Workload management in an external crisis

Recommendations for the work of nursing personnel

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Similar recommendations are also available for the work of rescue workers and paramedics, as well as for the work of nuclear industry control room operators and preparedness organization personnel:
www.ttl.fi/teemat/tyohyvinvointi-ja-tyokyky/tyokyky/tyokuormituksen-hallinta-ja-palautuminen-kriisissa

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1   Introduction

External crises challenge the well-being of employees, which also affects the workplace's resilience to crises. The purpose of these recommendations is to help health care workplaces draw up a concrete plan to prevent excessive strain in nursing personnel during an external crisis.

In a crisis, such as during a pandemic, the mental, social and physical strain caused by work is particularly intensified. In the health care sector, these effects are further emphasised by labour shortages. The employee's work-related strain and recovery are also influenced by their individual characteristics and life situation, as well as the nature of the work.

Workload can be managed by modifying the work and strengthening the employee's resources. Workload management is supported by the assessment of employee strain and recovery. These three areas will be discussed later in this document based on both research and experiential knowledge. The data was obtained from the Finnish Institute of Occupational Health's Workload Management in Safety-critical Work During an External Crisis project (www.ttl.fi/en/research/projects/work-stress-management-in-security-critical-work-during-emergency-conditions), in which the health care sector organization was represented by participants from the well-being services county of Kanta-Häme. The presented experiential knowledge is based on their views and assessments. In addition, the draft version of the recommendations has been reviewed by a wider group of health care experts.

2   Workplace accommodation

Workload can be managed by modifying work arrangements, working methods, and working practices. The measures include:

1. appropriate leadership, management, and information flow
2. ergonomic working practices that prevent physical overload
3. working time arrangements
4. rest break arrangements
5. clearly defined tasks, roles, and responsibilities
6. guidelines and checklists that support the work
7. plans for the use of facilities, patient flow and patient transfers
8. human resource planning

Table 1. Workload management measures related to work arrangements, working methods and working practices.

	Workload management measures related to work arrangements, working methods and working practices
1	**Appropriate leadership, management and information flow** prevent excessive strain caused by psychosocial factors in particular. When managing issues, it is important that the employees are familiar with the management relationships, information flow processes and the model by which their day-to-day work is managed. In leadership, encouragement and interaction are key. In information flow, regularity, transparency and the usefulness of shared information to the target group are important.
2	**Prevention of excessive physical strain** is emphasised in crisis situations where personnel use personal protective equipment and/or the work intensity increases significantly. Preventive measures include ergonomic solutions that reduce physical strain, as well as shorter shifts and increased rest breaks.
3	**Working time arrangements** can be used to prevent excessive strain in a comprehensive manner. Central working time characteristics include (some limit values in brackets): - the duration of shifts (max. 12 h) - the duration of the working period between two days off (up to 48 h) - the duration of time off between shifts (minimum 11 h and minimum 28 h after the last shift of a night shift period) - the number of consecutive shifts (maximum five shifts) - the number of consecutive night shifts (maximum three shifts)
4	**Rest break arrangements** provide comprehensive support for recovery during the work shift. A rest break should be taken before excessive fatigue, and it must offer the opportunity to detach from work. The frequency and duration of rest breaks must be proportionate to the requirements of the work.
5	**Clearly defined tasks, roles and responsibilities** can help prevent excessive strain caused by psychosocial factors in particular. Therefore, it is important that the employees are familiarized in advance with their tasks, roles, and responsibilities in a crisis situation.
6	**Guidelines and checklists** can be used to prevent excessive cognitive strain in particular. In terms of their level of detail, it is important to consider how clear and predictable the work situations are in a crisis situation. It is good to involve end users in the development of guidelines and checklists.
7	**With plans for the use of facilities, patient flow and patient transfers**, excessive strain can be prevented in a comprehensive manner. It is important that personnel are familiarized with these plans insofar as they relate to their work in a crisis situation.
8	**Human resource planning** can be used to prevent excessive strain in a comprehensive manner. In a crisis situation, the use of this measure is facilitated by having ready-made plans at the workplace for: - the tasks and roles of the personnel and their orientation - job rotation between more and less demanding tasks - float pool personnel and their orientation - the recruitment and orientation of additional personnel.

2.1 What do we know about leadership and information flow?

Based on the data and experiential knowledge, leadership and information flow practices are the best way to manage workload during crisis situations.

Leadership should focus on ensuring that senior management and supervisors

- are present among the employees
- support the performance of core tasks
- take into account the needs of the employees
- give encouraging feedback
- refer employees to mental health services, if necessary[1–3]

Communication that supports good information flow is

- timely
- regular
- clear
- concrete: practical and tailored to the target group
- transparent
- reliable[2,4–7]

Concrete communication means, for example, that the employees know what personal protective equipment needs to be used during a pandemic and how the equipment is used properly. Transparent communication means that facts and uncertainties relating to an external crisis are brought up and feedback and suggestions for improvement are requested from the personnel.

2.2 What do we know about working practices that prevent physical strain?

Experiential knowledge partially supports the idea that physical strain in a crisis situation can be prevented through ergonomic working practices. Challenges here are unpredictability and high time pressure.

So far, there is only limited research available on the effectiveness of this management measure in crisis situations. Especially when working in personal protective equipment, good ergonomics and sufficient rest breaks have been shown to reduce strain[8].

2.3 What do we know about other management measures?

Based on experiential knowledge, working time and recovery-promoting rest break arrangements, clear work tasks, roles, and responsibilities as well as guidelines and checklists that support the work are effective and feasible ways to manage workload in a crisis. In the event of pandemics and epidemics, it is good to have a plan on the use of facilities as well as patient flow and transfers between care units. So far, there is only limited research available on the association between these measures and employee well-being in a crisis situation.

Experiential knowledge also partly supports the use of human resource planning to manage workload in crisis situations. The effectiveness and feasibility of this measure are promoted by adequate orientation and defining crisis tasks in advance for each employee. The latter also allows crisis tasks to be practised in advance. There is limited research available on the link between this management measure and employee well-being.

3   Strengthening employees' resources

Workload can be managed by strengthening employees' resources before and during a crisis with the following means:

1. crisis training
2. ensuring professional competence and functional capacity
3. support provided by the workplace and the work community
4. methods that support mental health and well-being

Table 2. Workload management measures related to strengthening the employee's resources.

	Workload management measures related to strengthening the employee's resources
1	**Regular and sufficiently frequent crisis training** comprehensively prevents excessive strain in a crisis. The training can be carried out in • the real world • a simulator • a virtual learning environment • connection with a "classroom" or online training.
2	**Ensuring professional competence and functional capacity** in advance comprehensively prevents excessive strain in a crisis. The more flexibility an employee has in terms of resources, such as competence and the physical and psychosocial functional capacity required for the job, the more likely they are to avoid excessive strain in a crisis. In addition to crisis training, it is important that the workplace also supports the employee in maintaining competence and functional capacity in other ways. These include, for example, enabling on-the-job learning, providing training and encouraging exercise both at work and during free time.
3	**The support provided by the workplace and the work community** prevents excessive strain caused by psychosocial factors at work in particular. This support includes material, functional and emotional support. Workplace support also includes the provision of such working conditions in which the work can generally be performed without high time pressure and frequent unreasonable challenges.
4	**Mental health and well-being support** can prevent and reduce excessive strain caused by psychosocial factors at work in particular. These methods include training to support mental well-being, mental exercises, psychological briefing and debriefing, self-care and therapies. Organising this kind of support is part of what the workplace can do to support its employees in a crisis situation.

3.1 What do we know about crisis training?

Based on research and experiential knowledge, the most effective and feasible way to manage workload is to practise crisis situations regularly in advance, either in the real world or in virtual reality[9–13]. The practising can focus on, for example, working with personal protective equipment or typical curative measures in crisis situations.

3.2 What do we know about ensuring competence and functional capacity?

Experiential knowledge supports the idea that ensuring professional competence and functional capacity under normal conditions helps to manage workload in crisis situations. Research evidence also supports this notion in terms of competence. For example, knowledge and skills acquired in epidemics and other crisis situations, as well as previous experience, have been found to improve employees' preparedness to cope with subsequent crisis situations[4,9]. On the other hand, there is lack of research on the association between ensuring professional functional capacity and employee well-being during a crisis.

3.3 What do we know about support provided by the workplace and the work community?

Both research and experiential knowledge support the notion that the support provided by the workplace and the work community plays a significant role in employee well-being during a crisis[2,5,14,15]. The support provided by the workplace also includes the provision of working conditions that enable, for example, appropriate protection of personnel against pathogens in the event of a pandemic, participation in briefings, and preparation for encountering patients.

3.4 What do we know about mental health and well-being support?

There is some research evidence to support the use of the methods of mental health and well-being to strengthen the resources of health care personnel during external crises[16–19]. Evidence supports the benefits of, for example, mindfulness exercises and short-term cognitive-behavioural therapy. There is less evidence of the effectiveness of individual short training courses and psychological first aid[17,20].

The research data suggests paying special attention to the mental well-being of young and/or inexperienced employees, as well as employees with a history of mental health problems[21,22].

4   Assessing employee strain and recovery

Assessing the strain and recovery of personnel helps the workplace select and schedule management measures in a crisis. The assessment can be targeted at those employee groups whose duties change significantly in a crisis situation and/or whose contribution has a significant impact on the work community as a whole. Based on research and experiential knowledge, it is particularly important to assess the psychological workload of nursing staff.

In order to assess employee strain and recovery in a crisis situation, it is beneficial if the workplace has conducted a similar assessment before the crisis. This makes it easier to assess the additional burden caused by the crisis. However, assessments alone are not enough, as the workplace must have processes and procedures in place in order to utilise the assessment results.

Based on the research evidence, the key factors to be assessed include psychological and/or physical strain, sleep, as well as alertness and fatigue during the shift. Based on experiential knowledge, the most important factor to be assessed in a nurse's work is mental strain. The assessment can be based on, for example, surveys completed every 3–6 months and field measurements carried out in periods of 1–2 weeks at work and in free time. The most common surveys and field methods suitable for this purpose are described in Appendix 1. The employee can also choose to use smart devices available on the market to measure strain and recovery.

It is advisable for the employer to co-operate with occupational health care when assessing employee strain and recovery and utilising the results.

5 Recommendations for workload management

Based on experiential knowledge and research, it is recommended that health care sector work-places support the well-being of nursing personnel in crisis situations through workplace accom-modation and by strengthening the employees' resources. Preparing for crisis situations in ad-vance is essential because familiarising oneself with different workload management measures during a crisis is very challenging. In addition, some of the measures, such as crisis training, should be implemented before an actual crisis occurs.

Based on experiential knowledge, all the measures previously described in Tables 1 and 2 are at least reasonably effective and feasible. Of them, the following are recommended in particular:

Workload management measures based on workplace accommodation:

- **encouraging and interactive leadership**
- **regular, concrete, and transparent information flow and communication**
- recovery-promoting working time and rest break arrangements
- clearly defined tasks, roles, and responsibilities
- guidelines and checklists that support the work
- a plan for patient flow and transfers

Workload management measures based on strengthening the employee's resources:

- **regular crisis training in advance**
- **methods for supporting mental health and well-being**
- **support provided by the workplace and the work community**
- ensuring professional competence and functional capacity in a proactive manner

In the above list, the measures that are supported by research among nursing personnel are marked in **bold**.

Assessing employee strain and recovery in crisis situations through questionnaires and field measurements helps to create an overview of the personnel's situation and apply workload man-agement measures as effectively as possible. It is important for the workplace to have processes and procedures in place for utilising the results of the assessment.

6 Recommendations for creating a workplace-specific plan

In order to have an effective plan for managing workload in the event of a crisis situation, it is recommended that different levels and parties of the organization participate in its creation. The main principles of the plan are as follows:

- Management commits to the creation of the plan and organises the process.
- Different parties and organisational levels highlight key aspects from their point of view.
- The plan is produced as part of the management, occupational safety and health, and risk assessment processes and is compiled by a group appointed by the management.
- The plan is integrated into a broader crisis preparation protocol, such as the preparedness plan.

It is recommended that the plan includes at least the following:

- What is the purpose of the plan?
- Who does the plan apply to?
- Who is responsible for the plan?
- Who are informed about the plan?
- How is the plan updated?
- As concrete descriptions as possible of the workplace measures used to manage the workload in crisis situations. If necessary, the measures can be described separately for different crisis situations and occupational groups.
- Who is responsible for which management measures? For example, descriptions of who is responsible for preparatory crisis training and mental health and well-being support during a crisis.
- How are workload management measures integrated into the workplace's operations? For example, descriptions of how crisis training is integrated into a personnel training programme and how mental health and well-being support is integrated into occupational health collaboration.

Table 3 helps the workplace outline which workload management measures it will include in the plan. The plan should be so concrete that it can be used as a manual in a crisis.

Table 3. In the table, mark the workload management measures that are necessary and possible at your workplace in crisis situations. In addition, assess whether these measures are already in place or require further development. If development is required, assign a responsible party and determine the development schedule.

Management measure	Necessary and possible	In order	Requires development	Party responsible for development	Development schedule
WORKPLACE ACCOMMODATION MEASURES					
Appropriate leadership, management, and information flow					
Preventive ergonomic working practices					
Recovery-promoting working time and break arrangements					
Clearly defined tasks, roles, and responsibilities					
Guidelines and checklists that support the work					
Plans for the use of facilities and patient flow and transfers					
Human resource planning					
Other, please specify:					

Management measure	Necessary and possible	In order	Requires development	Party responsible for development	Development schedule
MEASURES TO STRENGTHEN THE EMPLOYEE'S RESOURCES					
Crisis training					
Ensuring professional competence and functional capacity					
Support provided by the workplace and the work community					
Methods for supporting mental health and well-being					
Other, please specify:					

7 References

1. Boone, L. D., Rodgers, M. M., Baur, A., Vitek, E., & Epstein, C. (2023). An integrative review of factors and interventions affecting the well-being and safety of nurses during a global pandemic. Worldviews Evid Based Nurs, 20(2), 107-115. doi:10.1111/wvn.12630

2. Curtin, M., Richards, H. L., & Fortune, D. G. (2022). Resilience among health care workers while working during a pandemic: A systematic review and meta synthesis of qualitative studies. Clin Psychol Rev, 95, 102173. doi:10.1016/j.cpr.2022.102173

3. Tolksdorf, K. H., Tischler, U., & Heinrichs, K. (2022). Correlates of turnover intention among nursing staff in the COVID-19 pandemic: a systematic review. BMC Nurs, 21(1), 174. doi:10.1186/s12912-022-00949-4

4. Lam, S. K. K., Kwong, E. W. Y., Hung, M. S. Y., Pang, S. M. C., & Chiang, V. C. L. (2018). Nurses' preparedness for infectious disease outbreaks: A literature review and narrative synthesis of qualitative evidence. J Clin Nurs, 27(7-8), e1244-e1255. doi:10.1111/jocn.14210

5. Poon, Y. R., Lin, Y. P., Griffiths, P., Yong, K. K., Seah, B., & Liaw, S. Y. (2022). A global overview of healthcare workers' turnover intention amid COVID-19 pandemic: a systematic review with future directions. Hum Resour Health, 20(1), 70. doi:10.1186/s12960-022-00764-7

6. Sirois, F. M., & Owens, J. (2020). Factors Associated With Psychological Distress in Health-Care Workers During an Infectious Disease Outbreak: A Rapid Systematic Review of the Evidence. Front Psychiatry, 11, 589545. doi:10.3389/fpsyt.2020.589545

7. Temeng, E., Hewitt, R., Pattinson, R., Sydor, A., Whybrow, D., Watts, T., & Bundy, C. (2023). Nurses' coping strategies caring for patients during severe viral pandemics: A mixed-methods systematic review. J Clin Nurs. doi:10.1111/jocn.16711

8. Zhang, X., Huang, D. S., & Guan, P. (2021). Nursing Scheduling Mode and Experience from the Medical Teams in Aiding Hubei Province During the COVID-19 Outbreak: A Systematic Scoping Review of 17 Studies. Risk Manag Healthc Policy, 14, 1805-1813. doi:10.2147/rmhp.S302156

9. Labrague, L. J., Hammad, K., Gloe, D. S., McEnroe-Petitte, D. M., Fronda, D. C., Obeidat, A. A., . . . Mirafuentes, E. C. (2018). Disaster preparedness among nurses: a systematic review of literature. Int Nurs Rev, 65(1), 41-53. doi:10.1111/inr.12369

10. Lee, H. J., Kim, E., Morse, B. L., & Lee, S. E. (2021). Barriers and Facilitators of Nurses' and Physicians' Willingness to Work during a Respiratory Disease Outbreak: A Mixed-Methods Systematic Review. Int J Environ Res Public Health, 18(13). doi:10.3390/ijerph18136841

11. Rodriguez-Arrastia, M., García-Martín, M., Villegas-Aguilar, E., Ropero-Padilla, C., Martin-Ibañez, L., & Roman, P. (2022). Emotional and psychological implications for healthcare professionals in disasters or mass casualties: A systematic review. J Nurs Manag, 30(1), 298-309. doi:10.1111/jonm.13474

12. Said, N. B., & Chiang, V. C. L. (2020). The knowledge, skill competencies, and psychological preparedness of nurses for disasters: A systematic review. Int Emerg Nurs, 48, 100806. doi:10.1016/j.ienj.2019.100806

13. Sierra-García, E., Sosa-Palanca, E. M., Saus-Ortega, C., Ruiz-Hontangas, A., Juárez-Vela, R., & Gea-Caballero, V. (2022). Modulating Elements of Nurse Resilience in Population Care during the COVID-19 Pandemic. Int J Environ Res Public Health, 19(8). doi:10.3390/ijerph19084452

14. De Brier, N., Stroobants, S., Vandekerckhove, P., & De Buck, E. (2020). Factors affecting mental health of health care workers during coronavirus disease outbreaks (SARS, MERS & COVID-19): A rapid systematic review. PLoS One, 15(12), e0244052. doi:10.1371/journal.pone.0244052;

15. Labrague, L. J. (2021). Psychological resilience, coping behaviours and social support among health care workers during the COVID-19 pandemic: A systematic review of quantitative studies. J Nurs Manag, 29(7), 1893-1905. doi:10.1111/jonm.13336

16. Ding, X., Jian, Z., Xu, Y., Lin, Z., Chen, Z., Zhang, Y., . . . Du, H. (2022). Psychological stress and coping strategies among frontline healthcare workers supporting patients with coronavirus disease 2019: a retrospective study and literature review. Ther Adv Respir Dis, 16, 17534666221130215. doi:10.1177/17534666221130215

17. Ottisova, L., Gillard, J. A., Wood, M., Langford, S., John-Baptiste Bastien, R., Madinah Haris, A., . . . Robertson, M. (2022). Effectiveness of psychosocial interventions in mitigating adverse mental health outcomes among disaster-exposed health care workers: A systematic review. J Trauma Stress, 35(2), 746-758. doi:10.1002/jts.22780

18. Raphael, J., Winter, R., & Berry, K. (2021). Adapting practice in mental healthcare settings during the COVID-19 pandemic and other contagions: systematic review. BJPsych Open, 7(2), e62. doi:10.1192/bjo.2021.20

19. Kunzler, A. M., Chmitorz, A., Röthke, N., Staginnus, M., Schäfer, S. K., Stoffers-Winterling, J., & Lieb, K. (2022). Interventions to foster resilience in nursing staff: A systematic review and meta-analyses of pre-pandemic evidence. Int J Nurs Stud, 134, 104312. doi:10.1016/j.ijnurstu.2022.104312

20. Schoultz, M., McGrogan, C., Beattie, M., Macaden, L., Carolan, C., Polson, R., & Dickens, G. (2022). Psychological first aid for workers in care and nursing homes: systematic review. BMC Nurs, 21(1), 96. doi:10.1186/s12912-022-00866-6

21. Caruso, R., Annaloro, C., Arrigoni, C., Ghizzardi, G., Dellafiore, F., Magon, A., . . . Villa, G. (2021). Burnout and post-traumatic stress disorder in frontline nurses during the COVID-19 pandemic: a systematic literature review and meta-analysis of studies published in 2020. Acta Biomed, 92(S2), e2021428. doi:10.23750/abm.v92iS2.11796

22. Blanco-Daza M, de la Vieja-Soriano M, Macip-Belmonte S, Tercero-Cano MDC. Posttraumatic stress disorder in nursing staff during the COVID-19 pandemic. Enferm Clin (Engl Ed). 2022 Mar-Apr;32(2):92-102. doi: 10.1016/j.enfcle.2021.10.006.

APPENDIX 1 Methods for assessing employee strain and recovery

The tables in the appendix have been prepared by the Finnish Institute of Occupational Health's working group Satu Mänttäri, Janne Halonen, Mikael Sallinen, Maria Sihvola and Pihla Säynäjäkangas.

Questionnaires and field methods for assessing mental strain

The superscript numbers refer to the references list at the end of the appendix.

Method	Description
QUESTIONNAIRES	
General Health Questionnaire 12[1]	A questionnaire for assessing mental strain, well-being and functional capacity. Filling out the survey is quick, and the total score is easy to calculate. No special training is required to use the survey. Available free of charge in Finnish.
Need for Recovery[2]	A questionnaire for assessing recovery from work at a general level. Predicts perceived health relatively well over the next few years, for instance. Filling out the survey is quick, and the total score is easy to calculate. No special training is required to use the survey. Available free of charge in Finnish.
FIELD METHODS	
NASA Task Load Index[3]	A relatively easy-to-use self-assessment tool that can mainly be used to assess the situational psychological and physical workload caused by the work during the shift. The data can be collected either with a smartphone, for example, or by the traditional pen-and-paper method. Available free of charge in Finnish.
Heart rate and heart rate variability measurement[4]	An easy-to-use and relatively inexpensive measurement method that is suitable for measuring over long periods of time and several people at the same time. Threshold values have been defined, but the interpretation of the results requires expertise. The measurement does not pose an occupational safety risk, and the method is also suitable for demanding work environments.

Questionnaires and field methods for assessing physical strain

The superscript numbers in the Method column refer to the references list at the end of the appendix.

Method	Description
SURVEY	
Work Ability Index[5]	A comprehensive questionnaire that covers different areas of work ability. Can also be used in conjunction with physical strain assessment to describe individuals' work ability. Filling out the survey is quick, and the total score is easy to calculate. No special training is required to use the questionnaire.
FIELD TEST METHODS	
Borg Rating of Perceived Exertion[6]	A reliable self-assessment method for measuring physical exertion and fatigue. The method is very easy to use and practically free. Available in Finnish.
Heart rate and heart rate variability measurement[4]	An easy-to-use and relatively inexpensive measurement method that is suitable for measuring over long periods of time and several people at the same time. Threshold values have been defined, but the interpretation of the results requires expertise. The measurement does not pose an occupational safety risk, and the method is also suitable for extremely demanding work environments.
Physical activity measurement	An easy-to-use method that is well suited for use in the work environment. Recommended for use with other physiological measurements. When used correctly, it also measures the physical requirements of the job. Various commercial measuring devices are available. The privacy protection of the collected data may vary depending on the device and its manufacturer.

Questionnaires and field methods for sleep assessment

The superscript numbers in the Method column refer to the sources in the references list below the tables.

Method	Description
SURVEY	
Pittsburgh Sleep Quality Index[7]	The most used questionnaire for measuring sleep quality. The questionnaire takes 5–10 minutes to complete. The scoring is easy, and threshold values for sleep quality are available. The Finnish version is subject to a fee.
Jenkins Sleep Scale[8]	Used to identify sleep problems. An effective and short questionnaire (four questions) that is easy to score. Threshold values for assessing sleep problems are available. A Finnish version is available.
Insomnia Severity Index[9]	Used to assess the severity of insomnia. The questionnaire is quick (seven or eight questions) and easy to score. Threshold values for assessing insomnia are available. A Finnish version is available.
Basic Nordic Sleep Questionnaire[10]	Used to obtain an overview of sleep and associated symptoms. Includes 21 questions.
FIELD METHODS	
Sleep diary[11]	An easy-to-use and practically free method. Suitable for measuring large groups of people. Accuracy depends on the subject's motivation and memory, so pairing it with an objective method is recommended.
Accelerometer-based activity monitors or actigraphs[12]	A widely used method for measuring sleep. The devices are relatively inexpensive and suitable for long-term measurements. Analysing and interpreting the results requires expertise.
Wearable smart devices	Various commercial measuring devices are available. The devices are easy to use, relatively inexpensive and suitable for measuring long periods of time and several people at the same time. No separate training is required for the measurement process and analysing the results. The reliability and accuracy of the measurement and privacy protection may vary depending on the device and manufacturer.

Field methods and mathematical modelling methods for assessing alertness and fatigue during work shifts

The superscript numbers in the Method column refer to the references list at the end of the appendix.

Method	Description
FIELD TMETHODS	
Karolinska Sleepiness Scale[13]	An easy-to-use and free method for the self-assessment of situational alertness (sleepiness) during a work shift. Also suitable for measuring large groups and several people at the same time. Can be used for different types of jobs, either with a smartphone app or the traditional pen-and-paper method. Available free of charge in Finnish.
Samn-Perelli Fatigue Scale[14]	An easy-to-use and free method for the self-assessment of situational fatigue during a work shift. Also suitable for measuring large groups and several people at the same time. Can be used for different types of jobs, either with a smartphone app or the traditional pen-and-paper method.
Psychomotor Vigilance Task[15]	Measures situational alertness and psychomotor reaction speed. The usability may be impaired by the fact that the duration of the vigilance task varies between three and ten minutes, depending on the test version. The test requires commercial software and a measuring device.
MATHEMATICAL MODELLING METHODS	
Sleep, Activity, Fatigue, and Task Effectiveness[16]	The method predicts alertness during work shifts based on their start and end times. The method is based on a so-called three-process model that consists of the relationship between sleep and wakefulness, the time of day and sleep inertia. The method has been validated in laboratory and field studies.
Fatigue Audit Inter Dyne[16]	The method predicts fatigue during work shifts based on their start and end times. The method is based on a so-called two-process model that consists of the relationship between sleep and wakefulness and the time of day.

References of the appendix 1

1. Goldberg, D. P., Williams, P. (1988). A Users' Guide To The General Health Questionnaire. London: GL Assessment.

2. van Veldhoven, M., Broersen, S. (2003). Measurement quality and validity of the "need for recovery scale". Occup Environ Med, 60 (Suppl 1):i3-9.

3. Hart, S., G., Staveland, L., E. (1988). Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. In: Hancock, P. and Meshkati, N., Eds., Human Mental Workload, North Holland, Amsterdam, 139-183.

4. Shaffer, F, Ginsberg, JP. (2017). An Overview of Heart Rate Variability Metrics and Norms. Front. Public Health, 28;5:258.

5. Rautio, M., Michelsen, T. (2013). TKI - MITEN KÄYTÄT TYÖKYKYINDEKSI-KYSELYÄ. Työterveyslaitos

6. Williams, N. The Borg Rating of Perceived Exertion (RPE) scale. (2017). Occup Med. 2017; 67(5):404–405.

7. Buysse, D. J., Reynolds, C. F., Charles, F., Monk, T. H., Berman, S. R., Kupfer, D. J. (1989). The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res, 28 (2), 193–213.

8. Jenkins, C. D., Stanton, B. A., Niemcryk, S. J., Rose, R. M. (1988). A scale for the estimation of sleep problems in clinical research. J Clin Epidemiol, 41(4), 313–321.

9. Morin, C.M., Belleville, G., Bélanger, L., Ivers. H. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. Sleep, 2011;34:601-8.

10. Partinen, M., Gislason, T. (1995). Basic Nordic Sleep Questionnaire (BNSQ): a quantitated measure of subjective sleep complaints. J Sleep Res, 4(S1):150-155.

11. Carney, C.E., Buysse, D.J., Ancoli-Israel, S., Edinger, J.D., Krystal, A.D., Lichstein, K.L., Morin, C.M. The consensus sleep diary: standardizing prospective sleep self-monitoring. Sleep, 2012,35(2):287-302.

12. Fekedulegn, D., Andrew, M.E., Shi, M., Violanti, J.M., Knox, S., Innes, K.E. Actigraphy-Based Assessment of Sleep Parameters. Ann Work Expo Health, 2020 ;64(4):350-367.

13. Åkerstedt, T., Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. Int J Neurosci, 52(1-2):29-37.

14. Samn, S. W., L. P. Perelli. (1982). Estimating aircrew fatigue: a technique with application to airlift operations. Brooks AFB, Texas: USAF School of Aerospace Medicine. Report SAMTR-82-21.

15. Basner, M., Dinges, D.F. (2011). Maximizing sensitivity of the psychomotor vigilance test (PVT) to sleep loss. Sleep, 34(5): 581–591.

16. Dawson, D., Ian Noy Y., Härmä, M., Åkerstedt, T., Belenky, G. Modelling fatigue and the use of fatigue models in work settings. (2011). Accid Anal Prev, 43(2):549-64.