rotation, or were 13 hours or longer. One third of quick returns were due to a backwards rotation while 42% were attributable to a long shift. Approximately 48% of person-years were non-rotating: day (32%), night (12%), evening (4%), day/evening (11%), day/night (24%), evening/night (4%) and day/evening/night (13%). Men were more likely to work rotational schedules (54.9% vs. 41.4%). White workers worked permanent day shifts most often, while racial minorities worked more day/night schedules. Older workers worked more permanent day and fewer day/

evening/night schedules. Distribution of shift domains such as quick returns, shift length, and rotations varied by schedule type.**Conclusions:** We identified variations in the joint distributions of shift domains by shift schedules, demographics, and schedule type. These shift domains are important to identify, as they may impact circadian rhythm disruption.

Modeling Injuries and Accidents Based on Selected Working Hours Characteristics - A Discussion of Open Questions and How to Deal With Them

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Introduction: Extensive research has provided accident risk estimates for different work hour characteristics, e.g. the "Updated Risk Index" (Fischer et al 2017) calculates risks based on type and length of shift, duration of the shift, etc.. However, research and the Risk Index hardly address non-standard work hours. **Methods:** In the process of designing a software tool incorporating the "Risk Index", we identified open questions in accident risk modeling. Based on theoretical assumptions, new approaches were developed and tested in their applicability: **Results:** Our suggestions for scientific discussion and empirical testing include:

- What classifies as night work can vary across studies due to countries' different legislation, etc.. We developed two components to address this question: Firstly, an hourly estimation of risks that provides a more precise estimation than a global estimation of a shift. Secondly, a unifying approach that quantifies the "nightness", "lateness", etc. of a shift based on its starting and ending times considering consequences on sleep, social interaction, etc.. This concept allows for considering the consequences of series of non-standard shifts in a row (e.g., three shifts of 70% nightness).

- How to model the effect of recovery over several work-free hours and/or days - e.g. how long does it take to recover fully after several night-shifts, how strong is the recovery after 24hours? If rest hours do not allow for complete recovery, how to estimate accumulative effects?

- How to model the effects of on-shift rest breaks (e.g., number, duration, and intervals? - How important is what workers do during their break (eating, exercise, nap)? How to include shift handover problems/effects into appropriate modelling approaches?

Discussion: Injury and accident risk modeling has come a long way, but it still needs improvement to tackle real-world working hour arrangements, especially within a frame of complex, non-standard working hours regulations.

Effects of Repeated-Dose Caffeine on Neurobehavioral Performance during 48 Hours of Total Sleep Deprivation

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Introduction: Caffeine is widely used as a countermeasure against neurobehavioral impairment during sleep deprivation, but the pharmacodynamics of repeated caffeine dosing are not well understood. To address this issue, we conducted a laboratory-based, randomized, double-blind, placebo-controlled, cross-over study using two different caffeine doses administered multiple times during 48 hours of sleep deprivation. **Methods:** Twelve healthy adults (ages 27.4 ± 6.9 y; 6 women) completed an 18-consecutive-day in-laboratory study consisting of three 48-hour total sleep deprivation periods separated by 3-day recovery periods. During each sleep deprivation period, subjects were awakened at 07:00 and caffeine gum was administered at 13:00 and 01:00 after 6, 18, 30, and 42 hours of sustained wakefulness. The caffeine dose at each time point was 0 mg (placebo), 200 mg, or 300 mg, randomized and counterbalanced across the three sleep deprivation periods. The Psychomotor Vigilance Test (PVT) and the Karolinska Sleepiness Scale (KSS) were administered every 2 hours during wakefulness. **Results:** The 200 and 300 mg doses of caffeine mitigated neurobehavioral deficits on the PVT and the KSS throughout the sleep deprivation period. Relative to placebo, PVT performance was improved nearly two-fold immediately after the gum administrations that occurred at 01:00 ($F>103.00$, $p<0.001$), but to a far lesser extent after the gum administrations at 13:00. There were no substantive differences between the 200 and 300 mg caffeine doses ($F<3.51$, $p>0.06$), and neither the 200 nor the 300 mg dose fully restored performance to baseline levels. **Discussion:** Relative to placebo, caffeine administered every 12 hours during 48 hours of total sleep deprivation mitigated neurobehavioral impairment most effectively during the nocturnal, circadian trough of alertness, although some impairment remained regardless of dose. Our results inform the development of biomathematical models of fatigue that account for the interactions between time awake, time of day, and caffeine dosing on neurobehavioral performance.

Schedule Factors Associated with the Use of Controlled Rest in a Long-Haul Airline

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Introduction: Controlled Rest (CR) refers to a short, voluntary nap opportunity taken by pilots on the flight deck as a countermeasure to unanticipated sleepiness in flight. This study explores the profile of CR use in a long-haul commercial airline. **Methods:** Forty-four pilots wore actiwatches and filled in an application-based sleep/work diary for approximately 2 weeks. After merging sleep diary, actigraphy, and schedule data, complete records were analyzed from 240 flights. Sleep was estimated during CR intervals using the Philips Actiware 6.0.9 (Bend, OR) software with wake threshold set to medium. Timing of sleep periods and flight schedules were analyzed relative to home-base time. A mixed-effects logistic regression was used to analyze the impact of schedule factors on CR. **Results:** Preliminary analyses revealed that CR was taken on 45% (n=107) of flights. Average sleep duration within these rest periods was estimated as 24.8 ± 16.1 minutes. CR was more frequent on return flights (arriving at home-base; 58%, n=69) vs. outbound flights (departing from home-base, 31%, n=38; $p<0.001$). There was no difference for direction of travel (eastbound: 49%, n= 56; westbound: 40%, n= 44; northbound/southbound: 50%, n=7; $p=0.272$). CR was more frequent on 2-pilot flights (62%, n=81) compared to augmented crew flights (24%, n=26; $p<0.001$). Of note, 21% (n=23) of augmented flights contained both CR and Bunk Rest. CR was more frequent on flights <10h duration (<10h: 59%, n=78; >10h: 27%, n=29; $p<0.001$). Flights departing between 12:00h-19:59h (25%, n=23; $p<0.026$) had the lowest frequency of CR. **Discussion:** Data from this airline show that CR is most commonly used as a countermeasure to sleepiness on return, unaugmented, <10h duration, and nighttime flights.

The direction of travel did not influence the use of CR. Future studies are required to determine generalizability of these results to other airlines.

Effects of Acute Total Sleep Deprivation on Sustained Attention and Response Inhibition

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Introduction: Many job- or safety-critical tasks (e.g., in control room, security, and law enforcement settings), require sustained attention, monitoring whether a response is required, and appropriate responding or response inhibition. Performance on such tasks may be significantly impaired when people are sleep-deprived, but the cognitive processes affected are still being debated. The Psychomotor Vigilance Test (PVT), which requires speeded responses to stimuli at random inter-trial intervals, provides a platform for measuring sustained attention that is sensitive to total sleep deprivation (TSD). We expanded the PVT to also measure response inhibition by including both normal response stimuli (green bullseyes) and inhibition stimuli (red bullseyes), and implemented this "stop-signal PVT" in a TSD study. **Methods:** Thirteen adults (ages 21–39; 7 females) completed a 4-day/3-night laboratory study with a baseline sleep opportunity, 39-hour acute TSD period, and recovery sleep. The stop-signal PVT (10-minute duration) was administered at 17:30 during baseline and after 34 hours of TSD. Participants were instructed to respond as quickly as possible to response stimuli (75% of trials) while withholding responses to inhibition stimuli (25% of trials). **Results:** There was a trend for reduced accuracy on response trials during TSD relative to baseline ($t(12)=1.91$, $p=0.080$, $d=0.70$). Response times for accurate response trials were slower during TSD ($t(12)=-3.32$; $p=0.006$; $d=1.06$). Accuracy on inhibition trials was not significantly different during TSD compared to baseline ($t(12)=-0.09$; $p=0.933$; $d=0.02$). **Discussion:** Response slowing on response trials indicated that sustained attention was impaired by TSD, as expected. In contrast, there was no evidence of impairment on inhibition trails, suggesting that inhibitory control was maintained on the stop-signal PVT during TSD. Whether inhibitory control was maintained by inherent resilience to TSD of key cognitive processes or rather by speed-accuracy trade-off remains to be determined.

The Impact of Cumulative 12-Hour Work Shifts on Nursing Critical Skills

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Introduction: Twelve-hour shifts have become popular in the nursing profession, despite reports of nurse fatigue and risks to patient safety. Although several hospital-based studies have associated shift-accumulated nurse fatigue with poorer patient outcomes, limited evidence exists quantifying the specific impact of cumulative 12-hour shifts on nurses' ability to make critical decisions around patient care. Our study addressed this need by testing nurses in Washington State University's (WSU) nursing simulation laboratory. **Methods:** Nurses (n=100) working 12-hour shifts at a local hospital were tested on two separate occasions at WSU: once following three consecutive 12-hour shifts (with 12 hours off between shifts) and once on a third consecutive day off. The order of testing for "on-duty" and "off-duty" conditions was randomized to control for learning effects, and test sessions were conducted at the same time of day to control for circadian factors. During testing, nurses were evaluated on patient care simulation scenarios using the Creighton Competency Evaluation Instrument (C-CEI). They also were tested for reaction time and accuracy on a series of medication calculation questions. **Results:** Nurses scored significantly higher on the C-CEI during their off-duty condition compared to their on-duty condition ($t=2.3$; $df=249$; $p=.02$), suggesting that cumulative 12-hour shifts degrade nurse ability to provide safe patient care. Furthermore, they were significantly quicker to respond to medication calculation questions ($t=-4.7$; $df=270$; $p=.01$) yet significantly more likely to make errors during their on-duty condition compared to their off-duty condition ($t=-2.2$; $df=270$; $p=.03$), suggesting that they favored speed over accuracy following cumulative 12-hour shifts. **Discussion:** This study provides compelling evidence for the patient safety risks associated with cumulative 12-hour shifts. To date, insufficient data has limited policy change around nursing shift length within the hospital setting. The results of our study could inform policy around safe shift scheduling to promote safe patient care.

Insomnia Interventions among Shift Workers: An RCT Trial in Occupational Health Services

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Introduction: The aim of the present study was to compare the implementation and effectiveness of group and self-help based CBT-I and sleep hygiene intervention in a randomized controlled design among shift workers with insomnia. In addition, we screened participants for features of shift work disorder (SWD) and if they affected the results. We carried out the study in the occupational health services (OHS) of the participating workplaces. **Methods:** A total of 59 shift workers with insomnia disorder were recruited by six OHS centers and participated in a) group-based CBT-I, b) computerized self-help CBT-I, or c) sleep hygiene intervention. The interventions were delivered by trained OHS nurses and psychologists. The outcomes were assessed before and after the interventions and at 6-month follow-up using questionnaires, a sleep diary and actigraphy. **Results:** Perceived severity of insomnia, sleep-related dysfunctional beliefs, burnout symptoms, self-reported restedness after a sleep period, recovery after a work shift and actigraphy-based total sleep time improved statistically significantly after all three interventions. Mood symptoms improved significantly among those who received group-based CBT-I. Half of the participants had features of SWD. Participants without SWD features had more mental diseases, and used more sleep-promoting medication (SPM), and reported having more pronounced insomnia severity, dysfunctional beliefs and mood symptoms than participants with SWD features. After interventions, participants without SWD features showed more improvements in dysfunctional beliefs, actigraphy-based TST, and SPM usage than those with SWD features. **Discussion:** Our results indicate that the benefits of both group-based and self-help CBT-I, and mere sleep hygiene for shift workers with insomnia are rather comparable. The main added value of group-based CBT-I seemed to be alleviation of mood symptoms. Half of the participants had features of SWD. Participants without SWD features had more severe clinical overall picture and they benefitted more from interventions than participants with SWD features.

Shift Work and Incidence of Dementia: A Danish Nurse Cohort Study

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Introduction: Few studies have examined the association between shift work and risk of dementia, showing conflicting results. Here we examined the association between shift work and incidence of dementia in Danish female nurses. **Methods:** 28,731 female nurses from the Danish Nurse Cohort, who reported information on shift work (day, evening, night or rotating) in 1993 and/or 1999 and duration of shift work in 2009, were linked to the Danish National Patient and Prescription Registers to obtain information on dementia hospital contacts and prescription medication until November 2018. We used Cox regression models to examine the association between shift work (evening, night or rotating) and incidence of dementia, defined as the first-ever dementia hospital contact or first-ever purchase of prescribed dementia medication after cohort baseline, adjusting for age. **Results:** Among 7,299 nurses who reported information on day, evening, night or rotating shift work in 1993 and 1999 cohort rounds, we detected an association between dementia incidence in those who worked night shifts for 6 years or more (HR: 2.41, 95% CI: 1.49-3.90) as compared to those who worked day shifts for at least 6 years. **Discussion:** We found suggestive evidence of an association between night shift work and dementia in Danish female nurses. However, the association needs to be further investigated and particularly if the detected association is mediated by pre-existing cardiovascular diseases or diabetes, which are also suggested as outcomes after night shift work.

What is the Impact of On-Call Working Time Arrangements for the Partners of On-Call Workers?

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Introduction: On-call work is an effective way for emergency service agencies to manage unpredictable service demands but is consistently associated with adverse impacts for sleep even in the absence of calls. Despite sleep being a common shared behaviour, studies are yet to assess the impact of on-call work on the sleep of co-sleeping partners, who play a critical role in supporting the on-call workers to fulfil their roles. The aim of this study was to assess the impact of on-call activity on the sleep of partners of auxiliary firefighters and the potential consequences to next day sleepiness and relationship quality. **Methods:** Sixty partners (93% female) completed an anonymous online survey to assess sleep, daytime sleepiness and relationship quality in relation to their partner's on-call commitments. Data were analysed using the Pearson's chi-square test, Wilcoxon Signed Rank test, Spearman's rho correlation and Mann-Whitney U tests. Free-text responses were analysed using thematic analysis. **Results:** Results showed that subjective sleep quality on nights there were calls, was significantly poorer than when no calls occurred and there was a significant association between the frequency of on-call sleep disturbances and sleep quality. No significant associations were shown between on-call sleep disturbances and sleep duration, next day sleepiness or relationship happiness. Further, analyses revealed no significant difference in relationship happiness when comparing those with poor and good sleep quality. **Discussion:** This study provides important first insights into how on-call work arrangements impact partner sleep, sleepiness and happiness in their relationship . Findings show that despite the consequences for sleep, partners appeared to be happy in their relationships and supportive of their partner's role. Future research should focus on outcomes at different times of the year (to capture changes relating to call frequency) using objective measures of sleep to better define the impacts observed in this study.

Night Shift Disrupts the DNA Repair and Enhances DNA Damage in Humans

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Introduction: Rodent studies have shown the importance of circadian regulation in the control of DNA damage. In humans, the impact of circadian rhythmicity on DNA damage is unclear. Here we used simulated night shift work as a model to understand the association between circadian regulation and DNA damage in humans. **Methods:** Circadian gene expression and DNA damage were measured from the lymphocytes of fourteen healthy adults (aged 22–34) randomized to 3 days on simulated night shift (n=7; scheduled wakefulness 18:00–10:00) or simulated day shift (n=7; scheduled wakefulness 06:00–22:00) in the laboratory. This was followed by 24 hours of constant routine, during which subjects were kept awake under fixed laboratory conditions while lymphocytes were collected at 3-hour intervals through an intravenous catheter. DNA breaks and double-strand DNA damage were quantified by comet assay and immunofluorescence and immunoblotting. Clock genes and circadian regulation of DNA repair were measured using qRT-PCR. These assays were repeated after ex vivo lymphocyte exposure to ionizing radiation. **Results:** There were more DNA breaks and more double-strand DNA damage over the 24–hour constant routine following simulated night shift compared to day shift. There was also evidence of dysregulation of circadian clock genes and a loss of the circadian regulation of DNA repair following simulated night shift. Exposure to ionizing radiation increased double-strand DNA damage in both conditions, but more so in the afternoon/evening after simulated night shift. **Discussion:** These results point to increased DNA damage in night shift schedules, which appears to be due to circadian dysregulation of clock genes and DNA repair. Furthermore, our results indicate that night shift schedules enhance sensitivity to DNA damage from direct exposure to sunlight or other sources of ionizing radiation. Our observations provide new insights regarding the increased risk of cancer in shift workers.

The Quantity and Timing of Food Intake by Police Officers on Rotating Shift Schedules Varies by Shift Type

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Introduction: People who engage in shift work are at increased risk of weight gain and the precise factors contributing to this are unclear and research about the quantity, composition and timing of food intake by shift workers is limited. The objective was to document the dietary patterns of police officers across different shifts. **Methods:** Thirty-one provincial police officers (6 women; age 32.1±5.4 years; BMI 25.0±2.3 kg/m^2) from Quebec, Canada, each participated in a ~35-day study, comprising 9- to 12-hour morning, evening, and night shifts alternating with rest days. Sleep and work patterns were recorded with actigraphy and diaries. For one day during each shift type and rest day, participants logged all food consumption by time-stamped photographs on smartphones. Data were analyzed with linear mixed effects models. **Results:** More calories were consumed on rest days than evening or night shifts days ($p < 0.05$), but days did not differ for macronutrient composition overall or as a function of time spent awake ($p=.63$). There was significant variation in the clock-timing of meals between shift types ($p<.01$). Mean caloric intake occurred later (23:10±1:16) for night-shift than for rest days (15:23±0:29) and was dispersed across a longer eating window. Officers consumed the amount of calories equivalent to their 24-h basal metabolic rate significantly sooner after waking on rest days than on evening or night shifts ($p<.001$). Although police officers obtained less sleep following night shifts than morning-shifts and rest days ($p<.05$), sleep duration was not associated with caloric intake. **Discussion:** This study of police officers revealed no differences in meal composition between shifts but did find less caloric intake on evening-shift and night-shift days than on rest days, and later clock-timing of caloric intake at night on night-shift compared to other days. This is consistent with hypotheses that implicate the timing rather than quantity of food intake as a contributor to weight gain amongst shift workers.

Individual Differences in Response to Bright Light Exposure to Enhance Adaptation to a Counterclockwise Shift Work Rotation

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Introduction: Rotating shift work is associated with adverse outcomes due to circadian misalignment. We tested a bright light countermeasure to enhance circadian adaptation on a counterclockwise shift schedule. **Methods:** Twenty-nine adults (ages 20-40; 15 women) participated in a 4-week laboratory/field simulation of a counterclockwise schedule with weekly transitions from Day, to Night, to Evening, and back to Day shifts. Each week consisted of five 8-hour workdays, two days off and an 8-hour sleep schedule relative to each shift. A 24-32-hour constant posture (CP) circadian phase estimation began on the 4th shift of each week, when hourly blood samples were obtained for melatonin assay. Subjects were randomized to Treatment (N=14) or Control (N=15); the Treatment group received bright light during work (1250-8000 lux), whereas the Control group worked in ordinary room light (~150 lux). Adaptation to the schedule was measured by overlap between melatonin secretion and the scheduled sleep episode. **Results:** Light treatment was beneficial; overlap of melatonin secretion relative to scheduled sleep was longer in the Treatment (4.9±2.8h) compared to the Control group (2.62±2.8h; $p=0.054$). No group differences were found on Evening or Day shifts. During the Night shift CP, 10 of 12 Treatment subjects (83%) had their melatonin rhythm peak during scheduled sleep time, whereas for 54% of the Control subjects their melatonin peaked during work time. We observed a strong relationship between degree of adaptation on the Night shift and baseline melatonin timing (r^2=-0.71, $p=0.01$). **Discussion:** Bright light exposure during work can enhance adaptation to a counterclockwise rotating schedule, such that the circadian system rapidly adapts to a night-active schedule and then re-adapts rapidly to a day-active schedule during evening and day shifts. Properly timed light regimens in accordance with individual circadian timing could be an effective workplace intervention for shift workers, improving their productivity, health and safety.

Shift Workers in Healthcare have a Higher Incidence and Severity of Respiratory Infections than Non-Shift Workers

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Introduction: Shift work results in a disruption of the circadian rhythm. Recently, there has been interest in whether circadian disruption may enhance susceptibility to infection. Therefore, the aim of this study was to determine whether shift workers in healthcare have a higher incidence, duration, and severity of influenza-like illness (ILI) and acute respiratory infection (ARI) than non-shift workers. **Methods:** In this prospective cohort study, 501 rotating and/or night shift workers and 88 non-shift workers employed in hospitals daily registered the occurrence of ILI/ARI symptoms during the 2016-2017 winter season (September-June) using a smartphone diary application. Incidence rate of ILI/ARI episodes (defined as ≥2 symptoms on the same day or ≥1 symptom during two consecutive days), mean duration per episode, and incidence rate of severe ILI/ARI episodes were compared between shift and non–shift workers using negative binomial regression and linear mixed-model analysis. **Results:** From September 2016–June 2017, participants completed 110,347 diaries reporting ILI/ARI symptoms. Compared to non-shift workers, shift workers' incidence rate of ILI/ARI episodes was 1.20 (95% confidence interval (CI): 1.01–1.43) times higher, and for severe ILI/ARI episodes 1.22 (95%-CI: 1.01–1.49) times higher. Mean duration per ILI/ARI episode did not differ (ratio between means=1.02, 95%-CI: 0.87–1.19). A subgroup analysis on frequency of night shifts (0, 1-2, 3-4, or ≥5 night shifts/month) and duration of night shift work (0, <10, 10-19, or ≥20 years) did not show a dose-response effect with incidence rate of ILI/ARI episodes. **Discussion:** In this study among healthcare workers, shift workers had more and more severe ILI/ARI episodes than non–shift workers, but with a similar duration. Studying mechanisms linking shift work to infection susceptibility is necessary for the development of preventive initiatives. This could assist in reducing infections, protecting others from infection (e.g. patients), and supporting sustainable employability of shift workers.

Changes in Body Weight After Exogenous Melatonin Supplementation on Days-Off in Overweight Nurses Who Work Permanent Night Shifts: Preliminary Results

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Introduction: The goal of this study was to evaluate the effects of exogenous melatonin supplementation on days-off on body weight of overweight nurses who work permanent night shifts. **Methods:** We performed a double-blind randomized clinical crossover trial in 20 female overweight nursing professionals (20-50 years old) working one 12h night shift (19:00-07:00 h) followed by 36h off. All had been working night shifts for at least six months, without a second night job. Participants either took exogenous melatonin (3 mg) or placebo on all their days off and between night shifts for three months, 1 h before bedtime at night. Anthropometric measurements were taken at baseline, and after three months of melatonin or placebo administration. ANOVA repeated measures with one factor (time working night shifts - dichotomized into <5 years and ≥5 years) was performed to evaluate the effects of intervention. **Results:** Participants had a mean (± SD) age of 36.6 ± 5.6 years and comprised 65% nurses and 35% nursing technicians. Mean (± SD) time working nights was 9.6 ± 6.6 years and 90% worked exclusively at the hospital. There was no main effect of melatonin vs. placebo on anthropometric measurements. However, nurses who had worked night shifts for <5 years, showed decreased body weight (82.3, SE 4.8 to 80.5kg, SE 4.8), BMI (32.1, SE 1.4 to 31.4kg/m2, SE 1.4) and hip circumference (114.6, SE 3.2 to 110.6cm, SE 3.1), in the baseline in comparison after melatonin supplementation, respectively (ANOVA $p<0.05$). **Discussion:** Exogenous

melatonin supplementation decreased body weight of nurses working night shifts for less than five years, suggestion that the use of melatonin may help to reduce excess weight when introduced in the first years of exposure to night work.

Model-Derived Estimates of Police Officers' Sleepiness Using Actual and Predicted Sleep/Wake Behavior

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Introduction: In operational settings, managing fatigue and sustaining performance are critical to maintaining safety and productivity. Biomathematical models have been developed to predict fatigue and performance from sleep-wake histories enabling the construction of work schedules that minimize fatigue and performance impairment. Often, however, sleep-wake histories are unknown. In these cases, work schedules can be used to predict sleep-wake histories, which, in turn, can be used to predict fatigue and performance. It remains to be determined whether workers in different operations organize their sleep similarly, and whether sleep predictions generalize across operations. We assessed whether a sleep estimator developed using sleep-wake data from pilots and rail operators accurately predicts police officers' sleep-wake behavior. **Methods:** N=191 officers enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress study were studied. Work schedules were obtained from payroll data and officers' sleep-work diaries. Sleep-wake behavior was measured using wrist-actigraphy and predicted using a biomathematical model (FAID Quantum). Fatigue exposure metrics included the proportion of shifts with <5h of sleep in the prior 24h (<5h sleep/24h) and <12h of sleep in the prior 48h (<12h sleep/48h). Sensitivity, specificity, and overall agreement were used to assess the validity of the predicted sleep-wake schedules. **Results:** Officers participated for 10.9 ± 3.8 days and worked 7.6 ± 2.8 shifts. Officers obtained <5h sleep/24h and <12h sleep/48h prior to 14.7% and 35.1% of shifts, respectively. The model predicted <5h sleep/24h and <12h sleep/48h prior to 3.3% and 18.7% of shifts, respectively. The model's sensitivity (79.5%), specificity (89.3%), and overall agreement with the actual sleep-wake data (86.6%) were high. **Discussion:** Officers' predicted sleep-wake behavior demonstrated high overall agreement with the officers' actual sleep-wake behavior. Sleep duration was generally overestimated, and the proportion of shifts likely worked fatigued was underestimated. It remains to be determined whether this significantly impacted the model's sleepiness predictions.

Daytime Light Exposure affects Circadian Adaptation to a Week of Night Shifts

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Introduction: The aim of the study was to examine the influence of sleep time in the dark, and thus the timing of daytime light exposure, on circadian adaptation to a week of night shifts. It was hypothesised that night work would delay the circadian system - and the size of the delay would increase as the duration of exposure to morning and early-afternoon light (MAL) decreased. **Methods:** So far, 43 adults (21F, 22M) have been randomly assigned to one of four conditions in a laboratory-based simulated shiftwork protocol. Each condition included 7 consecutive 8-h night shifts (23:00–07:00h). The only difference between conditions was in the timing of the 7-h sleep opportunities in breaks between shifts - morning (08:30–15:30h, shortest MAL), split#1 (08:30–13:30h & 19:30–21:30h, short MAL), split#2 (08:30–10:30h & 16:30–21:30h, long MAL), and afternoon/evening (14:30–21:30h, longest MAL). Circadian phase was assessed using salivary dim light melatonin onset (DLMO) on the nights immediately before and after the week of night work. Light intensity was 75lx during night shifts, <0.03lx during sleep, <10lx during DLMO assessments, and 350lx at other times. **Results:** The DLMO data were analysed using a mixed-design ANOVA with one within-subjects factor (time: pre/post) and one between-subjects factor (condition). There was a significant interaction ($F=10.6$; $df=3,39$; $p<.0001$) - the type/size of the phase shift differed between the conditions, i.e., morning (delay=5.06±2.11h), split#1 (delay=2.58±2.46h), split#2 (delay=1.30±2.62h), and afternoon/evening (advance=0.71±2.84h). **Discussion:** These data indicate that the timing of daytime sleep, and thus the amount of exposure

to morning and early-afternoon light (MAL), substantially affects the degree of circadian adaptation to a week of night work. In situations where a shiftworker wishes to maximise adaptation to night work, the most sleep should be taken in the morning. To minimise adaptation, sleep should occur in the later afternoon and evening.

Time, Work and Health among Brazilian Civil Servants: Working too Many Hours, Working Under Time Pressure, or Both?

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Introduction: The amount of time devoted to work and the high work pace has been associated to health consequences. The aim of this study was to investigate weekly working hours and time pressure in relation to self-rated health in a large Brazilian workers' sample. **Methods:** Cross-sectional data from wave 2 of the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil) were used (N=11,631 civil servants). A comprehensive set of questionnaires was applied, providing information about socioeconomic conditions, habits and lifestyle, health, and occupational aspects. Weekly work hours considered all professional activities regardless of when (at night or at weekends) or where (at workplace, at home, at transportation) they were carried out. Time pressure due to a heavy workload was based on a statement from Effort Reward Imbalance questionnaire. Self-rated health (SRH) refers to the perception about one's health status, compared with that of age peers. The software R, version 2.15 was used for analysis. **Results:** Among participants, 52% were women; mean age was 55.7 [SD =9.01] yrs; 12.4% reported poor SRH. In relation to the work hours, 38.5% worked 40-60h/week, and 8.7% worked more than 60 h/week; 54.9% reported time pressure. Both time pressure and long work hours were associated with poor SRH. The likelihood of poor health is 15% higher among those who reported time pressure compared to their counterparts (OR=1.15; CI95% 1.03; 1.29). Similarly, working more than 60 hours per week is associated to 31% higher chances of reporting poor health (OR=1.31; CI95 1.06; 1.59). **Discussion:** In a context of intensified work worldwide, and considering that SRH is a reliable measure of physical and mental health, the results encourage the identification of the

health effects of work situations that exceed human limits. Time-related health risks should be considered among the arguments that support policy actions for changing working arrangements.

The Impact of Different Daytime Sleep Strategies on Sleep Duration during a Week of Simulated Night Work

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Introduction: One of the challenges for individuals who work at night is obtaining sufficient sleep during the day. Individuals adopt different sleep strategies in the breaks between nights shifts, however these strategies have not been systematically compared. The aim of this study was to determine which of the four most common daytime sleep strategies produces the greatest amount and/or quality of sleep. **Methods:** In a between-groups design, 43 participants completed one of four strategies during a week of simulated night work in the laboratory. The only difference between strategies was in the timing of the 7-hour sleep opportunities that occurred during the 6 breaks between the 8-hour night shifts: a 7-hour sleep in the morning after work (08:30-15:30h), a 7-hour sleep in the evening before work (14:30-21:30h), a 5-hour sleep in the morning followed by a 2-hour sleep in the evening (split#1: 08:30-13:30h—19:30-21:30h), or a 2-hour sleep in the morning followed by a 5-hour sleep in the evening (split#2: 08:30-10:30h—16:30-21:30h). Sleep was monitored using polysomnography. **Results:** For each participant, total sleep time and the amount of slow wave sleep and REM sleep were averaged over the 6 daytime sleep episodes and separate one-way ANOVAs were conducted for each variable. Total sleep time was significantly higher in the morning (390.6±9.2min) and evening strategies (389.6±17.8min) compared to the split#1 (358.0±28.4min) and split#2 (361.6±37.7min) strategies. There was no difference in the amount of slow

wave sleep or REM sleep between strategies. **Conclusions:** More sleep was obtained in the morning and evening strategies compared to the split strategies. Interestingly, the four daytime sleep strategies were equally effective in terms of the amount of REM and slow wave sleep they provided. In future, it will be important to determine whether differences in sleep duration between strategies result in better performance and/or higher subjective alertness during night shifts.

Executive and Non-Executive Components of Visual Working Memory Task Performance during Total Sleep Deprivation

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Introduction: Working memory (WM) task performance is degraded by total sleep deprivation (TSD), which is relevant to productivity and safety in operational settings. Decomposition of performance into executive (i.e., specific to WM use) and non-executive processes (e.g., semantic encoding, motor response) has previously shown that TSD degrades non-executive processes while executive processes may be preserved. Here we employed a novel WM task to determine whether this finding generalizes to visual WM - an aspect of WM not previously examined this way. **Methods:** 12 subjects (ages 21-39, 6 women) completed a 4-day in-laboratory study. After baseline sleep (22:00–07:00), subjects remained awake for 39 hours, followed by recovery sleep (22:00-07:00). The Partial-Report Working Memory (PRWM) task, a novel visual WM task, and a 10-minute Psychomotor Vigilance Test (PVT) were administered at the same times of day during baseline, after TSD, and after recovery sleep. In the PWRM task, subjects recalled single items from arrays of 2 or 4 colored squares; responses were not speeded. The change in accuracy as a function of set size was used as an index of executive processing. For the PVT, lapses (response times ≥ 500 ms) were assessed to measure vigilant attention. **Results:** Mixed-effects ANOVA revealed that TSD impaired overall PRWM performance ($F_{2,55}=9.25$, $p<0.001$), but not executive processing ($F_{2,55}=0.43$, p=0.65). TSD also impaired vigilant attention on the PVT ($F_{2,21}=12.13$, $p<0.001$). During TSD, PVT lapses exhibited a stronger correlation

with overall PRWM performance (r=–0.44) than with executive processing specifically (r=–0.11). **Discussion:** In line with other recent studies, we found that TSD degrades performance on a visual WM task via declines in non-executive, rather than executive, cognitive functions. TSD-induced performance impairment on the PRWM may be caused by vigilant attention deficits, as observed on the PVT, while visual WM itself appears to be preserved.

Effects of Different Light Intensities on Adaptation to Simulated Night Shifts: A Randomized Counterbalanced Crossover Study

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Introduction: Bright light has been suggested as a countermeasure to sleepiness and cognitive impairment during night shifts. This trial investigated how a bright standard room LED-lighting intervention affected alertness and cognitive performance during three consecutive simulated night shifts. The effect on circadian rhythm was also assessed. **Methods:** Participants worked three consecutive night shifts (11:00 pm to 7:00 am) in a bright (~4000 K, 900 lux) and a low light (~4000 K, 90 lux) condition in a counterbalanced randomized order (separated by four weeks). Participants completed a Psychomotor Vigilance Task (PVT) and the Karolinska Sleepiness Scale (KSS) at five time points (11:40 pm, 1:10 am, 2:40 am, 4:10 am and 5:40 am) during each night. Salivary dim light melatonin onset (DLMO) was assessed before and after the night shifts. Data from 27 participants (20 females, 21.4±2.1 years; mean±SD) was analyzed using linear mixed models. **Results:** Subjective alertness (KSS) and sustained attention (PVT performance) declined during the night shifts in both conditions. Subjective alertness was significantly ($p<.05$) improved at 4:10 am and 5:40 am on nights 2 and 3 in bright light compared to low light. Sustained attention was significantly ($p<.05$) better in bright light compared to low light at 2:40 am, 4:10 am and 5:40 am on night 1, and at 4:10 am and 5:40

am on nights 2 and 3. DLMO delayed differently ($p<.05$) between conditions and was delayed by 3h16min±23min (mean±SEM) after the bright light condition and by 2h6min±15min following low light. **Discussion:** Bright light improved performance and alertness during simulated night shifts and led to a larger circadian phase delay than low light. Bright light administered through ceiling mounted LEDs may be implemented at worksites to facilitate alertness and performance during night work.

The Effects of the Use of Participatory Working Time Scheduling Tool on Sickness Absence: Results from Quasi-Experimental Study

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Introduction: Participatory working time scheduling may provide means for reducing sickness absence caused by the mismatch of timing between employees' desired and contracted working hours. We investigated the effect of implementation of digital participatory working time scheduling tool on sickness absence on unit level in healthcare sector. **Methods:** The effect of quasi-experimental intervention on log-odds transformed sickness absence rate of short (1-3 days) and long (>3 days) absences was examined among 670 units in 6 hospital districts in the Finnish Public Sector study. Continuous, balanced panel data of scheduling periods from 2014 to 2017 was used in the analyses. The intervention group (n=150) included units that started participatory scheduling (Titania®) in 2016 or in 2017, whereas the control group (n=520) continued with traditional scheduling. We used Generalized Difference in Differences method to account for multiple time periods and multiple potential starting points for the intervention in different units. A series of sensitivity analysis were conducted. **Results:** Our results showed a statistically significant effect of the use of the tool for participatory working time scheduling on sickness absence rate of short absences (β= -0.18, 95% CI= -0.30 - -0.06). For the early implementation of the planning tool that took place in 2016 the effect was stronger (β= -0.30, 95% CI= -0.44 - -0.15). We found no statistically significant effects on sickness absence rate of long absences. **Discussion:** The potential reduction of mismatch of timing between desired and contracted working hours may provide substantial benefits for employers in reducing sickness absence and related costs. The findings which were stronger in early implementation group, reflect two aspects. First,

the early implementation could have taken place in units which needed tools for, and had the know-how to execute participatory scheduling. Second, effective utilization of participatory scheduling tool takes time to be learned.

The Impact of Hours Worked on Near Miss Medication Error Alerts

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Introduction: Although Fatigue Risk Management Protocols (FRMPs) are common practice in many industries, the healthcare industry has lagged in adopting these safety strategies. A gap analysis of our organization utilizing the US Department of Transportation Federal Aviation Administration fatigue risk management system (FRMS) framework revealed that zero components of an FRMS were in place. Working excessive hours have been shown to negatively impact nurses' performance, judgement, and critical thinking skills. The purpose of this study was to investigate impact of nurses' work hours on near miss medication error alerts. **Methods:** A retrospective correlational design was used to evaluate the relationship between working hours and near-miss medication error alerts. Workforce management software was used to identify the work hours of all nurses between 2016-2018. Nurses who worked 60 hours or greater in seven days were considered to have worked extended hours. Medication error alerts for the same period were pulled from the EMR and matched to the nurse who administered the medications. **Results:** In the two-year period, 8,696 nurses triggered 477,263 near miss alerts on 12, 679, 323 medication administrations. 2,908 (33.44%) nurses had worked extended hours. Nurses that worked extended hours yielded an average near miss rate of 4.40% compared to 3.014% ($p<.001$) for nurses that worked less than 60 hours. **Discussion:** Valid data sources and routine monitoring of near misses and errors are critical elements of FRMSs that aid to enhance safety and care outcomes. Nurses working extended hours have a significant increased risk of triggering a near miss error alert compared to their counterparts that were not working extended hours given

their increased near miss rate. Although, nurses were not surveyed to confirm feelings of fatigue, medication administration performance suggest that judgement and critical thinking skills were impacted by hours worked.

BAuA-Working Time Survey: A Representative Panel Study

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Introduction: To give an overview of working time reality in Germany and its development over time, the Federal Institute for Occupational Safety and Health (BAuA) introduced the BAuA-Working Time Survey. This panel study is representative for large parts of the German working population and allows the investigation of relationships of working time with employees' health and well-being. **Methods:** The first wave of the BAuA-Working Time Survey was conducted in 2015. About 20,000 employees took part in computer assisted telephone interviews with an average duration of 35 minutes. The second wave was conducted in 2017 with around 10,500 participants. In 2019 the third wave of the survey is conducted with an expected number of around 10,000 participants. The questionnaire covers different aspects of working time but also other working conditions, employment status, and employees' health and well-being. **Results:** The BAuA-Working Time Report (Wöhrmann et al., 2016) gives a descriptive overview of the working time reality of employees in Germany as well as relationships between working time and employees' subjective health, psychosomatic problems, job satisfaction, and work-life balance. A comparison of the situation in 2015 and 2017 showed that only minor overall changes with regard to working time have occurred - such as a slight increase in working time control. However, several occupational groups such as care, transport, and hospitality are facing increasing working time demands (Backhaus et al., 2018). Focusing on working time preferences reveals that about half of the employees in Germany would like to reduce their actual working hours. While women's working time preferences depend on their current life stage, men's are relatively similar in different life stages (Brauner et al., 2018). **Discussion:** The BAuA-Working Time Survey aims to provide representative and reliable longitudinal data on working time. Information on data access and cooperation possibilities will be provided.

Supervision of a Self-Driving Vehicle Unmasks Latent Sleepiness Relative to Manual Driving

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Introduction: Drowsy driving has been implicated as a causal factor in up to 20% of road accidents. Automated driving systems purport to mitigate this risk, but partially autonomous systems require drivers to be prepared to retake control of the vehicle at any time. With this shift, the driver's role is shifting from active engagement to passive monitoring. Given that sleep loss impairs monitoring performance and that there is a high prevalence of sleep deficiency in modern society, we hypothesized that supervising a self-driving vehicle would unmask latent sleepiness compared to manual driving among individuals following their typical sleep schedules. **Methods:** During one laboratory visit, participants completed a simulated 42-minute manual and autonomous drive in a randomized order. Electroencephalography and electrooculography were recorded during both drives (BrainVision Recorder version 1.21). Power density was calculated in 0.5 hertz bins and slow rolling eye movements (SREMs) were identified. The Karolinska Sleepiness Scale (KSS) was collected following each drive. Participants kept sleep diaries and wore an actiwatch for two weeks prior to the laboratory visit. All comparisons were made using mixed-effects models (SAS version 9.4). **Results:** Seventeen participants (8F, mean age 34 +/- 11) completed the study. Pre-study sleep duration averaged 5.9 +/- 0.9 h. Sleepiness was higher during the autonomous compared to the manual drive (KSS: autonomous 6.9 +/- 2.1; manual: 5.4 +/- 2.4; p = 0.03; SREMS: autonomous 19.9 +/- 19.5; manual: 9.71 +/- 11.3; p = 0.04). Power density showed a non-significant increase in the theta range for the autonomous condition. **Discussion:** Our findings demonstrate that latent sleepiness is unmasked when individuals supervise a self-driving vehicle relative to manual driving. This suggests that autonomous systems may reduce driver situation awareness. Further research is needed to determine whether these attentional failures reduce an individual's ability to take control of a vehicle.

Strategically Timed Food Intake during the Night-Shift: Putting These Countermeasures to Practice

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Introduction: Our previous findings have shown that withholding food intake across the night-shift reduces the acute metabolic disturbance seen during shift-work. However, in order to successfully implement this change, shift-worker comfort and performance are critical considerations. This study explored the possible implications of withholding food intake across the night-shift on performance, hunger, and gastric upset. **Methods:** Participants underwent four nights of simulated night-work (16:00h-10:00h) with a daytime sleep opportunity each day (10:00h-16:00h). Healthy males were assigned to an eating at night (n=4, meals; 07:00h, 19:00h and 01:30h) or not eating at night (n=7, meals; 07:00h, 09:30h, 16:10h and 19:00h) condition. Participants reported feelings of hunger, and gastric upset and completed a 10-minute Psychomotor Vigilance Task (PVT) four times through each night-shift. Exit questionnaires (open ended questions) were completed by all participants and were assessed for themes. **Results:** Eating at night elevated bloating (p=0.018) on the first night-shift. Participants who did not eat at night reported increased hunger (p<0.021) and stomach upset (although not rising above neutral on the anchored scale) (p<0.026). PVT lapses (>500msec) and median response times were significantly higher in both conditions at 04:00h (p<0.002), and this was exacerbated when eating at night. Most participants indicated they would not be able to make it through a "real" night-shift without food, reporting several concerns including reduced performance, increased sleepiness and overall lack of energy associated with not eating at night. **Discussion:** Eating on the night-shift may be an underlying cause of feelings of bloating, commonly associated with night-shift, while not eating at night may reduce discomfort. Feedback from exit questionnaires suggest there may be disparity between subjective perception of food in relation to performance versus objective performance measures. This highlights the importance of education for the shift-worker regarding the benefits of altering meal timing on work performance.

Driving Time and Rest Periods in Highly Automated Long-Haul Trucking

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Introduction: The drivers' role is changing as sophisticated automated functions are introduced in modern vehicles. For example, if fully automated driving is available for parts of the drive, could professional drivers then be allowed to extend their driving time? Aside from the strong business case, this may also be beneficial for the individual driver who could occasionally drive the last miles and avoid an extra overnight. A prerequisite is robust continuous monitoring of when the driver is resting (to account for reduced time on task) or sleeping (to account for the reduced physiological drive to sleep). The objectives of this contribution are to raise a discussion about the consequences of flexible drive and rest regulations, and to present initial work on a data driven model aiming to estimate fitness to drive in automated long-haul trucking. **Methods:** The data driven model is based on the three-process model of alertness using homeostatic (S), circadian (C), ultradian (U), sleep inertia (W) and task demand (R) components. S is estimated partly based on prior sleep and time awake, but is also updated continuously while driving based on closed eyes monitoring. R is derived from continuous heart rate variability measurements estimating the driver's relaxation state. **Results:** The eyes-closed algorithm provided a precision of 85 % while the relaxed versus driving algorithm had an accuracy of 89% when validated on 100 participants. The full fitness to drive model has not been validated yet. **Discussion:** Rest is a complicated driver state and the recuperative value depends on the activities that are carried out while resting. The monotony that is characteristic for long-haul truck driving is clearly interrupted for a while, but the consequences for the remains of the drive should be further researched.

Implementation of Fatigue Risk Management Systems in Pipeline Control Rooms

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Introduction: Pipeline company control rooms in the United States have developed and implemented Fatigue Risk Management Systems (FRMS). The FRMS is developed to meet United States regulatory requirements to implement methods to "reduce the risks associated with Controller fatigue." The authors have assisted over 100 pipeline control rooms with the development and implementation of FRMS and completed 254 workload assessments that include controller alertness ratings. This presentation will focus on the use of FAID® fatigue modeling software in working control rooms as a component of FRMS. **Methods:** The authors and some pipeline companies are using FAID® fatigue modeling software as part of the FRMS. Companies have to demonstrate that their FRMS has a scientific basis for the provisions of their plan. FAID® provides a means of documenting the scientific basis. The software is used for evaluating shift schedules for potential fatigue risk, showing Controllers times during shifts when they are most likely to be fatigued, as part of fatigue hazard analysis, for quantifying the potential contribution of fatigue in incidents, for comparing one shift schedule to another, and for building FAID® scenarios for clients based on different overtime situations. **Results:** Before the use of FRMS, most companies had minimal staffing and used overtime to cover Controller absences. Now staffing has been increased and the hours of service are carefully monitored to avoid deviations. Individuals are more likely to use off-duty time for sleep and rest, and to seek medical help for sleep problems. One of the reasons for those results is that companies and individuals understand the risks of fatigue. FAID® results assist it in that understanding. **Discussion:** Companies that are using FAID® fatigue modeling software report that their Controllers understand the potential risks posed by their shift schedule, and particularly on overtime shifts.

The Longitudinal Association between Shift Work and Headache

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Introduction: This longitudinal study aimed to investigate the effect of shift work on headache and migraine in a large sample of public employees in a Danish county. Furthermore, we investigated potential mediation by perceived stress, poor sleep and health behaviors. **Methods:** We used questionnaire data (collected in 2007 and 2009) from 3,021 civil servants and hospital employees from the PRISME study. Shift workers were compared with permanent day workers. The outcomes were participants' experience of "being bothered by headache during the past 4 weeks" and reporting "ever being diagnosed with migraine by a medical doctor". We used binary logistic regression and adjusted for sociodemographic factors. In a subsequent step, we adjusted for potential mediators. **Results:** We found higher odds of headache (OR=1.26; 95% CI: 1.03–1.55) and migraine (OR=1.74; 95% CI: 1.05–2.87) among shift workers compared with day workers. Inclusion of potential mediators in the analyses did not attenuate the associations. **Discussion:** Shift workers have higher risk of headache and migraine. These associations were not explained by differences in perceived stress, sleep problems, or health behaviors. Thus, future research is needed to disentangle the underlying mechanisms with the aim of reducing headache or migraine related to occupational exposures.

Leisure Activities and Rest after Long Work Hours and Night Work - A Pilot Diary Study Using Mobile Devices

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Introduction: The negative effects of long work hours and night work on health and well-being have been studied in a variety of settings. However, less is known about effects on social participation of these working hours, especially in prospective and diary settings. Therefore, we designed a diary study based on mobile devices allowing daily real-time measurement of working hours, sleep/rest and several leisure time activities (alone or with others), as well as satisfaction with leisure time. A pilot test is currently conducted, and the results will be presented at the Symposium. **Methods:** A volunteer sample of 10 nurses with work schedules that included long work days (10-12 hrs) and frequent night work was recruited in an Austrian nursing home. They were provided with a mobile device in which participants entered daily start and end of work, sleep, and leisure time in real-time over the course of 4 weeks. During leisure time, a random sampling of leisure activities was conducted to measure timing and types of activities. At the beginning of each sleep period,

a short survey on leisure time satisfaction was conducted. **Results:** Data collection will be completed in March 2019. Data analysis will be conducted regarding patterns of work, sleep, leisure time activities and satisfaction with leisure time on work days and work-free days. If possible, long (>10hrs) vs. shorter (<=10hrs) work days and night shifts will be compared. **Discussion:** This is - to our knowledge - one of the first studies that combines diary measurements with random sampling of leisure time activities in combination with long work hours and night work. The results of the pilot test will inform future studies on the temporal patterns of work, sleep, and leisure time, and will help forming of new or altered hypotheses in the causation of social impairment due to working hours.

The Relationship between Workload, Performance and Fatigue in a Short-Haul Airline

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Introduction: Short-haul flights are associated with irregular work schedules and increased workload, due to frequent takeoffs and landings. We examined the relationship between pilot workload, performance and subjective fatigue during normal short-haul operations. **Methods:** Ninety airline pilots (8 female), mean age 33 (±8 years) completed a NASA-Task Load Index (NASA-TLX), a Psychomotor Vigilance Task (PVT; a reaction time test sensitive to sleep loss) and a Samn-Perelli (SP) fatigue scale, over a period of 20 duty days at top-of-descent on 2762 short-haul flights. The duty days included either 2 or 4 flights per day starting at different times as scheduled during normal operations. Workload was measured using the six NASA-TLX scales: mental demand, physical demand, temporal demand, effort, performance and frustration. Lapses (reaction times [RT] > 500ms) were calculated for the PVT. Spearman correlations were calculated to identify relationships between the NASA-TLX, PVT lapses, and SP. **Results:** The six scales of NASA-TLX were positively correlated with the PVT lapses ($p < 0.01$) showing an increase in workload when lapses increased. There was a positive correlation between subjective fatigue as measured by the SP fatigue scale and

each of the six scales of NASA-TLX ($p < 0.001$) suggesting that pilots reported higher workload when perceived levels of fatigue were higher. Of the six workload scales, mental demand and performance were rated the highest (mental: M = 40.99, SD = 20.32; performance: M = 41.61, SD = 20.71) and effort was rated the lowest (M = 15.59, SD = 8.98).**Discussion:** Preliminary analyses suggest that high workload is associated with poorer PVT performance and increased self-reported fatigue in this population of short-haul pilots. Future studies should explore how other workload factors (i.e. flight hours, time of day) influence self-reported and objective fatigue measures.

Sensitivity of Brief Cognitive Tests to Sleep Loss and Time-of-Day: Results from the Stockholm WakeAPP

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Introduction: Lab studies convincingly show that several cognitive functions are impaired after sleep loss as well as showing time-of-day variation. A number of problems face those studying cognitive functions in the field, long task duration and sensitivity to sleep loss being two. The purpose here was to determine how sensitive a set of brief cognitive tests are to sleep loss and time-of day influences. **Methods:** 176 participants (101 female, ages 18-45) participated in a sleep-deprivation experiment. After three nights of normal sleep (7-8 hours), participants were randomised to either one night of sleep deprivation or a fourth night of normal sleep. Participants completed a battery of cognitive tests using the Stockholm WakeApp. Cognitive tests included simple attention, working memory, episodic memory, mathematical ability and conflict processing (Stroop). Each test being 2 minutes. A baseline measurement was completed at 22:00, followed by three measures during the test day (approximately 08:00, 12:30 and 16:30), half of subjects being sleep-deprived.**Results:** Data indicated reduced performance on all tasks ($p<.001$), and a decrease in performance across the day ($p<.05$) due to sleep deprivation. **Discussion:** Sleep deprivation caused impairments in all five tested cognitive dimensions

as measured through the Stockholm WakeApp. The study supports that brief 2-minute tasks can be used to assess cognitive functioning, including several executive functions, following sleep loss.

Shortened Rest Periods and Well-Being of Full-Time Employees in Germany: Evidence from the BAuA Working Time Survey 2017

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Introduction: In the changing world of work, debates on the flexibilization of working hours increasingly challenge existing working time regulations, such as statutory rest periods. Since rest periods are essential for physical and mental recovery, shortening of rest periods is controversial. Existing research focusses primarily on quick returns in shiftwork. However, flexible working time arrangements may extend work into evenings also among non-shift workers. This raises the question of who is affected by shortened rest periods, which working time characteristics are associated with shortened rest periods, and how they are related to different aspects of well-being. **Methods:** On the basis of representative data from the BAuA Working Time Survey 2017, shortened rest periods among full-time employees (n = 6'564) are examined. Shortened rest periods, defined as periods shorter than the statutory minimum rest period of 11 hours (European Working Time Directive 2003/88/EG), were assessed via employees' self-reports. First, the prevalence of shortened rest periods in several groups of employees is analyzed. Second, relationships of shortened rest periods and psychosomatic health complaints and work-life balance are reported. **Results:** Analyses reveal that shortened rest periods are more common among young employees, managers, and employees in the service sector and often co-occur with long working hours, overtime, atypical working time arrangements, and high flexibility requirements. Further, shortened rest periods are accompanied by poorer health and impairments of work-life balance. **Discussion:** There are indications of the negative effects of shortened rest periods also among non-shift workers. The results therefore suggest that minimum rest periods are important and meaningful instruments of occupational safety and health. They limit the daily exposure duration and enable a minimum standard of recovery from work strain. Derogations from the regulation on statutory rest periods must therefore be critically assessed.

Short Sleep, Psychosocial Work Stressors, and Measures of Obesity: Results from an Australian Cohort Study

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Introduction: Short sleep and workplace stress are both established risk factors for overweight and obesity, yet few studies have considered how these two factors may intersect. The aim of this study was to establish the associations between these two exposures and their relative associations with body mass index (kg/m^2) and waist circumference (cm). **Methods:** A cross-sectional design sampled current employees (N=423) from an Australian cohort using a computer-assisted telephone interview and clinic-measured height, weight, and waist circumference. Short sleep ($\leq$6h/night) was reported by 25.8% of the participants. Psychosocial work stressors were defined using the Job Demand-Control-Support (JDCS) model and calculated at the subscale level (psychological demands; skill discretion; decision authority; coworker support; supervisor support). General linear models were used to assess associations between short sleep, the JDCS subscales (split at median), and BMI and waist circumference. **Results:** Separate analyses identified short sleep and a lack of skill discretion at work as predictors of both BMI and waist circumference. Furthermore, when both predictors were entered in the same model, each was associated with elevated BMI (b=1.79, p=.003; b=1.08, p=.045) and waist circumference (b=4.20, p=.005; b=2.97, p=.028). Short sleep was also associated with high perceived psychological demands at work (b=1.81, p=.003). All models were adjusted for gender, age, work hours, blue vs. white collar job, and household income. **Discussion:** These findings indicate the importance of considering the interplay between short sleep and psychosocial work stressors, and their respective associations with measures of overweight

and obesity. Further research using longitudinal data is needed to model potential mechanisms (e.g., behavioral and physiological). A novel feature was the subscale consideration of the prominent JDCS model of work stress. Advocacy for both improved habitual sleep (e.g., ≥7h/night) and job redesign to increase skill discretion at work may promote lower levels of overweight and obesity for employees.

Shift Work in the Wholesale and Retail Trade Sector

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Introduction: The Wholesale and Retail Trade (WRT) Sector employed 21,740,100 workers in January 2019, according to Bureau of Labor Statistics. WRT includes a wide variety of workplaces including gas stations, grocery stores, and wholesale warehouses, where workers face safety and health risks associated with shift work. This study focused on shift work in WRT and explored its association with socioeconomic and demographic variables including age, gender, income, region, and education during 2012-2017. **Methods:** We used data from the American Community Survey, a large nationwide survey conducted annually by the U.S. Census Bureau (USCB) that has information on individual work schedules as well as socioeconomic and demographic variables. We used USCB-provided weights to estimate annual nationally representative statistics. We used a multinomial logistic regression model to analyze data on 158,104,169 WRT workers, averaging over 26 million observations per year for each of the years examined. We classified shifts as follows: early, if the shift started before 6 am; regular, if the shift started between 6 am and 6 pm; and night, if the shift started at 6 pm or later. **Results:** Preliminary results showed that during 2012-2017, 82% of WRT workers worked in retail trade, 52% were male, and 45% were 14-34 years old. In addition, 10% of workers had early shifts, 86% worked regular shifts, and 4% worked night shifts. Individuals working in the early shift earned considerably lower wages compared to those who had regular or night shifts. Finally, the odds of working in the night shift were higher for retail workers and workers with less years of education, and the odds of working in the early shift were higher for older workers. **Discussion:** This is the first attempt on analyzing shift work in WRT sector and we found that socioeconomic factors are associated with shift work in WRT.

Dietary Intake of Registered Nurses Working Nights Compared to Days off Work

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Introduction: Night shift registered nurses report poor sleep quality which is associated with negative health outcomes. For instance, nurses working night shift are more likely than those on day shift to develop metabolic conditions including obesity and type 2 diabetes. Metabolic disorders can often be mitigated through a healthy diet. Little information exists on how dietary intake changes for nurses working night shift when at work compared to during days off. **Methods:** Registered nurses working 12-hour night shifts were tasked with keeping 7-day electronic food diaries using a free online application called MyFitnessPal. Information regarding water intake along with major macro and micronutrient intake were collected and averaged to reflect intake on working days compared to days off using ANOVAs. **Results:** Although data collection remains in progress, results are expected to be available by the conference. We anticipate gathering 15-20 completed food diaries. Preliminary data analysis reveals significantly greater caloric, carbohydrate, total fat, protein, and sodium intake on working days compared to days off. **Discussion:** By utilizing electronic food diaries, important information may emerge regarding the nutritional status of nurses working night shift. Such work may provide insight into how to best support healthy nutritional habits of night shift nurses to prevent health complications such as diabetes.

Discrepancies in Biological Aging of Long-Haul Truck Drivers

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Introduction: The aim was to reveal the differences of biological aging in truck drivers of international road transportation. **Methods:** Blood pressure (BP), heart rate (HR), duration of breath holding (BH) and static balancing (SB) were registered in 58 truck drivers aged 28-65 y.o. The 29-point questionnaire was used. Biological aging was counted using Voitenko's method. **Results:** The rate of biological aging in truck drivers outpaced

their peers for a 0,55±1,64 years, which corresponds to the mean population rate. In this, 35% of subjects showed sharply delayed (21%) or delayed (14%) rate of aging, 24% - mean population rate, 14% - accelerated, 27% - sharply accelerated rate. BP mean group data (135±2/86±1 mm Hg) showed the high norm level, while in 49% of subjects - hypertension (WHO, 1999). BH mean group score (49,47±2,50 sec) showed good level of oxygen body supply, while in 28% of subjects - bad level, in 38% - very good level. SB mean group rate (30,02±5,39 sec) corresponded to age standards for 20 years younger and increased with aging (r=0,27, *p*<0,05). Majority of drivers complained of back pain, deterioration of sight, skin flabbiness and sleep problems. **Conclusion:** About half of truck drivers manifested hypertension (49%) and showed accelerated or sharply accelerated rate of aging (41%) that gives the reason to qualify them as an occupational group of the risk of disease development evidencing the need for preventive measures. In this, favorable scores of tests on oxygen supply to both the body and brain, along with age improvement in SB could show the occupationally vital functions and reflect the effects of occupational training and selection. Hence, continuous work load on cognitive functions could cause the reduction in the tempo of mean group aging in truck drivers that manifested itself in its moderate score (0,55 year).

Working Time Preferences of Employees in Germany: A Representative Overview

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Introduction: Working hours that are tailored to individual needs may ease the compatibility be-tween work and private life, prevent overload situations, and improve the present and future financial situation. Notwithstanding, the actual working hours of employees often do not match their working time preferences. We present descriptive analyses on actual and preferred working hours of employees in Germany. **Methods:** Data of 8600 dependent employees from the BAuA working time survey 2017 - a representative panel survey among employees in Germany - were analyzed. Employee's working time preferences and actual working hours were assessed using computer-assisted telephone interviews. **Results:** Half of employees would like to work fewer hours than they currently do (49%), 39% want to maintain their working hours and 12% want to extend their working hours. While men's actual and preferred working hours remain relatively stable over different life stages, women's actual and preferred working hours show strong variations depending on their age and caring responsibilities. Financial reasons and a high amount of workload keep many employees from reducing their working

hours. Further, many employees do not extend their working hours despite preferring longer working hours because they are lacking the consent of their employer. Employees whose actual working hours match their preferences rate their health and work-life balance better than employees who are not satisfied with the length of their working hours. **Discussion:** This overview of working time preferences of employees in Germany points towards divergences between actual and preferred working hours. A life-stage perspective reveals the differential needs of men and women in different phases of life. Reasons voiced by employees who cannot put their preferences into practice point towards organizational and political leverage points.

A Prospective Study on Shift Work and Lifestyle Factors among Nurses

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Objectives: To evaluate different work schedules, short rest time between shifts (quick returns) and night shift exposure for their possible adverse effects on different lifestyle factors in a six-year follow-up study. **Methods:** Data stemmed from "The Survey of Shiftwork, Sleep and Health", a cohort study of Norwegian nurses started in 2008/9. The data analyzed in this sub-cohort of SUSSH were from 2008/9 and 2015 and consisted of 1371 nurses. The lifestyle factors were: Exercise (≥1h/week, <1h/week), caffeine consumption (units/day), smoking (prevalence and cigarettes/day), and alcohol consumption (AUDIT-C score). We divided the nurses into four groups: 1) day workers, 2) night workers, 3) nurses who changed towards, and 4) nurses who changed away from a schedule containing night shifts. Furthermore, average number of yearly night shifts (NN), and average number of quick returns (QR) were calculated. QR was defined as <11hours between shifts. Paired t-tests, McNemar tests, and logistic regression analyses were used in the analyses. Significance level α<0.05. **Results:** We found a significant increase (*p*<0.05) in caffeine consumption across all work schedule groups between baseline and follow-up: day workers (3,2 to 3,8 units/day), night workers (3.1 to 3.7 units/day), those who changed towards (2.6 to 3.4 units/day) and those who changed away from night work (2.6 to 4.2 units/day). Furthermore, a significant decline (*p*<0.05) in smoking prevalence was found for day workers (17% to 11%) and night workers (11% to 7%). Analyses did not show any significant differences between groups when analyzing 1) different work schedules, 2) different exposures to QR, 3) different exposures

to NN on the respective lifestyle factor trajectories. **Conclusion:** We found no significant differences between the different work schedule groups or concerning different exposures to QR or NN when evaluating these lifestyle factor trajectories. This challenges the notion that shift work has an adverse impact on lifestyle factors.

Nutritionist Counseling as a Health Promotion Strategy for Shift Workers in Oil and Gas Industry, Brazil

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Introduction: Shiftwork has been linked to an increased risk of obesity, lipid and glucose tolerance impairment. Employers should promote strategies at workplace to prevent these effects, like nutritional counseling services. The objective was to characterize the health status of employees from an oil and gas company at Rio de Janeiro, Brazil, and to investigate if shift workers were involved in a nutritional counseling service. **Methods:** Data obtained from the Occupational Medical Annual Exam of the company were analyzed. Variables were expressed by means or frequencies, and the Chi-square test was done. The significance level was 0.05 and all analyses were performed in IBM SPSS Statistics version 25. **Results:** The sample was formed by 2619 workers with medium age of 42 years, 92,7% males and with the mean of 12,07 years of work. 51,6% worked in rotating shifts (a sequence of seven day-shifts, seven night-shifts and twenty-one days off) in oil rigs, 72,3% had overweight or obesity, 39,6% had total cholesterol levels at 200 mg/dL or above and 55,6% had glycemia of 100 mg/dL or more. Less than 1/3 had nutrition counseling at least once a year. The percent of workers looking for counseling by a nutritionist was 34,1% between workers in regular schedule, 21,3% and 21,7% between day shift workers and day/night shift workers, respectively (chi square = 41,9; p < 0,001). **Discussion:** Shift workers are at a higher metabolic risk and should be a priority public for health promotion interventions. At this company, although the nutritional counseling service is freely available to all employees, it is not obligatory to shift workers and they were the group with the smaller frequency in the service. Shiftwork should be treated as a risk factor for metabolic disease during the health promotion programs planning to attenuate the health impacts of this work organization.

Motivation Behind Informal Workshift Arrangements of Crime Scene Forensic Investigators

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Introduction: Some of the duties of the forensic police sector "Crime against the person" (NPCCP) is to conduct investigations at crime scenes of urban violence. The shiftwork schedule of forensic teams at the NCCP in São Paulo, Brazil is officially organized as fixed shift schedules, from 12h on to 36h off (day 07h -19h or night 19h to 07h). Workers should be on duty an average of 12 monthly shifts, the remaining days are off times. This report aims to describe the motivation of forensic teams making informal arrangements of their work schedule. **Method:** This is a qualitative study. We use ethnographic assumptions. Data collection started April 2016 to March 2017. It included daily notes taken during 61 investigated crime scenes. Followed in-depth interviews, guided by a semi-structured questionnaire, which included work activities, stressors and health symptoms. Participants were 16 forensic experts and 12 forensic photographers belonging to the division of NPCCP of Criminology Institute of São Paulo, Brazil. **Results:** Participants reported informal arrangements of their work schedules, extending their shifts up to 24 hours or 48 hours continuously. Eight participants reported two informal jobs. Their allegations are to reconcile work with a second job in order to increase their income. Participants also reported this practice allow them to stay away from work a longer time, in order to recover (physically and emotionally) from their work activities. **Discussion:** Holding two jobs that totalize more than 60 hours/week, is an illegal practice in public service. However, managers often turn a blind eye, as monthly wages are usually low. Forensic jobs demand great emotional control. It was recommended to implement countermeasures, in order to provide psychological assistance and a career plan to limit the duration of work shifts.

Survey of Healthcare Workers' Break Use and Sleep Interruptions at Two U.S. Hospitals

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Introduction: Sleep disturbances resulting from shift work can negatively affect healthcare workers' health, mood, and patients' safety. Break practices and on-duty napping can be used to mitigate fatigue and sleepiness; however, little research has been conducted with hospital workers to understand how they use their breaks and barriers to rest or sleep. This study examined healthcare workers' use of break time and sleep opportunities in order to understand whether restorative rest at work and overall sleep quality could improve. **Methods:** Data were collected via secure online surveys that were accessible for one month to all employees of two regional hospitals in the USA's Inland Northwest. The present study was nested within a larger survey of 1,285 healthcare workers that has been reported on previously. A qualitative descriptive approach using content analysis methods was used to evaluate text responses from 605 workers who responded to two open-ended items that were previously unexplored. Workers were asked to identify reasons why they had trouble sleeping in the past month and what prevented them from taking their 30-minute break time at work. **Results:** 117 respondents reported on reasons for not taking their 30-minute breaks and 488 wrote in specific sleep interruptions. Four main categories were identified for trouble sleeping: Family, stress/worry, physical ailments, and environment. Four main categories were identified for reasons for skipping breaks: inadequate relief staffing, unit culture, too busy, and individual choice. **Discussion:** Among hospital workers, barriers exist to obtaining adequate sleep and utilizing breaks. Workers' perspectives should be considered when creating policies and promoting unit cultures that prioritize use of break and rest opportunities. Relief for patient care duties and providing wellness programs to address sleep hygiene and stress reduction may increase use of restorative breaks and improve sleep disturbances.

Survey of Working and Sleeping Time by Industry and Occupation of Fulltime Workers in the U.S.

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Introduction: Long working hours and inadequate sleeping time can lead to increased fatigue and injuries, and decreased wellbeing for workers. This analysis describes working and sleeping time by occupation and industry among fulltime workers in the United States. **Methods:** This analysis examined publically available data from the American Time Use Survey (ATUS) spanning 2015−2017. ATUS is conducted by the U.S. Census Bureau for the Bureau of Labor Statistics (BLS). It is a nationally representative sample of persons aged 15 years or older living in U.S. households. During a 20-minute phone interview, participants were asked about their sequential activities going back 24 hours. **Results:** In 2015−2017, on average fulltime workers worked 8.1 hours (excluding lunchtime), slept 7.9 hours on a working day, and slept 9.7 hours on a non-working day. There is no substantive difference in sleeping time by occupation and industry on a working day. However, working hours varied by industry and occupation. Among the general occupational categories, Farming/Fishing/Forestry occupations had the longest working hours (8.7 hours a day on average) and Education/Training/Library occupations had the shortest working hour (7.3 hours). Among the general industrial categories, Management of Companies and Enterprises had the longest working hours (9.2 hours a day on average) and Internet Publishing and Broadcasting had the shortest working hours (5.7 hours). For detailed occupations that characteristically worked irregular shifts, on average Emergency Medical Technicians and Paramedics worked 10.9 hours a day, Taxi Drivers and Chauffeurs worked 9.7 hours a day, Driver/Sales Workers and Truck Drivers worked 8.8 hours a day, and Physicians and Surgeons worked 8.3 hours a day. **Conclusion:** This analysis provided much needed national baseline data on working hours by occupation and industry for fulltime workers in the U.S. ATUS provides a useful data source to study working time and shiftwork by occupation and industry.

Predicting Circadian Phase in Night Shift Workers Using Actigraphy

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Introduction: A major barrier in addressing circadian misalignment in shift work disorder is the lack of feasibility in measuring circadian phase in the clinic, particularly because obtaining dim light melatonin onset (DLMO) is resource intensive. One promising solution is to predict DLMO based on actigraphy (light and movement) using mathematical models; however, these models have only been tested in adults with relatively small variations in daily light-dark schedules, especially compared to night shift workers. This study tested the feasibility of actigraphy in predicting DLMO in a sample of fixed-night shift workers. **Methods:** A sample of 30 fixed-night shift

workers wore wrist actigraphy for 7 to 14 days (mean = 9, SD = 3.4) before completing DLMO in the lab. DLMO was assessed via hourly salivary melatonin samples collected in dim light (< 10 lux) for a period of 24 hours. Light information (i.e., timing and duration) augmented with actigraphy recordings was used in a Kronauer model of the circadian clock to produce a predicted DLMO, which was then compared to in-lab DLMO. **Results:** Model predictions of DLMO showed high correlation with in-lab DLMO, with an R2 of 0.83. The 95% CI of the model predictions was ± 1.71 hours, which is comparable to studies using non-shift workers in the general population. Follow-up analyses extended the model by including PERIOD3 genotype (variable number tandem repeat) as a proxy for circadian period (tau), which raised the R2 to 0.86. **Conclusion:** This study is the first to provide evidence suggesting that actigraphy may be a feasible alternative to in-lab measurement of circadian phase in night shift workers. Future research should explore how inclusion of addition predictors (e.g., biological measurement of tau) may increase accuracy, and further refine the necessary parameters for accurate prediction of circadian phase, such as duration of actigraphy collection.

Dose Automation Probability Associate with Working Hours and Shift Work Prevalence? -Results from National Surveys in Taiwanese Workers 2001-2016

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Introduction: Job automation is increasing worldwide, and it has been claimed to help decrease workers' loads. This study aims to examine the long-term changes of working hours and shift work prevalence in jobs with different levels of automation probability. **Methods:** Data were extracted from the 6 rounds of population-based surveys of working people over the period from 2001 to 2016 in Taiwan. Participants were employees aged between 25-64 years old and completed self-administered questionnaire concerning work and health conditions. A total of 92,002 participants were available for this study and their occupations were categorized into high, median, and low level of automation probability groups, according to the level of perception and manipulation, creativity, and social intelligence required to perform their work. Distributions of working hours and shift work prevalence among the

3 automation probability groups were compared using chi-square tests and ANOVA tests. **Results:** Over the 15-year study period, weekly working hours decreased 0.09 hours and shift workers increased from 14.7% to 21.5%. When classified by automation probability, prevalence of high and low automation probability jobs had decreased by 15.7% and 1.4%, while those of median probability jobs had increased by 20.4%. Among workers in high and median automation probability group, working hours had decreased by 2.5% and 1.9%, respectively, while a 0.05% increase was observed in low automation risk group. The overall prevalence of shift work had increased steadily in all 3 groups, with increase percentage of 40.9%, 33.2% and 102.8% for high, median, and low automation probability groups, respectively. **Discussion:** Over the recent 15 years when job automation had increased but working hours had decreased only slightly. The prevalence of shift work had increased rapidly especially in jobs with low automation probability. The health impact of job automation should be examined.

Age Limits of Satisfactory Bloodcirculation Effectiveness in Shiftworkers

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Introduction: Cardiovascular system is one of the main physiological systems maintaining workability and limiting employability in human being. The purpose was to determine the age limits of satisfactory bloodcirculation effectiveness across some occupational groups of shiftworkers. **Methods:** The wide range of occupations was observed: from the predominantly physical (miners) to the predominantly mental (surgeons) character of work, including human-operator activity (drivers, telephonists). Surgeons and miners worked regular night hours under harmful environment, drivers and telephonists worked non-regular night hours, truck drivers and surgeons worked long work hours. Blood pressure and heart rate were studied in 59 telephonists (30-55 y.o., women), 62 truck drivers

(28-65 y.o., men), 67 surgeons (23-74 y.o., men) and 31 miners (32-58 y.o., men). Hemodynamic parameters were calculated. Bloodcirculation effectiveness was evaluated using Buzunov's classification (1991). Data were analysed at $p<0,05$. Mathematical model of linear regression analysis was applied. **Results:** As a mean group data, bloodcirculation effectiveness was found to be average in telephonists, below average - in truck drivers, at the boundary average-below average - in surgeons and miners. The transition of the bloodcirculation effectiveness in telephonists from the average class to below average occurred at the age of 48, from the below average to the low class - at 58 years; in truck drivers - at 43 and 56 years correspondingly; in surgeons - at 45 and 55 years; in miners - at 45 and 52 years. **Discussion:** The decrease in bloodcirculation effectiveness in the observed shiftwork occupational groups occurs before pensioned age (that is 60 y.o. in Ukraine) except for miners (50 y.o.). This corresponds to the literature data on health problems in shiftworkers and gives the grounds to raise the issues on the improvement the work environment and life standards, on reducing the workload and/or the retirement age.

When Work Invades Life: Work, Everyday Life, and Health of Teachers

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Introduction: Several studies have pointed to a scenario of precariousness of work conditions and illnesses among teachers. However, the way work affects their personal lives have not received significant attention, even though it is common to take work home. The aim of the study was to investigate the consequences of work on teachers´ personal lives and potential implications on the health-disease process. **Methods:** Data collection included 33 individual semi-structured interviews, and sociodemographic characterization. Eight teachers recorded the duration of daily activities on weekdays and weekends. Data were analyzed with the help of MAXQDA software, 12. Twenty-nine teachers from four public schools of São Paulo (part-time and full time schools) and their respective principals, participated in the study. **Results:** The vast majority of respondents perceived their lives were being harmfully invaded by their work, and these invasions occurred in different ways. It manifested through a state of continuous attachment to the work. Teachers perceived they could not detach themselves from work, no matter how much they tried. Four main forms of manifestation of invasion were identified, namely, a continuous link with work by: continuous work backlogs,

work preventing or interfering in their private lives, successive frustrations, and moral malaise. The records of the duration of daily activities during the week showed that leisure and sleep times were reduced compared to other activities, such as work and studies for professional improvement. **Discussion:** The situation described by the participants may generate a state of suffering and prolonged lack of availability for oneself and for others, that can damage families and social coexistence, also affecting one´s recovery from work. The phenomenon of life invasion due to work has a potential to be one of the elements that could explain the recurrent illnesses of teachers.

Longitudinal Study of Nurses' Quick Returns and Self Rated Stress when Entering Working Life

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Introduction: Little is known about quick returns (QR) and stress. The aim of the current study was to use a longitudinal design to examine if the variation in QR, both within and between individuals, was associated with self-rated stress. **Methods:** A questionnaire was sent weekly to 267 newly graduated nurses during the first 12 weeks of work (response rate 70-90%). Stress was measured with four items from the Stress-Energy-Questionnaire on a scale from 1 "not at all" to 6 "very much" (mean 3.64±0.8). QRs were identified by evening-morning shift combinations. 262 persons were included in the analysis (2417 observations, average cluster size 9.22). We used a multilevel model with random slope of the effect within-person QRs have on weekly stress ratings. Sensitivity analysis sought to identify threshold values of QR frequency for the onset of elevated stress. **Results:** The results of the within-person analysis showed that one more QR in a week was associated with half a point increase on the stress scale compared to the stress level of the same person in a week with one fewer QRs (r=.057, p=.007). The sensitivity analysis showed that, for both 0 versus 1-4 QRs and 0-1 versus 2-4 QRs, weeks with more QRs were associated with higher stress ratings. The confidence intervals in these two models overlapped (-0.004-0.073 and 0.022-0.177), indicating no absolute number where the increase in stress ratings happens; rather it seems to be a linear relationship. The between-individuals analysis also showed a significant association indicating that individuals with more QRs over the period of 12

weeks had higher levels of self-rated stress in this period (r=.248, p=.019). **Discussion:** An increase in QR was associated with elevated stress levels both within and between individuals. It was not possible to identify a threshold for when the increase started.

Night Work for Hospital Nurses and Sickness Absence: A Retrospective Study Using Routinely Collected Data

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Introduction: There is conflicting evidence on the effect of night work on sickness absence. While a number of studies found that working rotating night shifts increases sickness absence, others have found an association between permanent night work and higher sickness absence. However, previous studies tended to use nurse self-reported data on both shift patterns and sickness absence levels. The aim of this study is to measure the association of nurses' patterns of night work and sickness absence using routinely-collected data from staffing rosters. **Methods:** A retrospective longitudinal study using routinely collected data across 32 general inpatient wards at an acute hospital in England. We used generalized linear mixed models to explore the association between night work and the subsequent occurrence of sickness absence. **Results:** The total sample was 1944 nursing staff. Of these, 1244 were registered nurses (RN) and 700 were healthcare assistants (HCA). The majority of staff (71%, n= 1273) worked rotating shifts, while only 123 (6%) worked permanent night shifts. After controlling for potential confounders including proportion of long (≥12-hour) shifts worked, proportion of days worked in the past 7 days, and staff grade, we found that nurses working on permanent night schedules were more likely to experience sickness absence (OR= 1.13; 1.04-1.23), compared to nurses working on day only schedules. **Discussion:** Working permanent night work schedules on hospital wards is associated with a higher risk of sickness absence for RNs and HCAs. The higher sickness absence rates associated with permanent night shifts could result in additional costs or loss of productivity for hospitals. This study challenges the assumption that permanent night

schedules maximize circadian adjustment and therefore reduce health problems.

Design and Compensation of Shift Work Schedules; The Case of the Dutch Disability Sector

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Purpose: This study investigates the current state of shift working in the Dutch disability sector. The comforts and discomforts, the design of the schedule and the compensation for the discomforts are included. The impact of shift work on employee satisfaction, sleep quality and work-life balance (WLB) is investigated. Yearly working hours variation, short-term schedule disturbances, schedule disturbances, and five most distinctive working patterns serve as explaining variables. It is hypothesized that counter-value and counter-weight compensation will have a moderating effect on this relation. The main research question is: to what extent do financial compensation and work-time control influence the relation between shift work schedule characteristics and employee outcomes? **Methods:** Based on gathered information from previously performed case studies, a digital survey was composed and distributed in 2017. Respondents (N=6552) were employees working in any institution in the disability sector in the Netherlands. Through multiple regression analyses, the proposed hypotheses were tested. **Results:** Moderating effects of financial compensation and work-time control on the relation between schedule characteristics and satisfaction, sleep quality and/or work-life balance were found. However, their impact is very small. Financial compensation and work-time control showed to have a large direct effect on the employee outcomes. Also, direct effects of some of the schedule characteristics were found. Especially the experienced heaviness of the work schedule/shift played an important role in explaining the dependent variables. **Discussion:** The main conclusion has to be that both financial compensation and work-time control do not substantially weaken the negative effects of shift work on employee outcomes. However, they have a direct effect on the employee outcomes. Some recommendations for the sector were given. Limiting the late-early combination shifts, night shifts and late shifts in the weekends would improve the schedules. Yearly working

hours variation, short-term disturbances and schedule complexity should be minimized as this has a negative impact of the satisfaction and WLB. A compensation system based on the availability of the employee could be fairer. Moreover, the options of more work-time control should be explored.

Development of a Tool for Assessing the Health and Social Risks Associated with Shiftwork

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Introduction: The purpose of the study is to combine the ergonomic recommendations for shiftwork (such as Knauth & Hornberger, 2003) into one tool, showing a score indicating the physical and social strain of a work schedule. The tool generates a penalty score per working schedule, the relative size of this score compared with other schedules is an indication of physical and social risks. **Method:** The tool takes all kinds of work schedule characteristics into account (e.g. number of night shifts, number of consecutive night shifts, shift length, early working times, sequence, weekends, predictability) that influence physical and social strain. The choice of these characteristics and their relative weight were based on a literature review. The total score is based on a permanent use and infinite repetition of working schedule and based on an average person. The calibration of the tool was done by comparing many work schedules with each other. The tool is used for several years in two large companies in The Netherlands. Interviews were executed to assess the experiences of employees, health & safety officers, managers and the works council with the tool. **Results:** The paper will show the tool, including the 19 characteristics on which the total score is based. Secondly, more than 25 common work schedules are presented in the tool with their overall scores. Furthermore, the paper will present the use of the tool within two companies. The tool seems to support more objective discussions about perceived physical and social strains of shiftwork schedules. **Discussion:** The tool supports the discussion on health and social risks associated with collective work schedules. One of the distinctive features is that it provides a total score for a work schedule by weighing all relevant schedule characteristics. Further development is needed to include the personal characteristics of employees (such as chronotype, individual preferences, travel distance).

Qualitative Interviews of Registered Nurses' Experiences Taking Breaks on Night Shift

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Introduction: Night shift registered nurses have well documented sleep deprivation and associated increased patient error rates. A potential exists to reduce risks to health and patient safety by optimizing use of break time, but nurses commonly report not taking adequate rest breaks. The purpose of this study was to investigate barriers and facilitators to taking breaks for night shift nurses, and to better understand ways to optimize the restorative nature of breaks. **Methods:** Using a philosophical hermeneutic phenomenology approach, 15 registered nurse night shift workers were interviewed on a one-on-one basis regarding their experiences with breaks and meaningful rest periods during working hours. Using philosophical underpinnings of the methodology, the final step of this methodology involves team analysis and interpretation of interview transcripts, currently underway. **Results:** During the preliminary analysis, the following themes emerged with regards to barriers to meaningful breaks for night shift workers: concern for patient well-being during breaks, lack of staff to provide patient care during breaks, social/peer pressures regarding break time, and a lack of food options for night shift workers. **Discussion:** In-depth interviews add rich detail about the use of break time from the nurses' new and important perspective. This work may encourage a change in cultures regarding the necessity of taking restful breaks and empower nurses to participate regularly in restorative breaks. A high priority to nurses is providing adequate relief staff and environments that assure patient's needs are attended to during breaks. The importance of this work is to encourage a change in culture regarding breaks, empower nurses to participate in restorative breaks, improve the overall health of night shift nurses, and ultimately decrease error and improve patient outcomes.

Longitudinal Measurement of Occupational Fatigue Types among Hospital Nurses

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Introduction: The purpose of the presentation is to describe the longitudinal investigation of occupational fatigue types reported by hospital nurses who work twelve-hour shifts. **Methods:** A secondary analysis of results of two hospital nurse fatigue survey studies from 2012 and 2016 was conducted. All, approximately 1,000, registered nurses employed in a single hospital were emailed an online survey. A cohort of patient-care (not manager or director) nurses who completed the surveys was identified; there were 245 in 2016 and 111 in 2012. Latent profile analysis was used to identify fatigue profiles for the patient-care nurse cohorts based on five instruments that measure different concepts of fatigue: the Chalder Physical Fatigue Scale, Chalder Mental Fatigue Scale, Occupational Fatigue Exhaustion Recovery (OFER) Chronic Fatigue scale, OFER Acute Fatigue scale, and OFER Inter-shift Recovery scale. ANOVA was performed to compare fatigue profiles based on levels of adaption variables. **Results:** A comparable model structure with three latent profiles categorized as high fatigue/low recovery, moderate fatigue/recovery, and low fatigue/high recovery was identified for the data sets with consistent rates of fatigue types. Fatigue levels increased across all measures from 2012 to 2016. Nurses in the high fatigue/low recovery group in 2012 and 2016 were significantly more likely to have less compassion satisfaction, more burnout, more secondary traumatic stress, and a greater need for recovery. **Discussion:** This is the first reported longitudinal evaluation of nurse fatigue. Our results support the use of consistent definitions and measurements of nurse fatigue in U.S. hospitals to describe the context in which nurse fatigue occurs and to test interventions to determine effective strategies to mediate nurse fatigue and prevent associated nurse and patient harm. Hospital nurse fatigue is multidimensional and can be grouped into risk profiles to inform practice policies, evaluate fatigue risk management strategies and promote safety practices.

A Good Night's Rest: Trait Inter-Individual Differences in Deep Sleep

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Introduction: There are large, systematic inter-individual differences in sleep architecture, which are robust to prior sleep deprivation. Inter-individual differences in the amount of deep sleep, stage N3, in nighttime sleep have been found to be particularly large and stable within individuals. Here we investigated whether this extends to daytime sleep, and to what extent it is robust to prior caffeine intake. **Methods:** In an 18-day in-laboratory study, 12 healthy subjects underwent three 48-hour periods of total sleep deprivation (TSD). Each TSD period was preceded by three 8-hour baseline sleep periods (21:00–07:00) and followed by a 5-hour daytime nap (07:00–12:00). The study concluded with three 8-hour recovery sleep periods. In a randomized, counterbalanced, double-blind, placebo-controlled fashion, subjects received either placebo, 200 mg caffeine, or 300 mg caffeine every 12 hours during TSD. Sleep periods were recorded polysomnographically. Analyses focused on the baseline night immediately preceding and the daytime nap immediately following each TSD period. Mixed-effects ANOVA was used to assess between- and within-subjects variance in stage N3 sleep, accounting for baseline nights versus daytime naps and prior caffeine dose. **Results and Discussion:** Daytime naps after TSD had 44.6±5.1 minutes (mean±SE) more stage N3 sleep than baseline nights (F2,57=76.8, p<0.001), reflecting the effect of the prior TSD. Daytime naps preceded by 200 or 300 mg caffeine intake every 12 hours during TSD had 15.4±6.2 and 21.6±6.2 minutes less stage N3 sleep, respectively, than daytime naps in the placebo condition (F2,57=6.39, p=0.003). Across the baseline nights and daytime naps, regardless of caffeine condition, there were large inter-individual differences in stage N3 sleep, with a standard deviation over subjects of 23.2 minutes (95% range 50.2–143.0 minutes). These inter-individual differences were highly stable, with an intraclass correlation coefficient of 0.70 (substantial). Thus, the amount of deep sleep is a trait characteristic that is robust to sleep deprivation, circadian misalignment, and caffeine.

Biomathematical Modelling for Shift Planning in the Tunneling Industry

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Introduction: To date shiftwork and sleepiness in tunneling workers in the construction industry is under researched compared to other domains e.g. transport. This work aims to describe how the tunneling industry uses how biomathematical

models (BMMs) in tunneling operations and advise on how current practice could be improved. **Method:** Eight industry experts including tunneling managers, health and safety professionals and representatives from tunneling sub-contractors, attended a structured workshop facilitated by three researchers. The 2.5-hour discussion covered expectations of BMM's, compared the HSE FRI to other available BMM's, and generated advice for BMM users in the industry. Prior to attending the workshop participants were provided with an information pack outlining BMMs and describing FAID, HSE-FRI, SAFTE-FAST and SWP. **Results:** Participants reported that when bidding for work, clients often require evidence of fatigue risk assessment. However, shift pattern decisions are regularly made based on cost with modelling later applied to justify the decision. While the workshop attendees recognized that models provide an indication of the "risk" of fatigue, it was felt that this is not universally understood across the industry. For example, a threshold value of 60 on the HSE-FRI is commonly accepted but participants did not believe that the industry would tolerate 60% increase in risk for other factors, therefore, indicating a potential lack of understanding. **Discussion:** The HSE-FRI is widely used within UK tunneling, due to its association with the Health and Safety Executive and being freely available. There may be potential benefits of using other BMMs however, these would need to be significant to outweigh the value of the HSE brand. Advice for BMM use in tunneling included: understand the assumptions of the model, clearly communicate the risk level and what this means e.g. visually with RAG system and in words, and, revisit the calculation as shift schedules change.

Biological Effects of Night Shift Work on Total Sleep Time

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Introduction: Night shift work is associated with 1 to 2 hours of sleep loss daily, which has been attributed to the wake-promoting action of the biological clock interfering with daytime sleep, as well as social factors restricting sleep opportunity. In this laboratory study of simulated day and night work, we investigated sleep duration in those sleeping during the day versus those sleeping at night. **Methods:** Fourteen healthy adults (ages 22–34, 4 women) participated in a 7-day/6-night in-laboratory experiment. All subjects first had an 8-hour nighttime sleep opportunity (22:00-06:00). Subjects were then assigned to a simulated day shift (DS) condition (n=7) or a simulated night shift (NS) condition (n=7). The DS condition had three more nights with 8-hour nighttime sleep opportunities (22:00-06:00). The NS condition had a 4-hour transition nap (14:00-18:00), then three days with 8-hour daytime sleep opportunities (10:00-18:00). In both conditions, the experiment continued with a 24-hour period of sleep deprivation. Subjects in the DS condition then had a 4-hour transition nap (06:00-10:00), and all subjects ended the experiment with a 12-hour nighttime sleep period (18:00-06:00). All sleep periods were recorded polysomnographically. **Results and Discussion:** Subjects in the NS condition exhibited on average 0.5 ± 0.4 hours of total sleep time per day less than subjects in the DS conditions (t12=2.27, p=0.044). That difference, which was specifically attributable to the biological clock in this study, is less than the 1–2 hours per night indicated in previous field research. By implication, the larger amount of sleep loss observed in real-world NS settings must be caused at least in part by other, external factors restricting sleep opportunity.

Sleepiness among Pilots and Helicopter Emergency Medical Service Crew Members in the Norwegian Air Ambulance Service

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Objectives: To explore the effects of shift work and extended working hours on sleepiness among pilots and Helicopter Emergency Medical Service (HEMS) crew members. **Methods:** Sleepiness was examined during three consecutive weeks in a descriptive field study encompassing the week at home before work, the work week, and the week at home after work. The sample comprised 25 pilots and 25 HEMS crew members (mean age 43.8 years). Sleepiness was measured with wake diaries (Accumulated Time with Sleepiness; ATS and Karolinska Sleepiness Scale; KSS) and a reaction time task. **Results:** The overall sleepiness scores were low during all three weeks. When comparing the three weeks, sleepiness levels were lower on all ATS items during the work week compared to the week before work (all p <.05) and the week after work (all p <.05). There was a slight difference across work days, in which subjective sleepiness scores were highest the first day on duty compared to the remaining work days (KSS; all p <.01). No change in reaction times was evident during the work week. The crew members

reported highest sleepiness levels at midnight (KSS), compared to all the other time points over the course of a work day (all p <.001). **Discussion:** Surprisingly, we found lower sleepiness during the work week, compared to the weeks off. During the work week, a slightly higher sleepiness score was found on the first day compared to the rest of the days. Across work days, the highest sleepiness scores were reported at midnight. There were no significant differences in reaction times in terms of days or time of day.

Night Napping at Work in Practice: A Qualitative Study of Shift Workers' Perceptions and Strategies at a French Industrial Company

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Introduction: Napping is a recommended measure for reducing the effects of shift work on vigilance. This exploratory study was conducted at a French food processing company, which had officially introduced napping for recuperation during night shift breaks. The study aim was to investigate shift workers' views on napping and on the possibility offered by the company. **Methods:** 52 shift workers were questioned during the 4 work observation nights or at scheduled semi-structured interviews. The questions involved sleep habits during the cycle, including nap-taking, perception and implementation of napping at work, physical conditions, discussions on this issue among colleagues, etc. The interviews were transcribed and analyzed using qualitative, inductive methodology based on grounded theory. **Results:** We identified 5 types of recuperative practice outside the main sleep episode: a nap or rest in the nap area, a nap in the break room, a nap at home and dozing at the workstation. Only a small minority of employees (7/52) used the company nap area on a regular basis. Analyzing the different practices revealed common issues (problems associated with falling asleep, depth of sleep, waking up and even anticipating a later sleep period). Analysis allowed us to build a model based on 4 sequences, namely decompression, sleep, sleep inertia and recuperation. Strategies varied and revealed a number of prerequisites (material/physical, organizational, cultural and personal) necessary to proper performance of the process. **Conclusions:** Authorizing night napping is insufficient

for this practice to be broadly adopted by shift workers. Napping at work is a complex process and the worker does not find it straightforward to manage. Our research provides conceptualization components, which will be tested in subsequent case studies.

Estimating Injury Risks of Working Hours - Presenting a New Open Access Calculation Engine

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Introduction: A large and growing body of research has shown that different characteristics of working hours are associated with increased risks for injuries and accidents at work, such as:
- time of day,
- time on task,
- number of successive shifts,
- lack of (or short) rest breaks, and
- commuting times.

Findings have been included in a Fatigue and Risk Index [1] to calculate the risk imposed by actual working hours. However, the incorporated risk algorithms have since been updated and current applications do not provide a transparent risk estimation, where algorithms and detailed results are accessible. Therefore, we developed a new software to calculate the injury risk of specific working hours, of single work days, and of successive days. Our software is based on up-to-date research findings and delivers a detailed report describing the results and transparently linking them to the research findings. **Methods:** The software integrates the most recent meta-analysis on work hours and injury risk [2] (with some adjustment) to calculate total and daily risks. The tool contains a user interface to manually enter and to import working hours. Based on the data, it generates a detailed report in PDF format with risk estimates over the total period and for each work day. Several review stages were conducted and the tool is now in final testing. **Results:** The software tool will be available with support of the "Allgemeine Unfallversicherungsanstalt" (AUVA, the Austrian Public Accident Insurance, Vienna) via the platform www.eval.at. The calculation engine will be open-access. **Discussion:** The new software tool provides information about injury risks for employers, employees and social partners. Different working time arrangements can be compared based on their inherent risk. The open access approach of the core engine facilitates scientific advancements.

Beyond Position Statements: One Hospital's Successful Initiative to Implement Napping for Night Shift Nurses

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Introduction: Fatigue and sleepiness during the night shift is well-documented, and associated with increased errors, accidents, injuries at work, and drowsy driving. Napping has not been widely implemented in hospitals despite favorable scientific evidence. A multiphase quality improvement initiative is described that translates the evidence about napping into a successful program for nurses in one academic medical center. **Methods:** The phases of research to practice (r2p) spanned more than one year and included garnering leadership support and resources, building a translation team, evaluating the evidence, responding to operational concerns by managers, developing an implementation strategy, then implementing napping and evaluating the results. Night shift nurses were surveyed prior to and 15 months after napping was approved. Perceptions of drowsy driving, sleepiness at work, and co-worker relationships were assessed. Panel 1 (pre-napping) and Panel 2 (post napping) were compared using t tests of group differences; as well as post-implementation only nappers versus non-nappers. Nurses' and managers' perceptions of the barriers and facilitators to napping were assessed. **Results:** Thirteen of fifteen nursing units successfully implemented napping. After napping implementation drowsy driving was slightly reduced, and fewer nurses expressed concern about coworker fatigue, but more than half of nurses still had difficulty remaining awake during the shift despite napping. A subgroup of nurses did not nap due to fear of or actual sleep inertia. Barriers to implementation included space, staffing, unit culture, and manager attitude. **Implications:** A planned initiative to translate evidence about napping for night shift nurses was successful on most nursing units but changes were modest. Some barriers to napping are difficult to overcome. Nurses would benefit from having a variety of ways of reducing fatigue and sleepiness during the night shift.

The Effect of Work Shift on Fasting Blood Glucose and Lipid Profiles in Workers in Isfahan City, Iran, during the Years 2014-2015

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Background: Due to the high prevalence of diabetes and dyslipidemia, which are risk factors for diseases such as metabolic syndrome in today's modern society, especially in the working population, the aim of this study was to determine the effect of shift work on fasting blood glucose and lipid profiles in workers in Isfahan City, Iran, during the years 2014-2015. **Methods:** In this cross-sectional study, 6983 employees referred to labor centers for periodic examinations were entered according to the inclusion and exclusion criteria. The patients were divided into three groups based on the type of work shift as day, fixed night, and rotate shift workers, and two groups based of type of work as official and non-official workers. The level of blood glucose and lipid profiles [cholesterol, triglyceride, low-density lipoprotein (LDL) and high-density lipoprotein (HDL)] were evaluated and compared between the groups. **Findings:** There were no significant differences between three groups according to the levels of fasting blood glucose (FBS), triglyceride, and high-density lipoprotein ($p > 0.050$); but there was a significant difference between the three groups based on the cholesterol and low-density lipoprotein ($p < 0.001$, for both); so that the cholesterol and low-density lipoprotein levels were higher in day shift worker than others. **Conclusion:** Based on the results of this study, cholesterol and low-density lipoprotein levels was higher in day shift worker than fixed night and rotate shift workers in high sample sizes of workers in Isfahan City.

Fatigue Factors in San Francisco Bar Pilot Operations

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Introduction: San Francisco Bar Pilots have been guiding ships to and from the San Francisco Bay and its associated waterways since 1850. The work of these maritime pilots involves a challenging mix of activities that call for situational awareness, communications, and perceptual abilities comparable to those required by aviation industry professionals. Errors in this setting can have severe consequences for public safety and the environment, as well as significant financial costs. In 2012, the California State Legislature called for an independent study of the work/rest periods of the Bar Pilots, and the potential impact of maritime pilot fatigue on safe vessel operations. **Methods:** We gathered information via a literature review, observations of work activities, surveys, a task analysis, and an analysis of duty records using the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) model through the Fatigue Avoidance Scheduling Tool (FAST version 3.2). **Results:** The Fatigue Factors Survey (93% response rate) found that the Pilots did not believe they frequently experienced fatigue during work and deemed that it rarely affected job performance. Pilots mostly worked a 7 days on/7 days off schedule. On average, Pilots worked 7.6 ± 2.6 hours/duty, 35.0 ± 13.5 hours/week (18.7 ± 12.0 night hours/week) with 23% of duties starting between 0200 and 0500. Start time varied by 3 or more hours for 66% of consecutive duty periods. SAFTE predicted cognitive effectiveness at 70 or better during more than 99% of duty periods. **Discussion:** We identified a number of fatigue issues that merit attention including work periods that frequently infringe on the window of circadian low, work weeks with a high number of duty hours including consecutive periods of night work, and significant start time variability. Recommendations were made for possible fatigue risk management actions.

Brain Health during Simulated Night Shift Work in Rats

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Introduction: Circadian rhythms and sleep processes interact to modulate brain function through changes in neuronal plasticity and glial cell activity. However, the contribution of specific sleep and/or circadian rhythmicity parameters to brain health remain unclear. Here we assessed the effects of changes in both sleep and circadian organization on brain function in a rat model of shift work, with special emphasis on cognitive performance, circadian-driven protein translation in the prefrontal cortex (PFC) and markers of brain health (neuronal, glial and waste products). **Methods:** Electroencephalography and body temperature rhythm recordings were performed continuously while male rats (n=16) were exposed to forced activity, either in their rest phase (simulated night-shift work) or in their active phase (simulated day-shift work). After the third shift, cognitive flexibility was assessed using the Morris-water-maze (MWM) task. After a 4-week washout period the shift work procedure (3d) was repeated and PFC tissue samples collected for western blot analysis of protein expression. **Results:** Cognitive performance in MWM and markers of circadian driven protein synthesis in the PFC was impaired following simulated night shift work compared to simulated day shift work. Electroencephalography and circadian rhythm correlates of cognitive flexibility, markers of circadian-driven protein translation, neuronal and glial plasticity, and neuronal waste products will be presented. **Discussion:** Implications of night shift work for sleep and wake functioning, and the specific contributions of sleep and circadian rhythm processes on measures of brain health will be discussed.

Planned versus Executed Sleep and Activity Profiles in Air Force Mobility Operations

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Introduction: Fatigue remains a critical issue in aviation generally, and creates unique challenges in military environments. For that reason, the United States Air Force's Air Mobility Command (AMC) emphasizes fatigue risk management in its overall Aviation Operational Risk Management (AvORM) planning process. This process incorporates algorithms based on the Fatigue Avoidance Scheduling Tool (FAST), which provides a quantitative means of estimating operational risks associated with sleep and circadian rhythms. **Methods:** The current research was focused on assessing the extent to which assumptions underlying FAST and its use in AvORM apply to aircrew executing missions within AMC. Participants were 30 C-17 aircrew, including pilots and loadmasters. Each participant completed pre and post mission surveys to assess perceptions of fatigue issues and individual fatigue risk management strategies. In addition, they wore activity tracking watches beginning 1-2 days prior to a mission, and extending 1-2 days after mission completion. **Results:** This presentation emphasizes the watch-based activity data, which were used generate effectiveness estimates that were compared to effectiveness profiles based on the mission planning process in AvORM. The results highlight discrepancies between observed activity profiles and the mission plans, including delayed sleep opportunities, missed in-flight naps, and missed sleep periods. These divergences may have dramatic implications for mission risk in some cases. **Discussion:** The results point to significant challenges in managing and mitigating fatigue risk in real-world operational settings. It is folly to expect that missions will be executed as planned every time, but also impossible to plan for all possible contingencies. Currently, mission execution lacks the flexibility to adapt to changes in aircrew effectiveness brought on by fatigue-related factors. The results have potential implications for policies associated with mission planning, and highlight the need for greater consideration of how changes in mission profiles impact safety.

Exploring the Eating Behaviours and Gastrointestinal Health of Residential Support Workers during Dayshifts and Sleepover Nightshifts

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Introduction: Investigating the impact of shiftwork on the eating habits of workers is crucial for improving long-term gastrointestinal health. Residential Support Workers (RSWs) provide 24h care to clients with disabilities and are at high-risk of burnout and disrupted sleep. It is unknown how support work influences the eating habits of RSWs. An exploratory field study was conducted to investigate the impact of shift-type on eating behaviours and gastrointestinal health. **Methods:** Thirteen RSWs (7 female, age M±SD:46.8±10.4 years) who had most recently completed a day-shift (n=6) or sleepover-shift (n=7; overnight shift where the RSW assists clients with evening and morning activities and sleeps during the night while the client sleeps), completed a questionnaire on the timing of food intake on shift, motivations for eating on shift, subjective work performance, alertness and sleepiness post-shift, and gastrointestinal health since starting support work. **Results:** During a day-shift, 39% of food consumption occurred outside of traditional breakfast (6am-8am) lunch (12pm-2pm) and dinner (6pm-8pm) timing. During a sleepover-shift, participants reported snacking during the night (4 snacks reported from 10pm to 2am). Time available was the biggest determinant for when RSWs ate during a day-shift or a sleepover-shift. The strongest motivator for why workers chose to eat during a day-shift was food available, however during a sleepover-shift it was habit. Bloated stomach or flatulence and disturbed appetite was reported by 31% of the sample as occurring at least quite often since beginning support work. **Discussion:** This is the first study to demonstrate the impact that shift-type has on the eating habits and gastrointestinal health of RSWs. Given that RSWs may be at risk of long-term gastrointestinal upset, future research should continue investigating this under-represented workforce and focus on targeted interventions to improve eating habits at work, including reducing eating at night and making healthy foods available.

The Investigation of Association between the Maximum Aerobic Capacity (VO2MAX) and Physical Work Capacity (PWC) with General Health (GH) and the Factors Influencing Female Employees in Hospital

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Introduction: The maximum aerobic capacity (VO2 MAX) is a criterion that can be used to create coordination between the labor and worker. In order to keep the health and physical strength of the individuals and also the increase of the productivity, we can put the people in jobs tailored to their abilities by assessing their physical work capacity (PWC). **Method:** This cross-sectional study has been conducted on 120 women working in the hospital with ages of 21-49. They were evaluated by the single-stage treadmill test Ebbeling. The general health questionnaire, job fatigue and job satisfaction questionnaires and also the Treadmill test were used to collect data. Data were analyzed using statistical tests including T-test and Pearson Correlation by SPSS software (Version 22.0). **Findings:** According to the results, the maximum aerobic capacity, the physical work capacity and the level of general health were yielded respectively 38.89±1.85 ml/kg minutes, 4.10±0.47 kcal/minutes and 25.43±12.09. Also the mean and the standard deviation of the fatigue and job satisfaction scores were obtained respectively 85.87±32.35 and 57.47±13.01. In the study, there was a statistical significant correlation between the VO2 max and the age, weight, the body mass index (BMI), job fatigue and job satisfaction. **Conclusion:** According to the results, since the job fatigue and the job satisfaction are related to the maximum aerobic capacity (VO2 max) of the workers, it is recommended that in addition to paying attention to the aspects of physical fitness in the workplace, their mental and psychological aspects should be given special attentions, because it affects the workers' physical aspects and consequently their productivity. Moreover, the participants were allowed to perform light-moderate work during a work shift.

Assessing of Job Burnout and its Effect on Productivity and Job Satisfaction in a Packing Industry Workers

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Abstract: Job burnout can affect on different aspects of employees lives. So, this study aimed to assess job burnout and its effects on productivity and job satisfaction in a packing industry workers. **Materials and methods:** This cross-sectional study was conducted on 183 male workers in a packing industry in Isfahan in 2018. Maslach burnout inventory, Hersi-Goldsmith questionnaire and Minnesota questionnaire were used for assessing job burnout, productivity and job satisfaction, respectively. SPSS.Ver23 was used to analyze data. **Findings:** 14.8, 16.4 and 66.1 percent of subjects had severe

levels of emotional exhaustion, depersonalization and decreased personal accomplishment, respectively. Mean total score of productivity and job satisfaction were computed 71.72 and 57.60, respectively and 51.4 percent of subjects had high job satisfactory level. There were converse significant (*p*-value<0.05) relationships between productivity and job burnout and between job satisfaction and job burnout. Moreover there was a positive significant (*p*-value<0.05) relationship between productivity and job satisfaction. There was no relationship between age, work experience and education level with job burnout, productivity and job satisfaction. **Conclusion:** Job burnout had a converse significant effect on productivity and job satisfaction. It seems that interventions be necessary to decrease burnout level of workers.

Investigation of Morningness and Eveningness and It's Related of Factors Caused by Shift Working in Hospital Nurses

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Introduction: The workload of nurses in the care of patients incur, if morningness and eveningness type were not be identified, they might be vulnerable to the adverse effects of shift work. The purpose of this paper is to determine the type of rhythm and its relationship with risk factors of shift working. **Materials and Methods:** This cross-sectional study was done on 174 nurses in Al-zahra hospital in Isfahan on 2017-18. Morningness and eveningness were identifying with morningness- eveningness questionnaire (MEQ) and shift working disorder was identifying with survey of shift working questionnaire(sos). **Results:** The highest prevalence disorder were related to its effects on social life, uncomfortable side effects, familial and personal effects, and gastrointestinal disorders that respectively contained, 90.8, 90.3, 89.1, 88.6 and 76.9 percent. More of them were middle type. Chi-square test showed a significant association between job satisfaction with morningness and eveningness (*p*<0.001). There was no difference between men and women in their type. (*p*>0.05). **Conclusion:** Health, social and individual life disorders, in this group of people are high. With shortening the night shift, rotating shift work, regular staff training, regulation of shift working, as much as possible to prevent this problem. According to the vital job in functioning and tending to patient, identify the type of morningness and eveningness is important.

Characteristics of Working Hours and the Risk of Occupational Injuries among Hospital Employees: A Case-Crossover Study

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Introduction: Earlier epidemiologic studies on the association of different working hour and shift characteristics of working hours to occupational injuries are few. We investigated the association of the characteristics of working hours with occupational injuries in hospital shift work by using register data of daily working hours. **Methods:** Data from the hospital employees of the Finnish Public Sector (FPS) study (11 towns and 6 hospital districts) were used to identify the first incidence of an occupational injury for each employee (n=27 160 in 2000-2015) from the Federation of Accident Insurance Institutions. Physicians, employees without sufficient working hour data and injuries due to violence by patients were excluded. The pay-roll based data of working hours included planned and executed work shift data from a shift scheduling program (Titania®). The daily working hours were investigated for 37 days preceding the injury. We utilized case-crossover design with a matched-pair interval analysis to compare working hour characteristics within three hazard windows (on injury day, preceding day, preceding week) and earlier control window 1-4 weeks earlier of the same subjects. Conditional logistic regression was used to calculate odds ratios (OR) with 95% confidence intervals (CI). **Results:** There was a statistically significant elevated risk of an occupational injury only during the evening shifts (OR 1.08, CI 1.03-1.14), and after the night shifts (OR 1.30, CI 1.15-1.46). The shift combinations showed increased injury risk for the quick return of an evening-night shift (OR 1.39, CI 1.17-1.66). Long shifts (≥12 hours) were also associated with increased injury risk (OR 1.24, CI 1.07-1.44). Within the preceding week, the number of evening shifts and quick returns, but not the number of night shifts showed a dose-response pattern for the increase of injury risk. **Discussion:** The results indicate that specific working hour characteristics are association to occupational injury risk in hospital work.

Shiftworking Nurses and Diet Changes across Rotating Shifts

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Introduction: Shift work is associated with dietary disruption, which has adverse effects for health. This study explored the diets of shift working nurses, assessing the relationship between shift type and compliance with dietary guidelines specified in the Australian Guide to Healthy Eating (AGHE, 2018). **Methods:** Nurses (n=52, 46 female) working morning, afternoon, or night shift, or a combination of these shifts, at one of three metropolitan South Australian hospitals, completed food and work diaries for two consecutive weeks. Nutritional analysis software was used to estimate AGHE-circumscribed serves-per-day consumed from the five core food groups (vegetables, fruit, grains, meat and alternatives, and dairy and alternatives) relative to recommendations by sex (female, male) and age band (19-50y, 51-70y). The defining components of discretionary choices were also examined - added sugar, sodium, and saturated fat. **Results:** Across all shift types, more than 70% of participants consumed fewer than recommended serves of fruit, vegetables and dairy and more than 65% consumed more than the recommended amounts of added sugar. Approximately one third of participants consumed more than recommended levels of sodium and saturated fat. Expressed relative to each individual's recommended serves (by sex and age), participants on night shift consumed significantly more serves of grains than on morning (p=0.04) and afternoon (p=0.01) shift, such that 57% of participants met their requirements on night, compared to 41% on morning, and 21% on afternoon shifts. Participants on morning shift consumed significantly more serves of dairy than on afternoon (p<0.01) and night (p=0.04) shift, such that 30% met their requirements on morning, compared to 13% for afternoon, and 22% for night shift. **Discussion:** Shiftworking nurses are not likely to meet dietary recommendations, especially in terms of fruit, vegetables, dairy, and indulgence foods, and diet may fluctuate across rotating shifts. Future studies should explore these relationships across different industries.

Objectively Measured Sleep of Shift Workers in Healthcare

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Introduction: Disturbances in sleep may be one of the potential underlying mechanisms linking shift work to its negative health effects. The aim of this study was to compare sleep duration and social jetlag between shift workers and non-shift workers. Furthermore, differences in sleep across different types of shifts in shift workers were studied. **Methods:** Data were used from the Klokwerk+ study among healthcare workers employed in hospitals. In total, 120 shift workers and 74 non-shift workers were included who wore Actigraph GT3X accelerometers continuously for 7 days. Sleep duration and social jetlag (i.e. discrepancy between circadian and work-enforced sleep times) were predicted using the Actigraph data and compared between shift and non-shift workers using mixed models and generalized estimation equations. Within the shift workers, sleep across different shift types was compared with sleep on work-free days. Interaction terms were used to examine differences by chronotype and age. **Results:** Shift and non-shift workers had similar average sleep duration. However, on workdays, shift workers slept 3.5 times (95% confidence interval: 2.2–5.4) more often a short period (<7 hours/day) and 4.1 times (95%-CI: 2.5–6.8) more often a long period (≥9 hours/day) than non-shift workers. These differences were especially present in morning chronotypes, and not in evening chronotypes (interaction p-value <0.05). Shift workers aged ≥50 years had a 7.3 times (95%-CI: 2.5–21.8) higher odds of sleeping short between night shifts compared with work-free days. This difference was not found in younger shift workers. The difference in social jetlag between shift and non-shift workers increased with age (interaction p-value<0.05). **Discussion:** In this study among healthcare workers, shift workers had more objectively measured sleep disturbances than non-shift workers, especially older workers and morning chronotypes. Future research to the role of these sleep disturbances in health effects of shift workers is recommended. **Adapted from:** Hulsegge G, Loef B, van Kerkhof LW, Roenneberg T, van der Beek AJ, Proper KI. Shift work, sleep disturbances and social jetlag in healthcare workers. J Sleep Res. 2018:e12802.

Association between Daily Rest Periods and Sleep Duration/Timing on Workdays and Non-Workdays: A Cross Sectional Web Survey

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Introduction: Daily rest period (DRP) is the interval between the end of one workday and the start of the following workday. This study examined the relationship between DRP and sleep duration/timing during workdays and non-workdays among Japanese daytime workers. **Methods:** A cross sectional web survey was conducted with Japanese permanent daytime workers aged 20–64 years (n = 3,208; 1,045 females). The Workers' Living Activity-time Questionnaire was used to assess the average DRP in the previous month, sleep duration, and sleep timing (midpoint of bedtime and wake-up time) on workdays and non-workdays. Based on DRP scores, they were divided into the following 7 groups: < 11, 11, 12, 13, 14, 15, and ≥ 16 hours. **Results:** A two-way (DRP group × day) analysis of covariance (ANCOVA; with sex and age as covariates) on sleep duration showed a significant interaction effect (p < 0.001). For all groups, sleep duration was significantly shorter on workdays than on non-workdays (all p < 0.001). On the other hand, a two-way ANCOVA on sleep timing showed a significant main effect of group (p < 0.001), suggesting that sleep timing was earlier on workdays than on non-workdays. Additionally, different values were calculated for sleep duration (i.e., sleep debt) and sleep timing (i.e., social jetlag), by subtracting workdays from non-workdays. Trend analyses revealed a significant linear trend for sleep debt and social jetlag (all p < 0.001). **Discussion:** The primary findings showed that, although sleep duration was shorter on workdays than on non-workdays for any DRP duration, the magnitude of sleep debt and social jetlag was smaller in the longer DRP group. Sleep debt and social jetlag have several negative effects such as sleepiness, depression, and poor work ability. Ensuring a longer DRP duration may be useful to prevent these sleep health problems.

Acute Effects of Night Work and Meals on Blood Glucose Levels - Preliminary Results

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Background: Employees working at night have an increased risk of developing diabetes. A possible mechanism is related to changes in glucose regulation at night. Laboratory studies with simulated night work show that the regulation of glucose in blood is affected and insulin sensitivity is reduced at night. Regular exposure to high glucose levels at night may explain the observed relationship between night work and diabetes. The purpose is to investigate how night work and the composition of meals affect acute blood glucose levels in a field study. **Methods:** The project is planned to include 40 non-smoking women in the health care sector. Here we present results from 11 participants from which data has been collected. Blood glucose levels were assess by self-monitoring before a test meal and 15 minutes, 30 minutes, 1 hour and 2 hours after ending a test meal four occasions: two night shifts and two day shifts. The participants eat two different types of food that they themselves composed according to our instructions. One test meal was a light meal and the other contained high levels of sugar. Proc mixed with repeated measures was used to test differences in blood glucose between the 4 test occasions. **Results:** There was a statistical significant difference between blood glucose in the four test occasions ($p= 0.0086$). Over all blood glucose were higher after eating during the night compared to the day. There was also an overall effect of type of meal. Blood glucose levels rose faster and stayed elevated longer during night shifts compared with day shifts. After 15 minutes the blood glucose were 8.3 mmol/L when eating a high sugar test meal at night and 7.3 mmol/L when eating a high sugar test meal during the day.
Data collection is on-going. The results will be presented in more detail.

Short Shift Interval and Risk of Hypertension in Hospital Workers: A Longitudinal Study

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Introduction: Shift work is related to hypertension and other cardiovascular diseases. Although short shift interval (less than 11 hours) was reported to be related to some health problems including sleep disturbance and fatigue, its cardiovascular effect was rarely been examined. The object of this study was to investigate the relationship between short shift interval and risk of hypertension in hospital workers. **Methods:** A total of 1,372 non-hypertensive hospital workers who are working as shift workers were retrospectively followed for up to 4.26 years (mean±SD: 2.49±1.23). Demographic factors (gender and age), lifestyle habits (smoking, alcohol consumption, exercise, and obesity), and work-related factors (working hours, shift work experience, continuous night work, and shift interval) were included in analyses. Multivariate Cox proportional hazards models were conducted. **Results:** During the follow-up, 49 cases of hypertension were occurred. The risk of hypertension was significantly higher in the workers with short shift interval (HR, 95% CI: 1.89, 1.01–3.54). Also, the risk was higher when the workers with short shift interval worked continuously at night, with HRs of 3.30 (1.18–9.25) for workers with short shift interval and 2-3 days of continuous night work, and 3.67 (1.19–11.32) for workers with short shift interval and 4 or more days of continuous night work, compared to workers with long shift interval and no continuous night work. **Discussion:** The findings of this study indicate that short shift interval and continuous night work are related to increased risk for hypertension in shift working hospital workers.

Objective Working Hour Characteristics and Control Over Scheduling of Shifts

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Introduction: Few studies have investigated how working time control is associated with working hour characteristics. We studied the association of perceived control over scheduling of shifts (CoSS) with objectively measured working hour characteristics. **Methods:** Hospital employees (n=5128, 91% women, average age 43 years) from the 2015 Finnish Public Sector study with a survey response to a measure of CoSS were linked to payroll

data on working hour characteristics from the 91 days preceding the survey. We used multinomial logistic regression to assess differences in dichotomized proportion (cut points at 10% or 25%) of working hour characteristics (full-/part-time work, long work weeks (>40h and >48h/week), long work shifts (>12h), evening and night shifts, quick returns (<11h), single days off, weekend work, >4 consecutive work shifts, and variability of shift length) between employees with high, intermediate or low CoSS. Analyses were adjusted for multiple covariates. Differences between age, gender and work ability were examined using interaction terms. **Results:** The proportion of full-time workers was lower among employees with intermediate CoSS compared to those with high control. Low CoSS was associated less often with high proportion (>25%) of weekend work compared to high control. High proportion (>25%) of >4 consecutive work shifts was associated with lower CoSS. Variability of shift length was shorter among employees with intermediate and low CoSS compared to those with high control. No association was observed between CoSS and other measured working hour characteristics in the whole sample. In subgroup analyses, women with low CoSS had lower odds and men had higher odds for large proportion long work shifts. **Discussion:** Employees with high CoSS had slightly more irregularity in working hour characteristics than those with intermediate or low control. Our findings suggest that good work time control is possible without compromising shift ergonomics.

The Effect of the Use of Tool for Participatory Working Time Scheduling on Working Hour Characteristics and Well-Being: A Quasi-Experimental Intervention Study

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Introduction: Intervention studies on the use of tools for working time scheduling are very few. We investigated the effects of implementation of a digital tool for participatory working time scheduling on working hour characteristics and well-being. **Methods:** Using a quasi-experimental intervention design, changes in objective working hour characteristics among hospital employees were studied at baseline (2015) and after two years (2017) among those using or not using the tool for participatory working time scheduling in four hospital districts of the Finnish Public Sector (FPS) study (n=1976). As measures of well-being, changes in self-reported sleep length, shift-specific sleep difficulties, perceived health and work-life conflict were investigated utilizing FPS surveys from three hospital districts in 2015 and 2017 (n=1151). The intervention group (IG) used tool for participatory working time scheduling (Titania®) ≥18 weeks before the end of 2017, and the control group (CG) continued with traditionally scheduled rosters. Changes in objective working hour characteristics were analyzed with T-test or Kolmogorov-Smirnov test, and changes in well-being with repeated measures GLM (general linear model). **Results:** The working hour characteristics showed parallel changes in both IG (n=1226) and CG (n=750). The proportion of short shift intervals (<11h) decreased in both groups, but more in the IG (p<0,001). The proportion of long (>40h) work weeks, long work shifts (>12h), night shifts, weekend work, single days off and evening work increased in both groups. Work-life conflict increased both in the IG (n=757) and the CG (n=394), but less in the IG (p=0,001). Similarly, sleep length decreased less in the IG (p=0,017). Implementation of tool for participatory working time scheduling showed no statistically significant changes in other measures of well-being. **Discussion:** Utilization of tool for participatory working time scheduling decreased the proportion of short shift intervals, and had favorable effects on work-life conflict and sleep length compared to the control group.

Improving a BMM to Better Cope with Large Time Zone Transitions

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The rosters for airline crew are, almost without exception, planned using mostly automated crew scheduling processes that rely on industry-strength optimizers. In such processes there is a need of representing human physiology with a proxy that quickly can assess the suitability of combining flights and other activities in a certain way. Traditionally this has been done by using a prescriptive flight and duty time 'rule set' that constitutes a simple, but digital, 'fatigue model'. Increasingly, bio-mathematical models (BMMs) are now used in a direct way to provide a more precise representation of the

human physiology, predicting the average experienced alertness or fatigue levels throughout crew rosters. This presentation will report on attempts done to enhance a BMM by, a) adding a process for the 'activity level' of the local society to influence model sleep predictions, and b) by modifying the acclimatization logic to rely more heavily on light exposure (via predicted wakefulness), rather than be driven purely by time zone difference. These two new processes are added to an existing bio-mathematical fatigue model, and the resulting model have been parameter-tuned and analyzed using a sizeable data set from aviation crew collected in cooperation with airlines. We also discuss potential problems with this approach as well as possible future extensions.

The Association between Shift Intensity and Low-Back Pain in Nurses

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Introduction: Night work has been associated with short sleep duration and with various pain complaints, including low-back pain. This field study investigated the effect of shift intensity on low-back pain incidence, and whether this was mediated through sleep duration. Shift intensity was conceptualized as i) consecutive night shifts or ii) short rest breaks between shifts (quick returns). **Method:** A Norwegian sample of 679 nurses (18-63 years old) working rotating shifts responded to a diary about sleep, shift type and low-back pain (1-5 Lickert scale) for 28 days. It was hypothesized that low-back pain after the third shift would be more intense than after the second shift, and that this difference would be larger for night shifts vs. morning shifts. Furthermore, it was hypothesized that low-back pain would be more intense after quick returns (<11 hours between shifts) vs. no quick returns. The analyses (Generalised Structural Equation Modeling) were adjusted for use of sleep medication, age, psychological, social, physical work factors and baseline pain and baseline insomnia symptoms. **Results:** After the second consecutive shift, approximately 12% of the nurses experienced low-back pain irrespective of shift type. After the third night shift, low-back pain was experienced by 13.6%, vs. by 12.6% after the third morning shift ($p = 0.92$). After quick returns, low-back pain were experienced by approximately 9%, vs. by 11% without quick returns ($p = 0.19$).**Conclusions:** According to the current sample of nurses, working three consecutive nights or having < 11 hours rest break between shifts do not seem to be associated with increased low-back pain risk.

Is Reduced Working Times and Self-Scheduling Beneficial for Shift Workers Sleep and Health?

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Introduction: The design of the shift system is an important determinant for sleep and health. The present study compared three shift schedule systems; fixed rotating shift work, self-scheduling (representing high work time control), and a rotating shift system with 12-15% reduction of weekly working hours (with retained salary), with respect to sleep and stress complaints, and self-reported sickness absence. **Methods:** The participants were nurses and health care personnel. In total 526 rotating shift workers (86% women) participated in the study. The participants filled in two questionnaires and objective working time data was collected for a period of 5-10 weeks. **Results:** The prevalence of poor sleep quality (34% reports at least one insomnia symptom/several times per week), stress symptoms (33% reports frequent symptoms) and sickness absence (11% reports >15 days/last year) did not differ between shift schedule groups. However, the group with reduced weekly work times were more positive to their working hours . There were several group differences with respect to objective working hour characteristics. The group with reduced working time had fewer night shifts, but more evening shifts and short (<11 hours) rest between shifts. The self-scheduling group had more night shifts, and fewer day shifts and short rest intervals. A high number of night shifts and short rest intervals were associated with more sickness absence and stress symptoms, respectively. **Discussion:** Reduced working hours and self-scheduling was not associated with fewer sleep and stress problems, and lower levels of sickness absence. The results suggest that specific shift schedule components such as short rest between shifts and frequency of night work might be more important for sleep and health than work time control and reduced weekly working hours.

The Effect of Work Shift on Blood Pressure and Body Mass Index in Employed People in Isfahan City, Iran

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Background: Regarding the high prevalence of obesity and cardiovascular diseases in people, especially worker population, and the problems caused by these diseases, this study aimed to evaluate the effect of work shift (day, night, and rotate shift workers) on blood pressure and body mass index (BMI). **Methods:** In this cross-sectional study, 6983 employees who referred to the occupational centers of the city of Isfahan, Iran, in 2015, participated according to inclusion and exclusion criteria. They were divided into two groups based on type of work as official and non-official and three groups based on work shift: day, fixed night, and rotate shift working. Age, systolic and diastolic blood pressure, body mass index, and occupational type were compared between these groups. **Findings:** 82.2%, 0.7%, and 17.1% of participants were day, fixed night, and rotate shift workers, respectively. There was a significant difference between the groups in age and type of occupation ($p < 0.001$ for both); but there was no significant difference between the groups regarding systolic and diastolic blood pressure, and body mass index ($p > 0.050$ for all). **Conclusion:** The results of this study indicate that shift work has no effect on the level of blood pressure and body mass index.

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BMM Usage for Post-Analysis of Accidents, Incidents and Fatigue Reports

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On 22nd of May 2010, the Air India Express flight IX812 from Dubai to Mangalore suffered a fatal accident when attempting to land in Mangalore, resulting in 156 casualties. One of the contributing factors highlighted in the accident report was sleep inertia affecting the captain after awakening after a period of deep sleep in the cockpit seat just prior the approach and landing phase. The cockpit voice recorder was reported to contain 1h40m of snoring from the captain. The airline did not have a procedure in place for controlled rest on flight deck for two-pilot operation. This presentation will use the accident report and step-by-step build a modelling of this event using a BMM to investigate a few different fatigue aspects in the rostered sequence of flights for the captain. The presentation will discuss the pros and cons of using BMMs for this type of post-analysis, as well as analysis of fatigue reports.

Physical Activity May Reduce Sleep Problems in Overweight and Obese Hospital Workers

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Introduction: Data obtained from hospital workers (N=1005) were used to assess the relationship between physical activity and insomnia, in overweight and obese participants. **Methods:** A self-administered questionnaire with demographic and work related characteristics was completed from the participants. The Athens Insomnia Scale (AIS), and the International Physical Activity Questionnaire (IPAQ) were also administrated. **Results:** Almost half (55.6%) of the participants had normal body mask index, while 29.1% were overweight and 15.2% were obese. 65.8% of the overweight hospital workers had insomnia problems, while the correspondence proportion was 69.6% for the obese cases. Concerning the overweight and obese participants 34.8% had low physical activity, 34.8% had moderate and 30.4% had high. The proportion of overweight and obese participants with insomnia was 67.9% in those with low or moderate physical activity and 54.6% in those with high physical activity ($p=0.024$). When multiple logistic regression analysis was conducted with dependent variable the insomnia in the group of overweight and obese participants, it was found that physical activity had a significant protective effect (OR=0.55, 95% CI: 0.32-0.96) on insomnia even after adjusting for sex, age, shift, nights per week that they work. **Conclusions:** Overweight and obese hospital workers suffering from insomnia seem to benefit from physical exercise. Since sleep problems are frequent in hospital workers and may correlate with physical and psychological problems our results need attention in this special population.

Assessment of Circadian Adaptation of Police Officers across Seven Consecutive Night Shifts

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Introduction: While laboratory studies show that partial circadian adaptation is possible across successive simulated night-shifts, findings of circadian adaptation in real-world shiftwork conditions are mixed. The aim of this study was to determine the extent of circadian adaptation in police officers working a series of consecutive night shifts. **Methods:** A total of 63 police officers (16 women; aged 32.3±5.4 years, mean ± SD) from the province of Quebec, Canada, participated in a 35-day field study, comprising 9- to 12-h morning, evening, and night shifts. Participants collected urine samples over ~24-h periods before and after a series of 7 consecutive night shifts. Urinary 6-sulfatoxymelatonin (UaMT6s) was assayed as a marker of their circadian phase. Phase was derived from the midpoint of the upward and downward crossings of the mean. **Results:** The mean time of the UaMT6s midpoint was at 03:24h ± 00:46h (circular mean ± SD) preceding the series of night shifts and at 04:35h ± 01:15h following the night shifts. A circular ANOVA revealed no differences in timing of circadian phase before and after night shifts (p=0.10). There was a phase delay of 2.25h ± 1.42h (circular mean ± SD) after night shifts. Of all participants, 36.5% were delayed and 22.2% were advanced ≥3h. Before night shifts, 87.3% had their midpoint during night-work hours (23:00–08:00) and 7.9% during post-work sleep opportunities (9:00–17:00). After night shifts, this was 66.7% and 15.9%, respectively. In 49 participants who had ≥24h of data collected preceding and following the night shifts, no within-group difference was observed in the amount of 24-h excretion of UaMt6s (p=0.52). **Discussion:** The overall results of this study indicate that the rate of adaptation of police officers to a week of night shifts is slower than what has previously been found in some simulated night-shift protocols. Further research is required to investigate the social and environmental factors that might explain these discrepancies.

"*Working Out*" a Countermeasure for Sleep Inertia

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Introduction: Sleep inertia, the period of impaired alertness and cognition upon waking, may be more severe if waking occurs during the biological night and can therefore impact on the safety of on-call workers who may be woken to respond to night time calls. A possible countermeasure for sleep inertia-related impairment is exercise. Exercise has been found to increase cerebral blood flow and cognitive performance, both factors which are reduced during sleep inertia. The aim of the current study is to explore the impact of a short burst of exercise on subjective sleepiness and cognitive performance upon waking during the night. **Methods:** A counterbalanced repeated measures study was conducted. Fifteen participants (18-30 years), spent three separate nights at a sleep laboratory with a four-night wash-out between each night. Participants were woken at 0200 after a 2-h nap and, depending on condition, completed high-intensity exercise (30-s sprint at maximum heart rate), low-intensity exercise (30-s at 60% maximum heart rate) or were sedentary (no exercise). Two hours of testing followed and sleep inertia was measured at 15 minute intervals using a 3-min Psychomotor Vigilance Task (PVT) and the Karolinska Sleepiness Scale (KSS). **Results:** Data was analysed using mixed effects ANOVAs. Analyses of the KSS data found a significant effect of time (p=<.001) and condition (p=.003). Participants were most sleepy upon waking compared to subsequent time points and felt sleepiest, on average, in the sedentary condition followed by the low-intensity and then high-intensity exercise conditions. There was only a significant effect of time on PVT mean reciprocal response time (p=.007), with performance improving over the first hour of testing. **Discussion:** Findings suggest that exercise may reduce sleep inertia with regards to subjective sleepiness. A larger sample is needed to determine whether a short burst of exercise has a positive effect on other cognitive performance outcomes.

Examining Excessive Fatigue Symptoms among Truck Drivers by the List of Prodrome of Karoshi (Overwork-Related Cerebrovascular and Cardiovascular Diseases)

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Introduction: In Japan, Karoshi problems (death and disorder due to overwork) have become critical, and truck drivers are the largest occupation in Karoshi (overwork-related cerebrovascular and cardiovascular diseases) cases. Empirical research is needed to examine how their work and sleep conditions could cause Karoshi, more specifically excessive fatigue symptoms as an early sign. We aimed to investigate these cross-sectional associations. **Methods:** We distributed to a questionnaire regarding work, sleep, and excessive fatigue symptoms to 5,410 truck drivers and

collected a total of 1,992 samples (response rate; 36.8 %). Our institute collected 1,564 documents to require the compensation of Karoshi. Of them, 191 documents listed the prodrome of Karoshi was used to newly develop the excessive fatigue symptoms inventory. Consequently, those prodromes were classified into 26 symptoms (such as "chest pain and oppressing feeling", "heavy toothache"). Participants rated each symptom in the past 6 months on a 4-point scale (1 = never, 4 = always). The total score was analyzed. **Results:** One-way ANOVAs for excessive fatigue symptoms showed that significant differences were found in monthly overtime hours ($p < .001$), daily working time ($p < .001$), work schedule ($p = .025$), waiting time to deliver ($p = .049$), the number of night shifts ($p = .011$), sleep duration on working days ($p < .001$). Of those factors, the coefficient of liner regression showed that shorter sleep duration was the most effective parameter for increasing excessive fatigue symptoms, suggesting that less than 5 hours sleep hours could increase the excessive fatigue compared with 8 sleep hours or more (beta = 3.77, $p < .001$). **Discussion:** The findings suggested that shorter sleep duration was associated more closely with marked increase in fatigue, when compared with other factors. Hence, ensuring sleep opportunity is thought to be beneficial in reducing Karoshi risks among truck drivers.

Working Time Characteristics and Long-Term Sickness Absence. A Study of Danish and Finnish Nurses and Nurse Assistants

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Introduction: When comparing the European countries, the working time regimes in Denmark and Finland share many similarities e.g. nursing personnel work highly irregular shift systems. Yet, there are also differences e.g. policy-related differences regarding when sickness absence is compensated. The aim was to investigate the association between working hour characteristics and long-term sickness absence (LTSA) in two large datasets based on payroll data from Denmark and Finland.

Methods: We used Poisson regression models adjusted for age and sex to prospectively assess the risk of LTSA (30 days or more) among nurses and nurse assistants in relation to day shift (0, 1-100, 101-200 and >200 shifts/person/year); evening and night shift (0, 1-12, 13-50, and >50 per person/year). **Results:** 23 433 Danish participants (88% women, mean age 42.3) and 6 485 Finnish participants (93% women, mean age 46.9) were included. In Denmark there was a decrease in risk of LTSA when working >200 day shifts/year compared to no day shifts (IRR: 0.40, 95% CI: 0.29-0.55). The risk of LTSA increased with more evening shifts (>50 evening shifts/year: IRR: 1.25, 95% CI: 1.13-1.38). Risk of LTSA was decreased when working less than 50 night shifts/year (IRR: 0.85, 95% CI: 0.77-0.94), but increased when working more than 50 nights/year (not significant). In the Finnish data results were not statistically significant. The risk estimates did, however, show opposite trends: lower risk of LTSA with more day shifts, higher risk with <50 evening shifts a year, and lower risk when working >50 evening shifts a year and no or higher risk when working night shifts compared to work without night shifts. **Discussion:** Results suggest that the risk of LTSA in relation to day, evening and night work are different in Denmark and Finland. Reasons for the variance are unknown but could be due to contextual differences.

Night Work and the Risk of Ischemic Heart Disease and Anti-Hypertensive Drug Use. A Cohort Study of 145 861 Danish Employees

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Background: Ischemic heart disease (IHD) and hypertension are leading causes of mortality and night work has been suspected as a risk factor. Meta-analyses and previous studies are often limited by power and various definitions of exposure and outcomes. **Objectives:** This study aimed to investigate if night work increases the risk of IHD or anti-hypertensive drug usage in a large cohort of Danish employees. **Methods:** Individual participant data on night work were drawn from the

Danish Labour Force Survey (1999–2013). We included 145 861 participants (53% men) 21-59 years of age working 32 hours or more per week. Participants with diagnosis or drug use in the year prior to baseline were excluded. Data on outcomes were obtained from nationwide health registers. Using Poisson regression we analysed incidence rates of the outcomes as functions of night work adjusted for relevant covariates. **Results:** We observed 3635 cases of IHD and 20 648 cases used anti-hypertensive drugs. When examining main effects the association of night work with drug use was estimated at RR: 1.05 (95% CI: 1.01-1.09). A sensitivity analysis suggested a dose-response association. The association of night work with IHD was estimated at RR: 1.08 (95% CI: 0.98-1.19). Overall likelihood ratio test showed no statistically significant associations between night work and IHD or drug use when including interactions with sex and socioeconomic status. **Conclusion:** Night work was associated with an increased risk of anti-hypertensive drug use. Small estimates suggested a dose-response association. No statistically significant association between night work and IHD were found.

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Occupational Exposure to Chemicals and Unusual Working Hours. A Literature Review

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Introduction: Occupational exposure limits (OELs) are assigned to prevent harmful effects of exposure to chemicals at work place. OELs usually assume an 8-hour workday, 5 days a week and a 40 hours working week. However, a significant proportion of the work force is employed in other work schedules such as night shifts or extended working hours. Circadian rhythms and the time of exposure (day-night) may affect the biotransformation of chemicals, which may in turn affect the toxicity. The aim of this project was a review of the scientific knowledge of a potential combined effect of unusual working hours and chemical exposure, as a basis to evaluate the necessity of adjustment of OELs to chemicals, accounting for unusual working hours. **Methods:** A literature search, in six databases of epidemiological articles evaluating any consequences of exposure to chemicals among workers working unusual hours. **Results:** Out of initially 10 534 references, only eight articles met the inclusion criteria and

were of sufficient quality. Results from the eight studies, include observations of more reduced pulmonary function during night shift for workers exposed to dust in steel plants, and to endotoxins in potato processing. A synergistic effect between unusual working hours and exposure to organic solvents on spontaneous abortion was observed among laboratory personnel. One of two studies of the combined exposure to CS2 and unusual working hours reported of increased coronary artery disease mortality. **Discussion:** The reviewed data were insufficient to identify specific chemicals for OEL adjustment related to shift work, and to provide new information of relevance for adjustment of OELs for extended working hours. Potential mechanisms for a combined effect of exposure to unusual working hours and chemicals are suggested to be, among others, disruption of the circadian rhythms, which is important for maintaining metabolism and detoxification of chemicals.

Overtime Work and Occupational Safety and Health of Women Workers in a Developing Country

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Introduction: The Philippines has established many export zones as a response to the Structural Adjustment Programs of the World Bank in order to stabilize the national economy. The study aimed at looking into the problems caused by long working hours on health and safety of women workers in diverse manufacturing industries. **Methods:** This study was conducted in an export zone involving 31 industries and an interview with 613 women workers. **Results:** The results showed that most of the women workers worked overtime up to twelve hours (75.8%) compared to only 24.2% who did not. In fact, 33.9% and 33.2% of the workers in the garments and electronics said that they were required to work overtime during peak production; and that overtime was a prerogative of management. For hazard exposures, workers in the electronics industry reported the following exposures: high temperature (31%), intoxicating odor (25.8%), cold temperature (20.6%), noise (19.7%), prolonged standing (18.8%) and then radiation from machineries (18%). On the other hand, the workers in the garment industry reported the following: high temperature (28.4%), dust and particulate matter (18%), intoxicating solvents such as toluene (17.5%) and noise (13.6%). Results also showed that the illnesses aggravated after the work shift and (57.4% for garments and 58% for electronics) such as asthma, neurologic symptoms,

and musculoskeletal disorders. The injury data from the medical clinic for one year indicated 27 cases of laceration, 25 cases of punctures, 9 cases of chemical burns, 4 cases of fractures, and 3 cases each of amputation and eye injuries. These injuries were reported to occur during extended work coupled with fatigue. **Discussion:** The study showed that working overtime was associated with occupational health issues among the women workers in manufacturing industries.

Work Time Schedule and Organizational Stresses in Export Processing Zones

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Introduction: In the light of global industrialization, much attention has been focused on working time of workers and its influence on the health and welfare of workers. **Methods:** This was a cross sectional study using stratified sampling technique of manufacturing industries located in export zones in the country. This study was done in an export processing zone in the Philippines. **Results:** The establishment of export processing zones (EPZs) is seen as a subregional response to globalization. Transnational companies that forge merges and strategic alliances are major employers in export zones. In this economic enclave, economic activities are coordinated so as to produce globally competitive commodities. The activities are microregional and cross border strategies for zonal development across the globe. Export zones have been created to cope with the demands of globalization in subregional areas, or to take advantage of investment incentives offered by host Taiwan, Brazil, the Philippines and India in the late 1960s. The study sampled 24 industries, 6 were small scale industries and 9 each for medium and large scale industries. From the 24 industries, a total of 500 respondents for the questionnaire was taken. Among the 500 respondents, majority were female (88.8%), single (69.6%) and worked in the production or assembly-line station (87.4%). Sickness absenteeism was relative high among the workers in this study accounting for almost 54% among females and 48% among males. Many of the workers also reported of work overtime, nightshift work, poor performance at work, boredom, tardiness and absenteeism. Organizational stress was associated with fatigue from overtime work and overwork, lack of skills training lack of promotions, job insecurity, and poor relationship with employers ($p.$=0.05). **Discussion:**

From the data generated, important issues that must be dealt with in work organizations that include the quality of work life, and health and safety issues are affected by worktime schedule. There must be an active campaign for favorable and healthful worktime schedules for workers that remain to be indispensable in the industrial economy.

Association between Nightshift Schedule and Mental Health Symptoms among Filipino Factory Workers

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Introduction: Nightshift is one of the major issues in work-time schedule. This study aimed to look at the association between night shiftwork and mental health symptoms, and mediating factors to this association. **Methods:** This study utilized secondary data analysis. It looked at a database of 500 factory workers that originally investigated hazard exposures and occupational health of workers in export processing zones in the Philippines. The confounding effect of each probable confounder towards the main association was analyzed by obtaining the Mantel-Haenszel odds ratios of the association controlling for the particular confounder. Multiple logistic regression was used to analyze the overall association of interest, simultaneously controlling for all confounders. **Results:** The study showed that work schedule, work load and occurrence of mental health symptoms are associated with night schedule. The results show that without adjusting for confounders, those who work in the evening are 2.13 times more likely to have frequent occurrence of mental health symptoms as compared to those who work in the morning. Controlling for age, sex, educational attainment, tenure, work load, and exposure to occupational hazards, those who are working at night are 2.13 (0.79-5.71) times more likely to have frequent episodes of mental health symptoms compared to those who work in the day shift. The evidence suggests occupational hazards as mediating the association between night shiftwork and mental health symptoms. **Discussion:** The study has shown that among Filipino factory workers, nightshift work is associated with mental health symptoms. There may be conditions at work that predispose workers to more hazards during night shift compared to dayshift workers. Mental health among night shifters should be addressed as a concern in occupational health.

Association between Shiftwork of Long-Haul Bus and Truck Drivers and Road Collisions in Metro Manila

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Introduction: This study looked at occupational road crashes and work schedule among truck and bus drivers in comparison to other drivers and motorists on the road of Metro Manila, which is globally one of the cities with a high traffic density. One of the most precarious and risky occupations is driving, especially buses used for public transportation, and trucks for commercial activities. This is most astute in the metropolis. **Methods:** The study used meta-analysis of previous studies conducted, grey literature, government statistics, and validation through key database research in concerned national government agencies involved in road traffic from 2010-2015 **Results:** The study found that in terms of the number of public utility vehicles registered in Metro Manila (2015), 51.27% were buses and 20.21% were trucks. Majority of the drivers worked more than 12 hours a day. For the time and peak of accidents, it is alarming to note that about 35% of the road crashes occurred from 22-23 gmt, and 30% from 23-24 gmt. Human error accounted for the overwhelming cause of road crashes such as drunk driving, beating the red light, sleepiness, accounting for 99.52% in 2012, 99.47% in 2013, 95.33% in 2014, and 97.19% in 2015. Majority of the drivers worked prolonged hours on the road that can cause fatigue and sleepiness which are the highest risk factor to road accident based on the study. **Discussion:** The study has shown how risky driving is as an occupation especially due to their work-time schedule. The study suggests developing better information, education and communication campaign as well as policies particularly on driver safety, road safety, road-sharing concepts, and appropriate work-time schedule among public utility vehicle drivers.

Association between Eating Duration and Food Consumption Throughout a Complete Shift Rotation Schedule: A Prospective and Observational Study

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Introduction: The impact of the rotation between different shifts and free days within a short period on eating patterns is poorly addressed in the literature. The aim of this study is to evaluate if the eating duration (ED) - interval between the first meal after awaking and last meal before the sleep onset - is associated with energy and macronutrient intake throughout a complete shift rotation. **Methods:** Thirty male shift-workers from a mining company were evaluated over a complete rotation shift schedule: two day shifts (D1 and D2); two afternoon shifts (D3 and D4); 24 h free-day (D5); two night shifts (D6 and D7) and 72h off (D8, D9 and D10). Sleep periods and dietary intake were evaluated by actigraphy and 24 h recall, respectively. ED pattern (EDP) was classified according the frequency of ED <12h: longer-EDP (≤40%); intermediate-EDP (>40% and <70%); and shorter-EDP (≥ 70%). The Generalized linear model (GLzMM) was performed to analyze the association variables analyzed. **Results:** ED was associated with energy (β = 0.04, $p<0.001$) and carbohydrate intake (β = 0.02, $p<0.001$). The longer ED occurred on 24h free-day (D5) - interval between D4 and the first day of night shift (D6) –, as well as the higher values of energy, carbohydrate and fat (21.0h, 3410kcal, 413.8g and 122.5g, respectively) ($p<0.05$). Longer-EDP had a higher intake of energy, carbohydrate and fat than the other patterns ($p<0.05$). **Discussion:** The rotating shift-work impacts on eating habits, mainly on the day right before the first night shift by the extended periods of wakefulness. In addition, a longer-EDP can lead to a higher intake of energy and macronutrients than other patterns. Nutritional strategies for rotating shift workers must be consistent with the intense variation of their routine and focused on promoting a more restricted eating duration.

Establishing a National Working Time Registry in Norway - A Feasibility Study

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Introduction: Studies utilizing questionnaire-based data on working hours provide inaccurate measures of exposure and are prone to recall bias. We have investigated practical, legal, ethical, technical and economical aspects of establishing a national registry of individual daily working hours. **Method:** Electronic daily working time data is stored for approximately 1/3 of Norwegian workers by time registration companies (TRC). STAMI plans to retrieve data from a representative selection of these workers to a long-term national working time registry (NWR) available for research. The national identity number enables longitudinal studies and linking to other registries. A reference group of representatives from the authorities and social partners in Norway evaluates the project. **Results:** Legal aspects were satisfactory, according to the requirements

of data protection of the new EU regulations (GDPR). Key requirements were individual consent, encrypted data transfer/ storage and limited access to data. A majority of 20-25 contacted companies/municipalities were positive to participation. Protocol for data transfer, and an infrastructure for storage and backup, have been developed, and are being tested in a pilot study with two companies. An electronic consent module with 2-factor authentication has been developed in collaboration with the standard Norwegian government information portal. NWR aims towards integration with the Health Analysis Platform, which is part of the government's new standard for utilizing health data from Norwegian registers. Research groups may apply a steering committee for access to the data. **Conclusions:** It is practically, legally and ethically possible to establish a working time registry. The proposed longitudinal data infrastructure is particularly well suited for studying changes in Norwegian working hours over time, as a unique basis for intervention studies and prospective cohort studies, and for guidance in development of optimal work schedules.

Effects of Sufficient Sleep on Fatigue and Blood Pressure in Local and Long-Haul Truck Drivers: A Field Study

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Introduction: Overwork-related deaths and disorders by cerebrovascular and cardiovascular diseases (Karoshi) occur most frequently in truck drivers in Japan. In addition to long working hours, sleep, fatigue, and history of hypertension are major evaluation criteria to decide to compensate for Karoshi. Therefore, the present field study aimed to investigate effects of sufficient sleep on fatigue and blood pressure in local and long-haul truck drivers. **Methods:** A total of 11 local truck drivers (mean age 50.6) and 26 long-haul truck drivers (mean age 49.7) participated in a successive two-week survey. Twelve of the participant drivers had a history of hypertension. Sleep durations was identified by wrist actigraphy during the survey period. Blood pressure (BP), psychomotor vigilance task (PVT) and subjective fatigue feelings (SFF) was measured before and after each trip. Two-way (sleep duration before work [<7h vs. ≥7h] x measurement point) repeated-measures ANOVAs were used for data analysis. **Results:** On average, local truck drivers had 5.9 hours sleep before work, 11.8 hours between work intervals, and 5:52 departure time, whereas long-haul truck drivers took 7.3 hours sleep before work, 4.4 hours sleep on duty, 15.9 hours between work intervals, and 16:21 departure time.

The ANOVAs for PVT and BP showed a significant main effect of sleep duration. Less than 7 hours sleep before work was significantly associated with increases in PVT reaction times and lapses during work in the local truck drivers. The short duration of sleep was also significantly associated with the rise in BP in the hypertensive drivers. **Discussion:** Results showed that local truck drivers are difficult to recover from fatigue in contrast to long-haul truck drivers, probably through insufficient sleep before work. Moreover, given that hypertensive drivers may have vulnerability to short sleep duration, great care should be needed when planning their working schedules.

Cooperative Behavior Decreases during Simulated Nightshifts

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Introduction: Teamwork is essential in many shiftwork domains. Defined as 'Task Cohesion', individuals must coordinate their efforts with others to achieve team goals. Shiftwork is associated with high fatigue and sleep loss, leading to impaired performance. Whether and how fatigue affects cooperative behavior is unknown. Hence, this study measured Task Cohesion in small groups under simulated nightshift conditions. **Methods:** Eight healthy (BMI M±SD: 23.89±3.36) males (n=3) and females (n=5) aged 18 to 35y (M±SD: 24.75±4.95), participated in a seven-day nightshift study. Following a training and baseline day, participants completed four simulated nightshifts (2000h to 0800h), with 7h sleep opportunities (1000h to 1700h), followed by an 8h night-time recovery

sleep. During the nightshifts, at eight 1.5h intervals between 2000 and 0500, participants completed a 5min computer based behavioral assay of Task Cohesion/cooperation, called COHESION. **Results:** Data were analyzed using a mixed effect ANOVA, with fixed effects of test time, day, and their interaction, and also a random effect of participant ID. Cooperative behavior counts (Task Cohesion) significantly decreased across the nightshifts (test time; $F(7,221)=3.35$, $p=0.002$), in a cumulative fashion from one night to the next (test day; $F(3,221)=8.30$, $p<0.001$). This did not appear to recover following the 8h nighttime sleep. **Discussion:** While a strong effect of the nightshift on cooperation was suggested, the participants were not part of a pre-established team. Additionally, these results may be impacted by the laboratory experience rather than the nightshifts. Nevertheless, as pilot data, there is a strong case for further investigation of the Task Cohesion construct under sleep loss. These findings may reflect a (top-down) shift in the behavioral economic framework of cooperation/altruism, or a (bottom-up) load-shedding due to reduced attentional resources. Additional analysis of task performance and subjective ratings of individual and team perceived motivation for cooperation may help explain these findings.

The No Wake Zone: A Novel Way to Prospectively Predict the Magnitude of Sleep Inertia after Awakening

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Introduction: Sleep inertia is a temporary state of reduced performance manifested immediately after awakening and then dissipating rapidly. The magnitude of sleep inertia is influenced by a variety of factors, including prior sleep duration and sleep/wake history. Biomathematical models for the prediction of performance, which are increasingly used to manage fatigue in operational settings, typically include sleep inertia as an add-on function invoked at awakening. Here we introduce a different approach, which more parsimoniously predicts sleep inertia as an integrated neurobiological process. We implemented this approach into a biomathematical model of performance based on the homeostatic and circadian processes of sleep regulation and an allostatic process shifting the homeostatic setpoint in response to sleep/wake history. **Approach:** We added a set of ordinary differential equations to the model, which build the potential for sleep inertia across the sleep period and reduce the manifestation of sleep inertia across the waking period - thus

capturing the effect of prior sleep duration on sleep inertia and instantiating the rapid dissipation of sleep inertia after awakening. We linked the asymptote of the dissipation to the homeostatic setpoint modulated by the allostatic process - thus capturing the effect of sleep/wake history on sleep inertia. **Discussion:** Our approach has an emergent property that is consistent with experimental observations: it predicts relatively little sleep inertia for short naps, greater sleep inertia for sleep periods up to about 3 hours (or longer after chronic sleep restriction), and less sleep inertia again for more extended sleep periods. As a practical advantage, our approach tracks this dynamic explicitly, making it immediately clear what level of sleep inertia to expect after awakening at any time during the sleep period. This can help to prospectively manage sleep and plan wake-up times in 24/7 settings that may call for optimal performance right after awakening, such as emergency response and long-range augmented flights.

Circadian Dynamics for Jet Lag and Performance Prediction after Long-Distance Travel

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Introduction: Long-distance travel tends to dysregulate the circadian regulation of sleep as well as waking alertness, which causes jet lag and leads to performance impairment. Developing practical countermeasures for jet lag is a high priority. Therefore, research is ongoing to develop a comprehensive, quantitative model of the effects of long-distance travel on the circadian pacemaker (i.e., biological clock) and its influence on performance. We propose a novel, conceptual and mathematical framework to help accelerate this research. **Approach:** We envisioned a model in which the time cues from the environment across the day, at a given location on the planet, drive the circadian pacemaker. We posited that this can be represented by an oscillatory function, $z(t)$, for which the amplitude and phase reflect the location and the time of year (rather than just the time zone). We then used a set of two ordinary differential equations (ODEs) to model the circadian pacemaker, and considered a number of distinct possibilities for this set of ODEs, including a limit-cycle oscillator and a damped oscillator. We assumed that the circadian pacemaker would only be driven by $z(t)$ during wakefulness. We hypothesized that the circadian pacemaker, in turn, drives the circadian rhythm component of performance, which we implemented as another set of two ODEs. This

was a reformulation of the existing circadian component of a previously developed model of performance (McCauley et al., 2013) in the form of a limit-cycle oscillator during wakefulness and a damped oscillator during sleep (tending to zero during extended sleep), which captures the dependence on time awake of the expression of circadian rhythmicity in performance. **Discussion:** Through simulations we found that the temporal dynamics of jet lag may depend not only on the number of time zones crossed, but also on the path taken from one location to another, and on the timing of sleep during and after long-distance travel.

Associations between Shiftwork Organization and Sleep Disturbance in the Oil Industry

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Introduction: Rotating shiftwork is common in high hazard industries, despite documented associations with sleep disturbance and impairment. In the oil industry, work intensification and increasing overtime have been broadly documented over the last few decades, where rotating and extended shift schedules are used to staff safety-sensitive positions. Since the trend towards extended (12-hour) shifts and increasing overtime, research on the impacts of these work schedules on sleep and health has been limited for this work force. Further, the prevalence of certain morbidities that are uniquely associated with shiftwork is not well characterized. **Methods:** We examined sleep duration and quality among rotating shiftworkers in the oil industry, and explored associations between work organization and sleep disturbance (and associated health outcomes). We administered a survey on work schedules, sleep, and health outcomes to volunteers recruited from West and Gulf Coast oil sector members of the United Steelworkers union. **Results:** Our findings reveal a high prevalence of sleep deficit and disorders; these were associated with health outcomes found to be common in shiftworkers. Early rise and start times were associated with shorter sleep duration and poorer sleep quality. Sleep durations were shortest for 12-hour shiftworkers, and averaged <5 hours following shift rotation. **Discussion:** After three 8-hour shift schedules were eliminated, the swing shift--previously shown to provide recovery--was lost. Our data suggests that the 12-hour shift may further limit recovery by reducing available hours for sleep, and also limiting time for exercise and leisure activity (which were positively correlated with improved sleep). Later start times could be a tool to improve worker sleep quality and quantity, and help improve chronotype desynchrony on days off and during shift transitions. Shiftwork intolerance and difficulty with shift transitions have been shown to increase with age, making these interventions crucial for this aging workforce.

Regulatory Position on Managing Worker Fatigue - Intersection between Science, Benchmarking and Public Consultation

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Introduction: The Canadian Nuclear Safety Commission (CNSC) published a regulatory document (REGDOC) entitled REGDOC-2.2.4, Fitness for Duty: Managing Worker Fatigue (2017). The REGDOC includes a comprehensive suite of requirements and guidance for managing worker fatigue. These measures are intended to reduce high levels of fatigue and fatigue-related errors. The presentation will explain how CNSC staff addressed comments received during public consultation while maintaining a basis that is defensible based on science and benchmarking. **Methods:** Two phases of public consultation on REGDOC-2.2.4 resulted in numerous comments about operational needs and administrative burden. Each comment was considered and dispositioned in view of both research about the effects of fatigue on human performance and benchmarking with requirements of other domestic and international regulatory bodies. In addition, requests for changes to limits on hours of work were evaluated using the bio-mathematical fatigue model, FAID. **Results:** Several changes were made to REGDOC-2.2.4 during the consultation process. For example, instead of applying prescriptive hours of work limits to all workers, the modified REGDOC includes two populations. Performance-based requirements apply to all, and prescriptive limits apply to those in safety-sensitive positions. In addition, the disposition of consultation comments increased the focus on the highest risk aspects of shiftwork - extended shifts and night work. **Discussion:** REGDOC-2.2.4 establishes a modern regulatory framework for managing worker fatigue. It provides a risk-informed basis for assessing fatigue management and for enforcing compliance. CNSC staff continue to monitor fatigue science and regulatory practices domestically and internationally. New information will be considered for incorporation into subsequent versions.

Good Practices on Education and Training in Sleep Habits and Lifestyles in Shift-Work Security Guards at an Agency in Piura, Peru

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Introduction: There are few studies in Peru about sleep habits and health promotion in security guards. They are a vulnerable group, with significant exposure due to the shift work, changes in circadian rhythm and their workload. The purpose of the study was to describe good practices on education and training (ET) in sleep habits and lifestyles in shift-work security guards at an agency in northern Peru and its impact in their health status and quality of life. **Methods:** This research was an observational study. Unit of analysis was the indicators of ET practices as characteristics of participants (shift-work security guards), education methods used, questionnaires solved, and clinical parameters. The instruments used were: Data collection sheet, Sleep Hygiene Index, and Epworth Sleepiness Scale. The instruments and clinical parameters were assessed at the beginning of the study and 6 months after the ET practices implemented. **Results and Discussion:** 120 shift-work security guards participated, of which 58% were between the age of 30 and 50 years old. 62% shifted from day to night shift each week. the ET practices implemented were Case discussion, Role games and Performance-feedback and the topics were Prevention of Fatigue, Sleep Hygiene, and the impact of Cardiovascular diseases in quality of life. The frequency of sleep habits reported as fairly poor was reduced in 25%. Poor sleep habits that were more reduced included: going to bed at different hours, using alcohol, tobacco or coffee within 4 hours before sleeping, and eating within 2 hours before sleeping. The frequency of excessive daytime sleepiness was reduced in 18%. Body mass index, glucose and lipid profile improved after 6 months of ET practices. **Conclusion:** ET practices in Sleep Habits and lifestyles had good results in reducing poor sleep habits, excessive daytime sleepiness and improving health status in shift-work security guards.

Estimating Risk of Safety Critical Events in Trucking Operations Based on Drivers Hours of Service Data

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Introduction: Fatigue is a major safety hazard in transportation operations. Fatigue impairs neurobehavioral performance in general, and vigilant attention and reaction time in particular, thereby diminishing a driver's ability to safely operate a motor vehicle. We evaluated a fatigue monitoring approach that uses drivers' ELD (Electronic Logging Device) data in conjunction with a biomathematical model to identify periods of elevated fatigue risk. The overarching goal is to provide drivers with timely, relevant information about fatigue risk to aid in countermeasure selection. **Methods:** We developed an analytic approach that estimates driver fatigue based on driver ELD (Electronic Logging Device) data in conjunction with a biomathematical model and then estimates risk as a function of fatigue. The analysis used de-identified data from a field study of N=262 commercial motor vehicle drivers. Data collected included drivers' official duty logs and safety critical incidents that occurred while driving. A total of 78 incidents occurred across 109,373 hours of driving during a 3 month period. Each hour of driving was assigned a fatigue risk score. We examined driving hours associated with the highest 5% fatigue risk scores to evaluate the relative risk of safety critical events. **Results:** Driving hours associated with the highest 5% fatigue risk scores, had a 1.86 fold increase in the relative risk of safety critical events compared with all other driving hours. **Discussion:** These data provide proof of concept for an analytic approach that estimates driver fatigue risk based solely on driver ELD data in conjunction with a biomathematical model and then estimates risk as a function of fatigue. Timely, relevant information about fatigue risk has significant potential to serve as a valuable aid to drivers to select countermeasures to reduce driver fatigue, safety critical events, and collisions.

A Longitudinal Study of Shift Work, Long Working Hours and Dementia

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Introduction: Shift work and long working hours affect potential risk factors for dementia, but previous studies on shift work, long working hours and dementia are sparse and their findings are conflicting. Therefore, we investigated the effect of night shift work and long working hours on dementia. **Methods**: We conducted a longitudinal

study among 3435 occupationally active men and women from the general working population in Denmark. Work schedule covered day work (reference) and shift schedules without/with night work. Working hours covered <27, 28-36, 37 (reference), 38-44, and ≥45 hours/week (h/w). As the primary outcome, we used register-based information about dementia, and estimated incidence rate ratios (IRR) and 95% Confidence Intervals (CI). Estimates were adjusted for gender, age, psychosocial work factors, and cardiovascular risk factors. **Results:** We identified 85 dementia cases during a mean of 9.8 years of follow-up. We found a positive, but statistically insignificant association between night shift work and dementia (IRR=2.01; 95% CI: 0.87-4.65). Post hoc analyses indicated that this was only due to a higher risk in permanent night workers (IRR=3.25; 95% CI: 1.35-7.83). The dementia risk was also significantly higher among participants working 38-44 h/w (IRR=2.08; 95% CI: 1.11-3.90) compared with those working 37 h/w. We found no indications of a higher risk of dementia in participants working <37 h/week or ≥45 h/w. **Discussion:** We did not find arguments that night shift work or long working hours increased dementia risk in general. However, we found a higher risk of dementia in specific subgroups, i.e. permanent night workers and employees with moderately longer weekly working hours than the standard.

Adiposity Indicators as Criteria for Polysomnography in Shift Workers

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Introduction: To verify the discriminatory power of adiposity indicators in the prediction of obstructive sleep apnoea (OSA) in shift workers. **Methods:** A cross-sectional study was performed in 118 male shift workers from an iron ore extraction company, who presented with at least one overall risk factor for cardiovascular disease. Anthropometric data were collected, and polysomnography (PSG) was performed. **Results:** The frequency of OSA in the sample was 84.7%. The adiposity indicators used to predict OSA (≥ 5 events/hour) with a sensitivity of more than 70% were the body mass index (BMI), waist circumference (WC), waist-to-height ratio (WHtR), and total body fat (TBF). Visceral fat (VF), neck circumference (NC), and neck-to-height ratio (NHtR) showed specificity values of more than 70% and thus were the most effective in correctly identifying workers without OSA. The areas under the receiver operating characteristic (ROC) curves for WC and NHtR were greater than 0.7, which indicated the effectiveness of the test for the discrimination of individuals with OSA. **Discussion:** The use of abdomen and neck adiposity indicators as a screening method for PSG is effective since alterations in these indicators demonstrate a significant relationship with the presence of OSA. WC and NHtR are considered good tools for OSA prediction.

Circadian Disruption; More Likely In Late Night Eaters than Early Eaters T2DM Patients

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Background: People who stayed up & eating late, regardless of lifestyle factors, had a higher risk of dyslipidemia, diabetes or increased cardiac problems than those who were early risers. The aim of this study is to investigate whether there was a relationship between chronotype (morningness-50n & eveningness-25n) in T2DM. **Methods:** A total of 135 subjects (morningness n= 50, mixed n= 55 & eveningness n = 30) mixed aged 18 to 60 years were recruited in Clinical OPD of General Medicine, KGMU. The subjects we enrolled were mainly treated their diabetes & lifestyle related disease including hypertension dyslipidemia & so on. **Results:** When we compared these 2 groups, Significant Different was found in various parameters like FBG ($p = 0.01$) Postprandial ($p = 0.03$) HbA1c ($p = 0.001$) TG ($p = 0.001$), Total Cholesterol ($p = 0.01$) & VLDL ($p = 0.005$). Serum leptin (15.01 + 14.70) also reduced in eveningness when compared to morningness type, which may increase appetite & reduce energy expenditure leading in turn to the development of obesity & deterioration of metabolism. It also shows the complete inversion of the cortisol level (171.55+ 77.70). Insulin, IL-1 beta & IL-6 also show significant change in late night eating T2DM Patients. Systolic/ Diastolic readings of ABPM shows significant change between morning (124.42 + 19.99/76.28 + 16.24) and mixed type (147.42 + 21.38/86.42 + 17.38) but not from evening type (147.49 + 22.35/85.35 + 17.59). And for reliability of sleep by actigraphy shows morning (6:15+1:35) & evening type (8:18+1:23) take complete sleep but mixed chronotypes total sleep hours (5:10+1:05) are very less. **Conclusion:** Eveningness

& mixed chronotype more likely to have circadian disruption, poor sleep quality, sedentary life style, eating late & larger meals at night than individuals of the morningness chronotype.

Melatonin Profiles during the Third Trimester of Pregnancy and Health Status in the Offspring among Day and Night Workers: A Case Series Study

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Introduction: Successful pregnancy requires adaptation in maternal physiology. During intrauterine life the mother's circadian timing system supports successful birth and postnatal development. Maternal melatonin is important to transmit circadian timing and day length to the fetus. **Methods:** This study aims to describe the third trimester of pregnancy among day (n=5) and night (n=3) workers by assessing their melatonin levels in a natural environment. Additionally, we describe the worker´s metabolic profiles and compare the health status of the newborns between groups of day and night working mothers. **Results:** Our results indicate an occurrence of assisted delivery (cesarean and forceps) among night workers. Moreover, the newborns of night workers showed a significantly lower Apgar index ($p<0.04$) and breastfeeding difficulty indicating a worse condition to adapt to life outside the womb. The aMT6s acrophase was at 4:21h for night workers, which was later than day workers (1:52h; $p<0.05$). Additionally, there was significantly lower night-time melatonin production among pregnant night workers compared to day workers ($p<0.04$). **Discussion:** These findings may be related to light-induced suppression of melatonin that occurs during night work. We conclude that night work and consequent exposure to light at unconventional times may compromise the success of pregnancy and the health of the newborn. Further studies need to be carried out to monitor pregnancy and newborn health in pregnant night workers.

Sleep Hygiene in Paramedics: What do They Know and What do They do?

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Introduction: 'Sleep hygiene' describes a range of behaviours, lifestyle and environmental factors that positively influence sleep. Engagement with sleep hygiene practices can greatly benefit shiftworkers' sleep, but there is limited information on what specific groups of shiftworkers know about sleep hygiene practices and which practices they engage in. The aim of this study was to investigate the level of understanding of, and engagement in, sleep hygiene practices in a sample of paramedics. **Methods:** A group of shiftworking paramedics (n=173) completed an online survey to assess their sleep hygiene knowledge and sleep hygiene practices. The survey comprised questions from the Standard Shiftwork Index and Sleep Hygiene Index. Analyses were conducted using Pearson's Chi Square test. **Results:** Paramedics knowledge of the term 'sleep hygiene' was poor $x2(2) = 40.7$, $p<.001$ with only 16% of having an understanding of the term. The majority of participants (54%) had no prior knowledge or understanding of sleep hygiene, while 29% reported some familiarity with sleep hygiene but did not have a solid understanding. Engagement in sleep hygiene practices varied across the sample. A large number of paramedics often or always consumed caffeine to manage sleep-related fatigue (77.5%, $p<.001$) or engaged in strenuous exercise to promote sleep (67.6%, $p<.001$). Of concern was that two thirds of paramedics engaged in mentally-stimulating activities (e.g., watching television, browsing the internet) in bed, which can adversely impact sleep. For the majority of paramedics, noise (64%, $p<.001$) and light levels (53%, $p<.001$) rarely influenced sleep. **Discussion:** This exploratory study was the first to determine the level of understanding and engagement with sleep hygiene practices in a shiftworking population. Most participants reported no familiarity with the term 'sleep hygiene'. Respondents engagement in sleep hygiene practice varied. Sleep hygiene interventions are needed in shiftworking populations to improve sleep hygiene knowledge and ultimately sleep outcomes.

A Descriptive Analysis of Shift Start-Time and Schedule by Industry

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Introduction: Work schedule characteristics such as number of hours worked per week and the time a work shift begins can affect an individual's health. The American Community Survey (ACS), a large nationwide survey conducted by the U.S. Census Bureau, provides information on characteristics of an individual's work schedule. Understanding work schedule characteristics by industry would provide insights on which industries are more prone to unhealthy work arrangements and schedules. **Methods:** This descriptive analysis used 11 years of survey data (2007-2017) from the ACS to summarize certain work schedule characteristics by detailed industry and observe how these characteristics changed over time. Specifically, the average number of hours a worker worked per week by industry and distributional properties of shift start times by industry were analyzed across wage/salary income class. The ACS is a nationally representative survey conducted annually by the U.S. Census Bureau. The person-level information provided by the ACS, the survey's rolling sample design, and its large sample size provide a unique opportunity to take a detailed look at separate industries' work schedule characteristics. Additionally, the ACS has been used very little in occupational safety and health research. **Results:** Weights provided by the U.S. Census Bureau were used to estimate annual statistics at a nationally representative level, and the statistics were then appended to form a panel of industries using the Bureau's 2012 Industry Code (267 industries, comparable to North American Industry Classification System industries at the 4-digit level). **Discussion:** Not only does this descriptive analysis provide robust and detailed industry estimates, it also observes year-to-year change within each industry. Results enable researchers and decision-makers to identify industries that are experiencing - or trending toward - relatively unhealthy work schedules. This, in turn, points to opportunities for prevention.

Creating a Standardized Procedure for Measuring Sleep by Actigraphy in Aviation Field Studies

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Introduction: The Actigraph is a wrist-worn device containing an accelerometer that can detect changes in activity to measure sleep within individuals and quantify sleep across populations. While there is some literature comparing actigraphy with other sleep scoring methods, the exact nature of data-cleaning procedures for actigraphy is not well defined, and varies from laboratory to laboratory. There is a need for a standardized data-cleaning procedure. We have developed such a procedure and showcase it's use when monitoring the sleep of commercial aviation pilots. **Methods:** Our standardized actigraphy data cleaning procedure is a two-step process. The first step is to identify in the actigraph report by self-report, event marker, and activity level periods of time that are highly likely to be wake. The second step is to take the remainder of the report and determine which, by the same criteria, periods of time that are possibly sleep are in fact sleep. This method was compared to auto-generated sleep only and self-report only (applied to data collected from pilots) to demonstrate that our procedure more accurately measures actual sleep. **Results:** We have found the two-step procedure renders a more accurate and reproducible sleep/wake history, compensating for mistakes made by pilots when self-reporting sleep and eliminating most inaccuracies made when only actigraph sleep algorithms are used. **Conclusion:** In light of what our data shows, and the overall lack of literature surrounding actigraphy cleaning procedure, we highly recommend a standardized data cleaning procedure. While we apply the cleaning procedure to pilot's sleep data and believe it should be implemented for all aviation studies, this procedure may also be useful across multiple population types.

Phase Relationships between Dim Light Melatonin Onset and Sleep Markers Determined by Actigraphy and the Munich ChronoType Questionnaire

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Introduction: Measurement of body clock timing (circadian phase) is often required for diagnosis and treatment of circadian rhythm disorders. Measurement of Dim Light Melatonin Onset (DLMO), the gold standard measure of circadian phase, is

expensive and often impractical. As preferred timing of sleep reflects body clock timing, measurement of sleep markers may provide a simple way to determine circadian phase. The aim of this analysis is to determine the phase differences between DLMO and key sleep markers determined objectively by actigraphy, and subjectively by the Munich ChronoType Questionnaire (MCTQ). **Methods:** Wrist actigraphy data was collected from each of 53 (26f, 27m) healthy adults aged 23.3 ± 3.8 (mean ± SD) years for one week. Sleep diaries were completed concurrently with actigraphy to validate sleep start and end times. Participants then attended a sleep laboratory and completed a one-night adaptation sleep. During the following day participants completed the MCTQ and were kept awake. From 19:00 to 03:00 saliva samples were collected hourly in dim light (<10 lux) using polyester swabs, which were later assayed for melatonin concentration. **Results:** The sleep and melatonin data are currently being analysed. Sleep onset, mid-time and offset will be determined from actigraphy and the MCTQ. It is predicted that DLMO will correlate more strongly with the sleep markers determined by actigraphy than those determined by the MCTQ, and that DLMO will precede sleep onset, mid-time and offset by approximately 2h, 6h and 10h respectively. **Conclusions:** Circadian rhythm disorders are often treated by appropriately-timed exposure to bright light and/or administration of exogenous melatonin. The benchmark phase differences between DLMO and the key sleep markers determined in this study may allow these techniques to be timed from sleep markers rather than DLMO, improving their accessibility and effectiveness.

The Effect of Total Sleep Deprivation on Cognitive Performance during the First Night-Shift for Early and Late Chronotypes

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Introduction: Workers often find it difficult to transition to night-shift, with many spending up to 24 hours awake by the end of their first night-shift. Total sleep deprivation (TSD) impairs cognitive performance, escalating risk of accidents and injuries. Chronotype is an individual difference which reflects circadian phase and may influence the effect of TSD on cognitive performance. The aim of this study is to examine the effect of TSD on cognitive performance during the first night-shift for early and late chronotypes. **Methods:** Data was collected from each of 53 (26f, 27m) healthy adults aged 23.3 ± 3.8 (mean ± SD) during a simulated night-shift study. To determine chronotype, Dim Light Melatonin Onset (DLMO) was derived from saliva samples taken during the evening prior to the day of the first night-shift. Participants were kept awake during the day of the first night-shift from 12:00-23:00. During the night-shift (23:00-07:00), participants completed five Psychomotor Vigilance Tasks (PVT), with approximately 2 hours between each task. **Results:** Early and late chronotype groups will be identified from DLMO. Cognitive performance will be assessed by mean PVT reciprocal response time (RRT), with lower RRT corresponding to worse cognitive performance. A mixed-design ANOVA with one within-subjects factor (PVT time) and one between-subjects factor (chronotype) will be performed on mean RRT. It is predicted there will be a main effect of chronotype (better cognitive performance for late chronotypes), and an interaction demonstrating that the effect of TSD (i.e., PVT time) on cognitive performance is moderated by chronotype. **Conclusions:** TSD is commonly experienced by workers during the first night-shift, resulting in cognitive decrements which may vary over the course of the night according to their chronotype. The findings of this study may inform chronotype-specific strategies which assist in the management of workplace risk.

Can Your Fingers Separate REM and Non-REM Sleep?

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Introduction: Abnormal rapid eye movement (REM) sleep is often symptomatic of chronic disorders, however polysomnography, the gold standard method to measure REM sleep, is expensive and often impractical. Attempts to develop cost-effective ambulatory systems to measure REM sleep have had limited success. As elevated twitching is often observed during REM sleep in some distal muscles, the aim of this study was to assess the potential for a finger-mounted device to measure finger twitches, and thereby differentiate periods of REM and non-REM (NREM) sleep. **Methods:** One night of sleep data was collected by polysomnography from each of 18 (3f, 15m) healthy adults aged 23.2 ± 3.3 (mean ± SD) years. Finger movement was detected using a piezo-electric limb sensor taped to the index finger of each participant. Finger twitch densities were calculated for each stage of sleep. **Results:** Finger twitch density was greater in REM than in NREM sleep ($p < .001$). Each sleep stage had a unique finger twitch density, except for REM and stage N1 sleep which were similar. Finger twitch density was greater in late REM than in early REM sleep

(p = .005), and there was a time-stage interaction: the difference between finger twitch densities in REM and NREM sleep was greater in late sleep than in early sleep (p = .007). **Conclusions:** Finger twitching is higher in REM sleep than in NREM sleep and becomes more distinguishable as sleep progresses. As finger twitches are relatively infrequent, finger twitch densities appear to be too low to make accurate 30-second epoch determinations of sleep stage, but could be used with other variables to provide an ambulatory system capable of detecting REM sleep. As research studies and clinical diagnoses often require accurate temporal measurements, PSG is likely to maintain its gold standard status in the foreseeable future.

Predictors of Sleepiness in Two-Week Offshore Day-Shift Workers

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Introduction: This study aims to 1) investigate the individual courses of sleepiness and the daily prevalences of severe sleepiness in offshore day-shift workers and 2) examine which demographic, lifestyle and health factors predict the individual courses of sleepiness and daily prevalences of severe sleepiness in two-week offshore day-shift rotation periods. **Methods:** Data was collected from N = 42 offshore day-shift workers during two-week offshore shift rotations. At baseline, data on demographic, lifestyle and health factors were obtained. Sleepiness was assessed using daily pre- and post-shift measures of the Karolinska Sleepiness Scale (KSS). Severe sleepiness was defined as KSS > 6. Linear regression and generalized linear mixed model analyses were performed. **Results:** On average, individual post-shift sleepiness scores were higher (M = 4.59, SD = 1.86) and increased more (Median b = .06, 5% Percentile = -.10, 95% Percentile = .30) over the two-week offshore day-shift rotation periods, compared to pre-shift sleepiness scores (M = 4.02, SD = 1.66; Median b = .01, 5% Percentile = -.31, 95% Percentile = .20). Across the offshore shift rotation period, the average daily prevalence of severe sleepiness was 14%; 10% in pre-shift and 19% in post-shift periods. Demographic, lifestyle and health factors were found to predict individual sleepiness courses and daily prevalences of severe sleepiness. **Discussion:** Individual courses of sleepiness and daily prevalences of severe sleepiness differed between pre- and post-shift periods. Predictors for individual courses of sleepiness and severe sleepiness over time were identified, but not all results were in expected directions. The findings may help to improve fatigue risk management programs and systems.

The Likelihood of Crashing during the Post-Work Commute Decreases throughout a Week of Night Shifts

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Introduction: Shiftworkers are much more likely to have a crash driving home after a night shift than other drivers on the road at the same time. The aim of this study was to examine the likelihood of crashing during the post-work commute at the start, middle, and end of a week of night shifts. Given that prior wake is longest at the end of the first night shift compared to the others, it was hypothesised that the likelihood of crashing would be greatest at the start of the week of night shifts. **Methods:** So far, 43 adults (21F, 22M) have completed a laboratory-based simulated shiftwork protocol with 7 consecutive 8-h night shifts (23:00–07:00h). Participants had 9 h in bed on the night prior to the first night shift, then they had 7 h in bed in the breaks between each night shift. Participants had a 20-min commute before (22:30) and after (07:10) each night shift in a driving simulator (York Computer Technologies). Subjective sleepiness was assessed immediately prior to each commute using the Karolinska Sleepiness Scale (KSS). **Results:** Compared to the corresponding pre-work commute, participants were 8.2, 5.7, and 3.0 times more likely to crash during the post-work commute on nights 1, 4, and 7, respectively. Repeated-measures ANOVA indicated a significant night x commute time interaction in the sleepiness data (F=10.9;df=2,84;p<.0001) – KSS was similar for the pre-work commutes each night (N1=3.7±1.3, N4=3.6±1.4, N7=3.7±1.6), but it progressively decreased for the post-work commutes throughout the week (N1=8.1±1.1, N4=7.6±1.6, N7=6.9±1.9). **Discussion:** These data indicate that post-work driving crash risk and subjective sleepiness are both relatively high, but they progressively decline throughout a week of night shifts. If generalisable to shiftworkers, the results suggest that longer sequences of night shifts may have an advantage over shorter sequences, in terms of exposure to risk.

Sleep, Sleepiness, and Sleepiness Countermeasures among Tram Drivers

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Introduction: The present field study examined the sleep, sleepiness, and sleepiness countermeasures of tram drivers who worked irregular hours. **Methods:** A total of 23 drivers (mean age 41 yr, 11 females) volunteered for the study. The field measurements covered a 3-week schedule that was mainly composed of 3 consecutive morning shifts followed by 2 days off, 3 evening shifts, 2 days off, 4 morning shifts, 1 day off, 4 evening shifts, and 2 days off. For analyses, some shifts were classified as day shifts, as they did not meet the definition of the morning (start before 07:00h) or evening (end after 21:00h) shifts. Sleep was measured by a diary and an activity monitor and sleepiness by the Karolinska Sleepiness Scale (KSS). A KSS rating was given in the beginning and end of each shift and before and after each rest break. Sleepiness countermeasures were measured by the diary. **Results:** Mean sleep duration was 1.5 h shorter before morning shifts (5.5 h) than before evening shifts (7 h) or between days off (7 h) ($p<0.001$). The occurrence of on-duty sleepiness (KSS ≥ 7) was not affected by shift type or a spell of consecutive shifts. Sleepiness levels significantly decreased during rest breaks ($p<0.001$), independent of shift type. Participants reported mostly using alertness-enhancing activity (e.g., slight body movements) and caffeine consumption as their sleepiness countermeasures (38% - 68% of the shifts), independent of shift type. **Discussion:** Surprisingly, morning shifts did not prove significantly more fatiguing than the other shifts, even though the amount of sleep was rather limited prior to them. Moreover, the lack of accumulation of sleepiness over consecutive morning shifts was a somewhat unexpected finding. In all, these results suggest that limited prior sleep and unfavorable timing of a shift do not always result in markedly increased self-reported on-duty sleepiness.

An Accessible Web-Based Tool to Evaluate Risk of On-Duty Sleepiness

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Introduction: This project aimed to develop an accessible web-based tool to evaluate shift schedules with respect to risk of on-duty sleepiness. **Methods:** The development of the tool, named Vire, is based on the three-process model of alertness. To make the tool applicable to all jobs, latent sleepiness, instead of manifested sleepiness, was chosen as the main outcome. Shift schedules can be imported manually or as electronic files. To make the output of an evaluation easy to interpret, a traffic light analogy is used to grade each shift in terms of the degree of sleepiness risk (green = low risk of on-duty sleepiness, yellow = moderate risk, red = high to very high risk, black = very high). The output is shown in a summary table including all employees and the distribution of their shifts across the four risk grades. In addition, a detailed view shows all shifts of an individual employee, with every shift being marked by an indicative color. To make the tool usable for a wide range of potential users, three language versions (Finnish, Swedish, English) are available. **Results:** The beta version of the Vire is currently available free of charge at http://vire.arturcloud.com. Until now, three industrial partners have tried the Vire in our projects. They have been able to use the tool on their own and utilized the results when assessing risk of on-duty sleepiness and alternative shift scenarios. **Discussion:** In the future, Vire-like tools may help 24/7 operating organizations arrange their working hours in an alertness-friendly manner and also implement effective fatigue management strategies where needed. The next step will be to examine what are the best strategies to implement Vire-like tools in 24/7 organizations.

New Rules for Fatigue Management in Brazilian Civil Aviation

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Global discussion on Fatigue Risk Management Systems for aircrew in the civil aviation industry made several States look back at their rules on flight and duty time limitations, even before the publication of DOC 9966 by the International Civil Aviation Organization, in 2012. In Brazil, a new Federal Law concerning crew fatigue management has been approved on August 2017. Besides establishing limits, it has empowered the National Civil Aviation Agency of Brazil (ANAC) to approve exceptions for air operators. This lead to a 3-level model on managing fatigue, from the purely prescriptive to a performance-based approach. The result is the recently published Brazilian Civil Aviation Regulation (RBAC 117), on March 2019. From March 2020, air operators will be able to choose what best fit their operations.

In few words, the substantial requirements established by the Brazilian rules are: Specific airport indicated as base due to distance and traffic in big cities as Rio de Janeiro, São Paulo and Belo Horizonte; night flight duty defined from 1800 to 0600; late night operations defined between 0000 to 0600, limited to 4 within a week and 2 in-a-row; weekly cumulative flight duty time of 44 hours, achieving 60 hours with fatigue risk management applied; monthly cumulative flight duty time of 176 hours; 8 to 10 days-off within a month; flight duty time from 9 to 13 hours depending on starting time for two pilots, and from 14 to 18 hours depending on starting time and onboard facilities for three or four pilots; acclimatization conditions detailed. Brazil´s regulations on fatigue management have recently changed. Fatigue management is an on-going issue. We believe that the limitations prescribed by the States are essential, but they are not more than a starting point from which risk management starts.

Fatigue in a Search and Rescue Crew Population

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Introduction: Shiftwork is inherent in many first response occupations, including Search and Rescue services (SAR). The Royal Norwegian Air Force (RNoAF) SAR has a 15 min. response time 24/7/365, in addition to training and other responsibilities. Shiftwork, nightwork and long hours is therefore inherent in their operations. Although fatigue is periodically reported as a possible contributing factor in accidents and incidents, less is known about the exact workload and fatigue levels in this population. The aim of the current study was to examine levels of workload and fatigue in the RNoAF SAR in order to provide a basis for advice and future planning. **Methods:** Subjects included helicopter and maintenance crew of the RNoAF SAR. Participants answered an online questionnaire, filled out daily sleep- and activity logs, and completed psychomotor vigilance tests at the beginning and end of every shift and after flights and call-outs. A series of analyses were performed based on all three data sources. **Results:** We found signs of fatigue in both helicopter and maintenance crew. Crewmembers reported daytime sleepiness relatively often, but overall workload was relatively low. Although average levels of fatigue appear within acceptable limits, some fatigue scores for individuals at certain times give rise to a degree of concern. From a list of specified reasons, the most important contributors to fatigue reported were the number and length of missions, night missions, and loss of sleep. **Discussion:** Workload and fatigue levels in RNoAF SAR appears, in general, acceptable when comparing with similar populations, and do not provide a basis for a conclusion of high risk in general. This may be partly due to a relatively strong safety culture. However, there are notable differences in fatigue preventing strategies and culture when comparing with studies on similar groups. Fatigue management strategies should be implemented to manage peaks.

Working Time Issues for Food-Service Workers in Participatory Improvement Steps

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Introduction: Recent experiences in participatory approaches for improving stressful working conditions demonstrate the need to address working time arrangements and job content in a combined manner. The merits of applying participatory steps for this joint improvement were examined in the case of food-service workers. **Methods:** The working time aspects addressed by food-service workers in participatory action-oriented steps for improving their working conditions and environment were examined. The group work for improving broad-ranging conditions of their daily work utilized an improvement action checklist developed for food-service work. The relations of working time issues with other workplace conditions planned were examined. **Results:** The participatory steps for improving food-service conditions led to a number of broad-ranging improvement actions for food-service workers. The action checklist based on locally feasible good practices at work proved useful for planning these practical improvements. Main areas addressed were internal communication, working time, service work methods, physical environment and emergency preparedness. Working time improvements addressed were communication about shift changes, securing resting periods and scheduling annual leaves. It was striking that working time aspects were planned in close associations with communication and service methods. The simplified procedures for taking participatory steps were confirmed valid for planning broad-ranging actions for reducing stress at work. The main contributing factors for multifaceted improvements were the simple group work procedures and the use of an action checklist covering both working time and job content. **Discussion:** The participatory steps utilizing action tools facilitated multifaceted improvements including working time arrangements for foodservice workers. The group work procedures proved useful to address these arrangements, such as overtime hours and resting and paid leave conditions in association with job content aspects. It is suggested to promote multiarea actions including working time and job content as a means of preventing stress at food-service work.

How Much Sleep Does an Elite Athlete Need?

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Introduction: Elite athletes typically report obtaining less than the recommended target of eight hours of sleep per night, but little is known about how much sleep they need each night to feel rested. The aim of this study was to identify the subjective sleep need of elite athletes and to compare it with an objective measurement of habitual sleep duration. **Methods:** A total of 175 elite athletes from 12 sports wore an activity monitor and completed a sleep diary for a minimum of four nights during a normal phase of training. The data from the activity monitor and sleep diary were used to calculate habitual sleep duration for each athlete. Sleep need was assessed prior to data collection with the question 'how many hours of sleep do you need to feel rested?'. Sleep deficit was then calculated for each athlete by subtracting habitual sleep duration from sleep need. Paired t-tests were conducted to detect a difference between sleep need and sleep duration. **Results:** On average, athletes' subjective sleep need was 8.3±0.9h and their mean habitual sleep duration was 6.7±0.8h. There was a significant difference between sleep duration and sleep need [$t(168) = -19.2$, $p<0.0001$]; and this difference was observed in most sports (basketball, road cycling, rugby union, track cycling, triathlon, Australian Rules football, soccer, cricket, swimming) but not all (mountain biking, race walking). The mean sleep deficit (i.e., discrepancy between sleep need and sleep duration) was 1.6±1.0h. Only 3% of athletes met their required sleep need. **Conclusions:** A majority of elite athletes fall short of their sleep need by one hour or more. Insufficient or inadequate sleep, defined here as a failure to meet a required sleep need on a regular basis, could have important consequences for an elite athlete, particularly in terms of their ability to train effectively and/or compete at their best.

Comparison of Fatigue among Flight Crews during the Night - Night Flights Versus the Night - Early Morning Flights by Single Operations in Japanese Major Airline Companies

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Introduction: In 2017, we reported a paper that "A preliminary questionnaire study on fatigue of long-haul commercial flight crew members". In that paper, the fatigue of air crews was evaluated by whether long-haul operation, two-men operations, night flights, WOCL (Windows of Circadian Low), time differences and early morning operations exist or not. The results showed that higher fatigue in flights of the Haneda -Sydney and the Haneda -Vancouver than other flights. Therefore, purpose of the present study is that we assess fatigue of crews in these flights by objective measurements. **Methods:** Fifteen captains and 9 first officers participated (mean age; CAP = 49.9 yrs., FO = 33.4 yrs.). They completed 5-min psychomotor vigilance task and the Samn - Perelli Fatigue scales at pre- and post-flight during round-flights in Haneda - Sydney or Haneda - Vancouver. One of captains wore an actigraphy during every operation and sleep. The Haneda - Sydney flights were nighttime operations for round trips without time differences. Meanwhile, the Vancouver flight was operated at night on the outbound route, early morning flight on the inbound route, and there was a time difference. **Results:** Two-way ANOVAs for Samn - Perelli Fatigue scales showed more tired Sydney flights than Vancouver flights ($p < 0.0001$), and also showed flights (to Sydney or Vancouver) × routes (outbound or inbound) interaction ($p = 0.011$). However, there were no significant differences in any parameters of PVT. **Discussion:** The reason that no differences in any PVT parameters was that pilots could take naps. The other hands, differences in SP-scale assumed that caused by psychological burden that pilots had no choice but to take prophylactic naps even if at inappropriate circadian rhythms for safety before inbound flights. We concluded that at least augmented crews should be need at night flights.

Culture Change in the US Navy: From Data Collection to Mandated Policies

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Introduction: Since 2001, the Naval Postgraduate School Crew Endurance Team has conducted numerous studies on more than 30 surface combatants of the United States Navy (USN) to document the sleep patterns and performance of Sailors. The aim of this multi-year effort was to determine which watchstanding and work schedules are most effective while crews are underway, and to provide actionable recommendations to the US Navy leadership. **Methods:** All studies were naturalistic and longitudinal. Sailor (N=1269) well-being and performance was assessed in terms of sleep-related attributes (both subjectively and objectively using actigraphy), fatigue, insomnia symptoms,

mood states, performance in the Psychomotor Vigilance Task, and work hours. **Results:** Compared to non-circadian watchbills (i.e., rotating watchstanding schedules leading to a non-24-hour work/rest pattern), circadian-based watchbills (i.e., fixed watchstanding schedules with work/rest patterns resulting in a 24-hour day) and watchbills with more sections were associated with higher alertness, less severe insomnia symptoms, better sleep quality, better mood, and better psychomotor vigilance performance. That is, crewmembers on circadian-based schedules responded faster and made fewer errors than their counterparts who were pn non-circadian-based schedules. Notably, differences between circadian and non-circadian watchbills were more pronounced in 3-section compared to 4-section watchbills. **Discussion:** These results validate the operational utility of circadian-based watchbills. In contrast, non-circadian-based watchbills should be avoided if at all possible. The efficacy of circadian-based watchbills is even greater when manning is limited, i.e., when ship's company cannot support the use of 4-section watchbills. Our recommendations informed the fleet-wide directive to implement circadian-based watchbills onboard all US Navy surface ships. In parallel, the development of crew endurance and sleep hygiene training programs was initiated to support commands improve shipboard operational performance.

Effect of a High-Protein Meal during a Night Shift on the Food Consumption Pattern the Following Day: A Randomized Crossover Study with Fixed Night Workers

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Introduction: Night workers are more likely to have obesity and its associated diseases. Studies suggest that food choices at night is a key contributor to the increased risk of weight gain among these individuals. Thus, the development of strategies to avoid an inadequate nutritional status related to food intake at night are required. The aim of this study was to compare the acute effect of a high-protein versus normal protein meal served at night on the feeding behavior the following day. **Methods:** The study was conducted with 14 male nurses. After being followed-up for 7 days before each night intervention in relation to eating and sleeping habits, participants underwent two different isocaloric dietary conditions at 1:00 h of the night shift, with a 6-day washout period between them: high-protein (HP) meal containing 45% carbohydrate, 35% protein and 20% fat; and normal protein (NP) meal containing 65% carbohydrate, 15% protein and 20% fat. Participants answered a food register of all food consumed the following day after intervention. Generalized estimating equations analyses were used to examine the effect of each meal test on food consumption of energy and macronutrients. **Results:** Compared to NP intervention, HP intervention led to a higher percentage of carbohydrate consumption in the lunch and lower percentage of fat consumption in the dinner the following day (48.14% versus 36.98% and 27.34% versus 40.39%, respectively). For all other meals evaluated, we did not found differences between nutritional interventions. **Discussion:** Eating a high protein meal at night leads to changes in the pattern of food consumption the next day.

'No Time to Eat': A Qualitative Study about Nurses' Food Intake, Shift Work and Gender

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Introduction: Few studies highlight the importance of the relationship between shift work and food intake correlating aspects such as calories intake with metabolic problems. **Objective:** This study aimed to report female nurses' perceptions about how their food intake is influenced by their shift work and gender aspects, especially houseworking and motherhood. **Methods:** This qualitative study was conducted at a public maternity hospital located in São Paulo - Brazil. Data was gathered by ethnography and 10 in-depth interviews performed with female shift work nurses. The data collection was organized as two types of database: 'Field Journals' and 'Interviews Database'. Analytic process was performed by 'Triangulation Method' according to the conceptual framework of hermeneutical referential. **Results:** Day shift nurses explained two major problems to establish a regular schedule of meals that was conciliate houseworking and their shift, that demanded early waking up and late bed time at night. The main challenge for the night shift nurses was to bring health food to work and keep a meal schedule during the day, even because there were no places to eat nearby the maternity. We also observed impairments in order to balance their housekeeping and resting time. **Discussion:** According to the nurses perceptions, for both groups, not having meal options at/ or close to work made their food intake harder or less healthy. Besides that,

the double-burden of work hours and gender attributes (housework) impacted negatively in their food intake.

Tracking the Psychosocial Working Conditions of Shiftworking and Non-Shiftworking Nurses across Early to Mid-Career

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Introduction: We examined which psychosocial working conditions were associated with shiftwork, burnout and sleep disturbance among nurses, and whether these associations change over time. Firstly, we identified multidimensional patterns of work characteristics that were shared by groups of nurses and study how the prevalence of these patterns changed from early to mid-career. Secondly, we examined associations between those patterns and (1) type of shift schedules and (2) burnout and sleep disturbance. **Method:** N=1585 nurses were followed over their first 3 years post-graduation and again after 10-14 years. Firstly, psychosocial working conditions were measured using eight categorical indicators, which were empirically combined to form latent patterns of responses using Latent Class Analysis. Longitudinal measurement invariance was examined using Latent Transition Analysis. Secondly, covariates representing shift schedules and health outcomes, as well as controls (age and sex), were added to the model. **Results:** Five patterns of working conditions were identified: low demands and low control/support ('Constraining'), low demands and high control/support ('Supporting'), high demands and high control/support ('Challenging'), high demands and low control/support ('Demanding'), high non-cognitive demands and low control/support ('Pressuring'). Early career nurses tended to cluster into the three high demand patterns (Pressuring, Challenging, Demanding), but then tended to gravitate into the Supporting pattern as they move into mid-career. Nurses working 3 shifts were less likely to be members of the low demand patterns (Supporting or Constraining). The Supporting pattern was associated with lower burnout and sleep disturbance, while Pressuring and Demanding patterns were associated with higher burnout. **Discussion:** A supporting working environment was associated with lower burnout and better sleep quality. Nurses working rotating nightshifts experienced higher demands than other groups. Retention may be promoted by supporting early career nurses who experience high demands, particularly when combined with lack of appreciation and participation.

Associations of TNFα Gene Polymorphism with Resilience to Sleep Deprivation and Caffeine Sensitivity

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Introduction: Sleep deprivation degrades the fidelity of human brain information processing, leading to cognitive impairment. Caffeine mitigates the cognitive impairment associated with sleep deprivation. Carriers of the A allele of a single nucleotide polymorphism of the TNFα gene (G308A, rs1800629) have been found to be resilient to cognitive impairment due to sleep deprivation as compared to individuals homozygous for the G allele. Whether these caffeine and genetic effects are related and whether they interact is unknown. **Methods:** In an 18-day controlled in-laboratory study, 12 healthy adults (age 27.4 ± 6.9; 6 females) underwent three sessions of 48-hour total sleep deprivation (TSD), with each TSD session preceded and followed by three nights of baseline and/or recovery sleep (8 hours time in bed). In randomized, counterbalanced, double-blind, placebo-controlled fashion, during each TSD session a specific dose of caffeine (0, 200, or 300 mg) was administered four times at 12-hour intervals. Vigilant attention performance was measured every 2 hours during each TSD session by means of a psychomotor vigilance test (PVT), for which the log of the signal-to-noise ratio (LSNR) was determined as a measure of the fidelity of information processing. Each subject's TNFα genotype was assessed from a blood sample. **Results and Discussion:** Subjects homozygous for the TNFα G allele showed greater PVT impairment during sleep deprivation in the 0 mg caffeine (i.e., placebo) condition as compared to carriers of the A allele and as compared to the 200 and 300 mg caffeine conditions (ANOVA, TNFα genotype by caffeine dose interaction: $F_{2,566}=5.23$, uncorrected $p=0.005$). There was no appreciable caffeine-related difference in performance for carriers of the A allele, who were relatively resilient to TSD regardless of caffeine dose. This indicates non-additive effects of TNFα genotype

and caffeine and suggesting a shared mechanism of action regarding the fidelity of information processing during sleep deprivation.

The Effects of Night Shift and Overtime Work on the Recovery and the Social Life among Nurses in Korea

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Introduction: To explore the effect night shift and overtime work on the recovery and the social life among nurses in Korea.**Methods:** We collected and analysed the questionnaires for 357 nurses (total 539 nurses), interviews for 30 nurses, sleep diaries for 369 nurses (1966 cases), and the activities for 24 hours for 90 nurses to explore the effect of night shift and overtime work on the recovery and the social life among nurses in the 3 shifts in Korea. **Results:** The nurses in the 3 shift system have been suffered from overtime work, which is mainly caused from longer transition period of time. The transition period of time is about between 2 and 3 hours per shift (2 hours for day shift and 3 hours for night shift), makes between 40 and 60 hours per month. However, only 10 hours is recognized as waged labor, other 30 To 50 hours cannot be calculated as a waged labor. The nurses' night shift as well as overtime work gave rise to lack of recovery. Nurses had to sleep several times before and after the night shift: before the night shift, after the night shift (morning), after the night time shift (afternoon). The nurses spent outside of working hours to sleep for their recovery. The nurses had to take the sleep several times as well as long sleeping hours to recover when they transit to evening or night, off days after the night shift, or consecutive resting days. The analysis of time activities for 24 hours showed that social life was absent in the night shift. The night shift prevent the human basic needs for self-development, and the desire of human development as a species-being. **Discussion:** The overtime working hours should be reduced and the number of nurses should be increased, and then the shift system should be changed.

The Workplace Based Participatory Research for Changing Night Shifts: 14 Consecutive Night Shift Workers in the Underground Railway in Korea

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Introduction: This study designed as a participatory research to analyze effects of 14 consecutive night shift on the workers' workload, health, as well as family and social relationship, and to develop the strategy for changing night shifts among the underground workers in Korea. **Methods:** The participatory research was performed with workers (station employee, vehicle repair, maintenance workers, and engineer) to change this shift system: 2 shifts with 3 teams of 21days cycle(7 day shifts (09:00~18:00) and 14 night shifts(18:00~09:00)). We collected the questionnaires for 3640 workers, interviews for 30 workers, sleep diary as well as time table(activities) for 24 hours for 63 workers in the underground to explore the effect of 14 consecutive night shift, working hours, night shift working hours in Korea. After analysing the data, we discussed with workers to change the shift system. **Results:** The workers in the 14 consecutive night shift work in the underground in Korea have been suffered from destruction of circadian rhythm and failure for labour recovery. As the workers work for 15 hours(from 18:00 pm to 09:00am) for 14 consecutive work, there is no proper resting days and the time between shifts is only 9 hours, which is not enough for the workers. The workers used their entire 24 hours for work. This system alienate the workers from their family and society, which devastate family life as well as social life. Another problem of night shift is that the workers work for unpaid labour(surplus labour) between one and half hours and 3 hours per night shift. Considering the problem of 14-consecutive night shift, the workers suggested to the managers to change the shift system to the 2 shift system with 4 team (day-night-off-off). **Discussion:** The workers was enthusiastic to change their shift system, therefore, the workers could change their shift system.

Modeling SAFTE-FAST Predicted Effectiveness at Final Top of Descent: Actigraphy v. Self Report v. SAFTE-FAST Autosleep

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Introduction: Actigraphy is the standard for measuring total sleep time (TST) in operational sleep studies because of its high positive correlation with polysomnography (PSG), the laboratory standard for measuring sleep. In contrast to Actigraphy, Self-Report asks an individual to report their perceived TST. SAFTE-FAST's Autosleep function estimates likely sleep times using prior sleep times, time of work, and length of time awake. We seek to determine whether Self-Report or Autosleep is more highly correlated with Actigraphy, recognizing that Actigraphy is currently the most accepted modality for measuring sleep in the field. **Methods:** In this presentation, we compare Actigraphy, Self-Report, and Autosleep to generate SAFTE-FAST predicted effectiveness scores on a three-segment, overnight Guam (GUM) round trip to better understand how the modalities compare. **Results:** This study shows lower predicted effectiveness scores at final top of descent (TOD) as predicted by Actigraphy (M=70.07, SD=5.12), compared to Autosleep (M=74.34, SD=1.85) and Self-Report (M=73.19, SD=4.21). A strong correlation (r(20) = 0.748, p<0.000) was found between predicted effectiveness as measured by Actigraphy and Self-Report sleep data. No correlation was found between Actigraphy and Autosleep. **Discussion:** When comparing all modalities, it appears that both Autosleep and Self-Report may be overestimating predicted effectiveness scores. Since our results showed a strong correlation between Actigraphy and Self-Report, our recommendation is to use Self-Report when Actigraphy is unavailable.

Cumulative Exposure to Shift Work and Select Chronic Diseases: A Systematic Review

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Introduction: Shift work, broadly defined as work inclusive of times other than the hours of 7:00 A.M. to 6:00 P.M, has been linked to a number of short and long-term health effects. While these health effects have been explored in contemporary literature, the overall cumulative influence, particularly for its contribution to major chronic illnesses, has not been reviewed. Approximately 20% of workers engage in shift work, and for older adults who are more likely to have accumulated exposure to shift work, it would be particularly beneficial to evaluate whether the effects of shift work are cumulative. The objective of this research is to evaluate the evidence of associations between cumulative exposure to shift work and select chronic diseases. **Methods:** This systematic review is designed to evaluate evidence of a cumulative effect of shift work exposure for select chronic diseases (cardiovascular disease, diabetes, obesity, cancer) among adult workers with greater shift work exposure compared to those with less shift work exposure. Pooled results of homogenous studies, aggregate data, descriptive synthesis, and subgroup analysis will be reported. **Results:** Results available by June 1st 2019. **Discussion:** With an increasingly 24 hour economy, U.S. labor trends are exposing more and more workers to shift work. As the population ages, the accumulation of shift work exposure has the potential to contribute to the chronic disease burden faced by individuals and ultimately society/Medicare. A better understanding of the relationship between cumulative shift work exposure and chronic disease may help inform practice, policy and prevention efforts to address the mounting health and economic toll of chronic disease. This includes scheduling decisions by companies who ultimately incur expenditures for the health conditions and may inform labor laws and worker advocacy efforts.

Examination of Simulated Nightshifts Conducted at 100 Lux and the Endogenous Melatonin Secretion Profile in Relation to Nap Quality: A Preliminary Study

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Introduction: Napping is a fatigue countermeasure employed by shiftworkers. Sleep time may differ as a function of nap timing relative to individual circadian timing. The melatonin secretion profile can be confounded by lighting levels in napping studies >50lux. This study investigated the consistency of the melatonin secretion profile obtained during two simulated nightshifts (light levels ≤100lux), and time asleep during a 30-minute nap

opportunity at 0200h. **Methods:** Healthy participants (2 males and 3 females) were of intermediate morningness/eveningness preference (Composite Scale of Morningness: range=34-42), aged 20-29y. On two occasions, one week apart, participants entered the laboratory at 1100h, had a 30-minute nap opportunity at 0200h and then a recovery sleep between 1200h-1800h. Total sleep time (TST) was measured using polysomnography. Saliva samples were collected hourly from 1800h for 18h under ≤100lux light conditions to determine and the temporal profile of melatonin secretion. Nap and recover sleep were at 0lux. **Results:** On night1, melatonin onset ranged from 1940h to 0141h (mean=2225h) and nap TST ranged from 17.5-27.5min (mean=24.6min). Intraclass correlation coefficients indicated excellent consistency between nights 1 and 2 for melatonin onset, peak secretion, and TST (ICC>0.92) and moderate consistency for melatonin offset (ICC=0.65). Correlations with melatonin onset were moderate for morningness (night1 r=0.53, night2 r=0.52) and moderate-strong for TST (night1 r=-0.67; night2 r=-0.77). This relationship was strongly influenced by the participant with the latest melatonin onset, which occurred 30 minutes prior to (on night1) or after (on night2) the nap. **Discussion:** The temporal profile of melatonin secretion was consistent during repeated simulated nightshifts with lighting ≤100lux. There may be a relationship between individual circadian timing and the amount of sleep obtained during a nightshift nap opportunity. This highlights the potential for further study at lighting levels closer to work conditions to inform individualized countermeasures for nightshift workers.

Long and Irregular Work Days and Worker Health

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Introduction: Long and irregular work days (LIWD) may negatively affect worker and family health. We sought to understand how the experience of LIWD among transportation maintenance, correctional officer, and manufacturing workers impacts their health and well-being. **Methods:** We used a qualitative research methodology to assess how time at work impacts worker health as part of the larger mixed methods, cross-sectional, WorkTime study. Participants were recruited at their work site to participate in a 90 minute focus group. Recorded interviews were transcribed and analyzed using the qualitative software ATLAS.ti version 8. **Results:** A total of 49 workers including correctional officers (n= 17), transportation maintainers (n= 25) and manufacturing employees (n=7) participated. Workers reported that the aspects of their work and schedules that were the biggest obstacles to their health and well-being included long work hours, and irregular and unpredictable schedules. Poor work conditions, including poor sanitary environment, no bathroom facilities, and lack of adequate sleeping arrangements while on rest breaks also impacted worker well-being. Workers reported effects of LIWD on their physical and emotional health as well as health behaviors. Outcomes that workers identified as being affected by LIWD included exhaustion, lack of sleep, poor eating habits, lack of access to healthy food choices, weight gain, lack of time for exercise, inability to fall asleep, and missing out on family, leisure, social and community activities. **Discussion:** Long and irregular work hours were associated with adverse impacts on workers' abilities to engage in recovery, health, family and social activities. This highlights the importance of developing and implementing effective workplace interventions to address these barriers to health and health behavior.

Characteristics of Compensated Claims for Overwork-Related Mental Disorders among Employees in Transport and Postal Activities in Japan

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Introduction: Overwork-related deaths and disorders (i.e., Karoshi problems) become a serious sociomedical issue in Japan as well as other countries in Asian region. Transport and postal activities in Japan have produced the largest number of compensated cases for cerebrovascular and cardiovascular diseases. Although the number of compensated cases for overwork-related mental disorders in this industry does not hold first place, our previous analyses show that its incident rate ranks second, following Information and communications. The present study was conducted to understand the characteristics of overwork-related mental disorders among employees in transport and postal activities in Japan through examining their compensated claims. **Methods:** We used a total of 214 compensated cases (from January 2010 to March 2015) for overwork-related mental disorders in transport and postal

activities collected by our institute. We reviewed each case in terms of age, gender, diagnosis, suicide, and work-related events experienced. **Results:** The sample consisted of 176 men (mean age at onset: 41.6±10.3 years) and 38 women (38.2±10.8 years). Driving professionals included 70 truck, 25 taxi, 7 bus, and 3 train drivers. Non-driving employees covered mainly 25 clericals, 17 warehouse operators, 13 managers, and 11 post-office workers. Most of the cases were diagnosed as F32 Depressive episode (42.5%), F43.2 Adjustment disorders (23.4%), and F43.1 Post-traumatic stress disorder (17.8%), and F43.0 Acute stress reaction (4.2%). A total of 29 (14%, all men) committed suicide. Mental disorders in the cases were associated with long hours of work (50% of the work-related events), problems at work (31%, e.g., significant errors, drastic changes in job content), conflicts with supervisors (21%), conflicts with passengers (11%), injuries received by motor vehicle crashes (10%), and injuries by workplace accidents (9%). **Discussion:** Overwork-related mental disorders can be prevented through reducing long working hours and other sources of exposure when working in transport and postal activities.

Operator Self-Assessment of Alertness Levels Over a 12-Hour Shift

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Introduction: Being alert and vigilant on the job is essential to Controllers and other shift workers that monitor hazardous processes. Alertness for shift workers changes over the course of their shift. Alertness also varies with different levels of Controller workload. Understanding how alertness fluctuates over the shift can provide valuable information to support fatigue mitigation strategies. **Methods:** Pipeline Performance Group, LLC has conducted over 254 workload assessments in over 77 control rooms in the US, Canada and Australia since 2010. In our research, we ask Controllers to rate their alertness, workload and activities each hour over a 12 hour shift. Controllers use a 9-point scale to self-report their drowsiness. The scale was adapted from the Karolinska Sleepiness Scale (KSS) from the Karolinska Institute in Sweden. **Results:** The majority of Controllers in our assessments reported being extremely alert, very alert or alert. Controllers report being alert 82% of the time (Extremely Alert (21%), Very Alert (28%) or Alert (33%)). Day shift has a higher percentage of Alert ratings than night shift. Controllers on day shift report being alert 44% of the time, while on night shift this is 39%. On day shift or night shift, alertness starts out higher but continues to drop through the shift, it increases in the last hour or so as the end of shift activities increase. Workload levels also fluctuate with alertness levels. Higher levels of workload are related to higher levels of alertness. **Discussion:** Alertness is key for Controllers to maintain vigilance while monitoring on shift work. In order to maintain alertness, the Company needs to provide fatigue management to help Controllers understand key strategies to use on the job and off the job. Controllers also do their part, by getting enough rest, maintaining a healthy diet, drinking water, and getting family support.

Strategies for Time Management as Part of Daily Routine of Medical Residents

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Introduction: Medical training is a complex process involving a number of multiple competencies which begin to be developed during the undergraduate years of medical school. The studies and skills are strengthened during medical residency. It is a recognized form of professional qualification; however, criticisms are made regarding the high work demands. Resident physicians use certain practices in order to optimize their daily activities and to reconcile their professional and personal lives. **Aim:** To describe daily management strategies of Internal Medicine residents in a university hospital of São Paulo, Brazil. **Methods:** Eight second-year residents from a public hospital were interviewed. Information were provided about personal and family life, study, practical activities and work. Analyses of the interviews were performed using MaxQDA program. **Results:** Several strategies for time management were informed: living near the hospital; hiring domestic workers for cleaning; eating their meals at the hospital restaurants; postponing maternity; restricting the main social activities with colleagues and residence program supervisors. Night shifts were often scheduled. Sometimes the working hours were much longer than predicted by residence regulation, i.e. 60 hours per week. Although extra paid work performed out of residency activities is likely to reduce the time for sleep, study and leisure, it was a common practice to complement residents' income. **Discussion:** The adopted strategies aimed to maximize time available for medical residency activities. Management time strategies should be investigated when evaluating the impact of working hours of medical residents. These strategies, if successful, can improve the quality of life associated with medical residents' long working hours.

Can Psychosocial Working Environment Factors Explain Gender Differences in the Association between Work Schedule and Health?

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Introduction: We examined differences in the psychosocial working environment between shiftworkers and dayworkers in female- and male-dominated (FD & MD) occupations, and whether those differences corresponded with health differences. **Method:** Using data from the Swedish Longitudinal Occupational Survey of Health (N=21,024), cross-sectional analyses examined Occupational Gender Composition (OGC: FD occupations versus MD occupations) and Work Schedule (WS: categories - 'Daywork', 'Shiftwork including nights' and 'Shiftwork excluding nights') as predictors of strain (ratio of job demand & decision authority), skill discretion, social support, work time control (WTC) and effort-reward imbalance (ERI). Then, using longitudinal cross-lagged SEM models with fixed effects, we examined WS as a predictor of subsequent (i.e. four years later) mild depression, self-rated health, sickness absence, sleep disturbance and fatigue, separately for MD and FD occupations. The analyses adjusted for a range of background and job-related variables, as well as outcome at baseline. **Results:** In FD occupations, those working shifts excluding nights experienced higher demands and ERI, compared to other groups. In MD occupations, shiftworkers (both types) experienced the lowest levels of job control (skill discretion and decision authority). In both MD and FD occupations, shiftworkers (both types) experienced higher strain and lower WTC than dayworkers. In FD occupations but not MD occupations, shiftwork including nights predicted higher short-term (<8 days) sickness absence, before and after adjustments. In MD occupations but not FD occupations, shiftwork including nights predicted mild depression, after adjustments. WS did not predict fatigue, long term sickness absence, self-rated health or sleep disturbance, in either occupational group. **Discussion:** Associations between WS and psychosocial work environment in MD and FD occupations did not correspond with health differences, for the most part. The findings provide little support for the contention that gender differences in the impact of shiftwork are related to differences in the psychosocial work environment.

Experiences from Large-Scale, Non-Incentivized, Fatigue Data Collections in Aviation

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EASA recently commissioned a study to review the European flight and duty time limitations which came into effect in February 2016. The study, concluded in late 2018, relied in part on a large number of European airlines contributing with fatigue survey data. This data was collected by crew on voluntary basis using an iPhone app for data entry and upload. This presentation will present and discuss the design and trade-offs done when designing the application, affecting usability, data accuracy and completeness during the data collection. Experiences will be shared both from the EASA study, but also from almost a decade of application usage by many different airlines. We will also discuss an alternative 'bare-bone' approach for assessing alertness at top of descent, and associated pros and cons in terms of benefits for the scientific community from such an approach.

Online Survey on Fatigue Hotspots among Flight and Cabin Crew Members across Europe

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Introduction: EASA commissioned a study to review the effectiveness of the new European flight and duty time limitations. The study, concluded in 2018, started with an online survey to identify potential work patterns associated with fatigue, and to collect crew insights about perceived fatigue hotspots. **Methods:** The respondents (i.e., flight and cabin crew working for European commercial airlines) could select, from a pre-defined list of 'fatigue items', the items that they deemed most relevant for causing fatigue hotspots. The list of fatigue items resulted from a scientific literature review and expert input from the study's scientific committee. The respondents could also describe in their own words how their work patterns affect fatigue, and when they feel most fatigued during the duty. The survey was developed in a number of iterations and was tested with a small sample of pilots and cabin crewmembers to ensure high-quality questions using a language and format that is easy to understand for the targeted participants. **Results:** The total number of crew respondents was 15,680. Of these respondents 58.2% were pilots and 41.8% cabin crewmembers. The survey results

showed 'a long working day' as the most frequently indicated fatigue item, 'starting early' as the second, and 'flying during hours when I would normally sleep' as the third most frequent. Survey respondents most frequently indicated 'insufficient time between duties' as a contributing factor to fatigue. The most frequently indicated period when crew were most fatigued was 'during the Window of Circadian Low (WOCL)'. **Discussion:** The online survey results were used to scope the review of the European flight and duty time limitations which consisted of the analysis of airline rosters using bio-mathematical models and a field study collecting fatigue, alertness and sleep data in flight and cabin crews.

Internal Desynchrony of Central and Peripheral Circadian Rhythms during Simulated Night Shift Work

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Introduction: Shift work causes misalignment between internal circadian rhythmicity and externally imposed behavioral schedules, which has been implicated in elevated risk of metabolic disorders. We investigated the metabolic consequences of misaligned shift schedules using a targeted metabolomics approach. **Methods:** Fourteen healthy adults participated in a 7-day in-laboratory study in dim light. Following a baseline day, subjects were randomized to either a 3-day simulated day shift schedule (sleep: 22:00–06:00) or, after a transition nap (sleep: 14:00–18:00), to a 3-day simulated night shift schedule (sleep: 10:00–18:00). This was followed by a 24-hour constant routine protocol, during which subjects were kept awake under constant conditions, with food intake distributed across hourly, isocaloric snacks, and blood sampling every 3 hours through an intravenous catheter. Plasma was analyzed for markers of the central circadian pacemaker: melatonin and cortisol. Additionally, 132 metabolites were assayed by means of targeted liquid chromatography/mass spectrometry metabolomics. **Results:** Melatonin and cortisol rhythms maintained approximately the same phase alignment relative to clock time after the day versus night shift schedules. Of the 132 circulating metabolites analyzed, 65 showed significant 24-hour rhythmicity ($p<0.05$) during constant routine following either or both shift schedules. However, 24 of these metabolites showed a near-12-hour shift following the night shift schedule; 19 metabolites lost rhythmicity following the night shift schedule; and 19 metabolites showed significant rhythmicity following the night shift schedule only. **Conclusions:** After the 3-day simulated night shift schedule, the 24-hour rhythmicity of the majority of circulating metabolites investigated was shifted relative to the central circadian pacemaker, aligning instead with the prior behavioral schedule. This indicates that peripheral circadian clocks in organs involved in metabolism adapt to a shifted behavioral schedule more rapidly than the central circadian clock, suggesting that internal desynchrony between central and peripheral oscillators may underlie the elevated risk of metabolic disorders in shift workers.

Distinguishing Resting from Driving Truck Drivers

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Introduction: Within advanced driver-assistance systems (ADAS) it is crucial that different driver states (e.g. sleepiness) can be detected accurately in order for the automated vehicle to take or release control over the vehicle. Although much effort has been put in detecting safety crucial driver states like sleepiness, much less is known as to how rest can be detected nor as to how recuperative it can be. Here, the results are described of two pilot studies aiming to define rest in terms of different outcome variables. **Methods:** A total of 22 truck drivers participated. Periods of prolonged rest (>45 minutes) were integrated in both a real driving scenario as well as

a simulated driving scenario. Heart rate (HR), heart rate variability (HRV), and electroencephalography (EEG) were continuously recorded. Sleepiness (KSS), stress ratings, and reaction time were obtained every 5 minutes while driving. At the start and end of the drive a 5-minute psychomotor vigilance task (PVT) was carried out. **Results:** None of the continuously measured parameters (HR, HRV, EEG) change course when the driver goes into a state of rest or back into driving again. Over the course of the entire drive KSS levels rise considerably (from KSS 6 to KSS 9), but do so independently of rest. In a similar vein do reaction time (from 325 ms to 410 ms) and attentional lapses (3 to 7) increase but again without an effect of the rest episode. **Discussion:** Rest is a complicated driver state to describe in physiological terms where much of its recuperative nature depends on the activities that are carried out while resting. The monotony that is characteristic for long haul truck driving is clearly interrupted for a while, but it remains to be elucidated what this has for consequences for the remains of the drive as well as how rest can be described in physiological terms.

Total Sleep Time in Shift Work Disorder after a Shift Work Washout Period - An On-Site Questionnaire Study

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Introduction: Shift work disorder (SWD) is characterized by shift work related insomnia and/or excessive sleepiness. Total sleep time (TST) is known to reduce in the disorder; but we lack evidence whether a longer recovery period can normalise TST among those with SWD. In this on-site questionnaire study, we examined holiday effects on TST of employees with a questionnaire-based SWD compared to those without SWD. **Methods:** Twenty-one shift workers with a questionnaire-based SWD (SWD group: men 76 %, aged 27-59 years) and nine controls (men 78 %, aged 36-58 years) from a Finnish airline company completed an online questionnaire on SWD and background. They also answered an on-site questionnaire on TST regarding workdays and days off when visiting a laboratory during a normal work period and after at least two weeks off being on holiday. **Results:** The SWD group reported shorter sleep (h:mm: mean ± SD: 6:27 ± 0:41) than the control group (7:15 ± 0:30) on workdays ($p = 0.004$), but not on days off (7:49 ± 0:56

and 7:49 ± 1:05, respectively; $p = 0.989$) or on holiday (7:59 ± 0:44 and 8:24 ± 0:57, respectively; $p = 0.205$). The SWD group's sleep was significantly shorter during workdays than on days off ($p < 0.001$), and the control group's sleep showed a similar tendency ($p = 0.076$). Both the groups reported significantly shorter sleep on workdays than on holiday (SWD group: $p < 0.001$, control group: $p = 0.008$). **Discussion:** Holiday seems to associate with longer TST than work period regardless of SWD status, and the sleep length of employees with suggested SWD appears to normalize during holidays.

Mental Disorders and Absenteeism in Federal Civil Servants in Acre, Brazil, from 2013 to 2017

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Introduction: Over the last few decades the incidence of mental disorders has risen considerably, impacting the quality of life of sufferers and their work productivity, leading to absenteeism, medical leave and early retirement among employees. **Objective:** To analyze sickness absence due to mental disorders in federal civil servants in the State of Acre, Brazil. Method: A descriptive time series study was conducted between 2013 and 2017. **Results:** For the period analyzed, 2282 employees took medical leave, resulting in 72903 days of sickness absence. Diseases of the osteomuscular system and connective tissues were the most prevalent conditions, affecting 437 (19%) employees and accounting for 15105 sick days, followed by mental disorders affecting 297 (13%) employees. Despite ranking second in prevalence, mental disorders were responsible for a greater number of sick days (15151 days). The number of employees taking medical leave due to mental disorders tripled during the 5-year study period. Thirty employees took sick leave for mental disorders in 2013 versus 98 in 2017. Depressive episodes were the most frequent mental disorders (14%), followed by bipolar affective disorder (8%) and recurrent depressive disorder (7%). The 41-55 year-old age group was the most affected by mental disorders, and nine employees took early retirement due to the condition. **Discussion:** The steady rise in mental disorders among civil servants has led to a high rate of sickness absence, impairing worker

productivity and the efficiency of services provided in different public sectors. Studies assessing the impact of the conditions and organization of work processes on employee mental health are needed.

Does Shiftwork Modify Associations of Age with Injury among Police?

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Introduction: The average age of police officers is slowly increasing. The association between shift work, injury, and age among police officers has not been adequately explored. In the present study, we assessed these associations. **Methods:** Participants were 430 police officers from the Buffalo Cardio-Metabolic Occupational Police Stress study. Count of on-duty injuries during the 15 years prior to the date of exam were assessed using daily payroll records. Officers were categorized according to the dominant shift ('day (n=188),' 'afternoon (n=142),' or 'night (n=100)') in which they worked the highest percentage of hours. Unadjusted and multivariable-adjusted (sex, race-ethnicity, smoking status, and rank) mean number of injuries per year were estimated across age groups ('20-39', '40-49', '50+') using ANOVA/ANCOVA models. Effect modification was assessed for shiftwork. **Results:** A total of 268 (62.3%) reported injury during the past 15 years. Night shift officers were significantly younger compared to those on days shift (39.3 vs. 46.1 years). In adjusted models, the mean number of injuries per year decreased significantly with increasing age [Mean (SE): 0.19 (0.02), 0.14 (0.01), 0.08 (0.01), p-trend<0.001]. After stratifying by shift, adjusted associations remained significant among officers on day and afternoon shift: the means were highest among younger officers '20-39yrs' compared to older '40-49yrs' and '50+' groups [Means (SE): 0.22(0.03), 0.10(0.01), 0.05(0.02), and 0.20(0.03), 0.15(0.03), 0.06 (0.06), with p-trends: <0.001, and 0.032, respectively]. Associations were not significant among officers working night shifts. **Discussion:** The results from this study indicate negative associations between age and injury and suggest that shiftwork may significantly affect these associations. Small sample sizes may contribute to lack of significance among night shifters. It is important to create a culture in which officers receive information about the importance of good

sleep habits, the hazards of shift work, and fatigue management strategies.

Shift Work Disorder among Norwegian Nurses - A Two Year Follow-Up Study

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Introduction: Shift work disorder (SWD) is characterized by excessive sleepiness and complaints of insomnia related to the work schedule. This study aimed to investigate work schedule aspects and associations with having or not having SWD over time. **Methods:** Data were collected among 1480 Norwegian nurses from a longitudinal cohort study, and reports findings based on data from wave 7 (baseline,2015) and wave 9 (follow-up,2017). SWD was assessed with 3 questions based on the minimal criteria from the ICSD-3. **Results:** Mean age (at baseline) was 39.4 years (range 28-65), 90.4% females. The overall prevalence of SWD was 33.0% (baseline), and 33.1% (follow-up). We defined four groups based on having or not having SWD; 54.4% (n=653) of the nurses did not report SWD at baseline or at follow-up, 12.9% (n=155) reported SWD at follow-up but not at baseline (developing SWD), 12.4% (n=149) reported SWD at baseline but not at follow-up (losing SWD), and 20.3% (n=244) reported SWD at both assessments. Multinominal regression analysis with no SWD at baseline or follow-up and day work at both baseline and follow-up as reference groups showed that age was significantly associated with developing (OR 1.024, 95%CI 1.00-1.05) and having SWD at both assessments (OR 1.025, 95%CI 1.01-1.05). Start working nights between baseline and follow-up (OR 6.211, 95%CI 2.99-12.87) and working nights at both assessments (OR 5.608, 95%CI 3.66-8.60) were significantly associated with developing SWD. Stop working nights between baseline and follow-up (OR 11.437, 95%CI 6.47-20.22) and working nights at both assessments were significantly associated with losing SWD (OR 3.334, 95%CI 2.01-5.54). Stop working nights between baseline and follow-up (OR 2.640, 95%CI 1.32-5.29) and working night at both assessments (OR 9.013, 95%CI 6.19-13.13) were significantly associated with

having SWD at both assessments. **Conclusion:** Night work is significantly associated with SWD and whether such symptoms remain over time.

German Language Working Time Society - Bringing Together Research and Practice on Working Hours

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The aim of the Working Time Society (WTS) is the maintenance and improvement of workers' health and well-being through a healthy design of their working time by bringing together researchers and practitioners with very heterogeneous backgrounds from all over the world. WTS provides a unique opportunity to connect with researchers on shift work and working time at an international level and has promoted efforts on the development of local working time associations and networks: A "sister-organization" of the WTS, the German Language Working Time Society (Arbeitszeitgesellschaft), was founded in 2013 to establish a working time network in Germany, Austria, and Switzerland. Its goals are to promote research on working hours and translation of the results into practice. Annual symposia provide a platform for researchers from different disciplines and practitioners with different backgrounds to connect and share their latest findings on the organization of working time, their effects, dangers and opportunities for improvement. To make the findings accessible to a broader community, contributions are regularly published in a special issue of a scientific journal. Also, consensus papers on recommendations for the design of working time (e.g., on 12-hour-shifts) are approved and published. Board members of the Arbeitszeitgesellschaft would like to present its activities and cooperation efforts with the WTS on this 2019 Symposium. The goal of the poster presentation is threefold. First, on a more strategic/administrative level we would like to share information with participants about how to start a local working time organization and keep it running. Second, we present current trends in working time research in the German speaking countries against the background of political and societal developments, including flexible work hours, 12h shifts, and recovery processes. Thirdly, we would like to create synergy between WTS and Arbeitszeitgesellschaft and strengthen the existing cooperation and membership.

Working Time Demands and Working Time Control of Teleworkers

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Introduction: An increased use of information and communication technologies at work allows many employees to work outside their employer's premises from home or other locations. This spatial flexibility might give employees increased working time flexibility but might also enhance the dissolution of boundaries that limit daily working hours and separate work life from private life. The aim of the current study is to investigate working time demands and working time control of teleworkers and how these are related to their work-life balance. **Methods:** Data of 10.351 highly qualified and qualified white-collar employees from the BAuA-working time survey 2015 - a representative panel survey among employees in Germany - were analyzed. Telework and its extent as well as working time conditions were assessed using computer-assisted telephone interviews. We compare teleworkers to non-teleworkers but also investigate the role of the extent of telework in descriptive and multivariate analyses. **Results:** Fifteen percent of highly qualified and qualified white-collar employees in Germany have agreed on telework. Of these, about one quarter make use of this agreement less than one day per week, more than a third exactly once a week, and nearly four out of ten more often. Employees who telework have higher working time control but often experience also higher working time demands (overlong working hours, weekend work, permanent availability). With an increasing number of days worked from home employees report higher working time demands, but no increase in working time control. Employees who telework (to a larger extent) report more work-life conflict. **Discussion:** The results help understand working time conditions related to telework. This may have implications for policy making in the current debates on a right for telework but also for employees and employers to be aware of demands and resources related to telework.

The Role of Working Time and Space for Employees' Health and Work-Life Balance in the Health Care Sector

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Introduction: We investigate the role and importance of five temporal dimensions and one spatial dimension of working time and working space for aspects of perceived health, sleep, and work-life balance. We use the framework of dimensions from Anttila et al. (2015; adopted from Adam, 1995; Fagan, 2001). **Methods:** We conduct two parallel studies to investigate which working time (as well as space) dimensions have the strongest potential to affect employees' work-life conflict and health and to explore possible interactions. We use different data sources that complement each other, namely Titania® objective working hour data combined with data from the Finnish Public Sector Hospital Survey (N=5 050; all hospital employees), and data from the representative German BAuA-Working Time Survey (N=1 450 participants with NACE Q86). **Results:** Findings from logistic regression analyses reveal that hospital/health care workers' sleep, health, and work-life balance are differentially related to the working time duration (hours per week), timing of work (shift work, weekend work), work tempo (deadlines and performance pressure), working time autonomy, and demanded flexibility (on-call work). For example, working time autonomy is rather important for employees' work-life balance, but less important regarding employees' sleep and health across different samples. **Discussion:** Our study contributes to the understanding of the role of working time characteristics for hospital/health care workers' health and work-life balance. Thus, the results point to the fact that hospital/health care workers' well-being is at risk as the identified stressors, such as Sunday work, shift work, and long working hours are very common amongst them.