Program of the 25th International Symposium on Shiftwork and Working Time

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Basic-to-Translational Science for Preventing and Managing Chronic Diseases in Shift Workers: Challenges and Barriers Hindering Progress

The 25th edition of the International Symposium on Shiftwork and Working Time, a biennial international event held since 1969, is organized by the Working Time Society (WTS), an international non-profit scientific society whose primary objectives are the study, research, and practices related to organizational and psychosocial aspects, as well as health problems, performance, and accidents/incidents associated with shift and night work and irregular work schedules. The WTS is also a twin association linked with the International Commission on Occupational Health Scientific Committee on Shiftwork and Working Time. Thus, in addition to scientific members, the symposium also welcomes non-scientific participants such as industry, labor, health and safety professionals, policy makers and others interested in promoting safety, health and wellbeing of workers in nonstandard schedules.

Realization

Support

Funding

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Elaine C Marqueze
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Theme

The central theme this time is "Basic-to-Translational Science for Preventing and Managing Chronic Diseases in Shift Workers: Challenges and Barriers Hindering Progress."

The event will focus on the need to discuss fundamental and applied issues in the field of shift and night work, a labor modality that accounts for ~30% of the global work force and is associated with an increased risk of various health disorders, particularly sleep, metabolic, cardiovascular, and psychological disorders, as well as the risk of workplace accidents, according to scientific literature.

Venue

We are pleased to host the Symposium in Guarujá, a beautiful coastal region located just 100 km from the vibrant city of São Paulo, Brazil. This will be the third time the Symposium takes place in Brazil.

Program

Tuesday, Nov 11th

Opening Session

Claudia RC Moreno - Chair, Symposium Shiftwork 2025

Kimberly Honn - President, Working Time Society

Opening Lecture

Keynote speaker: **Shantha M.W. Rajaratnam**

Developing sleep and circadian health solutions for shift workers: from physiology to practice.

Chair: **Elaine C Marqueze**

1st Thematic session - Tailoring health interventions for shift workers: exploring personalized approaches and evidence-based strategies.

Chair: **Heidi Lammers Van-Der Holst**

- **Emily Manoogian.** The healthy heroes randomized control trial, focusing on the personalization of a time-restricted eating schedule for 24-hour shift workers.
- **Shantha M.W. Rajaratnam**. SleepSync: a personalized digital intervention for sleep and well- being in Australian shift workers.
- **Philip Cheng.** Personalized light therapy for night shift work: a precision medicine approach to reducing insomnia and sleepiness.
- **Maaike Van Der Rhee**. GRIP study: a personalized sleep and nutritional intervention to combat the adverse effects of night shift work.

2nd Thematic session - From research to practice – how research on working hours is applied.

Chair: **Anne Helene Garde**

Co-chair: **Imelda Wong**

- **Mikko Härma**. Implementation of the FIOH working time traffic light recommendations in the social and health care in Finland.
- **William Dawson**. Why prescription and risk management approaches to shiftwork and fatigue regulation are inevitably doomed.
- **Imelda Wong**. Lessons learned from working in the US Federal government.
- **Anne Helene Garde; Jesper Madsen; Jan Kristensen Schmidt**. Experiences with upstream implementation of research- based recommendations on shift work scheduling in a Danish context.
- **Johannes Gaertner; Anna Arlinghaus**. Experiences from Austria in jointly planning new shifts & schedules in companies.

Wednesday, Nov 12th

Keynote speaker: **Siri Waage**

Assessment and management of shift work disorder

Chair: **Patrícia A Nehme**

3rd Thematic session - Shift work, long working hours and health among women - new knowledge and research possibilities.

Chair: **Mikko Härmä**

Co-chair: **Claudia RC Moreno**

- **Claudia RC Moreno.** Night shift work and sleep disturbances in women.
- **Johnni Hansen**. Night shift work and female breast cancer risk – update of epidemiologic evidence.
- **Chiara Dall'ora**. Long shifts of 12+ hours in healthcare: consequences for staff health and patient safety.
- **Mikko Härmä**. Payroll-based data of working hours and health. A treasure trove for studies on detailed exposure to shift work and health.

Thursday, Nov 13th

Keynote speaker: **Stephen M. Popkin**

The Impact of 50 years of research and practice on improving the lives of shiftworkers.

Chair: **Frida M Fischer**

4th Thematic session - Shaping the Future Workweek: Global Trends and Effects of Longer versus Shorter Work Hours.

Chair: **Nils Backhaus**

Co-chair: **Anna Arlinghaus**

- **Imelda Wong.** Long Work Hours: Does Regional and Occupational Prevalence Influence Differences in Occupational Health and Safety?
- **Nils Backhaus**. Insights into employees' working time preferences and findings on health impacts.
- **Kati Karhula**. Examination of workplace-level interventions and trials of reduced working time and their implications for well-being.
- **Anna Arlinghaus.** Reduced working hours, job satisfaction and well-being: field studies from Austria.

5th Thematic session - Fatigue management in aviation: scientific principles, regulatory aspects and the role of biomathematical models.

Chair: **Tulio Rodrigues**

- **Tulio Rodrigues.** Aircrew rostering workload patterns and associated fatigue and sleepiness scores in short/medium haul flights in Brazil.
- **Hans Van Dongen.** Fatigue risk management in aviation and other 24/7 operations: the challenge of predicting when people choose to sleep.
- **Jaime K Devine.** More than math: practical applications within Fatigue Risk Management Systems.
- **William Dawson.** Biomathematical models: when not to use them.

Friday, Nov 14th

6th Thematic session- Do flight time limitations prevent fatigue in flight crew? A symposium on the findings of the FTL 2.0 study

Chair: **Alwin Van Drongelen**

- **Alwin Van Drongelen.** Opening and explanation of the study objectives and methods used.
- **Dorothee Fischer**. Feeling jet-lagged? Effects of flying in an unknown state of acclimatization on crew fatigue.
- **Mikael Sallinen**. Sleepiness and fatigue during long flight duties "at the most favorable time of the day."
- **Laurie Marsman.** Conditions, circumstances, and reasons for flight crew members to use controlled rest.
- **Kati Karhula.** Other than airport standbys: timing, circumstances and maximum hypothetical flight duty periods.
- **Alwin Van Drongelen.** Conclusions and recommendations for regulators, airlines, and flight crew.

7th Thematic session- Mechanistic studies in shift workers: understanding the biological mechanisms and designing interventions to mitigate the risks

Chair: **Kyriaki Papantoniou**

Chair: **Heidi Lammers Van Der Holst**

- **Kyriaki Papantoniou**. Night shift work and biomarkers of disease risk in observational mechanistic studies.
- **Anne Helene Garde.** Diurnal rhythms of melatonin and cortisol among permanent night workers.
- **Sylvia Rabstein.** Short and long-term effects of a dynamic light intervention in shift workers.
- **Heidi Lammers Van Der Holst.** Behavioral and sleep interventions in shift workers to improve health.

Closing session

Chair: **Cibele Crispim**

Oral Abstracts and Posters Presentations

ID: 01

Modeling Fatigue Associated with Workload in Commercial Aviation Operations

Jaime K. Devine, Jake Choynowski, Steven R. Hursh
Institutes for Behavior Resources, Baltimore, Maryland, United States

Introduction: Biomathematical models are widely used in commercial aviation to assess fatigue risk during operations. Most models are fundamentally influenced by the two-process model of sleep regulation, which estimates fatigue in relation to prior sleep duration and circadian rhythm/time of day. However, fatigue can also be due to workload. Many factors that contribute to workload are predictably related to scheduling and can be incorporated into a prospective model of fatigue. The biomathematical modeling software SAFTE-FAST recently introduced a Workload Calculator to allow users to estimate job demands during operations. Workload in SAFTE-FAST is modeled as a separate, but intervening, process from cognitive alertness related to time of day or sleep history. An important step toward accurate modeling of workload is to test the accuracy of the Workload Calculator against a real-world measure, like the NASA Task Load Index (TLX) scale. This study compared the accuracy of SAFTE-FAST Workload predictions against TLX scores taken by pilots during normal flight operations using equivalence testing.

Methods: Pilot participants from a major Asia-based airline completed the NASA TLX at top of descent (TOD) during the last flight of a multiple flight duty day on Day 1 and Day 3 of a three-day roster. Rosters consisted of daytime flights only to limit the influence of circadian fatigue or sleep debt on perception of workload. Pilots' schedules were modeled in SAFTE-FAST. SAFTE-FAST Workload predictions and TLX scores were independently normalized to a 100-point scale. Workload changes across the roster were evaluated using repeated measures analysis of variance (ANOVA). Equivalence testing compared Workload against TLX using the two-one sided *t*-test (TOST) approach.

Results: Ninety-nine ($N = 99$) pilots completed at least one TLX over the course of the three-day roster; 88 pilots completed both TLX surveys for a total of 187 surveys. SAFTE-FAST workload estimates increased significantly across the roster ($F(2,16)=62.02$, $p < 0.001$). The average SAFTE-FAST workload prediction score at TOD for all flights was 64 ± 7 out of a possible 100 points (indicating high workload). The average TLX score at TOD for all flights was 65 ± 15 scaled to 100 points. There were no significant differences between Workload and TLX mean scores controlling for flight number or roster day. TOST results indicated that the means of Workload predictions at TOD were equivalent to TLX scores for the same TOD ($t=1.56$, $p = 0.06$).

Conclusion: Predicting the impact of workload on fatigue is a new frontier for biomathematical modeling. Establishing the accuracy of workload predictions is an important first step toward risk management in situations where high workload may create a safety risk. SAFTE-FAST predictions were statistically non-different from pilot-reported workload in this study, indicating model accuracy for predicting workload during operations. This is an important step toward modeling the impact of psychological factors (workload) on operator fatigue.

ID: 02

Are Work-related Accidents Associated with Specific Times of the Day and the Elapsed Time after the Start of the Work Shift?

Claudio Jose dos Santos Junior, Frida Marina Fischer
University of Sao Paulo, São Paulo, SP, Brazil

Introduction: This study investigates the temporal distribution of work accidents (WA) in Brazil using data from the Notifiable Diseases Information System (SINAN) for the year 2022. SINAN is the official reporting system for public health events in Brazil, including notifications of work accidents among both formal and informal workers.

Methods: An analytical, cross-sectional study was conducted using data accessed from SINAN on October 20, 2024. WA cases were selected based on the completeness of information regarding the time of the accident and hours elapsed since the start of the work shift. Accidents were categorized into three groups: typical accidents, commuting accidents, and all accidents. A chi-square (χ^2) goodness-of-fit test was used to assess the distribution of accidents throughout the day. Analyses were conducted with Jamovi software version 2.2.5, supplemented by histograms and moving averages.

Results: In 2022, 65,535 WAs were recorded in Sinan. Of these, 47,367 included information on the time of occurrence, and 32,530 specified the time elapsed since the start of the shift. For all accidents, the highest frequency was observed at 10 AM, with 4,897 records (10.34% of the total), followed by 9 AM (4,636 accidents, 9.79%) and 8 AM (4,286 accidents, 9.04%). For typical accidents, the peak also occurred at 10a.m. (4,433 accidents, 11.47%), followed by 9 AM (4,180 accidents, 10.82%) and 8 AM (3,529, 9.13%). Commuting accidents had the highest number of records at 7 AM (973 accidents, 13.91%) and 6 AM (745 accidents, 10.65%). Chi-square tests confirmed a non-random distribution of accidents, with significant values for all types analyzed: $\chi^2 = 28{,}962$ (all accidents), $\chi^2 = 27{,}929$ (typical accidents), and $\chi^2 = 4{,}109$ (commuting accidents), all with $p < 0.001$. The analysis regarding hours after the start of the shift also revealed occurrence patterns. For all accidents, the highest concentration was observed between 0 and 4 hours, with peaks after 2 hours of work (4,455 accidents, 13.24%) and after 1 hour (4,128 accidents, 12.26%). For typical accidents, peaks were also observed after 2 hours (4,118 accidents, 14.18%) and 1 hour (3,823 accidents, 13.16%). For commuting accidents, 33.37% of records occurred before the first hour of work, with 1,162 accidents. Goodness-of-fit tests reinforced the unequal distribution of events after the start of the shift for all types of accidents ($p < 0.05$).

Conclusion: The results indicate a non-random and statistically significant distribution of WAs, influenced by specific times of the day and hours after the start of the shift, highlighting the importance of considering temporal factors in accident prevention strategies. Support: CNPq- Productivity grant to F.M. Fischer nº. 306963/2021–3.

ID: 03

Polysomnographic Determinants of Self-Perceived Sleep Quality at Night and During the Daytime Between Consecutive Night Shifts

Anastasi Kosmadopoulos, Charli Sargent, Gregory Daniel Roach
Central Queensland University, Norman Gardens, QLD, Australia

Introduction: Shift work and its associated disruption of the body clock can substantially impair the quality of sleep. Impaired sleep quality can influence both physical and

mental health and well-being. As such satisfaction with sleep is an important aspect of shift workers' quality of life. However, it is not clear to what extent perceptions of daytime and night-time sleep quality are similarly informed by its structural composition. The aim of this study is to identify the features of sleep that are most important for satisfaction with night-time and daytime sleep quality so that individuals may better evaluate their own sleep and how it might be improved.

Methods: Participants (n = 131, male = 73, female = 58; aged 24.9 ± 5.1 years) completed one of three laboratory-based simulated night shift protocols. These protocols comprised series of 4 to 14 consecutive nights shifts (n = 96, 19:00h- 07:00h; n = 35, 23:00h-07:00h). All participants had 9h of time in bed (TIB) on the first night (23:00h- 08:00h) and either 7h or 7.5h of TIB for daytime sleep periods (n = 18, 08:30h-15:30h; n = 17, 14:30h- 21:30h; n = 96, 09:30–17:00) between consecutive night shifts. Sleep was recorded using polysomnography and sleep stages scored according to standard criteria. Participants rated the quality of sleep episodes from 1 ("extremely poor") to 7 ("extremely good"). The first night-time sleep and the second daytime sleep were included for each participant in this analysis.

Results: Participants obtained more sleep during night-time sleep episodes than during daytime sleep episodes (8.0h vs 6.6h, $p < .001$), but maintained similar sleep efficiency— i.e., total sleep time as a proportion of time in bed — in both (88% vs 90%, p=.186). Self-perceived sleep quality did not differ between night-time and daytime sleeps (4.7 vs 4.9, p=.056). Mixed-effects models that included a "sleep type" interaction term (i.e., night-time vs daytime) revealed that the best individual predictors of self-perceived sleep quality (marginal R2 = 0.05–0.11; $p < .001$) were: the proportion of time awake between sleep onset and offset; wake after sleep onset; sleep efficiency; total sleep time; and the proportion of wake in the final third of TIB. These associations between more wakefulness/less sleep and poorer sleep quality did not significantly differ between sleep types.

Conclusion: Although participants obtained less total sleep during the daytime than at night, the perceived quality of each sleep was similar. Satisfaction with both daytime and night-time sleep primarily appears to be affected by total sleep time and the extent to which the sleep time is interrupted by wakefulness, more so than time spent in different stages of sleep. As such, individuals dissatisfied with their sleep quality could focus on addressing social and environmental factors that can impair sleep maintenance, such as light, noise, room temperature. Support: This paper was supported by funding from the Australian Research Council.

ID: 04

Association of Non-Standard Working Time Arrangements with Safety Incidents: A Systematic Review

Line Victoria Moen, Jenny-Anne S. Lie, Tom Sterud, Jan Olav Christensen, Fred Haugen, Marit Skogstad, Karl-Christian Nordby, Dagfinn Matre

National Institute of Occupational Health (STAMI), Oslo, Norway

Introduction: We performed a systematic review to assess the consequences of non-standard working time arrangements on occupational accidents (including fatal accidents), near-accidents, injuries, and other safety risks (referred to as «incidents») by considering the overall evidence.

Methods: We systematically searched five databases (Medline, Embase, PsycINFO, Web of Science, and Proquest Health and Safety Science Abstract) and identified 13569 studies until February 2024. Of these studies, 24 met the inclusion criteria. A structured approach was followed to evaluate the risk of bias and undertake a narrative analysis of the data using "Synthesis Without Meta-analysis" (SWiM).

Results: This review found associations between being a shift worker and experiencing safety incident risks. Most of the included studies found an increased risk of incidence during or after night shifts, with some noting an elevated risk during evening shifts. Accumulated exposure to evening or night shifts increased the risk of safety incidents in the following week. Due to heterogeneity in study designs, populations, and outcomes across findings, the overall certainty of evidence was rated as low to very low.

Conclusion: Broadly, a non-standard working arrangement was associated with an increased risk of safety incidents, notwithstanding the relatively low grading of the evidence. For future longitudinal studies on working time schedules and safety incidents, using payroll data is recommended.

ID: 05

Fatigue among Employees Who Work Over the Karoshi Line (More Than 80 Hours Overtime per Month): Hybrid Approach Based on Experimental and Field Studies

Tomohide Kubo[1], Matsumoto Shun[1], Hiroki Ikeda[1], Yuki Nishimura[1], Xinxin Liu[1], Shuhei Izawa[1], Toru Yoshikawa[1], Aritake-Okada, Sayaka[2]; Masako Tamaki[3]

[1]National Institute of Occupational Safety and Health, Japan
[2]Graduate School of Health Sciences and Social Work, Saitama Prefectural University, Saitama, Japan
[3]Cognitive Somnology Riken Hakubi Research Team, Riken Cluster for Pioneering Research, Saitama, Japan

Introduction: Empirical data regarding the adverse effects of overtime have been gathered. However, little is known about the magnitude of overtime risk, although the existence of risk has been discussed. Notably, it is informative to understand the risk magnitude in specific situations in terms of prevention. This study was intended to illustrate the risk magnitude by comparing a 40-hour sleep deprivation experimental study and field study targeted at employees with long working hours.

Methods: This study was based on a hybrid approach with experimental and field studies. In the 4- day experiment, we conducted a 40-hour sleep deprivation study to gain the reference value regarding excessive fatigue situations. Nine individuals (44.4 ± 6.0 years, including 4 females) participated in this experiment. The participants were required to stay awake in a sleep laboratory during a 40-hour period (from 7:00 AM on the 2nd day to 11:00 PM on the 3rd day). A 40-minute drive simulator task (Euro Truck Simulator 2) was performed hourly during the sleep deprivation period. Additionally, 100 employees (44.7 ± 9.1yr, including 18 females) participated in the 10-day field observational study. We focused on 7 individuals who worked more than 80 overtime hours (i.e., Karoshi line) in the pre-survey. In both studies, the participants were required to perform a 3-minute psychomotor vigilance task (PVT-B) using their smartphone. Measurements were taken hourly in the experimental study, whereas measurements were performed twice daily (morning, night) in the field study. We focused on the mean and 95% CI regarding median reaction times (RTs) as parameters to avoid a response time deviation.

Results: In the 40-hour sleep deprivation setting, the mean and 95% CI of median RT was 369.8 millisecondsec (321.4−418.3 millisecondsec). On the other hand, the mean

of median RT in the field study ranged from 289.3 to 482.9 millisecondsec. The longest median RT was observed on Saturday morning, and the shortest was on Wednesday night. RTs among employees who worked more than 80 overtime hours per month were suggested to be equivalent to those who experienced 40-hour sleep deprivation. The tendency was obvious from Thursday to Saturday.

Conclusion: Our primary findings suggest that fatigue from 40 hours of sleep deprivation could reach the level of fatigue among employees who worked over the Karoshi line. Applying the findings to specific workers who are required to sustain attention to prevent serious accidents (e.g., truck drivers, nurses, and doctors) could be beneficial in understanding the magnitude of long working hours. Support: This study was supported by the National Institute of Occupational Safety and Health, Japan (N-P05–01).

ID: 06

Associations Between Adverse Working Hours and Nurses' Sickness Absence: A Longitudinal Analysis of E-Roster Data

Chiara Dall'ora, Talia Emmanuel
University of Southampton, Southampton, United Kingdom

Introduction: In hospitals, nurses frequently have to work in shifts that cover the 24-hour day. There is a wealth of evidence that links shift work with negative outcomes for nurses, and as such, health organisations have a duty to promote safe working hours and monitor the wellbeing of their nursing workforce. One useful outcome for monitoring includes staff sickness absence, as documented by hospital administrative records. While previous research analyzing records of shifts and sickness absence have shown increased rates when nurses are working certain shift types, there is a gap in understanding the effects of more complex shift patterns, particularly those that occur over multiple days (e.g., working long and/or night shifts consecutively, having fewer than 48 hours rest between ending a night shift and starting a day shift, and frequent shift rotations).

Methods: We analyzed registered nurses' historical shift and sickness absence data, as recorded by electronic staff rostering systems from acute inpatient wards in two large NHS hospital Trusts in England. From this data, we created a series of variables that correspond with variation in shift types/patterns, including long working hours, night work, consecutive working days, and recovery time between shifts. Each variable was defined by an exposure period, i.e., the shift configurations worked in the 7 and 28 days prior to each worked shift and sickness absence episode. We then used logistic mixed regression models to estimate the relationships of these variables with sickness absence, in terms of the change in odds of a shift being cancelled due to sickness.

Results: The final dataset contained 1,367,497 worked shifts and 19,876 sickness absence episodes from 7,515 registered nurses across 95 wards. The majority of shifts were from nurses working full-time (60%), and sickness episodes lasted a median of 4 days long (IQR 2–8 days). In the 7-day exposure multivariable model, intense consecutive spells, quick returns, and shift rotations significantly increased the odds of sickness, with quick returns and shift rotations also showing longer term effects in the 28-day multivariable model. Nonlinear analyses of the proportion of long and night shifts worked revealed that higher proportions ($\geq$80%) were significantly associated with the greatest odds of sickness absence in both 7-day and 28-day lookback windows.

Conclusion: This longitudinal analysis of routinely collected roster records provides new objective insight into how shift patterns and working hours are linked with nurse wellbeing. Analysis of 1.4 million records revealed that long hours, night work, consecutive working spells, and inadequate rest periods significantly increased the odds of sickness absence in weekly and monthly exposure windows. These findings help to inform future research on how nurses' shift patterns can be improved, particularly in terms of optimizing ward rosters in ways that prioritize staff wellbeing. Support: The study dataset was derived from a project funded by the UK National Institute for Health and Care Research (NIHR) Health Services and Delivery Research Program (award No. NIHR128056) and the NIHR Applied Research Collaboration (Wessex). The primary author was supported by the UKRI Economic and Social Research Council South Coast Doctoral Training Partnership (Grant Number ES/P000673/1).

ID: 07

Rostering Features and Impact on Work and Living: Perspectives of Brazilian Airline Pilots

Izabela Tissot Antunes Sampaio[1], Frida Marina Fischer[2]
[1]*National Civil Aviation Agency, Curitiba, PR, Brazil*
[2]*University of São Paulo, São Paulo, SP, Brazil*

Introduction: Fatigue management is a global concern regarding human factors in civil aviation. The International Civil Aviation Organization (ICAO) requires contracting States to establish fatigue regulation within a framework that considers both industry experience and scientific findings. The aim of this study was to explore rostering features and the impact on the balance between work and living conditions from the aircrews´ perspective.

Methods: Fifty-one airline pilots (7 f, mean age 40 years) from four Brazilian airlines voluntarily participated in this study. Individual semi-structured interviews were conducted online (Dec 2021-Jun 2022), lasting from one to three hours. Content analysis was performed (Bardin, 2011). The following items were investigated: work schedules – starting and ending times, duty periods, resting times and days-off and fatigue management policies. The study was approved by the Ethical and Research Committee of the School of Public Health from the University of Sao Paulo (CAAE 36370720.9.0000.5421).

Results: Analysis of the interviews revealed the rostering features that affect pilots´ work and social lives. The main positive aspects revolved around the predictability of their daily routines. Knowing in advance the monthly schedule was considered key for organizing personal and work arrangements, especially if the requested days off are granted. The productivity of the schedules was also mentioned as a positive aspect, meaning a good distribution of flights throughout the duty period, without excessive sitting time. With respect to negative aspects, the perceived short resting times between duties (usually 12 hours including hotel transportation), daytime resting between consecutive nighttime duties, the irregularity of working hours and single days-off were the most mentioned. Some other examples were schedules 12x12 (meaning 12-hour duty followed by a 12-hour rest period), reporting at the airport with excessive advance time, frequent aircraft changes and rostering parameters limited to the regulatory prescriptions. Also, in the pilots´ perspective, addressing fatigue management as mainly an individual responsibility, the overreliance on biomathematical models and the complex fatigue reporting procedures in the airlines conflict with best fatigue management approaches.

Conclusion: Irregularity of working times is considered a natural aspect of aircrew lives. Nevertheless, it does

impact on circadian and social rhythms and may affect performance at work. The results of this study can help improve fatigue management in aviation and regulatory framework, as it brings real-life data to be considered. Support: FAPESP (ITAPAR 2019/13525–0); CNPq (Productivity grant to FM Fischer number 306963/2021–3); Graduate Program of Public Health (School of Public Health, University of Sao Paulo); National Civil Aviation Agency (Brazil). This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance Code 001.

ID: 08

Adapting Behaviors of Shift Workers That Prevent Health and Well-Being Negative Effects

Regina Skiba
Jagiellonian University, Kraków, Poland

Introduction: Shift workers have a different arrangement of day activities compared with the day- oriented rhythms of the general population. This study is a response to the need to examine the adapting behaviors of nonstandard hours workers. The research addresses questions about (1) daily and night routines, customs, habits (regarding general recommendations of health care organizations), (2) the role of family and (3) social relationships (outside the workplace and at work) that can help to prevent negative effects and maintain good health and well-being of workers. Identification of different types of actual activities during day and night was explored and described.

Methods: A qualitative research approach was applied. 30 anonymous in-depth interviews were conducted with Polish blue-collar workers (production sector) who are economically active, do or have done shift work- including night work, in the past 5 years, have worked shifts for min. 5 years. Analysis of the material based on the Social Practice Theory- which offers a comprehensive approach to explore the complexity of human behavior in its social and material contexts through the interaction of three elements: meanings (embedded symbols, images, ideas), skills (know-how, competence, ability to follow rules) and objects (materials, products, things).

Results: Widespread access to knowledge (dr. google) and mass communication on social media can pose a threat. The results show that it is not the typically adverse health behaviors described in the literature (alcohol, caffeine) that are a threat, but inappropriate supplementation with vitamins, the doses of which are not consulted with a doctor and are not prescribed. Respondents-shift workers reported taking vitamin supplements (Magnesium, vitamin C, Vit D) on their initiative 'for the sake of their health'. E.g., workers read that working in artificial light can cause deficiencies in Vit D-, so they take a high dose. Although respondents say the shift work dictates the rhythm of life, they report that they adapt to the rhythm of the general population. The results are conclusive with previous studies: they spend time with their families and perform family duties at the expense of sleep recovery time. Technological innovations support the reconciliation of work and family life.

Conclusion: The scientific research results produce knowledge that helps to improve working conditions, but workers are not aware of specially dedicated information for them. Recommendations for shift workers are not widely known among blue-collar workers. The study points out the need for better dissemination of information on recommendations for off-duty shift workers. Health and safety training focuses on the workplace; outside of work, only the more reflective workers will look for how to help themselves. In conditions that are also demanding for social adjustments and challenges, the large role of social skills (understanding, empathy, respect) from their close social environment plays a supportive role.

ID: 09

Optimizing Biomathematical Models of Fatigue for Predicting Performance in Military Operational Environments

Malena Lis Mul Fedele[1], Agustín Folgueira[2], Facundo Etcheún[3], Vicent Capaldi[4], Giorgio Varesco[5], Nicholas Van Den Berg[6], Daniel Fraiman[7], Guido Simonelli[8], Daniel Eduardo Vigo[1]

[1]Institute for Biomedical Research (UCA-CONICET), Buenos Aires, Argentina
[2]National Defense University, Buenos Aires, Argentina
[3]Mountain Military School "lt. gen. Juan Domingo Perón," Ministry of Defense, San Carlos de Bariloche, Argentina
[4]Department of Psychiatry, Uniformed Services University, Bethesda, Maryland, United States
[5]Department of Medicine, University of Montreal and Centre for Advanced Research in Sleep Medicine, Ciusss Nim, Canada
[6]Centre for Advanced Research in Sleep Medicine, Ciusss Nim and Viper, Royal Military Academy, Belgium
[7]Department of Mathematics and Sciences, UDESA, Provincia de Buenos Aires, Argentina
[8]Department of Medicine and Department of Neuroscience, University of Montreal, and Centre for Advanced Research in Sleep Medicine, Ciusss Nim, Canada

Introduction: The demands of our modern "24/7" society predispose individuals to various consequences, including fatigue. Fatigue reduces alertness, negatively affecting quality of life, increasing accident rates, and decreasing work productivity. Biomathematical models of fatigue (BMMF) predict fatigue risk based on factors such as sleep history and time of day. Few studies have examined their application in military operational environments for predicting performance in tasks of varying difficulty. This study assessed the adequacy of a BMMF (2-B alert) in the training of special operations troops and its predictive value for marksmanship.

Methods: Twenty-six subjects were analyzed over five days under varying sleep conditions. The model's fit to alertness predictions was evaluated using the original parameters reported in the literature, as well as after applying nonlinear optimizations (Nelder-Mead) with group data and individual data. Also, Bayesian learning (BL) and an Extended Kalman Filter (EKF) were used for a real-time, individual-level optimization. Finally, the model's ability to predict performance in the marksmanship tests was assessed, including difficulty and fatigue prediction as fixed factors in a linear mixed-effects model.

Results: The original model had an RMSE of ~50ms for alertness predictions, while the other models showed RMSEs below 20ms. The EKF adjusted model explained 18% (p = 0.001) of marksmanship variance (task difficulty: 9%, p = 0.001; fatigue: 1%, p = 0.014). When categorizing the variables, it was observed that, under high task difficulty, a response time of more than 250 milliseconds was associated with poorer performance (AUC: 0.74 [0.68–0.80], Sensitivity: 0.72, Specificity: 0.68, Positive Predictive Value: 0.74, Negative Predictive Value: 0.66).

Conclusion: The main finding showed that optimizing the parameters based on field alertness tests provided more accurate predictions than using parameters reported in the

literature. Additionally, we found that fatigue explained a small but significant proportion of the variance. Overall, these preliminary results will help in developing personalized strategies for managing fatigue and performance across different contexts.

ID: 10

The Four-Day Workweek: A Systematic Literature Review on Sustainability Trade-Offs Within and Between Compressed and Reduced-Hour Models

Islena Ferreira de Araujo, Laura Venz
Leuphana University Lüneburg, Lüneburg, Germany

Introduction: The four-day workweek (4DWW) has gained attention as an alternative working time arrangement, with potential implications for worker well-being, organizational performance, and environmental impact. However, different 4DWW models restructure working time in distinct ways, which likely lead to diverging consequences. In the compressed 4DWW, workers maintain a full-time workload over four extended workdays (e.g., four 10-hour shifts), whereas in the reduced-hour 4DWW, total weekly working hours are reduced, often with salary adjustments. While both models shorten the workweek, they likely imply different trade-offs with regard to well-being, productivity, and environmental impact, for example. Yet, the sustainability implications of different 4DWW models— spanning social, economic, and environmental dimensions—remain insufficiently understood.

Methods: This study conducts a systematic literature review to assess how compressed and reduced-hour 4DWW models differ in their sustainability impacts. The review follows established methodological guidelines and synthesizes empirical research from diverse fields, including labor economics, organizational behavior, sustainability studies, and environmental science. The review examines how work-hour restructuring in compressed and reduced-hour 4DWW models affects (1) social sustainability (e.g., work-life balance, well-being, workforce participation, working conditions), (2) economic sustainability (e.g., business performance, employment stability, labor demand), and environmental sustainability (e.g., commuting patterns, energy consumption, carbon footprint).

Results: Expected Results and Contributions: By explicitly distinguishing between compressed and reduced-hour 4DWW models, this review clarifies the role of working-time configurations in shaping sustainability outcomes. Previous research has often analyzed the 4DWW as a singular concept, overlooking key differences between 4DWW models in terms of working time. Extended workdays in compressed 4DWWs may increase worker strain, reduce recovery time, and heighten energy use (e.g., in the evening), while reduced 4DWWs may enhance well-being but introduce economic trade- offs such as reduced total labor input and potential salary adjustments. Moreover, while fewer commuting days are frequently cited as an environmental benefit of 4DWWs, longer daily hours might lead to shifts in transportation behavior and shorter workweeks might imply increased off-work travel. This narrative literature review systematically synthesizes these trade-offs, offering a structured overview of sustainability outcomes across different 4DWW working time arrangements. The review is currently being conducted and will be completed by July 2025 (i.e., ready for presentation at the 25th International Symposium on Shiftwork and Working Time).

Conclusion: This review contributes to a more nuanced discussion on the sustainability of alternative workweek structures, informing both academic research and managerial and policy decisions. By integrating insights on working time effects, this review enhances the evidence base for organizations and policymakers considering the adoption and design of 4DWW policies. A better understanding of how different workweek structures affect sustainability is essential for developing balanced, effective, and context-sensitive approaches to working-time reduction and compression.

ID: 11

Quick Returns, Sleep, Sleepiness and Stress – A Field Study Investigating the Intra-Individual Effects on Objective Sleep and Diary Data

Kristin Öster[1], Marie Söderström[2], Philip Tucker[3], Anna Dahlgren[2]
[1]*Karolinska Institute, Stockholm, Sweden*
[2]*Karolinska Institute, Stockholm University, Stockholm, Sweden*
[3]*Stockholm University, Swansea University, Stockholm, Sweden*

Introduction: Previous studies have associated quick returns (less than 11 hours of rest between shifts) with shortened sleep duration and increased sleepiness but have failed to find an association with sleep quality or stress. However, most previous work has relied on subjective measures of sleep which are limited. Thus, despite previous null results, an association with sleep quality cannot be ruled out. The aim of the present study is to examine how objective and subjective measures of sleep duration, sleep quality, sleepiness and stress are affected by quick returns compared with day- day transitions, in a sample of nurses and assistant nurses. The results have been published in the Scandinavian Journal of Work Environment and Health.

Methods: 225 nurses and assistant nurses wore actigraphy wristbands and kept a sleep and work diary for seven consecutive days. Sleep length was measured with actigraphy data. Sleep quality was assessed with both actigraphy data (sleep fragmentation index) and complementary subjective ratings (Karolinska sleep quality index, 1= poor, 5 = good). Participants also rated their stress and sleepiness (Karolinska sleepiness scale) levels every third hour throughout the workday and during leisure time (07AM-22PM). Quick returns and control conditions (day-day transitions) were identified from the reported working hours. As intra- individual differences were of interest, the data were analyzed in a linear mixed model where all participants acted as their own control. Thus, the final sample (N = 90) included those with at least one observation of both a quick return and a day-day transition.

Results: Quick returns were associated with shortened sleep length (-1 hour, 95% CI [-1.23, -0.81]), and a reduction in subjective sleep quality (-0.49, 95% CI [-0.69, -0.31]) compared with day-day transitions. The participants also experienced increased anxiety at bedtime (-0.38, 95% CI [-0.69, -0.08]) and increased worktime sleepiness during quick returns (0.45, 95%CI [0.22, 0.71]). No difference in sleep fragmentation and stress ratings was found.

Conclusion: Quick returns result in shortened sleep length, reduced subjective sleep quality and increased sleepiness during work, but do not seem to have an impact on perceived stress levels or sleep fragmentation among nurses and assistant nurses. Thus, managers, scheduling staff and employees should be cautious and consider the risk of fatigue when scheduling quick returns. Support: FORTE - Swedish Research Council for Health, Working Life and Welfare.

ID: 12

Food Intake, Work Shifts and Metabolic Syndrome: A Study with Healthcare Workers at a University Hospital in Southern Brazil

Francielle Lopes Reis[1], Maria Carlota Borba Brum[1], Julio Cesar Ferreira Bertoloto[1], Érica Lui Reinhardt[2], Sheila Castro Cardoso Toniasso[3], Ticiana Costa Rodrigues[1]
[1]*Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil*
[2]*Fundacentro, São Paulo, SP, Brazil*
[3]*Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil*

Introduction: Shift work is intrinsically associated with significant cardiovascular, metabolic, and nutritional health risks, including metabolic syndrome. There is an increasing awareness about the importance of eating habits, especially in challenging occupational contexts, such as shift work. Healthcare workers are subjected to long working hours and irregular schedules, and tend to develop inadequate eating habits, frequently preferring snacks and ultra-processed foods, while fiber intake, fundamental for the prevention of metabolic diseases, is often neglected. In this study we aim to evaluate the association between night work, metabolic syndrome, and food consumption patterns among healthcare workers in a large hospital in southern Brazil.

Methods: This quantitative cross- sectional research analyzed a sample of 156 healthcare workers (90-day workers and 66-night workers) with at least one year in the work shift at the hospital, excluding workers in fixed-term contracts, in the process of retirement, and pregnant women. Night work was defined to be work performed between 7:00 PM and 7:00 AM, at least 3 times a week. Data collections occurred between July 2023 and March 2024, and included sociodemographic and occupational information, smoking and alcohol consumption habits, physical activity, sleep variables and chronotype (estimated by the Munich Chronotype Questionnaire), and dietary pattern, as well as anthropometric measurements, blood pressure, and laboratory tests used to confirm the diagnosis of metabolic syndrome (MS).

Results: Night workers had higher blood pressure levels and reduced high density cholesterol (HDL) after adjustment for age, sex and time in the job at the hospital. They were 135% more likely to develop MS than day workers (PR = 2.35; 95% CI: 1.07- 5.15). Night workers had a later last meal ($p < 0.001$), a larger interval between the first and last meals ($p < 0.001$), and shorter night fasting ($p < 0.001$) compared with day workers. There was no significant difference in the consumption of fiber, fat, or ultra-processed foods between the groups, nor was there an association between eating intervals and MS.

Conclusion: Circadian dysregulation, poor eating habits, and sleep dysregulation may be contributing to the increased risk of metabolic syndrome, hypertension, and changes in body measurements in night shift workers. Strategies such as intermittent fasting and nighttime food restriction can help with these negative impacts for shift workers. Food intake at night may be associated with metabolic changes. Our results highlight the importance of interventions targeting this group of workers, including occupational health programs that consider the challenges of night shift work, as well as policies that promote health and well-being in the workplace. Strategies to promote healthy habits and adjust eating times are essential. Support: State of Rio Grande do Sul Research Support Foundation (FAPERGS).

ID: 13

Punching in or Burning Out? The Influence of Working Time Recording on Temporal Boundarylessness and Working Time Control

Nils Backhaus, Julius Kötter, Johanna Nold, Ines Entgelmeier
Federal Institute for Occupational Safety and Health, Germany

Introduction: Since the European Court of Justice's 2019 ruling, the issue of recording working hours has sparked heated debate in Germany. Some argue that recording work hours can help establish clearer time boundaries, while others contend that it reduces employees' flexibility and autonomy, resembling a return to traditional time clocks. The Effort-Recovery Model (Meijman & Mulder, 1998) suggests that accurately assessing the effort employees put into their work and their subsequent need for recovery is essential for managing stress, preventing burnout, and supporting overall well-being. However, this theory has yet to be empirically tested. This study examines the relationship between working time recording and factors such as temporal boundarylessness, recovery, control over work hours, and work-life balance.

Methods: The analyses are based on data from the BAuA- Working Time Survey, which includes representative samples of employees aged 15–65 from 2019 (n = 8,622), 2021 (n = 17,761), and 2023 (n = 9,775). The survey is conducted through computer- assisted telephone interviews (CATI), with all responses collected via self-report. Employees were asked whether their working hours are a) recorded by their company, b) documented by themselves, or c) not recorded at all. Temporal boundarylessness is assessed through various demanding work conditions, such as long hours, overtime, short rest periods, weekend work, atypical hours (outside 7 AM–7 PM), and availability beyond regular working hours. Work-life balance satisfaction is measured using a single item, while working time control is assessed using Val-cour's (2007) scale. The analyses explore the prevalence of working time recording across the three survey waves and different employee groups (e.g., knowledge workers, remote workers) using (cross-sectional) OLS regression as well as (longitudinal) fixed-effects regression analysis with predictive margins.

Results: Not recording working hours is linked to various aspects of temporal boundaryless work. Employees without time recording are more likely to work long hours, have shorter rest periods (less than 11 hours), and work on weekends. They are also more frequently contacted outside regular working hours in their private time. Additionally, employees who do not record their hours report lower satisfaction with work-life balance. Interestingly, employees who record their working hours report having greater control over their working time compared with those who do not record their hours.

Conclusion: The findings highlight the significance of recording working hours for promoting a healthy work structure and sufficient recovery. Contrary to many employers' expectations, employees without time recording do not have greater control over their working hours; in some cases, those who record their time actually report more influence over their schedules. However, the study has limitations, including potential common method bias due to self-reported data.

ID: 14

Employee Wellbeing in Healthcare: The Effects of Shift Schedule Evaluation Tool with Ergonomics Recommendations

Kati Karhula, Rahman Shiri, Jenni Ervasti, Aki Koskinen, Jarno Turunen, Annina Ropponen, Mikael Sallinen, Mikko Härmä
Finnish Institute of Occupational Health, Finland

Introduction: The Finnish Institute of Occupational Health (FIOH) has issued national evidence- based ergonomic shift scheduling recommendations using a traffic light analogy. The recommendations have been integrated into the most widely utilized shift scheduling software in the public healthcare sector. We aimed to investigate whether the shift planner's use of a shift schedule evaluation tool with ergonomic recommendations has an impact on the wellbeing of healthcare workers both at the individual and ward-level analysis.

Methods: Survey data from the Finnish Public Sector study were combined into four cohorts consisting of two consecutive waves: 1) hospital districts: in years 2015 and 2017 (n = 1943), 2) municipalities 2016 and 2018 (n = 5291), 3) hospital districts 2017 and 2019 (n = 1966), and 4) municipalities 2018 and 2020 (n = 4311). Data from the Titania® shift scheduling software were used to define the use of the shift schedule evaluation tool in the year prior to the survey wave. Multilevel mixed-effects logistic regression was used to calculate a propensity score for each participant and logistic regression was applied at the shift planning unit-level. The propensity score represented the probability of receiving an intervention, i.e., having (intervention group, IG) or not having (control group, CG) the shift schedule evaluation used by the unit's shift planner. The regression model included several covariates such as demographic and lifestyle factors as well as working hour characteristics. The outcomes were sleep duration, sleep difficulties, psychological distress, general health, and work ability. We used a generalized linear model to obtain risk ratios with 95% confidence intervals (IC) and compare the outcomes of interest between the IG and the CG.

Results: The shift schedule evaluation tool was used for an average of 88 minutes in the municipalities and an average of nine minutes in the hospitals, covering 52% of the 8879 employees (88% females) who had complete data on the software and on the outcomes at follow-up. No association was found between the use of the tool and wellbeing at the shift planning unit -level. At the individual level, there was a reduction in psychological distress among employees in the IG (risk ratio 0.92, 95% CI 0.85–0.99).

Conclusion: Although the use of the shift schedule evaluation tool with ergonomic recommendations by shift planners was not associated with perceived wellbeing at the shift planning unit-level, an association was observed with lower psychological distress at individual level. More rigorous use of the tool may be required to achieve significant benefits for wellbeing, particularly at the unit -level. Support: The Finnish Work Environment Fund [grant number 210064] and the Finnish Institute of Occupational Health.

ID: 15

The Association of Shift Work Characteristics and Shift Work Planning Strategies with Turnover in Social and Healthcare: A Payroll Study Utilizing Shift Planning Unit - Level Data 2006-2021

Mikko Härmä, Aki Koskinen, Olli Haavisto, Mikael Sallinen, Jarno Turunen, Kati Karhula, Päivi Vanttola, Annina Ropponen
Finnish Institute of Occupational Health, Finland

Introduction: Hight turnover in the nursing workforce, associated with a global shortage of personnel, poses significant challenges to the healthcare system and quality of care. To address this, we designed an interactive tool to social and health care organizations. The tool provides feedback based on FIOH Working Time Traffic Light (WTTL) recommendations, enabling units to assess the used shift planning strategies and to implement ergonomic shift planning to improve health and wellbeing. This study aimed to investigate how longitudinal changes in the working hour characteristics and shift planning strategies in the interactive tool were associated with annual changes in turnover.

Methods: Working Hours in the Finnish Public Sector (WHFPS) cohort with longitudinal data on registry-based working hours and turnover 2006–2021 was utilized. Annual characteristics of working hours, shift planning strategies and turnover of all shift planning units with at least 10 employees and 30 annual work shifts were included. Longitudinal fixed effects (FE) time- dependent logistic regression was used to investigate whether changes in the unit-level working hour characteristics were associated with a high annual turnover ($\geq$7.5% difference between two years). The model included all independent variables to account for their potential interrelationships. The Odds ratios (OR) with 95% confidence intervals (IC) were calculated. The cut-off levels of FIOH WTTL recommendations were used for independent variables. The final sample for external turnover consisted of 3938 independent shift planning units (36354 observations during 2006–2021). Shift schedules were mostly irregular, while 60% of the sample were working shifts and 14% of employees were men.

Results: Several long ($>$48 hours) free-time spells (OR 0.50, CI 0.46–0.55), single free days (OR 0.58, CI 0.60–0.76), the use of shift wishes (OR 0.91, CI 0.82–0.99), and $\geq$12 hour shifts (OR 0.86, CI 0.75–0.98) were less likely associated with high turnover, while lack of free weekends (OR 1.25, OR 1.10–1.44), shift work (OR 1.33, CI 1.08–1.65) and quick returns ($<$ 11 hours, OR 1.28 (CI 1.15–1.44) were associated with increased likelihood of high turnover. However, having at least 2-night shifts in a week and having slowly rotating shift schedules ($\geq$ 4 nights,) were linked to less likelihood of high turnover (OR 0.59, CI 0.49–0.72; OR 0.88, CI 0.79–0.98).

Conclusion: The results indicate that factors associated with frequent free-time arrangements and recovery in shift work, often linked to better worktime control and the use of 12-hour shifts, as well as slower rotating work schedules, could possibly promote staying in work in mostly irregular shift work in the social and healthcare. Support: This research is conducted as a part of the Mental Health Toolkit project. The project is a part of Finland's Sustainable Growth Program and funded by the EU Recovery and Resilience Facility (Next Generation EU).

ID: 16

Assessing FTL Effectiveness: Quantifying the Effect of Changes in Easa Regulations on Fatigue Risk and Crew Efficiency

Tomas Klemets, MagnusE.K.
JEPPESEN, Sweden

Introduction: Flight and duty time limits (FTLs) for pilots and cabin crew, defined by regulators, establish clear scheduling boundaries for flight operators. While primarily designed to mitigate fatigue risk, these limits also significantly impact crew efficiency. This study aimed to develop a method for quantifying and optimizing the effectiveness of FTLs and to compare the impact of the previous (Subpart Q) and current (2016) EASA FTL regulations.

Methods: A large dataset of flight schedules was used where we included all scheduled passenger fleets operating more than 200 and 100 flights per week for narrow body and wide body operation respectively, during three typical calendar weeks. These planning problems were then used to generate crew rosters limited solely by regulatory boundaries, without additional operational constraints. These rosters were optimized using commercial industry-grade scheduling tools with a strive to maximize crew efficiency. The resulting rosters, which would be the realistic working patterns produced by new operators only governed by regulations, were then analyzed in terms of both crew efficiency and fatigue risk. The latter was estimated by using one of the leading bio-mathematical fatigue models within aviation and a well-established method for quantification translating sleepiness into risk for lapses/slips/mistakes/violations during critical phases of flight.

Results: The transition from Subpart Q to the current EASA FTLs, applied to European-based operations, led to: • Short-haul operations: A 3.2% increase in fatigue risk with a 0.6% decrease in crew efficiency. • Long-haul operations: A 7.8% reduction in fatigue risk, accompanied by a 7.0% drop in crew efficiency.

Conclusion: Mitigating and limiting fatigue risk through rigid (binary) rules presents challenges. The revised EASA FTLs reduced crew fatigue risk levels for long-haul operations, albeit at a substantial efficiency cost, while changes for short-haul operations were counterproductive. This study highlights the need for a more data-driven approach, and provides concrete examples thereof, when updating regulations to better balance fatigue risk and operational efficiency.

ID: 17

Working Time Organization and Sleepiness in Uruguayan Road Transport Drivers: Preliminary Results

Mathias Cosentino[1], Melina Alaniz[2], Victoria Rodriguez[2], Ignacio Estevan[2], Bettina Tassino[1]
[1]*Facultad de Ciencias, UDELAR, Montevideo, Uruguay*
[2]*Facultad de Psicología, UDELAR, Montevideo, Uruguay*

Introduction: Road transport is one of the sectors whose Occupational Health and Safety (OHS) is most affected by working time organization. The industry is characterized by long and irregular working schedules, which significantly impact road transport drivers' OHS. Furthermore, Uruguay lacks specific regulations governing working hours for road transport drivers. These working conditions contribute to frequent sleepiness while driving, posing a substantial risk to their health and safety and the general public safety. This research is being conducted in collaboration with the Road Transport Work Health and Safety Commission, which includes representatives of the Ministry of Labor, business chambers, and road transport unions. The primary objective was to identify risk factors associated with working time organization that are relevant to OHS in Uruguayan road transport drivers.

Methods: The Road Transport Work Health and Safety Commission received paper-based questionnaires designed for self-completion. The questionnaires addressed employment conditions, occupational hazards, sleep, and health and were distributed nationwide to road transport drivers.

Results: A total of 213 road transport drivers (98.0% male) voluntarily participated and completed the questionnaires. The majority were truck drivers (79.6%), with ages between 21 and 72 years old. On average, they reported working 12.0 ± 2.7 hour and driving 422.9 ± 252.7 km daily. Irregular working schedules were reported by 23.5% of participants, while 71.8% indicated working night shifts, either permanent or occasional. The average sleep duration on workdays was 6.2 ± 1.7 hour. Additionally, 72.8% of drivers reported experiencing sleepiness while driving, and 51.1% indicated that they had to stop driving at least once in the past year due to sleepiness. Sleepiness was more prevalent in those exposed to irregular working schedules (90.0% vs 68.8%, $p < 0.01$), and also between those working night shifts (80.8% vs 45.7%, $p < 0.001$). It was found that drivers who reported being sleepy while driving worked 0.9 more hours per day, drove 86.9 more kilometers, and slept 0.7 fewer hours between workdays. Furthermore, work- related accidents were more prevalent among sleepy workers ($p < 0.001$). No statistical association was found between drivers who reported stopping driving because of sleepiness and sleep duration between workdays or kilometers driven per day.

Conclusion: The organization of road transport activities in Uruguay requires drivers to drive while drowsy, often without the opportunity to stop and rest. Generating evidence-based knowledge is crucial for informing OHS regulations in this sector. Support: This research was funded by the Comisión Sectorial de Investigación Científica de la Universidad de la República.

ID: 18

A Meta-Analysis on Work Schedule Characteristics and Sleepiness

Laura Vieten[1], Anna Arlinghaus[2], Marc Sobisch[2], Frank Brenscheidt[1], Johannes Gärtner[2]
[1]*Federal Institute for Occupational Safety and Health (BAUA), Germany*
[2]*XIMES GMBH, Austria*

Introduction: Atypical working hours, including shift work as well as work during weekends, evenings, and nights, are known to be risk factors for workers' health and safety. Fatigue, including sleepiness, is considered a key factor mediating these effects. Given this central role of sleepiness, many studies have investigated how it is affected by different aspects of working hours or work schedules. However, the empirical evidence is mixed and difficult to generalize, since many studies have focused on specific shift systems within particular organizations or occupational groups. Therefore, to better understand the relationships between work schedule characteristics and sleepiness, this study aims to meta-analytically synthesize research on these relationships. Specifically, we examine how sleepiness changes with (1) shift length, i.e., time into shift, (2) shift type (e.g., day versus night), and (3) number of consecutive shifts.

Methods: This review is part of a broader project examining the relationships between different aspects of

working hours and fatigue as well as need for recovery. In this broader project, we conducted a systematic literature search of peer-reviewed publications in various databases in February 2024, which yielded 16,804 hits. After removing duplicates, 9,168 abstracts and 805 full texts were screened. We updated the search in January 2025, and after removing duplicates, a further 744 hits were screened. This part of the study focuses on original studies examining sleepiness measured with the Karolinska Sleepiness Scale. Statistical analyses are in progress. We plan to calculate mean overall effect sizes (Hedges' g) comparing sleepiness for (1) different lengths of time into shift, (2) different shift types, and (3) different numbers of consecutive shifts using random-effects models.

Results: We included 38 studies on time into shift, 31 studies on shift type, and 13 studies on the number of consecutive shifts in the meta-analyses. Most of these studies used repeated measures design and had small samples, often less than 100 participants. Nurses were the most frequently studied occupational group. As expected, preliminary results indicate that sleepiness is higher during night shifts than during day shifts. However, results regarding time into shift and number of consecutive shifts are less clear. The final results will be presented at the symposium.

Conclusion: This review provides a comprehensive and up-to-date overview of research on work schedule characteristics and sleepiness, enhancing the understanding of these relationships. Besides, its findings will support the evidence-based design of work schedules that reduce the risk of worker fatigue in the short term, while contributing to reduced health and safety problems in the long term.

ID: 19

Assessment of Sleep Disorders in Professional Drivers

Ghezini Younes, Sebian Sid Ahmed, Rezkkallah Baghdad
Faculty of Medecine Oran, Algeria

Introduction: Road accidents constitute a major public health problem. Professional drivers are on the front line and a large number of accidents involving them could be linked to drowsy driving. The objectives of this study are to determine the prevalence of sleep disorders while driving and to identify the main risk factors among professional drivers.

Methods: This is a descriptive cross-sectional epidemiological study. The study population consists of professional heavy goods vehicle drivers. The Berlin and Epworth questionnaires and the Pittsburgh Sleep Quality Index were used to collect data.

Results: Two hundred and sixty-five male drivers with an average age of 42.3 $\pm$ 9.8 years participated in the study. The body mass index was high in 165 (62.3%) and smoking was found in 128 (48.3%) drivers. The pace of working in atypical hours is adopted by 130 (49.1%) drivers and 173 (65.3%) declared covering long distances of more than 500 km per day. Seventy drivers (26.4%) drive more than 12 hours per day. The average duration of sleep on the working day is less than 6 hours among 113 (42.6%) drivers. Half of the drivers declared themselves insomniac and drowsiness while driving was reported by 235 (88.7%). Sleep apnea syndrome was suspected in 27 (10.2%).

Conclusion: Information and awareness on the dangers of drowsy driving with quality medical monitoring should help protect the health of these drivers and improve road safety.

ID: 20

Addressing the Need for Scalable Fatigue Feedback from Pilots: Challenges and Opportunities

Tomas Klemets, David Karlsson
JEPPESEN Systems, AB, Sweden

Introduction: Current fatigue reporting procedures in aviation have significant limitations in providing a comprehensive understanding of fatigue risk exposure for airline operators. They also fail to generate sufficient data to refine bio-mathematical fatigue models. Three key shortcomings of traditional fatigue reporting systems include: 1. Time-consuming process – Filling out a fatigue report takes ~10–15 minutes, a considerable burden for an already exhausted pilot leading to significant under-reporting. 2. One-sided data – Reports are only submitted when fatigue is experienced, preventing insights into working patterns that pilots tolerate well. 3. Inconsistent reporting frequency – Submission rates are highly sensitive to external factors, such as reminders from management, labor disputes, or industry-wide disruptions (e.g., COVID-19). This study explored a scalable, technology-driven approach to complement traditional fatigue reporting by introducing a high-volume, representative data stream that serves as a proxy for overall fatigue risk exposure.

Methods: A smartphone app was developed to allow pilots to quickly and easily record their Karolinska Sleepiness Scale (KSS) score (1–9), with additional optional fields for: • Usage of controlled rest • Prior sleep last 24 hours • Mental effort rating • Free-text comments Only the KSS assessment was mandatory, ensuring minimal burden on users. The app was deployed in collaboration with several airline operators as a supplementary (not replacement) tool for fatigue reporting. Pilots could use the app on personal devices or company-provided iPads. Crew members were assigned a de-identified user account by their airline to ensure data privacy. The study aimed to assess how taxing this data collection method was for pilots, both in terms of time consumption and sustained participation.

Results: The implementation generated over 250,000 data points over a one-year period, with pilots spending an average of 22 seconds per entry (SD = 7.1s). Pilot interviews indicated that the main challenge was simply remembering to record data, rather than the time required to do so. The large dataset, when mapped onto flight rosters, immediately demonstrated added value for bio-mathematical fatigue model development. In particular, it enabled the detection of long-term effects of sleep deprivation, which had previously been difficult to identify in field data.

Conclusion: The use of non-intrusive, scalable technology for fatigue data collection presents a promising path forward for both airline fatigue risk management and bio-mathematical model improvement. Implementing routine KSS assessments as a standard operating procedure, similar to fuel checks, could provide the industry with a more detailed, real-time understanding of fatigue risk trends across different aviation sectors. By embedding KSS assessments into daily workflow, airlines could monitor risk development, contribute to enhancing fatigue model accuracy, improve their roster planning, and even in broader collaborations refine flight and duty time regulations. Fuel check = KSS check - a new memory item for pilots?

ID: 21

The Impact of Working Time Quality on the Health of Uruguayan Road Transport Drivers

Ignacio Estevan[1], Mathias Cosentino[2], Micaela Coelli[1], Bettina Tassino[2]
[1]Facultad de Psicología, UDELAR, Montevideo, Uruguay
[2]Facultad de Ciencias, UDELAR, Montevideo, Uruguay

Introduction: Working time quality goes beyond its duration, encompassing factors such as organization and predictability. Alongside environmental and personal elements, working time quality affects drivers' exposure to risk factors linked to common chronic diseases. In the road transport industry, poor working time quality is prevalent, characterized by long working hours often extended without the opportunity to return home, pressure to meet tight schedules, and prolonged waiting times for picking up or dropping off loads-issues frequently beyond workers' control. The primary objective of this study was to examine the influence of working time quality on the health of Uruguayan road transport drivers.

Methods: In collaboration with the labor union and the industry chamber, paper-based questionnaires were distributed nationwide to bus and truck drivers. The questionnaires addressed sociodemographic data, several aspects of working time quality, and perceived mental health, which were measured using the Goldberg Health Questionnaire-28 (GHQ- 28) Likert scale. Information on absences over the past year was also gathered.

Results: A total of 141 road transport drivers with complete data were included in the analysis. The sample was predominantly male (98.6%), with a mean age of 45.4 $\pm$ 9.8 years. Most participants were truck drivers (81.6%), averaging 18.7 $\pm$ 9.8 years of driving experience. On average, drivers reported working 12.1 $\pm$ 2.7 hours per day (78.6 $\pm$ 20.6% of which was spent driving) and covering 416.0 $\pm$ 233.4 km daily. The majority (80.1%) reported occasional or frequent nighttime driving, and 85.1% indicated irregular work days or hours, with 92.5% noting that such changes were often communicated at short notice and/or caused disruptions with their personal life. The mean GHQ-28 score was 18.1 $\pm$ 9.8, with 66.7% of participants classified as cases (>12). No significant association was found between daily working time duration or kilometers covered and perceived health (all p>0.05). However, nighttime driving was associated with poorer perceived health (mean estimated increase of 5.4 $\pm$ 2.2 in GHQ-28, p = 0.015), though it did not affect the percentage of cases (p = 0.1). Irregular working time was nearly positively associated with higher GHQ-28 scores (mean estimated increase of 4.7 $\pm$ 2.5, p = 0.062), and was linked to a 2.5-fold increase in the odds of being classified as a case ($p < 0.05$). Additionally, a 1-point rise in GHQ-28 score was associated with a 3.6% increase in the odds of reporting absences (p = 0.041), and being classified as a case increased the odds of reporting absences by 2.5 times (p = 0.038).

Conclusion: A broader definition of working time is essential for understanding the impact of working conditions on health inequalities. Therefore, it is crucial to expand and update government regulations to incorporate evidence on the health effects of various aspects of working time quality. Support: This research was supported by the Comisión Sectorial de Investigación Científica de la Universidad de la República.

ID: 22

Aircrew: Repeated Sleep Loss and the Accumulation of Fatigue

David Karlsson[1], Torbjörn Åkerstedt[2], Tomas Klemets[1]
[1]JEPPESEN Systems AB, Sweden
[2]Karolinska Institute, Stockholm, Sweden

Introduction: It is commonly assumed that two undisturbed nights of recovery reset the fatigue to normal. This is also the assumption in mathematical models designed to predict fatigue from work schedules which lacks long-term recovery processes. However, there is almost no research done on the effect of repeated sleep deprivation/sleep loss across longer periods of time. It is possible that fatigue/sleepiness accumulates across repeated bouts of sleep loss. Such findings should affect work hour regulations and mathematical models predicting fatigue from work schedules. The present study focused on aircrew, and the purpose was to study the association between repeated sleep loss and accumulation of fatigue across work rosters, and to derive metrics that can be used to improve the performance of mathematical models in predicting fatigue. As an indicator of sleep loss, we used the encroachment of work (roster based) on the window of circadian low – WOCL (timing between 0200–0600), since that was available directly from collected roster data.

Methods: The data was collected from long-haul operation conducted between March 2017 and December 2023. Flight deck crew assessed their sleepiness on the Karolinska Sleepiness Scale (KSS) at the top of descent for each flight. Each assessment was linked to crew id, flight number, and date of departure, and then merged with roster data from the day-of-operation system. In total 32,795 assessments could be matched with rostered activities. To represent WOCL encroachment, we calculated the amount of block time within the WOCL on three different time horizons: 60, 120 and 240 hours prior to each of the assessments. These three values were then added up to get one combined metric to use in the analysis with a greater weighting on more recent events.

Results: Fatigue accumulation was evident, with KSS scores increasing as WOCL encroachment increased: • Reported KSS increased from 5.7 $\pm$ 0.23 for 0–2 hours block time to 7.8 $\pm$ 0.23 at 30–34 hours (B = 0.25 $\pm$ 0.021, $p <$ 0.00001). •Predicted KSS increased from 4.9 $\pm$ 0.35 at 0–2 hours block time to 5.5 $\pm$ 0.35 at 30–34 hours (B = 0.081 $\pm$ 0.033, p = 0.042). • The residual (reported KSS - predicted KSS) increased from 0.89 $\pm$ 0.18 at 0–2 hours block time to 2.3 $\pm$ 0.18 at 30–34 hours (B = 0.17 $\pm$ 0.016, $p < 0.0001$).

Conclusion: These findings indicate that fatigue accumulates as flight duty time repeatedly encroaches on the WOCL, contradicting the assumption that just two nights of recovery is sufficient. This effect should be accounted for in aircrew scheduling, as well as in other industries where shift work disrupts normal sleep patterns. Furthermore, fatigue prediction models may be improved by incorporating a longer- term process representing this fatigue accumulation.

ID: 23

The Impact of a Sleep Intervention on Shift Workers: Improved Subjective Sleep Without Objective Changes

Maaike Van Der Rhee[1], Johanneke E. Oosterman[2], Suzan Wopereis[3], Martijn E. T. Dollé[4], Alex Burdorf[1], Linda W. M. Van Kerkhof[4], Heidi M. Lammers-Van Der Holst[1]
[1]Department of Public Health, Erasmus MC, Rotterdam, The Netherlands
[2]Division of Endocrinology, Department of Internal Medicine, Erasmus MC, Rotterdam, The Netherlands

[3]Research Group Microbiology & Systems Biology, TNO, The Netherlands Organization for Applied Scientific Research, The Netherlands
[4]Centre for Health Protection, National Institute for Public Health and the Environment (RIVM), The Netherlands

Introduction: Shift work is associated with disturbed sleep and adverse health effects. The aim of this study is to analyze the effects of two interventions, i.e., personalized sleep or nutritional advice, on sleep duration and quality in real-life shift workers.

Methods: This controlled intervention study included 57 healthy shift workers working 12-hour shifts. Participants received tailored advice based on their work schedule, social obligations, and physiological markers. The sleep advice focused on sleep timing, multiple sleep episodes, and sleep hygiene education, while the nutritional guidance structured meal timing, macronutrient distribution, and energy intake. Sleep was assessed objectively through actigraphy at baseline, start intervention and post-intervention (averaging 13-night shifts, 6 early shifts and 20 free days per participant). Subjective sleep was measured with the Insomnia Severity Index at baseline, post-intervention and follow-up. Mixed-effects models with a random intercept were used, adjusted for age, chronotype and household.

Results: Participants experienced on average shorter sleep duration when working night and early shifts, compared with recovery days. Neither intervention changed the objective sleep duration or quality. Participants who received the sleep advice had significantly higher insomnia scores at baseline, and their scores had decreased to match those of the other groups on post-intervention and during follow-up 8 months after the intervention. No such effects were observed for nutritional guidance.

Conclusion: Personalized sleep guidance improved subjective sleep experience (insomnia scores) but had no effect on objective sleep measures, highlighting the disconnect between subjective experience and objective sleep metrics.

ID: 24

Can an Anti-inflammatory Diet Offset the Increased Cancer Risk Associated with Night Shift Work?

Camille Lasalle[1], Gemma Castanyo-Vinyals[1], Trinididad Dierssen-Sotos[2], Victor Moreno[3], Vicente Martin[4], Amaia Aizpura[5], Marina Pollan[6], Marcela Guevara[7], James R. Hebert[8], Kyriaki Papantoniou[9]
[1]Barcelona Institute for Global Health, Barcelona, Spain
[2]University of Cantabria, Cantabria, Spain
[3]Catalan Institute of Oncology, Spain
[4]University of Leon, Leon, Spain
[5]Ministry of Health of the Basque Government, Sub Directorate for Public Health and Addictions of Gipuzkoa, Spain
[6]National Center for Epidemiology, Carlos III Institute of Health (ISCIII), Spain
[7]Instituto De Investigación Sanitaria De Navarra (Idisna), Instituto De Salud Pública De Navarra, Pamplona, Spain
[8]Cancer Prevention and Control Program, University of South Carolina, Columbia, South Carolina, United States
[9]Medical University of Vienna, Vienna, Austria

Introduction: Night shift work has been associated with increased risk of breast, prostate and colorectal cancer. Recent literature shows that shift workers may report poorer food choices, irregular mealtimes and more pro-inflammatory diets than day workers. We aimed to study the combined effects of night shift work and dietary inflammatory potential on risk of four common cancer types.

Methods: We used data from the MCC-Spain study, a population based multi-case- control study on 4 tumors, including 4325 cancer cases (colorectal, breast, prostate, stomach) and 3560 population controls recruited between 2008–2015 in 12 regions of Spain. Based on a food frequency questionnaire assessed around study recruitment, we calculated the energy-adjusted dietary inflammatory index (E-DII). We used the median E-DII among controls (-0.564) to define anti- and pro-inflammatory diet. We collected night shift work information using lifetime occupational history, including exact work hours, cumulative night shift work duration (years), night shift work frequency (average number of night shifts/month) for each job held for >1 year. Night shift work was defined as at least 3 hours of work between midnight and 6:00. Unconditional logistic regression was used to estimate Odds Ratios (OR) and 95%CI for the joint association of E-DII (anti- vs pro- inflammatory diet), and night shift work (never vs ever never), night shift work duration (<15 years vs ≥ 15 years) and night work frequency (<3 vs ≥ 3 night shifts/month) for each cancer type, adjusting for potential confounders

Results: Night shift workers were more likely to report a higher dietary inflammatory potential (higher E-DII), and a higher intake of calories, red meat, alcohol and sugar compared with day workers. Compared with day workers with anti-inflammatory diet, a pro-inflammatory diet in night shift workers was associated with elevated odds of colorectal (OR 1.59; 95%CI [1.28–2- 01]), breast (1.27 [0.91–1.79]), prostate (1.31 [0.99–1-73]) and gastric cancer (1.74 [1.32–2.31]). An anti-inflammatory diet in night shift workers was not associated with breast cancer (1.08 [0.80–1.45]) among those with <15 years of night shift work. However, long-term night shift work (≥ 15 years) was associated with 3 times greater odds of breast cancer in both anti- and pro-inflammatory diet groups, compared with day workers. Night workers who followed an anti-inflammatory diet did not show increased breast cancer odds (1.02 [0.66–1.55]) when employed in shift schedules with <3 nights/month, though this protective effect diminished (1.78 [0.86–3.79]) among shift workers with ≥ 3 nights/month.

Conclusion: In a large case-control study, night shift work and a pro-inflammatory diet were jointly associated with higher risks for cancer. An anti-inflammatory diet appeared to mitigate the increased breast cancer risk in night shift workers with low shift work duration and intensity, suggesting that dietary modifications could be a potential strategy to offset some of the adverse effects of night shift work. Support: We would like to acknowledge the rest of the co-authors that contributed to this manuscript: Manolis Kogevinas (ISGlobal, Barcelona, Spain), Barbara Harding (ISGlobal, Barcelona, Spain), Kurt Straif (ISGlobal, Barcelona, Spain), Jose Juan Jimenez- Moleon (Department of Preventive Medicine and Public Health, University of Granada, Granada, Spain), Ana-Molina Barcelo (Cancer and Public Health Area, The Foundation for the Promotion of Health and Biomedical Research of Valencia Region (FISABIO), Rafael Marcos Gragera (Epidemiology Unit and Girona Cancer Registry, Oncology Coordination Plan, Department of Health, Autonomous Government of Catalonia, Catalan Institute of Oncology Girona, University of Girona, Girona, Spain), Adonina Tardon (University Institute of Oncology (IUOPA), University of Oviedo, Oviedo, Spain), Juan Alguacil (Centro de Investigaciónen Recursos Naturales, Salud y Medio Ambiente (RENSMA), Universidad de Huelva, Huelva, Spain), Nuria Aragones (Public Health Division, Department of Health, Madrid, Spain) and Beatriz Perez-Gomez (National Center for Epidemiology, Carlos III Institute of Health (ISCIII), Madrid, Spain).

ID: 25

Working Time in the Cleaning Industry in Austria

Marc Sobisch, Anna Arlinghaus, Johannes Gärtner
XIMES GMBH, Austria

Introduction: Work in the cleaning industry is characterized by ergonomically and socially stressful working hours such as long and split shifts as well as work at the edges of the day. However, knowledge of working hours is often anecdotal, as analyses of actual working hours in the cleaning industry are largely lacking. The aim of this pilot study was therefore to better understand the working conditions of Austrian cleaning staff and to determine how compliance with legal and ergonomic recommendations on planning of working time is implemented in this sector.

Methods: To answer these questions, actual working hours worked by employees covered by the collective agreement for monument, facade and building cleaners were analyzed. The sample is based on a non-representative group of employees in the cleaning collective agreement who contacted the legal counselling service of the Vienna Chamber of Labor to check their working hours. A total of 32 cases with actual working hours between 1 January 2020 and 7 May 2023 were evaluated, which contained the start and end of working hours at daily level as well as breaks and absences (holiday, sick, ...). On average, 244 days were entered (min. 8, max. 524).

Results: The duration of daily working hours varied greatly between employees. While some only worked short shifts, most people worked between 7–11 hours per day. A significant proportion also worked more than 12 hours a day. In most cases, work was performed during the day between 6 AM and 7 PM on all days of the week. Night work occurred in eight cases. Most employees started between 6 AM and 7 AM The times at which work ended varied: A substantial proportion of people finished work between 2 PM and 4 PM, the majority between 6 PM and 8 PM As the individual working time patterns varied greatly, no 'typical' working time in the cleaning industry could be found. The analyses were therefore supplemented by individual case studies of prototypical working time patterns (e.g., day work, irregular working hours, split shifts) with an ergonomic evaluation, risk assessment and legal review of these times.

Conclusion: The analyses of a non-representative sample of working hours from the cleaning industry in Austria show an accumulation of legally and ergonomically problematic times such as very long daily working hours, work at socially unfavorable times (evenings, nights, weekends) and very irregular work assignments. Even if the sample suggests an above-average frequency of offenses, as non-critical cases are less likely to be found in legal advice, the analysis nevertheless provides valuable insights. The findings expand the data situation in this sector and point to the need for increased occupational health and safety protection for employees.

ID: 26

Fatigue and Sleepiness at Work in UK Ferry Workers

Ashleigh Filtness[1], Adam Asmal[1], Sally Maynard[1], Wendy Jones[1], Adnrew Pooley[1], Anna Sjors Dahlman[2]
[1]*Loughborough University, Loughborough, United Kingdom*
[2]*Swedish National Road and Transport Research Institute, Stockholm, Sweden*

Introduction: Seafarers operate under the standard pressures associated with 24h shift working operations, compounded by the unpredictability of maritime environments, which require a high degree of flexibility. Existing research on maritime fatigue has primarily focused on military operations and long-distance shipping. By contrast the current work focuses on the UK ferry sector, a busy transport industry with ~37,000 ferry crossings annually, characterized by shorter trip (single time zone) voyages. The primary aim of this research is to examine the prevalence of fatigue among seafarers, analyze its safety implications, and assess employer awareness regarding this issue.

Methods: 446 seafarers (80% male) participated in an online survey conducted between February and April 2024. 87% lived on-board their ships for at least a week at a time, while 13% returned home to sleep between shifts. The survey covered: 1. Work as a seafarer;2. Work patterns and shifts; 3. The impact of work patterns on performance; 4. Sleep; 5. Enjoyment and stress of work; 6. General health; and 7. Demographics. It was promoted by ferry operators, the UK Department for Transport, and union stakeholders. The survey was adapted from previous research involving bus drivers and received ethical approval from Loughborough University. Survey responses remained anonymous; however, upon completion, participants could enter a prize draw to win one of ten £50 cash prizes.

Results: 59% of participants reported having to fight sleep at work at least once in the past month. 18% had fallen asleep at work at least once during the last year. 31% reported work-related safety incidents caused by fatigue in the previous 10 years, but of these, 85% stated that their employer did not know that sleepiness had been involved. Only 35% of participants felt confident in accurately recording their rest and work hours, while 14% never felt confident.

Conclusion: Experiences of sleepiness are widespread in the UK ferry industry, often regarded as "part of the job." The disparity between individual perceptions of the role of fatigue in workplace incidents and a belief that this is not known to employers, suggests that fatigue is underreported. Accurate documentation of working hours is essential to support effective fatigue management, however, many seafarers find it challenging to adhere to this. Working hours regulations are complex and vary based on the distance from shore and the flag state the vessel is registered with. Furthermore, the stipulations for safe manning and muster lists are international and specify minimum crew numbers on board. However, the emphasis on safety centres on emergency response need, overlooking the safe operation of the vessel over a 24-hour period. Sleepiness is a significant safety concern for seafarers, which is inadequately addressed by the existing work-hour regulations. Support: UK Department for Transport funded this research.

ID: 27

Fatigue Field Study in United States Helicopter Air Ambulance Pilots: Methodology

Hannah M. Baumgartner[1], Cassie J. Hilditch[2]
[1]*Federal Aviation Administration, Washington, District of Columbia, United States*
[2]*San José State University, San José, California, United States*

Introduction: Helicopter air ambulance (HAA) pilots are exposed to fatigue risk due to on-call and shiftwork operations required for 24-hour emergency service. Cumulative fatigue, circadian disruptions, and sleep inertia may reduce safety margins, particularly in consecutive nighttime shifts and on-call emergency flights. Previous research on fatigue in HAA operations has largely focused on European operators, many of whom operate through state-run emergency service providers. HAA services in the United States

(US) instead operate as private companies, with a variety of company policies and environments that could differentially affect pilot fatigue and sleepiness. The current field study aims to investigate how shiftwork and on-call demands in US HAA operations influence sleep, alertness, and performance across different schedule types.

Methods: All US HAA pilots working 7-days-on, 7-days-off schedules were invited to participate. Schedules of interest include daytime shifts (typically 0600–1800), nighttime shifts (typically 1800–0600), or mixed-shifts (e.g., 3 daytime shifts, followed by 4 nighttime shifts). Before data collection, participants complete a pre- study survey that includes demographic and operational questions, the Morningness-Eveningness Questionnaire, and the Epworth Sleepiness Scale. The data collection period includes 3 days pre-shift, 7 days on-shift, and 3 days post-shift. During this period, sleep is measured via wrist actigraphy and daily sleep logs. Pilots complete a 5-minute psychomotor vigilance test (PVT), Karolinska Sleepiness Scale (KSS), and Samn-Perelli (SP) fatigue scale three times per day. Following every flying operation, pilots complete an additional PVT, KSS, SP, and take the NASA Task Load Index.

Results: To date, 54 HAA pilots have consented to participate. This includes 21 pilots with daytime shifts, 19 pilots with nighttime shifts, and 14 pilots with mixed-shifts. These pilots represent 19 companies. So far, 19 participants have contributed 247 days of data, including 763 PVTs. Preliminary results are forthcoming.

Conclusion: Data collection for the study is ongoing. Participation so far suggests that the methodology is not overly burdensome to the pilots while on duty and that pilots are compliant with the study methodology. Additionally, the large spread of companies participating suggests that our recruitment strategy and advertising is successfully reaching a broad range of pilots. Support: This research is conducted under the Flight Deck Program Directive/Level of Effort Agreement between the Federal Aviation Administration NextGen Human Factors Division (ANG-C1) and the Aerospace Human Factors Research Division (AAM-500) of the Civil Aerospace Medical Institute.

ID: 28

Impact of Shift Work on the Morbidity Profile and Respiratory Health Among Pig Iron Industry Workers: A Cross Sectional Study

Vishwaraj Kashinath Mhalshekar
Goa Shipyard Limited, Govt. of India, Goa, India

Introduction: Shift work adversely affects worker productivity, performance, health and quality of life and puts others at risk due to workplace or driving accidents. Shift work, including night work, is known to impact workers' health due to disrupted circadian rhythms and lifestyle modifications such as irregular and reduced quality of food intake along with impairment of social life. This study examines the differences in morbidity profiles, metabolic health and respiratory function among shift and regular workers in the pig iron industry where pig iron is produced by smelting of iron ore in blast furnaces.

Methods: This cross-sectional study was conducted between August 2024 to January 2025 among 641 workers in the pig iron industry in Goa, India. Following written informed consent, the workers were conveniently sampled. A semi-structured interview schedule was administered to collect data on socio-demography, morbidity profile and work-related characteristics. Anthropometric measures, laboratory parameters and spirometry data (to evaluate respiratory function) were obtained from records of annual medical screening. Data was entered in Microsoft Excel and analyzed using SPSS V.21. Descriptive statistics were represented as frequencies and percentages. Chi square test was used to study association and between group differences. Binomial logistic regression analysis was performed with illness as the dependent variable and gender, shift work, body mass index (BMI) and spirometry readings as covariates. A p value of <0.05 was considered to be statistically significant.

Results: Of the 641 workers, 277 (43.2%) were engaged in shift work. The mean age of the participants was 40.85 $\pm$ 10.08 years and 89.7% were male. Majority of workers were between 36–45 years (34.9%), followed by 46–55 years (28.2%). The prevalence of hypertension was significantly higher among shift workers (20.1%) compared with regular workers (10.4%) ($p < 0.040$). Diabetes was slightly more common among shift workers (10.8%) than regular workers (6.6%) ($p < 0.04$). Obesity (BMI >30) was more prevalent among shift workers (18.3%) than regular workers (12.5%). Almost 8.1% of the workers had high total cholesterol levels with significant differences between night shift workers and regular shift workers (10.8% vs 6.0%, $p = 0.020$). Spirometry findings showed a higher prevalence of mild restriction among shift workers (17.7%) compared with regular workers (10.4%). Binomial logistic regression showed that shift workers were at1.5 times higher risk of developing chronic illness ($p < 0.001$).

Conclusion: The findings suggest that shift work is associated with a higher prevalence of hypertension, obesity and mild lung restriction compared with regular work schedules and this may predispose them to ill health conditions such as cardiovascular diseases and accidents at workplace. These results emphasize the need for targeted occupational health interventions such as risk assessment and periodic medical surveillance to mitigate the adverse health effects of shift work in the pig iron industry.

ID: 29

Is this a Night Shift, An Evening Shift or What?

Johannes Gärtner, Pierre Rieger, Anna Arlinghaus, Marc Sobisch
XIMES GMBH, Austria

Introduction: Night shift work is associated with an increased risk of accidents, adverse health effects, and psychosocial impairments. Consequently, various recommendations exist regarding the maximum duration of night shifts, and similar parameters. To a lesser extent, comparable research and guidelines are available for evening and morning shifts. Currently, to study the effects of shift timing, and to develop guidelines for scheduling, classifications of shift types are used broadly. While types of shifts are relatively standardized in certain industries, e.g.., heavy industry, hospitals, shifts in other sectors is way more divers with hundreds or thousands of different shift times. Typically, legal definitions of night shifts are not helpful either. They often rely on timeframes, such as requiring at least some hours of work within a predefined night period (e.g., Austria's law NSchG defines a night as 6 hours between 22:00 – 6:00). However, these definitions exclude working patterns that have similar consequences as traditional night shifts, particularly in service industries. Furthermore, using such definitions, small variations in shift timing can lead to significant classification inconsistencies. For example, under a definition where a night shift requires work between 23:00 and 05:00, a shift from 23:00 to 04:55 would not qualify, despite having nearly identical physiological and psychosocial consequences

as one ending at 05:00. Given these limitations, there is a clear need for a more nuanced classification system that avoids discontinuities, accurately reflects the diversity of real- world working hours, and facilitates the application of existing research findings to a broader range of shift patterns.

Methods: As part of the Accident Risk Calculator / Risikorechner 2019 project, we developed software to estimate the degree to which a given shift (regardless of start and end time) resembles the consequences of a classical night, evening, morning, or day shift. This model accounts for its impact on sleep and psychosocial well-being. To enable further testing and comparative analysis, we have reimplemented the 2019 model as an open-source Python module, ensuring proper documentation and accessibility for broader research applications.

Results: The developed module allows for the classification of diverse working hours. It is designed for straightforward application across different industries and working time structures.

Conclusion: We invite other research groups to test and refine this initial version. Collaborative improvements will contribute to a more comprehensive classification framework that better captures the complexity of modern work schedules and their effects on health and safety. Support: The projects was partly funded by the German Federal Institute for Occupational Safety and Health (BAuA).

ID: 30

Prevalence and Risk Factors of Shift Work Sleep Disorder Among Healthcare Workers in a Tertiary Hospital in India

Merlyn Joseph[1], Bobby Joseph
ST. John's Medical College Hospital, Bangalore, Karnataka, India

Introduction: Shift work, particularly night shifts, disrupts the natural circadian rhythm and homeostatic regulation of sleep, leading to significant health consequences. One of the key disorders associated with shift work is Shift Work Sleep Disorder (SWSD), characterized by excessive sleepiness during work hours and insomnia when attempting to sleep during the day. Healthcare workers are particularly vulnerable due to their demanding and often unpredictable work schedules. The prevalence of SWSD and associated risk factors among healthcare workers in India remains underexplored. This study aimed to assess the prevalence of SWSD symptoms among hospital staff and identify occupational and demographic risk factors contributing to sleep disturbances and fatigue.

Methods: This cross-sectional study was conducted at a private teaching tertiary hospital in Bangalore from September to December, 2024. A total of 318 hospital staff were recruited using stratified random sampling from various departments, including nursing, housekeeping, hospital aides, nursing aides, and laboratory technicians. The inclusion criteria required participants to be under 60 years old and to have worked at least seven night shifts in the past month. Data were collected through structured interviews using standardized tools, including the Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS) and Functional Assessment of Chronic Illness Therapy (FACIT) Fatigue Scale. Data was entered in Microsoft Excel and analyzed using SPSS V.21. Descriptive data was represented as frequency and percentages. Chi square test was used to study association between insomnia, fatigue and daytime sleepiness with demographic and work-related characteristics.

Results: Among the 318 participants, 91.2% were female and the majority (54.7%) were between 21–25 years of age. Insomnia symptoms were reported by 39.9% of workers, while clinical insomnia (moderate to severe) was identified in 4.7%. Fatigue symptoms, measured by the FACIT Fatigue Scale, were present in 4.7%, with nursing aides (19.6%) reporting the highest levels of fatigue. Excessive daytime sleepiness (EDS), as measured by the ESS, was observed in 19.8% of participants, with 2.8% requiring medical attention due to severe sleepiness. Several occupational factors were significantly associated with fatigue and excessive daytime sleepiness, including working more than 8 hours per shift, frequent night shifts (more than twice per month), and prolonged 12-hour shifts without sufficient rest periods ($p < 0.05$). However, insomnia symptoms were not significantly associated with socio-demographic factors such as place of residence, marital status or mode of transport.

Conclusion: A significant proportion of healthcare workers experience insomnia, fatigue and excessive daytime sleepiness all of which can impact their health and job performance. The findings underscore the urgent need for workplace interventions to address shift work-related sleep disorders, including modifying work schedules, ensuring adequate rest breaks, and providing sleep health education. Implementing these changes could improve staff well-being, job efficiency and patient safety in healthcare settings.

ID: 31

An On-Board Study of Fatigue in Relation to Job Roles, Work Schedules and Roster Patterns in UK Ferry Workers

Anna Sjors Dahlman[1], Christer Ahlström[1], Wendy Jones[2], Sally Maynard[2], Adam Asmal[2], Ashleigh J. Filtness[2]
[1]*Swedish National Road and Transport Research Institute, Stockholm, Sweden*
[2]*Transport Safety Research Centre, Loughborough University, Loughborough, United Kingdom*

Introduction: Fatigue is prevalent among seafarers and is linked to an increased risk of accidents, as well as adverse effects on both their mental and physical health. Previous studies have identified significant differences in fatigue risk associated with varying work schedules and roster patterns. However, most research has focused on shipping, tanker, fishing, or naval vessels, leaving a gap in our understanding of how different shift schedules and weekly roster patterns affect ferry operations. In the ferry industry, shift patterns and rosters differ from those in other maritime sectors due to unique operational requirements. This study explores the relationship between roster patterns, work schedules, job roles, and fatigue among seafarers on board ferries in UK waters.

Methods: Sixty- three seafarers participated in this study during routine operations on ferry routes in and out of the UK. This exploratory study employed a mixed design, which enabled comparisons among participants with varying job roles, work schedules, and roster patterns. Over a period of approximately four weeks, each participant maintained a sleep/wake diary and wore a sleep and activity tracker to record sleep quantity, quality, and timing. In addition, daily subjective sleepiness was measured using the Karolinska Sleepiness Scale.

Results: Data from 914 working days were analyzed. Key findings indicated significant differences in sleep duration based on schedules and rosters. Participants working 12 hour split shift schedules had significantly shorter sleep durations than participants with other schedules and participants working 1 week on/1 week off rosters had significantly longer sleep durations than participants with other rosters. The average sleep duration was 7.1 hour, and sleep durations $\leq$ 5h were found in 7% of all working days. There were no

significant differences between job roles, shifts, or rosters in sleep quality or max KSS rating during work shifts. One third of participants reported having to fight sleepiness monthly, and 14% reported this 2–3 times a week or more often. Approximately 24% of KSS ratings were 7 or higher, with 27% of work shifts having KSS≥7. Sleepiness increased with longer work hours across all groups, suggesting time on task related fatigue.

Conclusion: Most participants managed to have 6–8 hour of sleep per night and few suffered from chronic sleep restriction. However, a substantial proportion of work shifts was associated with high levels of fatigue. Split shifts were associated with short sleep durations and daytime sleepiness. There were relatively small differences between groups and the overall picture is that fatigue is a workplace hazard for all job roles, rosters and schedules. To mitigate the risk of sleepiness on duty, seafarers should be afforded sufficient time for sleep between work shifts and the opportunity for rest breaks during long shifts to mitigate task related fatigue. Support: The UK Department for Transport funded this research.

ID: 32

Effects of Exogenous Melatonin Administration on Psychic Symptoms in Fixed-Shift Workers During Climacteric

Susy Pereira Saraiva[1], Cristina Luz[2], Carolina D'aurea[3], Fernanda Gaspar Ddo Amaral[4], Elaine C. Marqueze[5], Jose Cipolla-Neto[2], Claudia Roberta C. Moreno[6]

[1]School of Public Health, University of São Paulo, São Paulo, SP, Brazil
[2]University of Sao Paulo, Sao Paulo, SP, Brazil
[3]Catholic University of Santos, Santos, SP, Brazil
[4]Federal University of São Paulo, Sao Paulo, SP, Brazil
[5]Nove de Julho Hospital, Sao Paulo, SP, Brazil
[6]School of Public Health, University of Sao Paulo, Sao Paulo, SP, Brazil

Introduction: Menopause is the point at which menstruation permanently ceases, defined by the absence of menstrual periods for 12 consecutive months, typically occurring between the ages of 45 and 55. The climacteric, the period in which menopause takes place, is characterized by hormonal changes, a decline in follicular activity and fertility, as well as alterations in the menstrual cycle. In addition to physical symptoms such as hot flashes and night sweats, this phase is often associated with increased levels of stress, anxiety, and depression, which impact mental health and quality of life. These effects may be exacerbated in shift workers, especially night workers, due to circadian rhythm dysregulation and a possible reduction in endogenous melatonin levels. The objective of this study was to analyze the effects of exogenous melatonin administration on stress, anxiety, and depression symptoms in 46 female workers across different work shifts during the climacteric period.

Methods: This study, a randomized clinical trial, was conducted with 46 nurses working in three shifts: morning (7h-13h, $n = 16$), afternoon (13h-19h, $n = 15$), and night (19h-7h, $n = 15$) in a hospital in São Paulo. In each shift, participants were divided into an intervention group and a placebo group. The intervention group received 0.3 mg of melatonin to be administered on alternating nights. The placebo group received an identical capsule and the same instructions. Data collection was performed using the Depression, Anxiety, and Stress Scale (DASS-21).

Results: The participants had a mean age of 47.2 years, and 34.7% had already gone through menopause. The intervention group in the night shift showed a significant reduction in stress after the intervention (Wilcoxon test, $p = 0.04$), with scores decreasing from the moderate to the normal range, while the placebo group maintained higher levels. No differences were observed in baseline depression scores after the intervention among morning shift workers. However, after three months of study, the Mann-Whitney test showed that the intervention group had a significant difference in depression scores compared with the placebo group ($p = 0.03$) in this shift, with scores improving from the moderate to the normal range. On the other hand, no significant differences were found in anxiety scores in any of the analyzed shifts.

Conclusion: The administration of exogenous melatonin significantly reduced stress scores in night shift workers during the climacteric period. Additionally, in the morning shift, after the intervention, depression was significantly lower in the intervention group compared with the placebo group. No effects of the intervention on anxiety were observed in any shift or group. Support: This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brazil (CAPES) - Finance Code 001 and Fapesp (2019/24327–5; 2022/04365–2).

ID: 33

Effective Prevention and Mitigation of Fatigue in European Air Traffic Controllers: Results of a Delphi Study

Alwin Van Drongelen, Laurie Marsman, Anneloes Maij, Jenny Eaglestone

Royal The Netherlands Aerospace Center, Amsterdam, The Netherlands

Introduction: Air traffic controllers (ATCOs) play a critical role in ensuring the safety and efficiency of air travel. However, their work is often characterized by high levels of stress, long hours, and irregular schedules, which can lead to fatigue. Research has shown that fatigue can affect ATCOs' ability to concentrate, make decisions, and communicate effectively, increasing the risk of errors and accidents. Effective fatigue prevention and mitigation is therefore essential. From scientific literature however, little evidence is available.

Methods: A Delphi study was conducted to review and analyze the effectiveness of existing and new approaches to prevent and mitigate ATCO fatigue. The study utilized a panel of 31 experts with diverse backgrounds. The panel was presented with a list of 28 potential measures, which were derived from existing knowledge of the researchers, a literature review and other domains, but excluded rostering-related approaches. The Delphi study consisted of three rounds, allowing the panel to provide feedback, motivate their answers, and suggest additional measures. The study aimed to achieve consensus among the experts, defined as at least 80% of participants having a similar opinion.

Results: The Delphi study identified six preventative and mitigating measures that were deemed most effective and applicable for ATCOs in Europe: 1. Implementing a Fatigue Risk Management System (FRMS) to structure mitigating measures; 2. Providing bedrooms near the operations room to allow ATCOs to sleep before, during, or after shifts; 2. Offering quiet rest facilities near the operations room; 4. Introducing an educational program on strategies to enhance adaptation to shift work, such as light exposure, physical activity, and nutrition; 5. Promoting pre-duty napping (e.g., before a night shift); and 6. Promoting napping during on-duty breaks. These measures primarily focus on enhancing ATCOs' ability to cope with irregular working hours, either through individual behavior or coaching.

Conclusion: The Delphi study provided valuable insights into the perceived effectiveness of various fatigue prevention and mitigation measures for ATCOs. The implementation of a FRMS was considered the most effective

measure among experts, indicating that a comprehensive and systematic approach is necessary to manage fatigue in ATCOs. While the identified measures show promise, additional scientific studies are needed to prove their effectiveness. The development of a FRMS can incorporate several of the other identified measures, providing a structured approach to fatigue mitigation. Air traffic service providers (ATSPs) should consider the specific culture, needs, and wishes of their target population, as well as individual characteristics of ATCOs, when implementing these measures and monitoring their effects.

ID: 34

Unobtrusive, Camera-Based Fatigue Detection During an Overnight Simulated Flight: A Two-Phase Calibration and Validation Study

Kimberly A. Honn[1], Amanda N. Hudson[2], Hans P. A. Van Dongen[1]
[1]Sleep and Performance Research Center & Department of Translational Medicine and Physiology, Washington State University, Spokane, Washington, United States
[2]Institute for Social Science Research, The University of Alabama, Tuscaloosa, Alabama, United States

Introduction: In shiftwork operations, including aviation, night work and other schedule demands can contribute to increased fatigue, which is associated with performance impairment. Standard fatigue assessments use either subjective, performance-based, or physiological measures, however, their utility can be hindered by a need for repeated assessments to track changes over time, report bias in the case of self-report measures, interference with work tasks, and other confounds and constraints. To help detect and manage fatigue, there is need for an unobtrusive system with continuous monitoring of fatigue that reliably tracks performance impairment. A camera-based, face- and eye-tracking system has been developed for this purpose (FOVIO Driver Monitoring System, Seeing Machines). An independent validation of this system was conducted against a standard, objective fatigue measure within a simulated nighttime flight operation setting.

Methods: The two-phase study used professional flight instructors, simulator technicians, local flight school students, and others able to act as captain or first officer for simulated flights in a high-fidelity Boeing 767 simulator. Participants were paired and a priori assigned to either the calibration or validation phase; the more experienced in each pair served as captain. They completed a 6-hour overnight flight (00:00–06:00) with continuous recording using the camera-based system. Concurrently, objective performance measurements were taken using a 10-minute psychomotor vigilance test (PVT) at 6 time points across the night corresponding with key times within a flight. The camera-based system used an infrared camera with two IR illuminators mounted in front of each participant and Linux-based software to continuously record and process the data to generate drowsiness scores. For the calibration phase, the camera-based data were fitted to PVT mean response times (mean RT) using mixed-effects regression analysis. Goodness-of-fit between PVT means RTs and the camera-based predictions were quantified with the root-mean-square-error (RMSE). For the validation phase, the regression coefficients from the calibration phase were retained, allowing camera-based drowsiness levels to be linearly transformed to PVT mean RT predictions without further model fitting (i.e., no recalibration occurred). Again, goodness-of-fit was quantified with the RMSE. A bootstrap analysis was then used to statistically compare the calibration and validation RMSEs.

Results: Data were available for 14 individuals in the calibration phase and 12 individuals in the validation phase (ages 20–50, 3 females). The RMSE for the calibration phase was 68.2ms, reflecting acceptable prediction accuracy. The RMSE for the validation phase was 82.0ms, which was not significantly different from the calibration phase ($p = 0.219$) and indicated that acceptable prediction accuracy was retained.

Conclusion: The findings of this validation study constitute independent, scientific evidence of the adequacy of this camera-based system to measure objective fatigue in a simulated nighttime flight operation. Further research is needed to verify that these findings generalize real-world flight operations. Support: Research supported by Federal Express Corporation, camera-based system provided by Seeing Machines (neither company was involved in data collection, analysis, reporting).

ID: 35

Exposure to Normal Indoor Light During Night Shifts Facilitates Circadian Adaptation

Charli Sargent, Anastasi Kosmadopoulos, Gregory D. Roach
Central Queensland University, Norman Gardens, QLD, Australia

Introduction: Working at night is challenging because it can be difficult for the circadian system to adapt to a nocturnal schedule. The intensity of light exposure during the night-time is likely to be a major determinant of the rate of adaptation. The aim of this study was to examine the degree to which the circadian system adapts to a nocturnal schedule when exposed to different indoor ambient lighting conditions – normal (350 lux), moderate (100 lux), and dim (10 lux).

Methods: Participants (20 F, 30 M; age = 25.5 $\pm$ 4.9 year; mean $\pm$ SD) were randomly assigned to one of three conditions in a between-groups design. In each condition, participants spent 16 consecutive nights in the laboratory, including: (i) adaptation sleep, (ii) baseline sleep, and (iii) 14 consecutive nights shifts (19:00– 07:00h) followed by 7.5-hour sleep opportunities (09:30–17:00h). The only difference between conditions was the intensity of the indoor ambient light during the night shifts: dim light (10 lux; $n = 17$), moderate light (100 lux; $n = 16$), and normal light (350 lux; $n = 17$). Urine samples were collected during the baseline and daytime sleeps and subsequently assayed for urinary 6-sulphatoxymelatonin (aMT6s) by radioimmunoassay. Circadian adaptation was examined using the hourly rate of aMT6s production during sleep periods.

Results: There was a main effect of condition on the rate of aMT6s production during daytime sleep periods ($F2,262=111$; $p < .001$). Over the 14 consecutive night shifts, the concentration of aMT6s was higher in normal light condition compared with the moderate light condition ($p < .001$) and the dim light condition ($p < .001$). When expressed as a percentage of the total amount of aMT6s produced during sleep on the baseline night, the percentage of aMT6s after five consecutive nights shifts was 84% in the normal light condition, 40% in the moderate light condition, and 31% in the dim light condition; and the percentage of aMT6s after 14 consecutive nights shifts was 99% in the normal light condition, 57% in the moderate light condition, and 36% in the dim light condition.

Conclusion: The data indicate that people may adapt more quickly to night work when exposed to normal indoor light conditions during nights shifts (i.e., ~350 lux) than when

exposed to less bright conditions during night shifts (i.e., ~10-100 lux). The findings suggest that (i) longer sequences of night shifts may be suited to workplaces where shiftworkers operate in normal indoor light and are more likely to adapt to a nocturnal schedule; and (ii) shorter sequences of night shifts may be suited to workplaces where shiftworkers operate in dim light and are less likely to adapt to a nocturnal schedule. Support: This project was funded by the Australian Research Council.

ID: 36

Evaluation of the Impact of Shift Work on Cognitive Functions: Possible Implications for Work Capacity

Tommaso Gioacchino Rotella, Giovanni Marrucci, Luca Fontana, Veruscka Leso
Section of Occupational Medicine, Department of Public Health, University of Naples Federico II, Napoli, NA, Italy

Introduction: Shift work refers to a work system where employees are assigned to predetermined schedules, including rotating shifts, to ensure continuous or intermittent operations. This system requires workers to perform duties at varying hours over a defined period. The demands of these shifts are particularly significant in healthcare, where 24/7 patient care is crucial. This system exposes workers to intense psychophysical stress, increasing the risk of burnout and health-related complications. Shift work disrupts circadian rhythms, leading to sleep disorders and impairments in attention, decision-making, and executive function. Research suggests that long-term shift work accelerates cognitive aging, raising the risk of neurocognitive decline. Identifying risk and protective factors is crucial to sustaining cognitive function, productivity, and well-being in aging workers.

Methods: The sample includes healthcare workers from the Occupational Medicine Unit of a University hospital in Southern Italy, who were recruited as part of the mandatory health surveillance to which they are subjected according to the legislation in force in Italy, comprising a group of shift workers and a control group with no night shifts. Neuropsychological assessments were performed pre- and post-shift using standardized tests: SDMT – Digit Symbol Modalities Test (processing speed and attention), TMT A/B - Trail Making Test (cognitive flexibility), DS - Digit Span Test (working memory), WAI - Work Ability Index (work capacity), ESS - Epworth Sleepiness Scale (daytime sleepiness), PSQI - Pittsburgh Sleep Quality Index (sleep quality), and QMCI - Quick Mild Cognitive Impairment screen (cognitive impairment screening).

Results: The study analyzed 30 shift workers (mean age 42 $\pm$ 9.58) and 30 non-shift workers (mean age 32 $\pm$ 3.41). Shift workers had greater prevalence of neurological or metabolic disorders (80% versus 30%). Post-night shift, shift workers showed significant declines in SDMT ($p < 0.001$), TMT-A/B ($p < 0.001$), and DS forward ($p = 0.007$), indicating deficits in processing speed, cognitive flexibility, and working memory. WAI scores were lower in shift workers ($p < 0.001$), correlating with cognitive decline. ESS revealed increased daytime sleepiness post-night shift ($p = 0.014$), while PSQI indicated significantly poorer sleep quality ($p = 0.008$). QMCI scores confirmed cognitive decline in shift workers post-night shift ($p < 0.001$).

Conclusion: Shift work, particularly night shifts, impairs cognitive function and work capacity due to circadian rhythm disruptions and sleep deprivation. Early identification of neurocognitive decline is essential in occupational medicine to ensure worker safety and efficiency. Preventive strategies should include ergonomic shift scheduling, reduced night shift hours, and structured rest periods to mitigate cognitive decline. Workplace interventions promoting cognitive health through lifestyle modifications, sleep management, and psychometric monitoring may improve long-term well-being and job performance in shift-dependent professions.

ID: 37

Untargeted Proteomics in EPHOR Night Shift Cohort

Evi Dde Ryck[1], Barbara N. Harding[2], Karin Broberg[3], Anne Helene Garde[4], Anjoeka Pronk[5], Manolis Kogevinas[2,6], Lode Godderis[1,7], Manosij Ghosh[1]
[1]*Environment and Health, Katholieke Universiteit Leuven, Leuven, Belgium*
[2]*Barcelona Institute for Global Health (ISGLOBAL), Barcelona, Spain*
[3]*College of Population Health, University of New Mexico, Albuquerque, United States*
[4]*Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden*
[5]*The National Research Centre for the Working Environment, Copenhagen, Denmark*
[6]*Department of Risk Analysis for Products in Development, TNO, Utrecht, The Netherlands*
[7]*Idewe, External Service for Prevention and Protection at Work, Leuven, Belgium*

Introduction: Night shift work is associated with several adverse health effects. Untargeted proteomics can help elucidate underlying biological mechanisms by analyzing protein expression and pathway alterations.

Methods: Within the EU Exposome Project for Health and Occupational Research (EPHOR), we recruited 300 night and day shift workers in Spain, Sweden, and Denmark. Plasma samples were prepared with PreOmics® iST-BCT and analyzed using the EvoSEPZenoTOF platform, employing 100SPD method with 11-minute gradient in data-independent mode. Preprocessing was performed using Spectronaut (v19) under default settings. Potential confounders assessed in the analyses include age, sex, medication use, smoking status, and study center.

Results: Preliminary data include 107 permanent night shift workers, 67 rotating night shift workers, and 126 permanent day workers with ages of 44.71 ($\pm$ 11.26), 37.33 ($\pm$ 10.48), and 46.36 ($\pm$ 11.15) years, respectively. Participants worked in the health care sector and consisted of 30 men and 270 women with 153 never smokers, 94 former smokers, and 51 smokers. For 75% of samples we identified a minimum of 2,472 peptides (range: 914–4,147) mapping to 407 proteins (range: 176- 608). Ongoing analyses include differential expression across shift groups, followed by gene enrichment and pathway and network analysis. In addition, night shift intensity, frequency, and total duration working night shifts will be investigated.

Conclusion: This large-scale proteomic assessment in night shift workers will provide unique insights in biological mechanisms, short-term and long-term health effects of night shift work. Support: EPHOR is funded by the European Union's Horizon 2020 research and innovation program under grant agreement 874703. Parts of the data processing were performed in collaboration with EXIMIOUS, funded by European Union's Horizon 2020 research and innovation program under grant agreement 874707.

ID: 38

Comparison of Cognitive Ergonomic Performance Between Diabetic (TYPE2) and Non-Diabetic Shift Control Operators

Ehsanollah Habibi, Mansour Siavash, Akbar Hassanzadeh, Javad Gholamian, Mahdi Khademian
Isfahan University of Medical Sciences Isfahan, Iran

Introduction: Sleep deprivation is a consequence of shift work and may have a negative impact on the cognitive function of individuals. Other essential mental variables in information processing, such as memory, accuracy, attention, and reaction time are also altered by sleep deprivation. Previous studies suggested that sleep deprivation has adverse effects on executive functions, attentional processes, as well as temporal and working memory. According to Ansiau et al., cognitive and mental performance impairment can cause serious issues in the workplace, particularly when an immediate and accurate response is required Shift work may lead to sleep deprivation and perturb the circadian system. Several other important cognitive performance indicators in information processing, such as working memory, accuracy, attention, and reaction time, are significantly altered by sleep deprivation as well. Since it is hypothesized that disruption of the circadian rhythm is linked with an elevated risk of type 2 diabetes, the purpose of this study was to examine the cognitive ergonomic performance of diabetic (type 2) and non-diabetic shift control operators.

Methods: Cognitive tests Reaction time test Stroop test Flickr Fusion test in this descriptive-analytical cross- sectional study, 80 shift workers were recruited as the participants and divided into two groups: diabetic (n = 40) and non-diabetic (n = 40). Using the Stroop Test, the Simple Reaction Time Test, and Flickr Fusion test, cognitive function was assessed at the beginning, middle, and end of the work shift. Data were analyzed in SPSS software (version 20) using an independent t-test. A p-value less than 0.05 was considered statistically significant.

Results: Data were analyzed in SPSS software (version 20). Frequency and percentage were utilized for expressing the categorical variables. Kolmogorov-Smirnov test was used to evaluate the normality of data distribution. An independent t- test was used for the comparison of cognitive performance parameters between the two groups. In all calculations, a p-value less than 0.05 was considered statistically significant. There was a significant difference between the two groups regarding the Stroop test time at the beginning (p = 0.015), middle (p = 0.022) and end of shift work (p = 0.024). A significant difference was observed with regard to the number of errors between the two groups at the end of the shift work (p = 0.045). In all three stages, there were no significant differences between the two groups in terms of mental fatigue and reaction time (P>0.05).

Conclusion: The results from this study indicated that diabetic and non-diabetic subjects differ significantly in several cognitive abilities. In comparison to non-diabetic participants, cognitive skills were severely diminished among the diabetic ones. Cognitive impairments were also influenced by the time (beginning, middle, and end) of shift work, with the lowest cognitive function observed at the end of the shift. Support (if any): Conclusion As evidenced by the results of this study, it can be concluded that diabetic and non-diabetic subjects significantly differed in most cognitive performances. Cognitive functions were significantly poorer in diabetic participants, as compared with those in non-diabetic subjects. The time (beginning, middle, and end) during shiftwork was also an important factor for cognitive impairments, with the lowest cognitive performance being observed at the end of the shift. According to the obtained results, more effective preventive measures are necessary to reduce human errors caused by insufficient sleep, especially in people with underlying diseases, such as diabetes, in shift work. Funding: This research was funded by the Isfahan University of Medical Sciences, Isfahan, Iran (Grant number 398734 and ethical number IR. MUI.RESEARCH.REC.1398.665).

ID: 39

Pilot Fatigue and Sleepiness: Model Predictions with and Without Actigraphy Data Versus Self-Rated Samn-Perelli and Karolinska Sleepiness Scale Scores

Eduardo Furlan[1], Izabela Tissot Antunes Sampaio[2], Tulio Eduardo Rodrigues[1], Frida Marina Fischer[3]
[1]*Technical Board, GOL Aircrew Association, Sao Paulo, SP, Brazil*
[2]*National Civil Aviation Agency, Brasilia, DF, Brazil*
[3]*Department of Environmental Health, School of Public Health, University of Sao Paulo, Sao Paulo, SP, Brazil*

Introduction: Fatigue and sleepiness play a crucial role in aviation as they can affect several pilot skills, such as cognitive performance, situation awareness, communication, and decision making. Fatigue risk management systems are usually based upon several components, including aircrew fatigue reactive reports and proactive and predictive approaches based mostly on bio-mathematical models. In this study, the predictions of fatigue and sleepiness from the SAFTE-FAST model [1] were compared with self-rated Samn-Perelli (SP) and Karolinska Sleepiness Scale (KSS) scores from Brazilian airline pilots [2].

Methods: The sample included 51 airline pilots that rated their perceived fatigue and sleepiness three times a day (at the beginning, middle, and end of the work shift), using SP and KSS scales, respectively, for 15 consecutive days. The pilots also wore actigraphs and rated their perceived sleep quality in sleep diaries throughout data collection [2]. SAFTE-FAST calculations were performed either using: (a) a standard set of inputs, which included all the auto-sleep functions of the model with all sleep events considered to be of excellent quality, and (b) a tailored set of inputs that considered more realistic parameters, such as actual sleep from actigraphy and sleep quality from the pilot (diary) reports. In both calculations, the exact date and time of pilot responses were considered, yielding a total of 1,583 validated assessments.

Results: The preliminary results indicated statistically relevant group effects ($p < 0.001$) comparing the SAFTE-FAST Effectiveness (ESF) for the standard (90.07 $\pm$ 0.21%) and tailored (82.82 $\pm$ 0.34%) calculations using the Wilcoxon signed-rank test for paired samples. Strong Pearson´s correlations ($p < 0.001$) were also observed between ESF and SP (KSS) either for the standard rho=-0.204 (rho=-0.292) or for the tailored rho=-0.297 (rho=-0.281) simulations. The risk ratio for low Effectiveness scores (ESF $\leq$ 77%) was 2.604 (95% CI: 2.177–3.115) comparing the calculations for tailored (actigraphy data) versus the model standard sleep inputs, which presented 23.7 and 9.1% of low scores, respectively.

Conclusion: These findings highlight the importance of adopting model inputs as closely as possible to specific operational scenarios and real worker conditions to obtain more accurate and realistic results. Moreover, current bio-mathematical models do not fully consider the effects of workload on fatigue and sleepiness [3], which may cause further systematic inaccuracies and sub estimations of fatigue and sleepiness scores in operational contexts. References: [1] Hursh, S. R., et al. (2004). Fatigue models for applied research in warfighting. Aviat. Space Environ. Med 75(3), A44-A53. [2] Sampaio, I. T. A. (2023). Regulação e trabalho em jornadas irregulares: o caso de pilotos brasileiros.

Implicações para o trabalho e para a saúde. PhD thesis, USP. [3] Rodrigues, T. E., et al (2024). Aircrew rostering workload patterns and associated fatigue and sleepiness scores in short/medium haul flights under RBAC 117 rules in Brazil. arXiv preprint arXiv:2408.08889. Support: The licenses for the SAFTE-FAST software are equally supported by the Brazilian Association of Civil Aviation Pilots (ABRAPAC), Gol Aircrew Association (ASAGOL) and LATAM Aircrew Association (ATL); F.M. Fischer receives a productivity grant from CNPq (306963/2021–3).

ID: 40

The Impact of Gamification on Employee Training in the Steel Structure Manufacturing Industry

Samane Khorshidikia, Ehsanollah Habibi
Occupational Health and Safety Engineering, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran

Introduction: In the steel structure manufacturing industry, training and skill enhancement of employees play a crucial role in improving productivity and reducing operational errors. Given the technical and precise nature of this industry, adopting innovative training methods is essential. One such method is gamification, which incorporates game-based elements such as scoring, challenges, and rewards to make the learning process more engaging and effective. This approach not only enhances employees' motivation but also transforms learning into an interactive and immersive experience, leading to improved technical knowledge and skill acquisition.

Methods: This study was conducted in a steel structure manufacturing facility in Iran. To design a gamification-based educational application, workplace conditions, operational processes, and statistics on human- induced errors and workplace incidents were analyzed. Based on these insights, a system integrating scoring mechanisms, motivational badges, and practical challenges was developed. The application aimed to actively engage employees in the learning process, encouraging them to solve practical problems and participate in friendly competition. To evaluate its effectiveness, user behavior was monitored, and their progress in learning and error reduction was assessed.

Results: The findings indicate that incorporating gamification into employee training had a positive impact on motivation and engagement. Employees who used the application demonstrated significant improvement in their technical knowledge, while operational errors decreased notably. Additionally, the time required for learning and mastering essential skills was reduced. These outcomes highlight an increase in productivity and overall improvement in the quality of manufacturing processes.

Conclusion: The implementation of gamification in educational applications can serve as an effective strategy for enhancing employees' skills in the steel structure manufacturing industry in Iran. This method not only fosters motivation and engagement with educational content but also directly contributes to reducing operational errors and increasing productivity. Future research should explore additional gamification elements and tailor them to the specific educational needs of this industry. Furthermore, integrating advanced technologies such as augmented reality and virtual reality could further enrich the learning experience. Support: This study received ethical approval from the Isfahan University of Medical Sciences, Isfahan, Iran (Ethical approval number: IR.MUI.REC.1401–063). The research was funded by the Isfahan University of Medical Sciences (Grant number: 3401657).

ID: 41

Unveiling the Roots of Occupational Risk: A Grounded Theory Analysis of Individual Factors in Workplace Accidents

Azim Karimi, Ehsanollah Habibi
Isfahan University of Medical Sciences, Isfahan, Iran

Introduction: Unsafe behaviors persist as a primary cause of workplace accidents in manufacturing, critically undermining occupational safety. While existing studies address fragmented aspects of human error, the interaction between individual traits (e.g., psychological factors, demographics) and organizational systems (e.g., leadership, safety protocols) remains underexplored. This study bridges this gap by applying Grounded Theory Method (GTM) to analyze multifactorial drivers of unsafe acts. Findings aim to inform targeted interventions, revealing how personal vulnerabilities and systemic pressures jointly shape risk-related decisions in high-risk industrial environments.

Methods: A qualitative approach was used, involving semi-structured interviews with 40 participants from steel industries, safety experts, and academics. Data analysis followed Strauss and Corbin's Grounded Theory Method framework, using open, axial, and selective coding to identify themes. This method ensured a systematic and rigorous exploration of the data.

Results: Demographic Characteristics: Five themes emerged, including age, experience level, and educational background. Older workers with extensive experience demonstrated lower risk-taking tendencies, aligning with findings on workforce composition and safety performance. General Health: Physical fitness and chronic health conditions (e.g., sleep disorders) directly influenced risk perception and decision-making accuracy. Poor sleep quality correlated with increased errors, corroborating studies on fatigue-related safety compromises. Individual Competencies: Safety knowledge, situational awareness, and procedural adherence were critical. Gaps in formal training exacerbated unsafe acts, emphasizing the need for high-quality competency development programs. Personality Traits: Five traits significantly impacted behavior: Risk tolerance, conscientiousness, stress resilience, attentional control and peer influence dynamics. Psychological Factors: Motivational deficits, cognitive overload, complacency, perceived time pressures, and emotional states (e.g., anxiety) emerged as key contributors. These align with organizational research on mental workload and safety culture. Organizational Interactions: The study revealed that organizational factors such as leadership quality, resource allocation for safety, and production-safety balance amplified or mitigated individual risks. For instance, time pressures from inefficient scheduling directly exacerbated estimation errors, while robust safety communication channels improved situational awareness.

Conclusion: This study presents an integrated framework connecting individual vulnerabilities (e.g., cognitive biases, health limitations) to organizational safety systems. Prioritized strategies include competency-based training targeting estimation errors; workflow redesign aligned with fatigue patterns; personality-tailored safety coaching; and leadership- driven safety culture enhancements via resource allocation. These measures address systemic roots of unsafe behaviors, bridging gaps between worker decision-making flaws and organizational pressures to foster proactive risk mitigation in high-hazard industries.

ID: 42

Proposal for A Research Data Server on Working Hours

Johannes Gaertner[1], Pierre Riieger[1], Anna Arlinghaus[1], Marc Sobisch[1], Nils Backhaus[2]
[1]XIMES GMBH, Austria
[2]Federal Institute for Occupational Safety and Health (BAUA), Germany

Introduction: Research on shift work and working time arrangements is often hindered by inconsistencies in how working hours and core features are reported and by the substantial amount of time that is necessary to understand such time arrangements and to compute additional variables. To address these issues, we propose the development of a server-based platform for collecting, standardizing, descriptions of working hours in research and automatically calculating many features of these working hours. This platform will serve as a centralized repository where researchers can describe, categorize, and compare studies on shift work and working time arrangements systematically.

Methods: DESCRIPTION ELEMENT A: WORKING TIME DESCRIPTION To ensure cross-study consistency and comparability, we propose three potential approaches for describing working time characteristics: 1. Actual Working Hours in a Standardized Format: Work periods are recorded using a universally recognized time format (e.g., 24-hour notation), ensuring precision and consistency. 2. Standardized Statistical Descriptors: Shift schedules are characterized using statistical measures such as mean start and end times, variability in shift duration, and frequency of night shifts. 3. Shift Similarity Descriptors: A concise, standardized notation to represent schedules that allows for translation into actual hours. DESCRIPTION ELEMENT B: RESEARCH OUTCOMES & WORK CHARACTERISTICS To facilitate cross-study comparisons, we also propose standardized methods for describing research results, with labels that can be defined by users: • Availability and Access: Clear metadata indicating where articles and datasets are available. • Measurement Scales: Standardized recording of results using established scales e.g., scores on the Karolinska Sleepiness Scale (KSS), reaction times, biomarkers. • Work Characteristics: Free-text labels and structured sub- labels for capturing contextual factors (e.g., sector, workload intensity, exposure to rotating shifts).

Results: To support data standardization and enhance usability, we suggest the development of an open-source software package that: • Computes many relevant shift-related features based on the selected working time description. It should be easy to add additional indicators or variables. • Provides filtering and querying capabilities, enabling users to select datasets based on criteria such as shift length, time-of-day effects, etc. • Allows authors to add a link to their paper, that gives immediate access to a large number of indicators/features. By this, other researchers identify studies more easily and can conduct different cross-study comparisons with greater accuracy.

Conclusion: This initiative aims to improve consistency, comparability, and accessibility of research on working hours. By providing a centralized standardized shift descriptions, outcome measures, and analytical tools, we can enhance collaboration across research groups and facilitate the integration of findings into policy and occupational health recommendations. This platform will foster greater collaboration among researchers, support meta-analyses and reviews, policy development, and ultimately contribute to better-informed occupational health and labor policies.

ID: 43

Changes in Core Body Temperature after Overnight Sleep Deprivation

Valdenio Martins Brant[1], Amaury Tavares Barreto[1], Renato de Carvalho Guerreiro[1], Andressa da Silva[1], Ricardo Torrezani de Oliveira[2], Rodrigo Santarelli[1], Marco Tulio de Mello[1]
[1]Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil
[2]Corpo de Bombeiros Militar de Minas Gerais, Belo Horizonte, MG, Brazil

Introduction: The wake-sleep cycle is regulated by the Circadian (C) and Homeostatic (S) processes. The C process controls endogenous markers such as Core Body Temperature (CBT). On the other hand, the S process induces sleep to compensate for the time spent awake. CBT exhibits a circadian rhythm (1), often related to performance (2), and changes under sleep deprivation conditions (3). CBT reaches its nadir during the early morning, a time of greater sleep propensity and reduced alertness and attention. Conversely, during the acrophase, it is the time of highest attention, alertness, and quick response to stimuli (2,4,5). Thus, CBT can serve as an indicator of performance (6) in sleep deprivation situations where direct testing and evaluations are not feasible, such as for military firefighters during incident responses. The objective of this study was to compare the CBT of Military Firefighter cadets after a typical night of sleep and during a 36-hour sleep deprivation protocol.

Methods: The sample consisted of 37 volunteers, including 31 men and 6 women, with an average age of 30.7 years, members of the Military Firefighters Academy of the CBMMG, who underwent 36 hours of sleep deprivation. CBT was measured from gastrointestinal temperature by swallowing a capsule and using a telemetric system (CorTemp® EliteTM Data Recorder). The swallowed capsule transmits low-frequency radio waves that vary in wavelength depending on body temperature. These radio waves are received and converted into a digital format by a data recorder (CorTemp® EliteTM Data Recorder). Volunteers were evaluated every two hours starting from day 1 (08hD1), totaling 19 evaluations by the end of day 2 (20hD2)

Results: The CBT from the first seven evaluations (08hD1, 10hD1, 12hD1, 14hD1, 16hD1, 18hD1, 20hD1) was compared with the CBT from the last seven evaluations (08hD2, 10hD2, 12hD2, 14hD2, 16hD2, 18hD2, 20hD2), which occurred chronologically at the same time, using a paired sample *t*-test. No statistically significant differences were found in six comparisons, while the CBT at 20h on day 1 was significantly different from 20h on day 2 ($p < 0.01$).

Conclusion: CBT displayed a circadian pattern (Process C) throughout the 36 hours of sleep deprivation, showing no significant differences between day 1 (post-typical sleep) and day 2 (during sleep deprivation), but with a potential homeostatic effect (Process S) after 36 hours of sleep deprivation, consistent with existing literature. The measurement of CBT can be used as an indicator of performance in Military Firefighter cadets of the CBMMG during sleep deprivation situations where direct assessments and measurements cannot be conducted. Support: UFMG, FEPE, CEPE, CEMSA, CAPES, CBMMG, CNPQ.

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Sleep Quality, Insomnia, Sleep Apnea, and the Assessment of Risk Factors in Shift Workers

Amaury Tavares Barreto, Valdenio Martins Brant, Rodrigo Santarelli, Renato de Carvalho Guerreiro, Andressa da Silva, Marco Tulio de Mello
Universidade Federal De Minas Gerais, Belo Horizonte, MG, Brazil

Introduction: Shift work organization has become increasingly prevalent in industry. This work modality presents considerable challenges to workers' health and quality of life. One critical factor that deserves attention is the impairment of sleep quality, which can lead to increased sleepiness, fatigue, and other disorders that impact productivity and worker safety. Sleep disorders, such as insomnia, sleep apnea, and excessive sleepiness, are directly associated with a higher risk of workplace accidents and reduced performance, making the identification of these factors crucial to ensuring worker health and safety in their work environment. However, due to the variety of questionnaires, inventories, and tests available for assessing these sleep disorders, this activity must be conducted cautiously, as the methodology used may be redundant or fail to address the proposed objectives.

Methods: The aim of this study was to evaluate the relationship between the Pittsburgh Sleep Quality Index (PSQI), Berlin Questionnaire (BERLIN), and Insomnia Severity Index (ISI), administered between 2022 and 2024, assessing 3,220 shift workers in Brazilian mining companies. The correlations between these questionnaires were analyzed using the Spearman correlation coefficient.

Results: The Spearman correlation coefficient (Rho) between the PSQI and the BERLIN was 0.268, with an associated p-value less than 0.001 ($p < 0.001$). A Rho value of 0.268 suggests a weak to moderate positive correlation, indicating that as sleep quality (evaluated by the PSQI) deteriorates, the score on the BERLIN questionnaire tends to increase. On the other hand, the Spearman correlation coefficient (Rho) between the PSQI and the ISI was 0.651, with an associated p-value less than 0.001 ($p < 0.001$). A Rho value of 0.651 suggests a moderate to strong positive correlation, indicating that a worsening in sleep quality, as evaluated by the PSQI, is associated with an increase in the severity of insomnia.

Conclusion: The moderate to high correlation between the PSQI and ISI suggests a strong link between perceived sleep quality and the occurrence of insomnia symptoms. However, the weaker correlation observed between the PSQI and BERLIN suggests that, while there is a relationship, other factors besides sleep quality may influence the risk of sleep apnea. Examples of these factors include the structure of the questionnaire itself and the disorder, which tends to be less perceptible than insomnia. Thus, the BERLIN questionnaire does not seem to be a good predictor for evaluating sleep quality in the studied population. Support: UFMG, FEPE, CEPE, CEMSA, CAPES, CNPq;

ID: 45

Genetic Characteristics May do not Track the Circadian Preference of a Shiftwork Brazillian Population - What is the Better Indicator

Marco Tulio de Mello[1], Amaury Tavares Barreto[1], Valdenio Martins Brant[1], Renato de Carvalho Guerreiro[1], Rodrigo Santarelli[1], Vania D'almeida[2], Sergio Tufik[2], Andressa da Silva[1]
[1]Universidade Federal De Minas Gerais, Belo Horizonte, MG, Brazil
[2]Universidade Federal De São Paulo, São Paulo, SP, Brazil

Introduction: The Period 3 (Per3) gene is associated with individual differences in several sleep and circadian functions. Shift workers experience sleep restriction and exposure to wakefulness during an adverse circadian phase. Workers who carry genetic polymorphisms in the Per3 gene may experience particularly high levels of sleepiness during the night shift, which can lead to the development of various diseases. They may also be at greater risk for automotive or occupational accidents when assigned to work hours that do not align with their chronotype profile. We hypothesize that the Morningness and Eveningness Questionnaire, also known as the AutoMEQ, developed by Horne and Östberg in 1976 (HO), may not be sufficient for defining work schedules in companies. It would, therefore, be necessary to include the evaluation of Per3 gene polymorphism to make more accurate decisions.

Methods: Our study aimed to investigate the genetic profile of night and shift workers, as well as whether they present differences between the circadian preference results from the HO questionnaire and their genetic chronotype. For this study, DNA extracted from archived buccal cell samples was obtained from randomly selected subjects participating in the Brazilian mining companies, average age 43.7 years, and we applied a validated MEQ containing 19 questions about the sleep and activity preferences by Horne and Ostberg 1976, Brazilian version. Chronotype was assessed according to the formula provided in the instruction for MEQ score interpretation.

Results: We detected significant discrepancies in the HO questionnaire when compared with the genetic results of workers, especially among 1.9% of workers who self- identified as evening types according to the HO questionnaire but had a genetic chronotype of 38.1% classified as eveningness. Unexpectedly, 77.9% of workers reported being morning types, which agreed with their genetic profile in only 12.1% of cases.

Conclusion: Our data serves as a warning for companies to assess the genetic profiles of their employees to avoid misinterpretations regarding circadian preference, which could contribute to poor work performance, harm worker health, and increase the risk of accidents. Support: UFMG, UNIFESP, FEPE, CEPE, CEMSA, CAPES, CNPq.

ID: 46

Applying the Fuzzy Delphi Method in the Cement Industry: Enhancing Decision-Making and Operational Efficiency

Samane Khorshidikia, Ehsanollah Habibi
Occupational Health and Safety Engineering, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran

Introduction: The cement industry plays a critical role in economic growth but faces challenges such as high energy consumption, environmental pollution, and rising production costs. Increasing global competition and the need for sustainability demand advanced decision-making approaches. The Fuzzy Delphi Method (FDM), combining expert consensus with fuzzy logic, enhances decision- making under uncertainty. This study explores FDM's applications in optimizing managerial strategies and industrial performance.

Methods: This research follows a narrative review of studies from 2015 to 2024 on FDM in the cement industry, analyzing data from peer-reviewed articles, industrial reports, and case studies. Key applications include assessing environmental impacts, reducing pollutants, optimizing energy use, prioritizing performance indicators, managing risks, and enhancing competitiveness. A qualitative analysis was conducted to evaluate FDM's effectiveness and limitations.

Results: Findings indicate that FDM converts expert opinions into quantifiable data, reducing uncertainty in strategic decisions and improving efficiency. The method has significantly contributed to higher product quality, reduced waste, enhanced energy efficiency, and innovative environmental solutions. Additionally, it fosters expert collaboration, aiding informed policy-making and sustainable development.

Conclusion: FDM is a valuable tool for improving decision-making, reducing costs, and promoting sustainability in the cement industry. Given ongoing challenges in energy management and environmental concerns, future research should explore hybrid models integrating FDM with other decision-making techniques. The method's application can drive greater efficiency, competitiveness, and long-term industrial sustainability. Support: This study received ethical approval from the Isfahan University of Medical Sciences, Isfahan, Iran (Ethical approval number: IR.MUI.REC.1401–063). The research was funded by the Isfahan University of Medical Sciences (Grant number: 3401657).

ID: 47

Perceptions of Workplace Fatigue and Fatigue Risk Management Among Health Leaders in Aotearoa New Zealand

Karyn M. O'keeffe[1], Linsey M. Steege[2]
[1]*Massey University, New Zealand*
[2]*University of Wisconsin-Madison, United States*

Introduction: It is well recognized that workplace fatigue is associated with decreased patient safety, increased healthcare costs and adverse health and safety consequences for health workers. Recent nationwide surveys of the public health workforce in Aotearoa New Zealand have highlighted that fatigue-related outcomes are commonly experienced by workers at all levels of the organization, including those in leadership roles. Leaders in the health sector have an important role in implementing policies and organisational approaches to address fatigue among health workers. However, little is known about their perceptions and understanding of fatigue risk management (FRM), including in Aotearoa New Zealand. Among health leaders in Aotearoa New Zealand, we aimed to explore perceptions of fatigue and its impacts, understanding of FRM, and perceived barriers and facilitators for being involved in developing new FRM approaches.

Methods: All leaders working in national, clinical, and occupational health and safety (OHS) leadership roles in Aotearoa New Zealand's national public health organization were invited to participate in an anonymous online survey.

Results: The survey was completed by 632 leaders in our target groups (national: n = 89, clinical: n = 523, OHS: n = 20). Overall, the majority of leaders reported that workplace fatigue has consequences for patient and worker health and safety outcomes, and that it negatively impacts staff retention. Approximately half of the sample (46.5%) felt that there is equal responsibility between leadership and individual workers in managing workplace fatigue, but a small proportion (13.1%) reported that individual workers were mostly or completely responsible. Most leaders thought that their organization did not have effective policies (65.7%), processes (85.3%) or strategies (78.0%) for managing workplace fatigue. While most leaders (86.7%) acknowledged they would benefit from resources or tools to increase their knowledge of FRM, many (61.8%) did not feel they had the time to engage with them. Similarly, some leaders (23.9%) reported that compared with other issues that needed to be addressed, managing fatigue was not at all, slightly or moderately important.

Conclusion: Workplace fatigue is acknowledged as having significant consequences in the health sector in Aotearoa New Zealand, but is perceived to be one of many risks that health organisations must manage. FRM systems include fatigue monitoring and allow for improved management of fatigue risks. One barrier to addressing the health- and safety-related consequences of fatigue in a workforce, including New Zealand's health workforce, is the lack of implementation of FRM systems. Targeted strategies for health leaders may support them to increase their knowledge of FRM and increase participation in developing new system-based approaches to FRM. Support: This project was funded by the Health Research Council of New Zealand.

ID: 48

A Systematic Review of Permanent Night Work vs. Rotating Shift Work with Night Work: Relationships with Mental Health

Karyn M. O'keeffe, Diane P. Muller, Tracey Leigh Signal
Massey University, New Zealand

Introduction: Approximately 20–25% of the global population is engaged in shift work. Shift work has no consensus definition but can be conceptualised as any work schedule that involves work outside traditional daytime hours (i.e., ~8 AM to ~6 PM). Therefore, shift work encompasses morning, evening and night work, as well as rotating, permanent and irregular schedules. It is well established that the sleep loss and circadian disruption associated with shift work results in adverse health, psychosocial wellbeing and safety outcomes. As humans are day active, night work poses the greatest challenge to the circadian system. As such, many health and safety regulators and labor organisations worldwide encourage special provisions for health assessments for night workers, and some provide guidance to avoid permanent night work. We conducted a systematic review to evaluate the differential effects of permanent night work (PNW) and rotating shift work that includes night shifts (RWN) on health, safety and performance.

Methods: PubMed, CINAHL, PsycINFO, Medline and Scopus databases were searched for peer-reviewed scientific studies published between 1990 and 2024 that evaluated health, wellbeing, safety or performance outcomes in both PNW and RWN. Study quality was appraised using JBI critical appraisal checklists. Thirty-eight studies were included in the overall review, and three examined mental health outcomes.

Results: The design and quality of the reviewed studies that examined mental health varied considerably. The reporting of shift work schedules was poor in all studies, and details regarding exposure to night work were excluded, making evaluation difficult. While the sample size in two studies was sufficient to evaluate associations, one study had a very small sample size (n = 136). The sample of night workers in each study was comparatively small (2.3–7.4% of the overall sample). The studies suggest that compared with day work, PNW is associated with greater odds of having a mood disorder or reporting suicidal ideation, whereas RWN showed no association.

Conclusion: Few studies have examined the differential effects of PNW and RWN on mental health, and assessment of study quality suggests the findings should be interpreted with caution. Future studies must capture and adjust for night work exposure to determine differential effects. Support: The study was funded by the Civil Aviation Authority of New Zealand.

ID: 49

Long-Term Prognosis of Cardiometabolic Disorders Among Workers in the United States: The Impact of Shift Work on Mortality

Xiang Li, Jian Li
University of California Los Angeles, Los Angeles, California, United States

Introduction: Cardiometabolic disorders (CMD) are highly prevalent among workers. Though much evidence has gained that shift work is a risk factor for CMD onset among healthy workers, its impact on CMD prognosis is under-investigated. The aim of our study was to examine the temporal relationships between shift work and mortality outcomes among workers with CMD, and to provide insights into targeted secondary prevention strategies for this population.

Methods: Data was extracted from the 2010 and 2015 National Health Interview Survey (NHIS), which employed multistage sampling techniques to select dwelling units representing the civilian, non-institutionalized adult population (age 18 or older) of the United States (U.S.). A total of 9,622 workers with CMD and complete data were included. Working schedule was self-reported at baseline and shift work was defined as 'a regular evening shift', 'a regular night shift', or 'a rotating shift'. The National Center for Health Statistics (NCHS) provided a linkage to the NHIS data with death records from the National Death Index (NDI) where participants were followed up through December 31, 2019 for mortality outcomes, including all-cause mortality, CMD mortality, and cardiovascular diseases (CVD) mortality. Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs), with adjustment for baseline demographic information, socioeconomic status, and occupational characteristics.

Results: Among 9,622 study participants, 2,470 (25.7%) were engaged in shift work at baseline. Over the follow-up period, 308 deaths in the non-shift work group and 129 deaths in the shift work group were documented, resulting in the all-cause mortality rates of 45.0 per 1000 person-years and 52.2 per 1000 person-years, respectively. Furthermore, CMD mortality rates were 14.0 per 1000 person-years (in the non-shift work group) and 20.2 per 1000 person-years (in the shift work group), CVD mortality rates were 12.6 per 1000 person-years (in the non-shift work group) and 17.4 per 1000 person-years (in the shift work group). After adjusting for baseline covariates, including age, sex, race, marital status, education, income, insurance, number of jobs, and occupation, multivariable regression analyses suggested that shift work was associated with a 28% higher risk of all-cause mortality (HR=1.28, 95% CI=1.02, 1.62), a 57% higher risk of CMD mortality (HR=1.57, 95% CI=1.01, 2.42), and a 61% higher risk of CVD mortality (HR=1.61, 95% CI=1.02, 2.53).

Conclusion: In this nationally representative cohort of U.S. workers with CMD, shift work contributed to a significantly higher risk of mortality. We anticipate that our research will address critical knowledge gaps among workers with CMD, thereby ultimately improving current clinical guidelines for CMD secondary prevention, given the fact that the current guidelines in the U.S. do not recognize the crucial role of workplace / working conditions in preventing adverse outcomes among CMD patients.

ID: 50

Sleep Disturbances, Sleep Habits and Excessive Daytime Sleepiness Frequency in Shift Work Informal Fishermen in Piura, Peru

Norvil Antonio Mera Chu
University of Piura, Piura, Peru

Introduction: Informal workers in Latin America accept and tolerate risky working conditions especially in sectors such as fishing. These include shift work and non-typical working hours, which might affect their sleep status and health. The objective of this study was to determine the frequency of sleep disturbances, sleep habits and the frequency of excessive daytime sleepiness in shift work informal fishermen in Piura, Perú.

Methods: It was an observational, descriptive, cross-sectional study on shift work informal fishermen in Piura. The instruments used were Data collection sheet, Jenkins Sleep Evaluation questionnaire, Sleep Hygiene Index, and Epworth Sleepiness Scale.

Results: 340 informal fishermen were included at this study. All of them were male, 60% were younger than 40 years old, and 35% were single.55% were overweight and 35% were obese. All of them followed an irregular schedule and non-typical working time because they adapted to the adequate moment for fishing a specific product (squid, mahimahi, tuna, etc.). 20% travel alone in small boats from 4am to 11 AM and return home every afternoon. 45% travelled in groups of 5 fishermen in bigger boats to fish mahimahi, departing early in the morning and staying deep in the sea for 15 days. The other 35% kept deep in the sea for 8 days for fishing tuna or other fish species. 60% worked 12 hours or more per day (working time A) and 40% worked 8–10 hours per day (working time B). Among those travelling and coming back in the same day, 30% had another job during their free time, especially driving a moto-taxi. Overall,42% reported slept between 5 to 7 hours per day and 30% less than 5 hours per day. 25% reported difficulty of sleep during the last 31 days. 17% reported difficulty on starting to sleep and 13% felt tired after waking up. 38% had excessive daytime sleepiness. 55% presented poor sleep hygiene. The OR was calculated comparing the presence or absence of excessive daytime sleepiness of the working time A versus working time B, and it was 0.1543, with a 95% confidence interval [0.0947; 0.2514].

Conclusion: Most of the informal fishermen were young and overweight single men who used to stay deep in the sea for ~15 days, and more frequently were under the working time A. Most of the participants slept less than 7 hours per day. Being part of working time A (12 hours or more per day) was associated with sleeping less than 7 hours per day, frequent sleep disturbances, poor sleep hygiene, and excessive daytime sleepiness.

ID: 51

Effect of Nighttime Fasting vs. Nighttime Eating on Urinary Melatonin Excretion in Fixed Night Workers: A Randomized Crossover Trial

Bruno Simão Teixeira[1], Yara Cristina de Paiva Maia[1], Mário Pedrazzoli[2], Cibele A. Crispim[1]
[1]*Federal University of Uberlândia), Uberlândia, MG, Brazil*
[2]*School of Arts, Sciences and Humanities of University of São Paulo, São Paulo, SP, Brazil*

Introduction: Shift work disrupts circadian rhythms and has been associated with metabolic and sleep disturbances. Melatonin, a key hormone in circadian regulation, is influenced by food intake timing. Emerging evidence suggests that in night shift workers, nighttime food intake may act as a secondary zeitgeber, modulating melatonin secretion and potentially reducing the effects of circadian misalignment induced by shift work. This study aimed to evaluate the effect of nighttime fasting versus nighttime eating on urinary melatonin excretion in fixed night workers, contributing to a better understanding of chrononutrition strategies that may mitigate circadian misalignment and improve long-term health outcomes.

Methods: A randomized controlled, three-condition, crossover trial was conducted with ten metabolically healthy

police officers working fixed night shifts. Participants underwent three conditions in randomized order: (1) Night Shift Fasting (fasting during night shift), (2) Night Shift Eating (consumption of a standardized meal providing 30% of daily energy intake at ~02:00), and (3) Nighttime Sleep (control condition). Each condition lasted 48 hours with a minimum six-day washout period. Urinary 6-sulfatoxymelatonin excretion was assessed at five-time intervals. Actigraphy was used to monitor rest-activity cycles and assess potential confounding effects related to variations in physical activity and sleep duration. The controlled dietary protocol ensured that total caloric intake and macronutrient distribution remained constant across conditions, isolating the impact of meal timing on melatonin secretion. Data were analyzed using Generalized Estimating Equations (GEE) models adjusted for age, BMI, activity level, and light exposure. The AUC for 6-sulfatoxymelatonin was calculated using the trapezoid method.

Results: Melatonin excretion was significantly lower in the Night Shift Fasting condition compared with the Night Shift Eating condition (10.61 ± 1.42 versus 14.61 ± 2.85, $p = 0.038$). Significant differences were observed in melatonin excretion over time within each intervention ($p < 0.05$). Area under the curve (AUC) analysis showed significantly lower 6-sulfatoxymelatonin excretion in Night Shift Fasting compared with Night Shift Eating ($p = 0.020$).

Conclusion: Nighttime fasting is associated with reduced urinary melatonin excretion compared with nighttime eating in fixed-shift workers. These findings suggest that nighttime eating may function as a secondary zeitgeber, providing a temporal cue that helps synchronize circadian rhythms and modulate melatonin secretion. Future studies should confirm these results. Support: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

ID: 52

Merging Scientific Knowledge and Operational Experience: Lessons Learnt in Applying a Fatigue Risk Management System to Ultra Long Range Operations Signal

T. Leigh[1], Margo Van Den Berg[1], Clare Ladyman[1], Jennifer Zaslona[1], Mark Hughes[2], Ben Johnston[2], Cameron Dyer[2], Mark Glover[3]
[1]*Sleep/Wake Research Centre, Massey University, New Zealand*
[2]*Operational Integrity and Safetyair, New Zealand*
[3]*Operations, Air New Zealand, New Zealand*

Introduction: Fatigue Risk Management Systems (FRMSs) are utilized in the aviation industry to manage the fatigue risks associated with Ultra Long Range (ULR) operations. In these operations, fatigue risks are primarily created by very long flight and duty times which result in prolonged periods of wake and limited opportunities for sleep, operating the aircraft during the circadian nadir, and circadian disruption associated with large time zone changes. A key aspect of FRMSs is the combined use of scientific and operational knowledge to identify and manage fatigue risks. The integration of knowledge is described here in relation to the planning and operation of two ULR routes (Auckland-Chicago-Auckland and Auckland-New York-Auckland).

Methods: ULR operations in this airline are embedded within the wider safety and risk management processes, which include an existing FRMS that apply to all flight operations. Before beginning each ULR operation, a safety case was developed by the airline that included identification of risks, proposed mitigations and biomathematical model predictions of fatigue at key points in each flight. Prior to submission to the regulator for approval, the safety case received independent scientific review. A condition of regulatory approval to operate the route and part of special scheduling agreements between the airline and the pilot body was data collection during initial operations to determine if fatigue mitigations were functioning as intended.

Results: Three studies were conducted, the first for the initial Auckland-Chicago operation, the second after altering the crew complement on this route (from 2 Captains and 2 First Officers to 1 Captain, 2 First Officers, 1 Second Officer) and the third at the commencement of the Auckland-New York route. Each study was designed with input from scientists, operational personnel and pilot union representatives, and utilized valid and reliable measures of fatigue, sleepiness, sleep, and performance. Data from each study were analyzed and reported independently by fatigue scientists but a collaborative approach was used in the application of findings to produce recommendations of operational value. For example, findings from the first study were used to educate pilots and enhance the guidance provided on in-flight rest and inform the in-flight rest pattern for the second ULR route.

Conclusion: This example demonstrates the importance and value of combining expertise in fatigue science and safety science with operational knowledge to manage fatigue risk in safety critical operations. It also supports the need for a tripartite approach in conjunction with fatigue education to get buy-in from crew to participate in these studies and engage in the recommendations that emerge from them. Support: Funding for the three studies was provided by the airline.

ID: 53

The Phenomenology and Experience of Fatigue within the Australian Defence Workforce

Raymond William Matthews[1], Anjum Naweed[2]
[1]*Operational Performance and Safety Australia, Australia*
[2]*Central Queensland University, Norman Gardens, QLD, Australia*

Introduction: Increasing domestic commitments (bushfire, flood, storm, and COVID responses), coupled with training and operations, have served to highlight the importance of effective fatigue risk management within the Australian Defense workforce. To assess the utility of an enterprise approach to fatigue management, a qualitative investigation was undertaken to understand the phenomenon of Defense workforce fatigue.

Methods: Thirteen focus groups were conducted across Australian Defense Groups and Services using the Scenario Invention Task Technique (SITT). This resulted in a sample size of 64 Defense personnel, 75% male, including 12.5% Navy, 36% Army, 39% Air Force and 12.5% Australian Public Servants. Within the SITT methodology, participants created scenarios to unpack the nature of fatigue in Defense. Some of these were hypothetical, and some were real- life scenarios, but all were drawn from lived experiences. Data analysis adopted a combination of conventional context analysis and Thematic Networks Analysis. Analysis was performed inductively in multiple rounds of iterative coding. This means that categories of analysis were not predefined beforehand and instead emerged as a function of the data analysis. Data saturation was achieved in this study partway through data collection, such that additional participant responses offered no new insights or themes.

Results: The analysis explored participants' relationship with fatigue, showing the complex and multifaceted ways in which participants perceived and coped with fatigue. This was analyzed across four dimensions of emotional experience, intensity, self-awareness and attempted control.

Analysis of these scenarios generated themes as well as key elements and risk factors. Further analysis of these data provided six thematic groupings of feelings states, depicting the live experience of workforce fatigue within Defense; Work and Performance, Cognitive and Mental, Physical and Sensory, Emotional and Affective, Self-worth and Identity, Existential and Moral.

Conclusion: The data collected yielded rich and meaningful insights into the experience, phenomenology, and dynamics of fatigue in Defense. Two overall conclusions can be made from the findings: 1) The feeling states and lived experiences of fatigue in Defense are unique and, hence, require a tailored approach to management. 2) There was a tendency to conflate or confuse short- term risk and safety issues with long-term psychosocial, health and well-being issues. Currently, within the Australian Defense workforce, the term 'fatigue' is used to capture a very broad set of feeling states and experiences. For example, fatigue generated from a perceived lack of purpose or meaning from the organization, or the connection between individual capability, fatigue impairment and self-worth and identity. While this 'all-encompassing' schema of fatigue might be technically valid, a safety and operationally focused definition of fatigue will enable it to be used within a risk management framework. The study was approved by the Department of Defense and Veterans' Affairs Human Research Ethics Committee.

ID: 54

The Relationship Between Subjective Workload and Fatigue in Multi- Sector Flight Operations

Laurie Marsman[1], Marika Melin[2], Torbjorn Åkerstedt[2], Alwin Van Drongelen[1]
[1]*Royal The Netherlands Aerospace Centre, The Netherlands*
[2]*Karolinska Institute, Stockholm, Sweden*

Introduction: Flight crew members who fly multiple sectors per duty are at risk of experiencing high levels of fatigue, which can compromise safety. Although it is known that subjective workload and fatigue are closely related, the relationship between these two constructs is not well understood. This study aims to investigate the relationship between subjective workload and fatigue during flight duties, taking into account the number of sectors flown. The influence of duty duration, previous workload, and demographic factors is determined as well.

Methods: Data used for this study was derived from the FTL2.0 study, a large-scale study executed by a consortium of research institutes, with the objective of determining the effectiveness of the current European Flight Time Limitations. In the overall study, a total of 226 participants (both cockpit and cabin crew) were studied for 2–4 weeks, and were asked to fill out questionnaires on dedicated smartphones during both on and off duty days. Of these, 102 flight crew members who flew multiple sectors were included in the present analysis. Questionnaires used were the Karolinska Sleepiness Scale (KSS), the Samn-Perelli Fatigue Scale (SP), the Rating Scale Mental Effort (RSME) and the NASA Task Load Index (TLX). In addition, a 3-minute Psychomotor Vigilance Task (PVT) was performed before and after each flight duty. Demographic factors such as age, experience, and rank were collected at baseline, together with information on health, lifestyle and previous workload. Information about the number of sectors and flight duty duration was provided by both the participants as well as the airlines involved. Multiple linear regression analysis will be used to examine the relationship between subjective workload, number of sectors flown, and the outcome measures subjective fatigue and PVT performance. It will also be determined if one of the two independent variables acts as a moderator (affects the causal relation between two other variables). In addition, since participants could indicate what was the main reason for their perceived high workload (e.g., turnaround time, ATC, weather, unruly passengers, difficult airport, technical issues), descriptive statistics will be applied to these reasons as well.

Results: The analyses are being conducted at the moment. Results will be presented during the WTS symposium in Brazil.

Conclusion: This study aims to disentangle the effect of perceived workload, the number of sectors flown, and fatigue of flight crew. The outcomes have implications for the development of effective fatigue risk management systems in airlines who fly multi-sector operations.

ID: 55

Fatigue Exposure in the Context of Nighttime Airline Operations

Pauline Vrancken, Thibault Grimaldi, Benjamin Frantz, Viravanh Somvang, Philippe Cabon
WELBEES, France

Introduction: A. Introduction Managing crew fatigue is a critical aspect of aviation safety, particularly in the context of night duties. Following changes in fatigue risk requirements (EU2023/023/R) by the European Aviation Safety Agency (EASA), a leading airline operating medium- and long-haul flights conducted scientific research investigating its crews' exposure to fatigue risk. A key component of this regulation is the classification of nighttime flight duty periods (FDPs) based on their potential to induce fatigue. EASA distinguishes three subtypes: FDPs starting between 02:00 and 04:59, FDPs starting before 02:00 and ending between 02:00 and 05:59, and FDPs starting before 02:00 and ending after 05:59. The effects of these nighttime FDPs on fatigue levels among crews were analyzed. By assessing fatigue exposure and identifying contributing factors, the study aimed at supporting regulatory compliant fatigue risk management. The objectives were 3-fold: - To identify currently implemented fatigue risk management measures; - To diagnose fatigue risk exposure levels among crews; - To support the airline in managing fatigue risk.

Methods: To capture an accurate view of crew fatigue, the project was based on scientific principles, establishing an objective research methodology performed in multiple phases. First, current measures in place were identified through the analysis of documentation and rosters using scientific criteria. Additionally, collective interviews were organized with crews. Associated research hypotheses were defined based on the results of this review. Subsequently, a detailed fatigue data collection was performed. Data of 72 participants were gathered during actual operations to identify operational factors contributing to crew fatigue, allowing for fatigue risk management tailored to the operations.

Results: Overall, 10.4% of reported FDPs (daytime and nighttime) showed critical fatigue levels, i.e., values exceeding 5 on the Samn-Perelli scale. Workload was identified as a key factor influencing fatigue. Delays and challenging passengers correlated with increased fatigue levels. The types of nighttime FDPs do not impact critical fatigue levels. While long-hauls showed higher fatigue levels compared with medium-hauls, mixing operations do not affect fatigue. No other factors related to schedules were found to significantly affect fatigue levels.

Conclusion: By integrating scientific assessment methods, this study provided a foundation for enhancing fatigue risk management processes in compliance with regulations. Workload, delays, and challenging passengers were identified as significant contributors to fatigue. This data-driven fatigue risk management allows the airline to minimize fatigue risk while ensuring regulatory compliance. Moving forward, continued fatigue monitoring, crew feedback integration, and periodic assessments remain essential in fatigue risk management. Future research must explore the effectiveness of countermeasures and investigate fatigue on longitudinal levels.

ID: 56

Night Work During Midnight Sun and Polar Nights: Impact on Alertness, Sleepiness and Fatigue

Andreas N. Holme[1], Line Victoria Moen[1], Mikael Sallinen[2], Kristian Bernhard Nilsen[3], Charlotte N. Boccara[4], Fred Haugen[1], Dagfinn Matre[1]
[1]National Institute of Occupational Health, Oslo, Norway
[2]Finnish Institute of Occupational Health, Finland
[3]Oslo University Hospital, Neuroscience Clinic, Norway
[4]Centre for Molecular Bioscience and Medicine Norway, University of Oslo, Oslo, Norway

Introduction: The circadian clock's sensitivity to light means that seasonal changes in photoperiod can affect circadian entrainment in shift workers, thus influencing their adaptation to night work. At high latitudes, such as the Arctic, extreme daylight variations across seasons, provide a unique context for studying such circadian disruption. Polar nights and midnight sun may further challenge circadian entrainment mechanisms. Whether shift work and seasonal variations cumulate or combine their effect in the photoperiodic zeitgeber remains unclear. This study investigates how seasonal variations may interact with consecutive morning and night shifts to impact alertness, sleepiness and fatigue.

Methods: We recruited 112 three-shift process operators at 71°N, among which 84 participated during both the dark and light seasons. Their work schedule included blocks of seven consecutive morning shifts and seven consecutive night shifts, separated by four rest days. Alertness was measured by the 3-minute Psychomotor Vigilance Task (PVT-B), using lapses (omissions $\geq$355ms) and response speed (inverse response time) as outcome variables. Sleepiness was assessed by the Karolinska Sleepiness Scale (KSS). A separate question was used to assess mental fatigue. Tests were conducted at the end of the operators' shift on days 1, 3, and 6 of each shift block. KSS was also assessed at the start and end of all shifts. Data were analyzed using multilevel mixed-effects regression models with season, shift type (morning/night) and consecutive workday number as fixed effects.

Results: Night shifts were linked to lower alertness, as well as higher sleepiness and fatigue, especially on the first night shift. Interaction effects indicated improved response speed, fewer lapses, and reduced sleepiness and fatigue over six-night shifts, with significant differences between night 1 and night 6. These patterns were similar for both seasons across all variables. However, PVT-tests showed that the overall contrast between morning and night shifts was only significant during the dark season (response speed: $p < 0.0001$, lapses: $p \approx 0.005$), but not during the light season. Neither sleepiness, nor fatigue, were significantly affected by seasons.

Conclusion: These findings suggest that while night shifts generally impair alertness, as well as increase sleepiness and fatigue, workers may gradually adapt over consecutive shifts, as evidenced by improvements by the sixth night. The lack of significant seasonal effects on sleepiness and fatigue suggests that workers might adapt equally well to night shifts regardless of the photoperiod. However, the more pronounced differences in alertness between morning and night shifts during the dark season highlight the potential interplay between reduced daylight's influence on circadian rhythms and adaptability to work night shifts.

ID: 57

Caffeine-Containing Food Consumption Throughout A Rotating Shift Schedule

Luisa Pereira Marot[1], Getúlio Aguiar Lima Neto[1], Laura Cristina Tibiletti Balieiro[1], Dayane Eusenia Rosa[2], Tassia do Vale Cardoso Lopes[3], Cibele A. Crispim[1]
[1]Federal University of Uberlandia, Uberlandia, MG, Brazil
[2]Federal University of Catalao, Catalao, GO, Brazil
[3]Universidade Católica de Santos/ Universidade Santa Cecília, Santos, SP, Brazil

Introduction: Understanding how rotating shifts influence behaviors, such as caffeine intake, is important for optimizing worker performance and well-being. The aim of this study was to assess the variability in caffeine-containing food consumption among shift workers throughout a rotating shift schedule.

Methods: Thirty male shift-workers from a mining company were evaluated in a complete rotation shift cycle over 240 consecutive hours (two days of morning shifts, two days of evening shifts, 24 hours free, two days of night shifts and three days of). Caffeine intake related variables [consumption over a 24-hour period (mg) and consumption during working period (mg)] were assessed by 24 hours recall. Mixed models were used to analyze the fixed effects of shift day on caffeine intake related variables.

Results: The caffeine intake over a 24-hour on N1 (119.7 mg $\pm$ 18.6) was higher than all other shift days ($p < 0.05$), except for E1 (83.0 $\pm$ 18.1, $p = 0.078$). The consumption occurring exclusively during working hours on N1 (62.9 $\pm$ 20.0) was also higher compared with the other workdays, except for the second morning shift day (M2 - 25.6 $\pm$ 14.7, $p = 0.091$).

Conclusion: Caffeine consumption appears to be influenced by the shift day, especially during working hours. The night shift seems to promote increased caffeine intake during the night periods for rotating shift workers.

ID: 58

How to Support First-Line Healthcare Managers in Promoting Both Their Own and Employees' Sleep and Recovery: A Qualitative Interview Study

Majken Epstein[1], Marie Söderström[2], Andrea Eriksson[3], Anette Harris[4], Anna Dahlgren[2]
[1]Karolinska Institutet, Stockholm, Sweden
[2]Karolinska Institutet, Stockholm University, Stockholm, Sweden
[3]KTH Royal Institute of Technology, Sweden
[4]University of Bergen, Bergen, Norway

Introduction: Nursing staff often face a challenging work situation characterized by high workload and demanding working hours. A previous study showed that a sleep and recovery intervention for new nurses, focusing on individual strategies, decreased burnout and fatigue symptoms and had a preventive effect on somatic symptoms. However, a process evaluation highlighted workplace- related factors as barriers

for individual sleep and recovery, such as overtime work, demanding shifts and schedule changes at short notice. In line with previous research, this highlights the importance of management involvement and leadership for employee sleep, recovery and health. At the same time, first-line healthcare managers often also struggle with heavy workloads, which may hinder health-promoting leadership. The aims of this study were 1) to explore first-line healthcare managers' strategies for their own sleep and recovery, and work-related factors affecting sleep and recovery opportunities, and 2) to explore if and how first-line healthcare managers work to support employees' sleep and recovery, and factors affecting such work.

Methods: Semi-structured interviews were conducted with 15 first-line healthcare managers (13 women) working in different medical specialties at two Swedish hospitals. The managers had between 9 months to 10 years (M=5y, SD=4y) of work experience. Thematic analysis was used.

Results: Managers had to actively engage in strategies for their own recovery, e.g., through setting limits for work hours and tasks, and optimising recovery during breaks. To promote employees' recovery, managers aimed to be present and accessible to pick up signs of employee ill-health and to be an immediate support. They were also promoting open communication about recovery; facilitating detachment by creating opportunities for reflection during work; considering the impact of scheduling; trying to create a manageable workload; and making schedules for meal breaks. Only a few actively supported shorter microbreaks. Factors related to the organization (e.g., staffing), the individual manager (e.g., stress management strategies) and the employees (e.g., communication) affected the possibilities for managers' and employees' recovery.

Conclusion: A systems approach for promoting sleep and recovery among first-line managers and nursing staff in healthcare is likely needed. In addition to address organisational conditions, first-line managers may need individual support in promoting both their own recovery and employee recovery. For example, support in how to handle the potential conflict between being a present and accessible manager versus their own recovery needs, and support in the creation of workplace-related conditions for employee recovery, e.g., opportunities for micro-breaks. A behavior analytic approach could be used to address own behaviors and employee behaviors interfering with recovery, and to support recovery behaviors. Based on the results from this study, a recovery and leadership program for first-line healthcare managers has been developed. At the conference, the content of the program and preliminary results from a process evaluation will be presented. Support: The study was funded by AfaFörsäkring (230022), Sweden.

ID: 59

Unhealthy Eating Behaviours and Junk Food Consumption in Industrial Shift Workers

Ilaria Capitanelli[1], Maura Minonzio[2], Dana Shiffer[2], Carolina P. Andrade[3], Franca Di Paola[2], Saverio Stranges[4], Franca Barbic[2]
[1]*ASL Roma 1, Italy*
[2]*IRCCS Humanitas Research Hospital, Italy*
[3]*Instituto Itapetiningano de Ensino Superior-IIES, Itapetininga, SP, Brazil*
[4]*University of Naples Federico II, Italy*

Introduction: Shift work, including night work currently involves more than 17% of workers in Europe and is associated with increased cardiovascular risk (CVR). Meal timing and diet play an important role in promoting cardio-metabolic diseases. In the present study we aimed at evaluating the cardio- metabolic profile and the intake of Junk Food (JF) and fresh vegetables (FV) in a sample of shift workers (SW) working in an industrial setting.

Methods: In an Italian Cement Plant we enrolled 22 male SW, (30–59 years), currently working 3 shifts over 24 hours (morning, M 6 AM-2 PM; afternoon, A 2 PM-10 PM; night, N 10 PM22–6 AM), with a fast rotation schedule (M-M, P-P, N-N, Rest-R). Sixteen age-matched day coworkers with similar mental and physical job tasks (DW; 8a.m.-5 PM) were also enrolled as controls. In all workers' weight, height, waist (W) and hip (H) circumferences, W/H, triglyceride, HDL and LDL cholesterol were quantified. The weekly JF and FV intake were obtained in each participant by ad hoc individual food diaries. Values are expressed as mean $\pm$ SD. All subjects signed an informed consensus for data collection.

Results: BMI and W/H, triglycerides were higher in SW compared with DW (29.9 $\pm$ 6.9 versus 25.7 $\pm$ 2.7kg/m2; 0.97 $\pm$ 0.079 versus 0.91 $\pm$ 0.05; 134.8 $\pm$ 99 vs 98.5 $\pm$ 35.8mg/dl); HDL blood levels were lower in SW compared with DW (48.3 $\pm$ 10.4 vs 52.2 $\pm$ 11.9mg/dL). A complete dysregulated time eating pattern both during work and rest days was observed in SW, with skipping breakfast, lunch and dinner in favor of high-fat snacks characterized by low quality of nutrients. In SW, the weekly intake of JF was higher (p = 0.005) and FV lower (p = 0.019) compared with DW.

Conclusion: The overweight and initial dyslipidaemia observed in these still healthy SW associated with an unhealthy eating pattern (timing and quality) may increase, especially if this condition will last a long time, the risk of developing cardiometabolic disease that are already facilitated by the circadian misalignment and sleep disorders. Introducing policies in working place aimed at modifying the unsafe global eating behavioral and at facilitating regular physical exercise, may help in preventing acute and chronic morbidity in these workers. Support: Heidelberg-Materials Occupational Health System, Italy.

ID: 60

Do the Characteristics of Participatory Scheduling Arrangements Affect the Quality of the Schedules that are Produced?

Philip Tucker[1], Majken Epstein[2], Anna Dahlgren[3]
[1]*Swansea University, United Kingdom*
[2]*Karolinska Institute, Stockholm, Sweden*
[3]*Stockholm University, Stockholm, Sweden*

Introduction: Participatory working time scheduling (PWTS) is a common working time model in Swedish healthcare, but its characteristics can vary a lot between workplaces (e.g., division of responsibilities, scheduling guidelines, technical support, use of vetoes, leadership and employee engagement). The primary aim of this study was to investigate whether these characteristics of participatory scheduling were associated with (1) the ergonomic characteristics of the schedules that emerge from this process, and (2) employee satisfaction with those schedules. The study also explored whether any such associations were contingent upon sufficiency of staffing levels.

Methods: 248 (response rate 29%) nurses and assistant nurses from 12 units in 2 hospitals answered a survey between November 2022 and September 2023. The survey included questions about the respondents' experience of how the scheduling process is managed and implemented, and their own priorities when planning their schedules.

Participants' realized work hours were derived from the hospitals' administrative systems, for the 3 months prior to the completion of the survey. Principal components analysis (PCA) was used to identify composite factors of PWTS characteristics. Logistic regressions then examined: (1) associations between PWTS characteristics and the prevalence of ergonomically unsound work schedule characteristics; (2) associations between PWTS characteristics and satisfaction with work hours. These analyses also examined the potential moderating role of staffing levels.

Results: PCA identified four PWTS characteristics: Management Support & Personal Influence (MSPI); Usability of Scheduling Tools (UST); Prioritising Personal Motives (PPM); and Preference for Compressing Hours (PCH). UST and PCH predicted the frequency of long (> 40 hours) working weeks (adj.OR = 1.64; 95% CI = 1.17, 2.32; $p < 0.05$; adj.OR = 1.76; 95% CI = 1.20, 2.58, $p < 0.05$, respectively). No other work schedule characteristics were predicted by participatory scheduling characteristics. MSPI predicted satisfaction with workhours (adj. OR = 1.79; 95% CI = 1.24, 2.59, $p < 0.01$), satisfaction with influence over work hours (adj.OR = 2.01; 95% CI = 1.31, 3.07, $p < 0.01$) and frequency of thought about leaving the job (OR = 2.11; 95% CI = 1.45, 3.07; $p < 0.001$). None of the associations were moderated by staffing sufficiency.

Conclusion: The findings indicated that, for PWTS to be perceived positively and promote sustainable work hours, nurses should feel supported by their managers, with whom they can have clearer and open communication; that the process is fair; that there is shared sense of responsibility within the team; and that they are able to influence their work hours. However, we found only very limited evidence that PWTS characteristics affected the ergonomic characteristics of the schedules that emerged from this process. Support: This study was funded by AfaFörsäkring (180242), Sweden.

ID: 61

Effects on Blood Markers for Stress, Metabolism and Inflammation in Nurses Working Quick Returns (<11h Between Shifts) – and Experimental Field Study

Anna Dahlgren[1], Kristin Öster[2], John Axelsson[3], Anders Larsson[4], Bijar Ghafouri[5], Jenny Lindehall Hadrevi[2]
[1]*Karolinska Institutet, Stockholm University, Stockholm, Sweden*
[2]*Karolinska Institutet, Stockholm, Sweden*
[3]*Stockhoms Universitet, Karolinska Institutet, Stockholm, Sweden*
[4]*Uppsala Universitet, Sweden*
[5]*Department of Health, Medicine and Caring Sciences, Linköping University, Linköping, Sweden*

Introduction: Quick return (<11h between shifts, QRs) have been common in Swedish Healthcare. Previous research has shown an association between QRs and increased risk for sick leave. The mechanisms driving this association could be related to short sleep as sleep length is reduced by ~1 hour in relation to quick returns. Short sleep could alter the activation of the hypothalamic-pituitary-adrenal (HPA)-axis, increase inflammation and increase risk for metabolic diseases. The aim of the study was to explore the acute effects of a quick return on blood markers for stress, inflammation and metabolism.

Methods: Newly graduated nurses were recruited via the introduction program for new nurses at one university hospital in Sweden. Of the 54 nurses recruited 24 participants completed participation. They were followed during two prescheduled work periods, with and without a quick return. The order of the two conditions was randomized across participants. The participants left blood samples in the morning (fasting) and afternoon of the second day in both conditions; "evening-day-day" versus "day-day-day." Both conditions were preceded by a day off work. Food intake was standardized during sampling days. Blood samples were analyzed for creatinine, glucose, erythropoietin and cortisol using ELISA kits. Further analysis from U-PLEX Custom Metabolic Group 1 V-PLEX Custom Human Biomarkers 1 are ongoing and will be presented at the conference. The data were analyzed with an ANOVA examining the effects of the conditions, time of day, and interaction effects between conditions and time of day (18 participants had complete blood samples at both conditions).

Results: There was a significant effect of condition on creatinine (F=5.04; $p < 0.05$; df=1,17) and cortisol (F=9.58, $p < 0.01$; df=1,17) which were higher both in the morning and in the afternoon after a quick return. There were no significant effects of condition on CRP (F=0.32; p>0.05; df=1,17), erythropoietin (F=0.02; p>0.05; df=1,17) or glucose (F=1.26; p>0.05; df=1,17). None of the outcome measures showed a significant effect on condition and time of day.

Conclusion: The results indicate that an acute effect of a quick return is increased activation of the HPA-axis with higher levels of cortisol throughout the day. This increase was not mirrored by changes in glucose, erythropoietin or inflammatory levels. While this study indicates that quick returns leads to an acute (and probably functional) stress response, future studies should determine in what circumstances this stress may be harmful. Support: FORTE- Swedish Research Council for Health, Working Life and Welfare (2017–02032), Sweden.

ID: 62

Effects of Night Shift Work on Diurnal Glycemic Profiles: A Field Study Among Female Hospital Employees

Rasmus H. Reeh[1], Anders Aagaard[1], Thomas Mandrup-Poulsen[2], Kirsten Nabe-Nielsen[1], Anne Helene Garde[1]
[1]*The National Research Centre for the Working Environment, Denmark*
[2]*Univerisity Copenhagen, Copenhagen, Denmark*

Introduction: Around-the-clock work schedules disrupt the natural circadian rhythms resulting in circadian misalignment and increases risks for metabolic and cardiovascular diseases. Yet, it remains to be settled, how night shift work affects glycemic profiles in real-world settings. We hypothesized that working during the night impairs glucose profiles among female hospital employees compared with working during the day.

Methods: In the 1001 nights-cohort, 1075 female hospital employees in Denmark registered working hours, sleep, and food intake in diaries. A subgroup of 54 participants without known diabetes wore Continuous Glucose Monitors (GCM, Dexcom) for 6–8 days. The night shift and day shift were defined as working 8 hours from 23:00 to 07:00 and 07:00 to 15:00 respectively. An off night and off day were defined as working 0 hours during the same intervals, respectively. 51 participants were eligible for inclusion. They all worked at least one night and one day shift and had at least one-off night and one-off day. Daily mean and standard error of glucose levels for night and day shifts as well as off nights and days were calculated.

Results: Participants completed a total of 77-night shifts and 282 off nights, along with 74 days shifts and 252 off days. The mean glucose level was 115.2 (SEM 1.81) mg/dL during night shifts, 113.4 (SEM 0.93) mg/dL during off nights, 111.2 (SEM 1.52) mg/dL during day shifts, and 111.6 (SEM 0.95) mg/dL during off days.

Conclusion: Preliminary results indicate that night shifts modestly increase mean glucose levels at night but not during the daytime. Results of other CGM-derived outcome variables and statistical variance component modeling using a within-person design will be presented at the conference. Support: This project is supported by funding from The Danish Working Environment Research Fund (26–2020–09; 19–2022–09), The Health Foundation (22-B- 0452), The National Research Centre for the Working Environment, and The Danish Cardiovascular Academy, which is funded by the Novo Nordisk Foundation (NNF17SA0031406) and the Danish Heart Foundation.

ID: 63

A Proactive Intervention Supporting New Nurses' Strategies for Sleep and Recovery When Starting Shiftwork: Results from A Randomized Controlled Trial

Anna Dahlgren[1], Kristin Öster[2], Majken Epstein[2], Philip Trevor Tucker[3], Marie Söderström[1]
[1]*Karolinska Institutet, Stockhom University, Stockholm, Sweden*
[2]*Karolinska Institutet, Stockholm, Sweden*
[3]*Swansea University, Stockholm University, United Kingdom*

Introduction: Entering working life as a new nurse is stressful and often an introduction to shiftwork, which has been associated with impaired sleep and recovery. In a randomized controlled trial, we previously examined the effects of a proactive 'sleep and recovery intervention' for new nurses showing preventive effects on somatic symptoms, decreased burnout and fatigue symptoms but no significant effects on sleep ratings. The aim of this study was to examine the effects of the intervention on day-to-day sleep, detachment and stress.

Methods: 209 new nurses were recruited at eight Swedish hospitals and randomly assigned into an intervention or control group (Clinical Trial NCT04246736). The intervention included three 2,5h group sessions, with psychoeducation on strategies enhancing sleep and recovery, based on cognitive behavioral therapy techniques modified for shiftworkers. A subsample of participants (64 in the intervention group, 74 in the control group) wore an actigraph and filled in a diary for one week before (baseline) and after (follow up) the intervention. The diary contained questions from the Karolinska Sleep Diary; sleep quality index, anxiousness at bedtime, questions about detachment (difficulties stopping thinking about work during free time), satisfaction with leisure time and feeling tense. Sleepiness (Karolinska Sleepiness Scale) and stress were rated during the day. Regression analysis estimated the effect of treatment on outcomes, controlling for baseline scores.

Results: The mean age was 27 years (SD=5.2), 86% were women with an average of 3.1 months (SD=2.5) experience in the profession. Measures during days off showed that at follow up, the intervention group reported significantly less problems with detachment (-0.59, 95% CI -0.87- -0.3) and exhibited -3.39 percentage points less fragmented sleep (95% CI -6.76- -0.02). A significant interaction indicated that those who had more problems detaching at baseline also had a greater benefit of treatment (-0.41, 95% CI -0.7 - -0.13, t = -2.9, $p = 0.004$). The intervention had no significant effect on other measures of sleep, satisfaction with leisure time or feeling tense during days off. Measures during workdays showed that at follow-up, the intervention group reported less problems with detachment (-0.47, 95% CI -0.76- -0.17), felt less tense (-0.25, 95% CI -0.48- -0.03) and reported higher satisfaction with their leisure time (-0.22, 95% CI -0.43- -0.01). The intervention did not affect sleep outcomes during workdays. There were no significant effects on sleepiness or stress ratings either during workdays or days off.

Conclusion: Results were promising showing that detachment was improved during workdays and days off, indicating that the intervention could promote better conditions for sleep and recovery for new nurses. Sleep was only improved during days off, which might indicate that organisational factors affect the use of sleep-improvement strategies during workdays. This should be examined further in future studies. Support: AFA Insurance (150024).

ID: 64

Light and Dark Management to Mitigate Sleepiness and Fatigue Associated with Night Shift Work: Insights into Circadian Disruption and Sleep Quality

Liliana Bustos-Gonzalez[1], Jean Paul Maidana[2], Mauricio Aspe[1], John Ewer[1]
[1]*Universidad de Valparaíso, Chile*
[2]*Universidad Andres Bello, Chile*

Introduction: Numerous studies indicate that night shift work negatively impacts health and performance. Work during times designated for rest, and sleeping during periods intended for wakefulness, conflicts with human diurnal physiology, which is regulated in part by the circadian clock. This misalignment results in sleep deprivation, increased sleepiness, decreased performance, and impaired health and quality of life for shift workers. Although studies conducted in controlled environments suggest that managing exposure to light and darkness can alleviate these problems, it is necessary to evaluate the effectiveness of such interventions under real-world working conditions.

Methods: We recruited two samples ($N = 24$ and $N = 38$) of rotating night-shift workers from two different transportation companies located in the northern Chile. Demographic information such as age, years working night shifts, medication use, commuting times, sleep quality, and quantity were assessed using the Karolinska Sleep Questionnaire and Sleep Diaries. Regression analyses were conducted to evaluate associations between demographic variables and sleep outcomes, specifically examining how these factors influence sleep quality and quantity during night shifts.

Results: Preliminary findings indicate reduced sleep quality among workers from both samples, suggesting widespread circadian disruption. In addition, workers reported substantial commuting times from their homes to their workplace, highlighting an additional factor that may contribute to sleep deficits. Regression analysis revealed a significant positive correlation between years performing night shifts and total sleep hours achieved during night shifts, suggesting adaptive or compensatory mechanisms whose effectiveness increases with experience.

Conclusion: Our study confirms significant sleep disturbances and circadian disruptions among night-shift workers. The observed relationship between years spent working night shifts and sleep duration highlights potential adaptive mechanisms worth further exploration. These insights are crucial for developing targeted interventions to improve night shift workers' health and well-being. Support: The authors would like to thank the CINV and the VRII from Universidad de Valparaíso for their technical support in the execution of this project. We also would like to thank to the Agencia Nacional de Investigación y Desarrollo, Proyecto Idea ID22I10053 (to JE) and Concurso Subvención a la Instalaciónen la Academia 85220042 (to LBG) as our funding sources.

ID: 65

Factors Related to Work Tension in Long-Haul Truck Drivers of Different Ages

Natalia A. Bobko, Diana A. Gadayeva, Anna Y.U. Antoniuk
Kundiiev Institute of Occupational Health, Ukraine

Introduction: Work tension is the leading adverse factor in the working conditions of long-haul truck drivers. At the age of over 40 years, work tension is evaluated to be higher than at the age of under 40 years. The purpose is to reveal the characteristics of the work process and the functional body state that affect the development of work tension in truck drivers under and after 40 years- old.

Methods: 77 long-haul truck drivers were examined: 18 men aged 28–41 (young group), 59 men aged 42–67 (old group). Felt work tension over the performed round-trip was evaluated using 5-ancor Likert scale. There were registered: number of trip-days per year, maximum trip duration, number of night working hours per round-trip, quality of night sleep – over the last year, 5 and 10 years ago; age-experience parameters; blood pressure, heart rate, Stange's and Uemura's tests performance, health deterioration index (HDI) by Voytenko; felt fatigue, stress, workability by 5-ancor Likert scale; personal anxiety by Spielberger-Khanin. Data were processed at $p < 0.05$.

Results: Felt work tension in the young group was lower than in the old group (M±m: 2.06 ± 0.22 vs 2.82 ± 0.12, $p < 0.006$). Both felt stress and fatigue - positively correlated to the felt work tension within each group ($p < 0.0001$). In the young group, felt work tension positively correlated to Kerdo's vegetative index ($p < 0.04$), cardiac output ($p < 0.05$); number of round-trip days per year 10 years ago ($p < 0.01$), maximum round-trip duration - 5 ($p < 0.04$) and 10 ($p < 0.05$) years ago; driver experience, away from home work experience and night work experience ($p < 0.02$); negatively correlated to sleep quality ($p < 0.01$ 0.05) and feeling of pleasure ($p < 0.05$). In the old group, felt work tension positively correlated to number of night working hours per trip - currently ($p < 0.01$), 5 ($p < 0.001$) and 10 ($p < 0.001$) years ago; HDI ($p < 0.03$) and anxiety ($p < 0.05$), proneness to disappointment ($p < 0.04$); negatively correlated to Stange's test performance parameters ($p < 0.007$).

Conclusion: The work tension of long-haul truck drivers is being developed on a cumulative basis over many years. At the age of ~40, the increase in the work tension of drivers does not occur linearly, but through the transition to a new level of body functioning and the inclusion of new mechanisms to ensure its functioning. Under 40 years-old the antidote to the increase in the work tension of drivers can be qualitative sleep and pleasant moments of life, beyond 40 years-old - maintaining the respiratory system in a good state. Support: We are infinitely grateful to our defenders for the opportunity to work. We are grateful to the drivers and their management for cooperation, to the National Academy of Medical Sciences of Ukraine for financial support (State Registration: 0122U000648).

ID: 66

Seasonal Impacts on Sleep in Arctic Shift Workers: Insights from Wearable Monitoring

Line Victoria Moen, Andreas Holme, Dagfinn Matre, Fred Haugen
National Institute of Occupational Health (STAMI), Oslo, Norway

Introduction: Studies suggest that seasons may influence sleep, though findings are inconsistent. In Arctic settings, the extreme light conditions including polar night (dark season) and midnight sun (light season) may have a distinct impact on the relationship between shift work and sleep. This observational crossover study aimed to examine seasonal variations in sleep among Arctic shift workers using both subjective and objective sleep measures.

Methods: A cohort of 112 rotational shift working process operators (mean age 32 ± 11.3 years, 21% women) from an industrial plant at 71°N in Norway participated during both light and dark seasons. Their work schedule included seven consecutive morning shifts and seven consecutive night shifts, separated by four rest days. Objective sleep duration was measured over 20 days with the Oura smart ring, while subjective sleep was measured over 25 days by sleep diary.

Results: Preliminary results indicate that objectively measured sleep duration (minutes; mean ± SEM) after night shifts was slightly longer in the dark season 385 ± 4 compared with the light season 374 ± 4. The opposite trend was observed for seasonal effects on sleep after morning shifts: 379 ± 3 in the dark season; 387 ± 3 in the light season. Sleep on free days followed the same pattern as morning shifts, with shorter duration in the dark season (443 ± 6) compared with the light season (452 ± 6). Overall, our findings indicate that sleep duration tends to be longer on free days than on workdays. The timing of sleep measured objectively as mid-sleep (hours past midnight), was similar after night shifts across dark and light seasons; at 11.6 and 11.5, respectively. Mid-sleep during the dark and light seasons after morning shifts occurred at 3.0 and 3.3; and on free days, at 5.7 and 6.0; respectively. Subjective sleep duration (minutes; mean ± SEM) in dark and light season after night shifts was 404 ± 5 and 406 ± 5; after morning shifts 411 ± 5 and 404 ± 4; and on free days 492 ± 8 and 489 ± 6, respectively. These subjective ratings were somewhat higher than the objective measures.

Conclusion: Our data suggests that night shifts and seasonal variations have only a minor impact on objective and subjective measures of total sleep duration among these Arctic shift workers. Follow-up analyses will explore potential underlying factors, day-to-day variation and individual variability. Support: This research is supported by the RRESEARCH COUNCIL OF NORWAY; the PETROMAKS2 program ID# 326291.

ID: 67

Associations of Shift Work Patterns With Work-Related Accidents and Dozing Off: Combining Objective Working-Time Registers and Retrospective Questionnaire Data

Bjarte Birkeland Kysnes[1], Anette Harris[1], Siri Waage[2], Erlend Sunde[3], Ingebjørg Louise Rockwell Djupedal[4], Ståle Pallesen[1], Bjørn Bjorvatn[2], Øystein Vedaa[3]
[1]*Department of Psychosocial Science, Faculty of Psychology, University of Bergen, Bergen, Norway*
[2]*Norwegian Competence Center for Sleep Disorders, Haukeland University Hospital, Bergen, Norway*
[3]*Department of Health Promotion, The Norwegian Institute of Public Health, Bergen, Norway*
[4]*Department of Research Administrative Support, Norwegian Institute of Public Health, Norway*

Introduction: The present study examined associations between different work shift characteristics and self-reported work-related accidents as well as incidents of dozing off at work and while driving to or from work.

Methods: Data were obtained from the payroll register of a Norwegian hospital in 2020 encompassing information on the number of quick returns (<11 hours between shifts),

day-, evening-, night-, and long (>9 hours) shifts worked during the last year. These payroll data were subsequently linked to retrospective questionnaire data, collected from 1195 healthcare workers (85.4% females; mean age 38.3 years, SD=12.6) in January 2021. The questionnaire included items about dozing off at work the last month and dozing off while driving to or from work the last year, as well as assessment of work-related accidents resulting in harm to (1) oneself, (2) patients/others, and/or (3) equipment during the last year. A composite score indicating overall harm (all three items) was also computed. Negative binomial regression analyses were performed to investigate the relationship between different work shifts and work-related accidents, controlling demographics, shift work experience, circadian type, and monthly work hours. To correct for multiple testing, the Benjamini-Hochberg procedure with a false discovery rate of 5% was applied.

Results: Number of quick returns during the last year was positively associated with healthcare workers causing harm to themselves (IRR=1.021; 95% CI=1.009–1.034). Number of day shifts were negatively associated with causing harm to patients/others (IRR=0.987; 95% CI=0.981–0.992), equipment (IRR=0.988; 95% CI=0.982–0.994), and overall harm (IRR=0.992; 95% CI=0.988–0.995). Number of night shifts were positively associated with dozing off at work (IRR=1.005; 95% CI=1.002–1.008) and while driving to or from work (IRR=1.007; 95% CI=1.003–1.010). Lastly, the number of evening shifts was negatively associated with causing harm to patients/others (IRR=0.989; 95% CI=0.982–0.996).

Conclusion: Number of quick returns was associated with increased risk of causing harm to oneself, while number of day shifts was associated with a lower risk of overall harm, harm to patients/others, and to equipment. The number of evening shifts was associated with a lower risk of causing harm to patients/others, whereas number of night shifts was associated with a higher risk of dozing off at work and while driving to or from work. A novel element and strength of the present study is that it combines objective working-time registers with subjectively reported work-related accidents. A limitation concerns the challenge of adjusting for medical operations/workload variations across shifts, potentially influencing risk estimates, especially during night shifts. Future studies should aim to measure and adjust for relevant occupational and operational confounders.

ID: 68

Sleep Deprivation with and Without Stimulant Use Exposesdistinct Dimensions of Cognition

Rachael A. Muck, Courtney A. Kurinec, Stephen M. James, Paul Whitney, John M. Hinson, Brieann C. Satterfield, Jonathan P. Wisor, Kimberly A. Honn, Hans P. A. Van Dongen
Washington State University, Washington, United States

Introduction: Stimulants are commonly used as countermeasures to sleep loss-induced performance impairment in operational settings. People show substantial interindividual variability in vulnerability to sleep loss, and this variability is task-dependent. Limited prior evidence suggests that caffeine and modafinil, stimulants that act through adenosinergic and dopaminergic systems, respectively, may differentially affect interindividual and task-dependent differences. As a first analysis to investigate this, we assessed whether the dimensions of cognition underlying task-dependent performance during total sleep deprivation (TSD) are conserved with caffeine and modafinil during a double-blind, randomized, placebo-controlled TSD in-laboratory study.

Methods: $N = 68$ healthy adults (25.0 ± 5.0y; 37 males) completed a 3-night/4-day in-laboratory study. During a 38h TSD period (08:00 day 2 to 22:00 day 3), participants received 4 drug administrations beginning at 01:00 on day 3 after randomization to either caffeine ($n = 26$; 200mg every 4h), modafinil ($n = 22$; alternating 200mg and placebo every 4h), or placebo ($n = 20$). On day 3 participants completed an 18min go/no-go task with reversal (GNGr) at 09:30 and a 30min traffic light task in a high-fidelity driving simulator at 12:00. At 13:30, they completed a computerized task battery with the Karolinska Sleepiness Scale (KSS), 10min psychomotor vigilance test (PVT), 4min digit-symbol substitution task (DSST), and Positive and Negative Affect Schedule (PANAS). Performance outcomes included stimulus acquisition and cognitive flexibility measures from pre- and post-reversal discriminability indices on the GNGr; drowsiness and prepotent response inhibition measures from lane deviation and a discriminability index on the traffic light task; subjective sleepiness score on the KSS; vigilant attention assessed by lapses ($RT \geq 500$ms) and log signal-to-noise ratio of RTs on the PVT; number correct as a combined measure of vigilant attention and associative learning on the DSST; and positive and negative affect scores on the PANAS. Clustering of interindividual differences in these outcomes was investigated using principal component analysis (PCA) with varimax rotation, controlling for drug condition.

Results: Two distinct factors emerged from the PCA analysis. The first factor captured increased subjective sleepiness and reduced vigilant attention, associative learning, and positive affect. The second factor captured increased drowsiness (lane deviation), negative affect, reduced stimulus acquisition, cognitive flexibility, and prepotent response inhibition. Together, these dimensions of cognitive performance explained 45.8% of the variance in TSD-induced performance impairment.

Conclusion: When controlling for caffeine, modafinil, and placebo drug conditions, cognitive performance impairment during sleep deprivation clustered around two orthogonal dimensions – one predominated by vigilant attention deficits, the other predominated by cognitive control deficits – suggesting distinct underlying neurobiological mechanisms shared across conditions, regardless of the neurobiological mechanisms involved in the actions of caffeine and modafinil. Follow-up analyses will assess the extent to which these stimulants may also have interacted differentially with the task-dependent interindividual differences in vulnerability to sleep deprivation. Support: USAMRDC W81XWH-18–1-0100.

ID: 69

Quick Returns – Effects on Sleep, Sleepiness and Cognitive Performance. An Experimental Field Study

Kristin Oster[1], Marie Soderstrom[1], Philip Tucker[2], John Axelsson[3], Anna Dahlgren[1]
[1]*Karolinska Institute, Stockholm University, Stockholm, Sweden*
[2]*Stockholm University, Swansea University, Stockholm, Sweden*
[3]*Stockholm University, Karolinska Institute, Stockholm, Sweden*

Introduction: Quick returns (<11h between shifts, QRs) result in shortened sleep length (~5–6h) and increased sleepiness and are thus likely to have a negative impact on work performance. Previous registry studies and field studies utilizing retrospective ratings have associated QRs with an increased risk of accidents and mistakes, but there is a shortage of studies that have adopted an experimental design to assess the acute effects of quick returns on work performance. The aim of the present experimental field study was

to investigate differences in objective and subjective measures of sleep, sleepiness and cognitive performance between QRs and day-day transitions.

Methods: In the years 2018–2023, 67 newly graduated nurses were recruited from the introductory program at 3 Swedish university hospitals. In total, 35 completed participation and were followed during two pre-scheduled work periods, with and without a quick return (evening-day versus day-day). Both conditions were preceded by a day off work, and the order of the two conditions was randomized across participants. The participants wore an actigraphy watch during sleep and kept a sleep diary (Karolinska Sleep Diary) and a work diary throughout the day. In addition, the participants performed smartphone based cognitive tests three times a day on the KarolinskaWakeApp. The cognitive tests measured simple attention, episodic memory (memorizing a list of words) and cognitive conflict (Stroop). The data has been analyzed using Bayesian linear mixed models. Preregistered analysis plan and priors can be found here: https://osf.io/kr4su.

Results: Nurses were estimated to sleep on average 6h 57min (95% Compatibility Interval [6h40m, 7h15m]) during day-day transitions and 49 minutes (95% CI [70,27]) shorter during quick returns. Sleep fragmentation did not differ between conditions, but the participants were more anxious at bedtime (-1.19, 95% CI [.89, 1.47]). Following a QR, participants felt less rested (0.64, 95% CI [0.32, 0.93]) in the morning and sleepier (0.52, 95% CI [0.11,0.90]) during daytime. The estimated effects of working a QR, for attention (95% CI [-6, 17]ms), incongruent stroop-trials (95% CI [-25, 68]ms), and the probability of misremembering words (95% CI[-0.02, 0.02], were small and overlapped zero.

Conclusion: Quick returns shorten sleep and are a source of fatigue among nurses. The sleep deprivation caused by QRs (compared with day-day transitions) were, however, approximately one hour and did not manifest in worse attention, conflict processing or memory impairments. The effects of QRs on subjective ratings of safety and performance will be analyzed and presented at the conference. This study indicates that the cognitive consequences of a single QR are not substantial, but future studies should investigate the effects of repeated QRs on cognitive performance and potential safety consequences. Support: FORTE – Swedish Research Council for Health, Working Life and Welfare (2017–02032).

ID: 70

A Change in Working Hour Legislation Banning Quickreturns in Sweden – from the Perspective of Employees in Elderly-Care

Philip Tucker[1], Kristin Öster[2], Marie Söderström[3], Anette Harris[4], Annina Ropponen[5], Anna Dahlgren[3]
[1]Swansea University, United Kingdom
[2]Karolinska Institute, Stockholm, Sweden
[3]Stockholm University, Stockholm, Sweden
[4]University of Bergen, Bergen, Norway
[5]Finnish Institute of Occupational Health, Finland

Introduction: In 2023, Sweden effectively banned quick returns (<11 hours of rest between shifts), which had previously been common in care-sector workers' schedules. Quick returns are associated with insufficient recovery and sick leave but are also regarded by some as having beneficial effects e.g., facilitating better information transfer between shifts. This study investigated factors predicting employees' attitudes toward the rule-change, post-implementation, and how those attitudes related to employees' health and wellbeing.

Methods: A survey was emailed to a random selection of half of the members of a trade union working in elderly-care (≈61 000). Of those 52% opened it, and 14% of those participated (N = 4319). The survey assessed attitudes toward work hours and the rule- change, experiences of its implementation and impacts on professional and personal life. It also evaluated perceptions of workload, work environment, leadership, health, sleep and work-life balance. Preliminary descriptive analysis of responses has been conducted. Ongoing regression analyses, to be presented at the conference, will examine whether attitudes toward the rule-change are predicted by their experience of its implementation, or by other organisational, managerial, or individual factors; and whether respondents' attitudes toward the rule-change predict their health and wellbeing.

Results: Thirty percent of respondents rated work hours negatively and 75% reported a negative impact of the rule-change upon their work hours. Most reported an increase in working three consecutive evening shifts (72%) and changes in the scheduling of weekend work (65%). Most (76%) reported that their ability to influence the planning of work hours had been impaired by the rule-change, as was the possibility to amend already planned schedules (82%). Many were negative to the new rules before the implementation (49%) but more were negative after implementation (74%). Additionally, 28% reported that derogations from the new rules occurred frequently after the rule-change. During the implementation, 72% felt that management had not listened to employees' suggestions concerning the rule-change. Most reported negative effects of the rule-change on their work (e.g., less job satisfaction 63%, more conflicts in the work group 55%, impaired information transfer between shifts 58%) and personal life (e.g., more work-life interference 72%, impaired sleep 59%; impaired recovery in free time 71%).

Conclusion: The response rate was low, so the negative experiences of the rule-change reported here may not be representative of the whole workforce. However, data from this large sample will be used to examine the factors that prompt negative attitudes toward changes in working time rules, and how negative attitudes relate to health and wellbeing. These findings will provide valuable insights into how to successfully manage the implementation of such changes in the future. Support: Funded by Forte (2023–00556), Sweden.

ID: 71

Altered Coordination Between Sleep Timing and Cortisol Profiles in Night-Working Female Hospital Employees

Katarzyna Burek[1], Sylvia Rabstein[1], Thomas Kantermann[2], Céline Vetter[3], Rui Wang-Sattler[4], Martin Lehnert[1], Dirk Pallapies[1], Karl-Heinz Jöckel[5], Thomas Brüning[1], Behrens, Thomas[1]
[1]Institute For Prevention and Occupational Medicine of the German Social Accident Insurance (IPA), Institute of the Ruhr-Universität Bochum, Bochum, Germany
[2]Institute for Labor and Personnel (IAP), University of Applied Sciences for Economics and Management (FOM), Essen, Germany
[3]Department of Integrative Physiology, University of Colorado, Boulder, United States
[4]Institute of Translational Genomics, Helmholtz Zentrum München, German Research Center for Environmental Health, Neuherberg, Germany
[5]Institute for Medical Informatics, Biometry and Epidemiology, University Hospital of Essen, University Duisburg-Essen, Essen, Germany

Introduction: The circadian cortisol rhythm is closely aligned with the sleep-wake cycle. Cortisol peaks within 30–45 minutes after waking up in the morning, gradually decreases throughout the day, reaching lowest levels around midnight before rising again prior to waking. This study aimed to determine and compare cortisol profiles in women working day and night shifts. Additionally, diurnal cortisol profiles were analyzed between two groups with different start times for day shifts.

Methods: A total of 68 female shift workers (mean age: 37 ± 10 years) and 21 female non-shift workers (mean age: 45 ± 10 years) from a German hospital participated in this cross-sectional study. Shift workers were monitored across two consecutive day shifts and three consecutive night shifts, while non-shift workers were monitored across two consecutive day shifts. Each study day included six to eight saliva samples collected during wakefulness, along with sleep timing data obtained via polysomnography and sleep diaries. Generalized additive mixed models were applied to estimate the non-linear relationship between time since waking up and log-transformed cortisol levels. Shift- specific cortisol curves were fitted and compared. In addition, the following summary measures were calculated: cortisol awakening response (CAR), cortisol peak-to-bed slope, and total cortisol output.

Results: In shift workers, cortisol curves differed between night and day shifts. On night shifts, a flattened U-shaped cortisol profile was observed after the post-awakening peak, whereas a normal diurnal cortisol profile, with decreasing levels throughout the day, was observed on day shifts in the same individuals. The shape of the cortisol curves was indicated in the peak-to-bed slopes: close to zero on night shifts (-0.02, 95%-CI = -0.82, 0.78) and steeply negative on day shifts (-2.57, 95%-CI = -3.17, -1.98). For shift workers, significant differences in cortisol curves between night and day shifts were observed during the following time periods after waking: 40 - 55 minutes, 2 - 12 hours, and 15 - 22 hours. Comparisons of day-shift cortisol curves between shift workers and non-shift workers showed no significant differences in the shape of the curves. However, differences were detected in mean cortisol levels at waking up (-0.41 log (nmol/L), 95%-CI = -0.79, -0.02) and in CAR (0.37 log(nmol/L), 95%-CI = 0.10, 0.63).

Conclusion: This study demonstrates that night shifts disrupt the alignment between cortisol rhythms and the sleep-wake cycle in female hospital employees. Cortisol secretion during night shifts remained lower, despite the physiological demand for higher levels to support work. Conversely, cortisol levels were elevated after night shifts when the women needed to rest. These findings highlight the physiological challenges associated with night work and the potential health and performance implications for shift workers. Support: This study was funded by the German Social Accident Insurance (DGUV Grant No. FF-FP0321). The funder had no role in study design, data collection, data analysis and interpretation, or decision to publish.

ID: 72

Nightshift Nutrition: A Content Analysis of Social Media Posts from Shiftworkers to Understand Barriers to Healthy Eating on-Shift

Charlotte C. Gupta, Angela Jackson, Emma Mcintosh, Sally A. Ferguson

Appleton Institute, Cquniversity, Australia

Introduction: The negative impact of food at night on the health and safety of shiftworkers has been well documented. Evidence exists on the underlying reasons for eating on-shift and the existing barriers to healthy eating within shiftwork environments. However, this previous research has utilized questionnaires, interviews, dietary recalls and food diaries which can be limited by social desirability bias and recall bias. Social media may overcome these limitations by offering a real-world environment for shiftworkers to discuss their eating behaviors.

Methods: This qualitative study investigated the dietary behaviors reported by shiftworkers through Facebook comments and TikTok videos. Facebook comments were collected if they were on public shiftworker-relevant posts about nutrition or diet. TikTok videos were collected if night-shift and nutrition were mentioned. Posts and videos were included if they were posted by self-identified shiftworkers, relatives of shiftworkers, or partners of shiftworkers.

Results: A thematic analysis of the 144 comments (Facebook) and 78 videos (TikTok) highlighted factors that influence eating on-shift that support previous research, such as limited availability to purchase or store foods, cravings on-shift, weight changes, job demand, and workplace culture. Novel results were also identified including excessive use of energy drinks at night, the preference for high-protein foods at night, the use of weight loss products on-shift (including fat loss shakes), and challenges adhering to time-restricted eating diets with rotating shifts.

Conclusion: Social media presents a unique opportunity to understand the eating patterns of shiftworkers and identify emerging issues. Future research should focus on further exploring these issues identified by workers on social media, including diet practices (e.g., time-restricted eating) on- shift, and the use of energy drinks on-shift. This will ensure future interventions for eating on-shift target the existing behaviors reported by shiftworkers, with the goal of improving health and safety on-shift.

ID: 73

Sleep Quality in Populations Exposed to Toxic Substances at Work and Environmentally in Brazil

Liliane Reis Teixeira[1], Gilvania Barreto Feitosa Coutinho[1], Tatiana Maia Azevedo[1], Marcus Vinicius Corrêa dos Santos[1], Priscila Jeronimo da Silva Rodrigues Vidal[1], Ana Paula das Neves Silva[1], Ana Paula Sousa Macedo[1], Ariane Leites Larentis[1], Thelma Reis Pavesi[1], Frida Marina Fischer[2]

[1]Oswaldo Cruz Foundation, Rio De Janeiro, RJ, Brazil

[2]Department of Environmental Health, School of Public Health, University of São Paulo, São Paulo, SP, Brazil

Introduction: Work organization and chemical exposures may affect mental and physical health. Chemical exposure can also significantly impact sleep quality through various mechanisms and molecular pathways. In addition, inadequate sleep has been linked to impairments in bodily functions. Therefore, this study aimed to analyze sleep quality in three populations exposed to chemicals, based on health parameters.

Methods: A cross-sectional study was conducted with 189 residents in the city of Volta Redonda (Rio de Janeiro, Brazil), and 66 endemic workers. Assessments on health, work, Pittsburgh Sleep Quality Index (PSQI), self-reported questionnaire, clinical and toxicological tests were performed. Sleep quality was evaluated by an actigraphy (Act-Trust) for ten consecutive days. Cd, Pb, Ni, Mn, BZN, and TLN concentrations in blood and urine were determined by GFAAS and GC/MS, and genotyping was performed using PCR.

Results: Study 1: Regarding the chronotype of the participants, 47% were afternoon,11% were morning, and

42% were indifferent. Higher urinary Mn levels were associated with the morning chronotype ($p < 0.01$). The evening chronotype was associated with poor sleep quality, higher Pb blood levels, and BZN and TLN levels in urine ($p < 0.01$) in non-occupationally exposed individuals ($p < 0.01$); as well as the highest BZN ($p < 0.01$) and TLN ($p < 0.01$) levels detected in residents from the influence zone 2. Moreover, most participants (57%) reported poor sleep quality. Residents with higher scores for daytime dysfunction ($p = 0.01$) and sleep disturbance ($p < 0.01$) were associated with higher Cd levels in urine; for sleep disturbance with both Mn ($p < 0.01$) and Ni ($p = 0.03$); and for sleep duration, with TLN ($p < 0.05$). Study2: The average score of sleep quality was 7.8 points in the PSQI score, and 60% of the population was classified as having unhealthy sleep (PSQI > 5). Additionally, the total sleep time was 5 to 6 hours, the sleep efficiency was 80%, and WASO was ~60 minutes. Sleep stability and variability were 0.48 and 0.80 respectively, and a positive correlation between the hormone free T4 and total sleep time ($p < 0.05$) was observed, also, the Intraday variability had a negative correlation with the hormone levels. Moreover, a positive correlation (0.66; $p < 0.05$) was found between the scales of common mental disorders and PSQI, with greater confidence intervals between the most extreme levels of poor sleep quality and common mental disorder.

Conclusion: Exposure to contaminants influenced sleep patterns and the different chronotypes in the population exposed to toxic substances. These contaminants potentially act as activators of the neural circadian system, affecting sleep quality. Support: Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro (FAPERJ) under Grant [number E-26/203.263/2016]; Foundation Coordination for the Improvement of Higher Education Personnel (Capes) and Oswaldo Cruz Foundation (Fiocruz). FM Fischer receives a grant from CNPq (306963/2021–3).

ID: 74

Night Work, Sleep Deprivation and Their Association with Progression of Prediabetes into Diabetes Mellitus: Insights from Elsa-Brasil

Aline Silva-Costa[1], Lucia Rotenberg[2], Rosane Härter Griep[2]
[1]*Universidade Federal Fluminense, Niteroi, RJ, Brazil*
[2]*Oswaldo Cruz Foundation, Rio de Janeiro, RJ, Brazil*

Introduction: Both night work and sleep deprivation are independently associated with diabetes mellitus (T2DM). Despite the high incidence of T2DM among adults with prediabetes, few studies investigate work schedules and sleep deprivation in relation to the progression from prediabetes into T2DM. This study aimed to analyze night work and sleep deprivation as to their association with the progression of prediabetes into T2DM.

Methods: Participants from the Brazilian Longitudinal Study of Adult Health were evaluated longitudinally at two distinct time points: 2012–2014 (wave 2; $N = 14{,}014$) and 2017–2019 (wave 3; $N = 12{,}636$). To evaluate the progression from prediabetes to T2DM, we considered a sample that comprises only workers with prediabetes at wave 2 ($N = 4{,}500$). The exposure variables were sleep deprivation and night work. Sleep deprivation was estimated using data from wave 2 considering the difference between the desired number of hours of sleep and the number of hours slept. The difference was categorized as "non-sleep deprived" when it was 1 hour or less and "sleep deprived" when it was more than 1 hour. For the work schedule, participants were divided into three groups: day workers (reference group), former night workers, and current night workers. T2DM diagnoses were based on laboratory measurements and self-reported information. Prediabetes was considered if laboratory values reached the threshold for fasting plasma glucose (>=100 mg/dL and < 126 mg/dL) or 2-hour plasma glucose (>= 140 mg/dL and < 200 mg/dL). The outcome was divided into two categories: no diagnosis of T2DM at both waves (reference group) and progression from prediabetes (wave 2) to T2DM (wave 3). Logistic regression was employed (odds ratio (OR), 95% confidence interval (CI).

Results: Sleep deprivation was shown to be associated with the progression from pre-diabetics to T2DM (OR = 1.37; 95%IC = 1.17; 1.61), whereas night work was not associated – former night workers (OR = 1.04; 95%IC= 0.87; 1.25); night workers (OR = 1.20; 95%IC = 0.91; 1.54). Among 2348 workers who were not sleep deprived in wave 2, 19.8% showed a progression to T2DM. This group corresponded to 24.8% of night workers, 18.2% of former night workers, and 18.0% of day workers. Among non-sleep deprived workers, night work was associated with the progression to T2DM (OR=1.53; IC=1.02;2.27), whereas former night work was not (OR = 1.01; IC= 0.76; 1.34). No significant association was observed among sleep deprived workers.

Conclusion: Findings contribute to the understanding of the relationships between night work, sleep deprivation and metabolic function related to glucose. The possibility to disentangle night work from sleep deprivation is relevant as a way to evidence the influence of night work on glucose metabolism independent from sleep deprivation. Support: Brazil's Ministry of Health and Ministry of Science, Technology and Innovation; FINEP; CNPq; FAPERJ.

ID: 75

HR Representatives' Experiences of the Implementation of New Working Time Rules Guaranteeing Healthcare Employees Eleven Hours of Rest Between Shifts

Marie Söderström[1], Sofia Renman[2], Lina Ullman[2], Anna Dahlgren[1]
[1]*Department of Clinical Neuroscience, Karolinska Instiitutet, Solna, Sweden*
[2]*Department of Psychololgy, Stockholm University, Stokcholm, Sweden*

Introduction: Working time rules are a central part of work environment legislation aiming to ensure employee recovery and to promote health and safety. From October 2023, new working time rules guaranteeing employees at least eleven consecutive hours of rest during a 24-hour period have been implemented in Swedish regional healthcare. The aim of this study was to investigate the HR representatives' experiences of the implementation of the new working time rules within Swedish regional healthcare, guaranteeing employees a minimum of 11 hours of rest time between shifts.

Methods: Semi-structured interviews with twenty HR representatives, from different healthcare regions in Sweden, were conducted. The interviews were recorded (audio recordings) and transcribed before coding. A subsample of seven of these interviews have now been analyzed using thematic analysis. The analysis process is ongoing and the results presented here are preliminary.

Results: Five themes were identified highlighting factors that challenged or facilitated the implementation process. Among the main challenges identified were "Resistance to change," "Lack of knowledge and skills related to working hours and scheduling," and "Working hours not a prioritised area." At the same time, "Collaboration" and "Information and support" were highlighted as important

success factors. As a common thread, connected to all themes, leadership was especially important explaining both implementation difficulties and success.

Conclusion: The study deepens the understanding of factors hindering or facilitating the implementation of working times rules in healthcare organisations from an HR perspective, highlighting the key role of managers and the challenge of change management when there is a low readiness for change. Support: The study was funded by FORTE, Swedish Research Council for Health, Working Life and Welfare, (2023–00556).

ID: 76

The Impact of Moral Stress on Turnover Intention in Shift-Working Nurses: Test of a Moderated Mediation Model

Anette Harris[1], Ståle Pallesen[1], Øystein Vedaa[2], Bjørn Bjorvatn[3], Siri Waage[4], Erlend Sunde[2], Morten Birkeland Nielsen[5]

[1]*University of Bergen, Bergen, Norway*
[2]*The Norwegian Institute of Public Health, Norway*
[3]*Universitetet I Bergen, Norway*
[4]*Norwegian Competence Center for Sleep Disorders, Haukeland University Hospital, Norway*
[5]*National Institute of Occupational Health, Oslo, Norway*

Introduction: High employee turnover is a significant challenge among nurses. Turnover intention is a key indicator of future turnover. To address this issue effectively, it is important to understand the risk factors, mechanisms and conditional factors involved in the development of turnover intention. This study examined a moderated mediation model investigating 1) moral stress as a predictor for turnover intention, 2) burnout as a potential mediator, and 3) the personality traits conscientiousness and neuroticism as potential moderating variables.

Methods: The associations between the abovementioned factors and turnover intention were analyzed utilizing data from The Survey of Shiftwork, Sleep and Health (SUSSH), a longitudinal study conducted among Norwegian nurses with annual surveys. In total, 477 nurses provided responses to all study variables of interest collected in 2022 (personality traits) and 2023 (moral stress, burnout and turnover intention). The average age of the participants was 46.8 years (SD=7.57), and 88.9% were women. Moderated mediation analyses were performed using Hayes' PROCESS macro.

Results: Moral stress was found to have a significant and positive association with turnover intention (B= 0.3260, $p < .001$). However, when examining the simultaneous association with moral stress and burnout on turnover intention, it was observed that burnout had a significant and positive impact on turnover intention (B=3057, P>.001) while the direct association between moral stress and turnover intention became non-significant (B=.0049, p=.84). These findings indicate that burnout fully mediates the relationship between moral stress and turnover intention. Additionally, the findings reveal that conscientiousness moderated the mediating effect of burnout on the relationship between moral stress and turnover intention (Index: 0.0122, Boot CI 95%: 0.0017-.0239). Specifically, the magnitude of the direct association between moral stress and burnout, as well as the indirect association between moral stress and turnover intention through burnout, were stronger among those with high scores on conscientiousness compared with those with low scores. Neuroticism did not moderate the relationship between moral stress and turnover intention, nor the mediating effect of burnout.

Conclusion: These findings highlight the importance of organizational efforts to support nurses working shift in managing moral stress. This is particularly pertinent for employees exhibiting high levels of conscientiousness, a personality trait associated with being well-organized, demonstrating self-control, and managing time. Such individuals are recognized as exemplary team members and diligent workers. Support: the Norwegian Nursing organization.

ID: 77

Circadian Rhythmicity Analysis Using Optimized Cosinor Models and Entropy Measures in Real Night-Shift Workers

Jean Paul Maidana[1], Liliana Andrea Bustos-González[2], Mauricio Aspé[3], John Ewer[3]

[1]*Universidad Andrés Bello, Santiago, Chile*
[2]*Universidad de Valparaíso, Valparaíso, Chile*
[3]*Centro Interdisciplinario de Neurociencia de Valparaíso, Valparaíso, Chile*

Introduction: Shift work, particularly night shifts, disrupts circadian rhythms, adversely impacting workers' health and performance. Core body temperature (CBT) is a robust physiological marker of circadian rhythmicity, yet in real world setting it's underused due to measurement challenges. When available, traditional methods of analysis assume a fixed period (typically 24 hours) to characterize circadian oscillations. However, shift workers may exhibit non-standard or irregular rhythms, highlighting the need for more flexible and rigorous analytical approaches. In this study, we aimed to develop and apply advanced mathematical models to detect rhythmicity, quantify irregularity, and assess circadian disruptions in real-world shift work settings.

Methods: We collected continuous core body temperature data from 27 shift workers engaged in rotating night shifts using CorTemp® sensors. To analyze circadian rhythmicity, we applied the cosinor model but optimized the period parameter rather than fixing it at 24 hours, thus allowing the identification of the most representative periodicity for each individual. For cases where rhythmicity was weak or absent, we employed entropy-based measures and nonlinear dynamic indicators of chaos (e.g., approximate entropy, sample entropy) to quantify irregularity and complexity in temperature signals.

Results: Optimizing the period parameter revealed significant heterogeneity in circadian rhythmicity among shift workers. While many exhibited near-24-hour periodicity, indicative of preserved circadian rhythmicity, a subset of workers displayed significantly altered or irregular periodicities. Entropy and chaos analysis effectively distinguished between stable and disrupted temperature patterns. Higher entropy values correlated with severe disruption of circadian rhythmicity, suggesting a possible physiological signature of chronic circadian misalignment.

Conclusion: Our findings demonstrate that mathematical optimization of cosinor models and the application of entropy-based metrics provide sensitive tools for identifying and quantifying circadian rhythm disruptions in shift workers. This approach offers enhanced capabilities to detect workers at greater risk, guiding personalized interventions to mitigate adverse health effects associated with disrupted circadian rhythms. Support: The authors would like to thank ANID-FONDEF ID22I10053.

ID: 78

Adopting A Total Worker Health® Perspective to Examine Shiftwork in Firefighters

Katia Maciel Costa-Black, Nicole P. Bowles
Oregon Institute of Occupational Health Sciences, OHSU, Portland, Oregon, United States

Introduction: Firefighters often face disrupted sleep, increasing their risk of accidents, cardiovascular disease, cancer, and mental health issues. They also struggle to balance family and social obligations with the need for sleep during days off. To address this conflict, many U.S. firefighter departments have shifted from a 24/48 schedule to schedules that provide additional consecutive days off-shift such as the 48/96 or the 24/72/48/72 schedules. To guide decisions around work schedules while prioritizing firefighter health, well-being, and safety, we aimed to systematically assess the impact of work schedules on these outcomes and develop effective methods for widely disseminating our findings via the SWIFT (Shift work in firefighters) study, a Total Worker Health (TWH) initiative.

Methods: This is natural experiment participatory action research designed to respond to the needs expressed by labor unions and leadership in Fire Services in Oregon and Utah. A multi-pronged data collection was used to assess objective measures of sleep (actigraph), heart rate (polar H7), performance (psychomotor vigilance test and number of safety accidents), and daily subjective measures of stress, mood, and family dynamics. All measures were conducted over a 14-day assessment interval and to date were collected among 186 firefighters (10% female). Study outcomes on an individual level and in aggregate form were shared with all participants. A subset of participants was invited to participate in interviews to provide feedback on data presentation format and style, including its digestibility and potential for behavioral change. Interviews were recorded, transcribed, and analyzed using NVivo 12 Plus.

Results: Participants provided feedback on the data presentation, with the majority expressing a preference for clear, actionable information that could potentially lead to changes in behavior. Among the outcomes presented on the individual level, optimum sleep schedules and related practices were the most discussed among participants. They suggested using color-coded results to allow easier and quicker interpretation of the severity of results (e.g., red = the need for more sleep). For data on the aggregate level of outcomes, the need to address call volume was the most relevant topic discussed, with additional considerations for organizational programs and policies to address more comprehensively the mental and physical health needs of firefighters.

Conclusion: This study offers comprehensive data from a Total Worker Health (TWH) perspective on the impact of shiftwork on firefighters and their families. It also illustrates how researchers and firefighters can collaborate to implement evidence-based strategies when disseminating outcomes and making crucial decisions about shift schedule reforms and related sleep interventions. These efforts aim to enhance research uptake with attention to firefighters' overall health, safety, and work-life continuum. Support (if any): This work was supported by NIOSH grant number U19OH010154 and by the Institute via funds from the Division of Consumer and Business Services, Oregon (ORS 656.630).

ID: 79

Occupational Stress and the Occurrence of Accidents Involving Biological Material Among Health Professionals: A Scoping Review

Tatiany Marques Bandeira, Thainá Souza Ribeiro, Greiciane da Silva Rocha, Suleima Pedroza Vasconcelos
Federal University of Acre, Rio Branco, AC, Brazil

Introduction: Workplace stress is defined as a set of psychological disturbances or mental suffering associated with work experiences, causing discomfort or affecting health. Among workers exposed to stress, health professionals experience excessive workloads in a context of pain, suffering, and death. Despite the relevance of this topic, studies investigating its relationship with the occurrence of needlestick injuries remain scarce. This study aims to map the publications on the effects of occupational stress influencing the occurrence of accidents involving biological material among health professionals.

Methods: This is a scoping review based on the systematic review method of the Joanna Briggs Institute (JBI). The review question was: "What are the effects of occupational stress as a precursor to accidents involving biological material among health professionals?" Searches were conducted in MEDLINE/PubMed, LILACS, CINAHL, Embase, Scopus, and Web of Science, filtering for articles in English, Portuguese, and Spanish without a time restriction.

Results: A total of 7,506 studies were identified, of which 97 were selected for full text reading, 42 were assessed for eligibility, resulting in a final sample of 15 potential studies for synthesis. The studies are both national and international in scope, using quantitative research approaches that highlight various effects of stress preceding accidents involving biological material, including lack of attention, lack of concentration, exhaustion, momentary distraction, judgment errors, and unsafe behavior.

Conclusion: Occupational stress is a state characterized by the wear and tear on the human body and a decrease in work capacity, producing various deleterious effects in the cognitive domain that lead professionals to engage in unsafe practices, particularly in handling sharp materials. Consequently, it contributes to the occurrence of accidents involving biological material. In this context, it is necessary to implement measures within health institutions by managers regarding this topic to prevent or reduce the incidence of this issue.

ID: 80

Simultaneity of Behavioral Risk Factors among Military Police Officers in the Western Amazon

Janielly Vilela Gonçalves, Tatiane Nogueira Gonzalez, Suleima Pedroza Vasconcelos
Federal University of Acre, Rio Branco, AC, Brazil

Introduction: Shift workers face challenges in maintaining healthy habits due to changes in their routines. Irregular work hours can lead to poor eating patterns, sedentary behavior, and compromised sleep quality. Additionally, the alternation between work and rest periods can disrupt the circadian rhythm, contributing to weight gain, obesity, and an increased risk of non- communicable chronic diseases. In this context, the aim of this study is to describe the prevalence and factors associated with the simultaneity of behavioral risk factors among military police officers in Rio Branco, Acre.

Methods: A cross-sectional study was conducted with 91 military police officers from two battalions, working in 12-hour on/24-hour off and 12-hour on/72-hour off shifts. Data

collection took place between December 2022 and July 2023 through a structured questionnaire administered by trained interviewers. Five modifiable risk factors for non-communicable chronic diseases were investigated: smoking, alcohol consumption, overweight, physical inactivity, and sleep quality. The simultaneity of risk behaviors was evaluated using a score from 0 to 5, assigning one point for each factor present. For analysis, the data were categorized into two groups: 0 to 1 risk factor and 2 to 5 risk factors, with the latter considered as the presence of simultaneity. The analyses were performed using Stata software, and the association between variables was tested using Fisher's exact test, adopting a 5% significance level.

Results: Nearly 84% of the police officers reported poor sleep quality, 72.5% were overweight, 30.8% were physically inactive and reported excessive alcohol consumption, and 3.3% were smokers. The presence of simultaneity of behavioral risk factors was observed in 76.9% of the officers. A significant association was found between the simultaneity of risk factors and variables such as sex, age, marital status, length of service as a military police officer, and perceived safety in the work environment.

Conclusion: These findings underscore the importance of developing specific public health strategies for shift workers, focusing on the prevention of non-communicable chronic diseases and the promotion of healthy habits, to improve the quality of life and well-being of this population.

ID: 81

Influences of Recovery Time and Time of Day on Sleep Duration Prior Work Shifts: Analysing Diary and Actigraphy Data From 14 Studies

John Axelsson[1], Göran Kecklund[1], Mikael Sallinen[2]
[1]Stockholm University, Stockholm, Sweden
[2]Finnish Institute of Occupational Health, Finland

Introduction: Flexible working hours are common and recovery times between shifts vary extensively. It seems obvious that shorter recovery times curtail sleep duration, but there is a poor understanding of how time of day affects this relationship.

Methods: The analyses were based on diary and actigraphy data from 328 subjects in 14 data collections at 11 work sites in Sweden, Finland and Australia, totally rendering data on 4000 sleep episodes. The recovery times between shifts were used to predict sleep duration before morning, evening and night shifts using multilevel mixed effects modeling.

Results: Sleep duration was strongly associated with recovery times between shifts, particularly before evening and night shifts (b=+.31 hours of total sleep time for each hour of recovery time, p=.012; and b=+.34 hours, $p < .001$, respectively). More recovery time before morning shifts was also a significant predictor of sleep duration (b=+.12 hours, $p < .001$), but this amount of sleep seemed more affected by schedule specific factors, e.g., the starting time of the morning shift. In addition, sleep duration was strongly affected by work site and individual differences.

Conclusion: Sleep duration prior shifts are curtailed by several factors including 1) short recovery times between shifts, 2) circadian influences (most dramatically shortened prior evening and night shifts), 3) shift specific aspects (e.g., change-over times), and 4) individual differences. It is recommended to avoid recovery times shorter than 12 hours off between shifts, since it drastically increases the number of workers having curtailed sleep.

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Differences in food intake and subjective perceptions of food between day and night shift workers over 24 hours

Nayara Bernardes da Cunha, Nowane Borges Alves Silva, Catarina Mendes Silva, Milena Ferreira Ramos, Gabriela Pereira Teixeira, Cibele Aparecida Crispim
Chrononutrition Research Group, Faculty of Medicine, Federal University of Uberlândia, Uberlândia, MG, Brazil

Introduction: Shift work is a common scheduling practice in contemporary society due to the ongoing demand for specific products and services throughout the 24-hour day. Research has established associations between shift work and the developing obesity and metabolic disorders, and the dietary intake during nighttime seems to increase the risk of these conditions. Nevertheless, it remains unclear if hunger, food preferences, and satiety differ between night workers and day workers. This study aimed to compare the daily patterns of dietary intake and subjective dietary perceptions among day and night workers. Our hypothesis suggests that night workers are more likely to concentrate their meals during the nighttime hours. Furthermore, it is expected that night workers would have a greater appetite for indulgent foods, which are typically high in fat, sugar, and sodium, compared to day workers.

Methods: A cross-sectional study was conducted with sixty workers (30-day workers and 30-night workers) employed in the healthcare sector at the Public Hospital in Uberlândia city, Minas Gerais State, Brazil. Dietary intake was assessed using a daily food record for an entire workday, accompanied by a Numerical Rating Scale used to measure subjective feelings of food satisfaction after each meal. To examine dietary intake throughout the day, the day was divided into four periods: P1 (6am - 10:59am), P2 (11am - 3:59pm), P3 (4pm - 8:59pm), and P4 (9pm - 5:59am). Generalized Estimated Equations (GEE) were employed to compare meal distribution throughout the day and subjective food perception for each meal among day and night shift workers.

Results: Night workers had higher energy intake ($p = 0.046$) during P4, along with an increase in calories derived from protein ($p = 0.035$), the corresponding percentage ($p < 0.001$), and calories derived from lipids ($p = 0.03$) compared to day workers. Furthermore, night workers showed a stronger preference for vegetables during the evening snack ($p < 0.001$) and a greater appetite for meat, eggs, and savory foods during the morning snack ($p < 0.001$ and $p = 0.007$, respectively) compared to day workers.

Conclusion: Night workers demonstrated higher night food consumption compared to day workers. Additionally, the subjective food perceptions of night workers exhibited minor variations from those of day workers. Further research is needed to gain a more comprehensive understanding of the long-term meal distribution patterns and appetite for various food groups throughout the day. Support: CNPq.

