Työterveyslaitos | Arbetshälsoinstitutet
Finnish Institute of Occupational Health

Workload management in an external crisis

Recommendations for the work of firefighters and paramedics

Mikael Sallinen
Anne Punakallio
Janne Halonen
Irmeli Pehkonen
Maria Sihvola

Finnish Institute of Occupational Health

P.O. Box 40
00251 Helsinki

www.ttl.fi

Authors: Mikael Sallinen, Anne Punakallio, Janne Halonen, Irmeli Pehkonen ja Maria Sihvola

The project received funding from the Finnish Work Environment Fund

Työsuojelurahasto
Arbetarskyddsfonden
The Finnish Work Environment Fund

INDEX

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

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 assist the workplaces of the rescue and emergency medical services to draw up a concrete plan to prevent excessive strain, especially in firefighters and paramedics, during an external crisis.

During crisis, which can be caused by, for example, extreme weather or a pandemic, the psychosocial, physical, and working time related workloads increase. This is a result of, among other things, the increased number and complexity of emergency tasks, their longer duration and shorter recovery periods. Employee strain and recovery are also influenced by 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 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/workload-management-in-safety-critical-work-during-an-external-crisis), in which the participants included rescue and emergency services representatives from the Helsinki City Rescue Department and the Southwest Finland Emergency Services, as well as the Ministry of the Interior. In addition, the draft version of the recommendations has been reviewed by a wider group of rescue and emergency care experts.

2 Job accomodation

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 strain
3. working time arrangements
4. rest break arrangements
5. clearly defined tasks, roles and responsibilities
6. guidelines and checklists that support the work
7. 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, for example, the number and complexity of emergency tasks increase, as do their duration and intensity. The latter is due to the handling of heavy loads and tools as well as exposure to hot or cold conditions. The use of personal protective equipment increases strain. 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 (≤ 12/24 h) • the working period between days off (≤ 48 h) • the duration of time off between shifts (≥ 11 h and ≥ 28 h after the last shift of a night shift period) • the number of consecutive shifts (≤ 5) and night shifts (≤ 3).
4	**Rest break arrangements** provide comprehensive support for recovery during the work shift. A break should be taken before excessive fatigue, and it must offer the opportunity to detach from work. The frequency and duration of 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 familiarised 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 during crisis. It is good to involve end users in the development of guidelines and checklists.
7	**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 job accommodation

Based on experiential knowledge, all of the previously-mentioned work-directed management measures are at least reasonably effective and viable in preventing excessive workload in both rescue workers and paramedics in crisis situations.

Based on experiential knowledge, the following aspects are emphasised in the work of a fire-fighter

- appropriate leadership, management and information flow
- working time and rest break arrangements
- clearly defined tasks, roles and responsibilities

Based on experiential knowledge, the following aspects are emphasised in the work of a para-medic

- appropriate leadership, management and information flow
- guidelines and checklists that support the work

There is insufficient research evidence available on the use of these workload management measures in crisis situations to be able to assess their effectiveness properly. However, similar re-search is available on nurses. Based on that research, excessive strain can be prevented in crisis situations with appropriate leadership and information flow practices in particular. In leadership, it is important that senior management and supervisors are present among the employees, pay attention to their needs, give encouraging feedback and, if necessary, refer them to mental health services[1,2,3]. Communication that supports good information flow is timely, regular, clear and con-crete (practical and tailored to the target group), as well as transparent and reliable[2,4,5,6,7].

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 during 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 during 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 supporting 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 psycho-social 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 strengthening the employee's resources?

Based on experiential knowledge, all of the above measures can be used to manage the workload of firefighters and paramedics in crisis situations. For both occupational groups, crisis training, ensuring professional competence and functional capacity, and the support provided by the workplace and the work community are emphasised as measures to manage workload in a crisis situation.

Research evidence on paramedics, as well as other health care professionals, supports the notion of the importance of crisis training for coping with crisis situations[8, 9,10,11,12,13]. There is less research available on firefighters. So far, there is little research available on the significance of ensuring professional competence and functional capacity under normal conditions for crisis situations in the rescue and emergency medical services sectors.

Some evidence is available on the benefits of mental health and well-being support, such as psychological debriefing and cognitive-behavioural therapy, in strengthening an employee's mental resources in crisis situations in frontline rescue and healthcare workers[14,15]. Research evidence on health care professionals as a whole supports this notion[16,17,18,19]. A key issue is the availability of support in its various forms in crisis situations.

According to research in the health care sector, the support provided by the workplace and the work community also strengthens employees' resources in crisis situations[2,5,20,21]. This support includes material, functional and emotional support. Together, they reduce the workload and prevent the unfavourable effects of the increased workload on the employee. Based on experiential knowledge, working in teams or pairs in particular and the associated sense of togetherness strengthen the support provided by the work community in firefighters and paramedics.

4 Assessing employee strain and recovery

Assessing the strain and recovery of personnel helps the workplace select and schedule management measures in crisis situations. 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.

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 situation. 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 experiential knowledge, the main challenge in assessing employee strain and recovery in a crisis situation in the rescue and emergency medical services sectors is not only collecting the data but also using the results effectively. One solution is to assess the workload of different tasks in normal conditions. This data can be used to plan the work of rescue and emergency medical service units in crisis situations.

Based on general research evidence, the key factors to be assessed include mental and/or physical strain, sleep, as well as alertness and fatigue during the shift. Based on experiential knowledge, the most important factors to be assessed in the work of firefighters and paramedics are mental and physical strain. The assessment can be based on, for example, questionnaires completed every 3–6 months and field measurements carried out in periods of 1–2 weeks at work and in free time. Some questionnaires and field methods suitable for this purpose are described in Appendix 1. In addition, 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 workplaces support the well-being of firefighters and paramedics in crisis situations through job accommodation and by strengthening the employees' resources. Preparing for crisis situations in advance 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 of the measures described in Tables 1 and 2 are at least reasonably effective and feasible in preventing excessive strain in firefighters. Of them, the following are recommended in particular:

- appropriate leadership, management, and information flow
- working time and rest break arrangements that enable recovery
- clearly defined tasks, roles and responsibilities
- regular crisis training in advance
- ensuring professional competence and functional capacity in a proactive manner
- support provided by the workplace and the work community

Corresponding workload management measures for paramedics include:

- appropriate leadership, management, and information flow
- guidelines and checklists that support the work
- regular crisis training in advance
- ensuring professional competence and functional capacity in a proactive manner
- support provided by the workplace and the work community

Of these management measures, crisis training has been especially studied among frontline workers. These results support the notion of the usefulness of crisis training.

In addition to the above-mentioned workload management measures, research supports the recommendation that the methods of mental health and well-being support suitable for the work of firefighters and paramedics are utilised. These methods can mitigate the unfavourable effects that increased workload has on well-being in a crisis situation.

Assessing employee strain and recovery and utilising the results in a crisis situation can be challenging. One solution is to assess the workload of different tasks in normal conditions and subsequently use the results to plan the work of rescue and emergency medical service units in crisis situations.

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 organisation 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 partis and organizational 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 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 situation.

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
JOB 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					
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. Baetzner AS, Wespi R, Hill Y, Gyllencreutz L, Sauter TC, Saveman BI, Mohr S, Regal G, Wrzus C, Frenkel MO. (2022). Preparing medical first responders for crises: a systematic literature review of disaster training programs and their effectiveness. Scand J Trauma Resusc Emerg Med. 24;30(1):76. doi: 10.1186/s13049-022-01056-8.

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. Palmer J, Ku M, Wang H, Crosse K, Bennett A, Lee E, Simmons A, Duffy L, Montanaro J, Bazaid K. (2022). Public health emergency and psychological distress among healthcare workers: a scoping review. BMC Public Health. 20;22(1):1396. doi: 10.1186/s12889-022-13761-1.

15. Winders WT, Bustamante ND, Garbern SC, Bills C, Coker A, Trehan I, Osei-Ampofo M, Levine AC; GEMLR. (2021). Establishing the Effectiveness of Interventions Provided to First Responders to Prevent and/or Treat Mental Health

Effects of Response to a Disaster: A Systematic Review. Disaster Med Public Health Prep. 15(1):115-126. doi: 10.1017/dmp.2019.140.

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. 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;

21. 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

22. van Veldhoven, M., & Broersen, S. (2003). Measurement quality and validity of the "need for recovery scale". Occup Environ Med, 60 (Suppl 1):i3-9. doi: 10.1136/oem.60.suppl_1.i3.

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

24. 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. doi.org/10.1016/S0166-4115(08)62386-952.

25. Borg, G., A. (1982). Psychophysical bases of perceived exertion. Med Sci Sports Exerc, 14(5):377-81.

26. 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 Research, 28 (2), 193–213.

27. Partinen M., & Gislason, T. Basic Nordic Sleep Questionnaire (BNSQ): a quantitated measure of subjective sleep complaints. J Sleep Res. 1995 Jun;4(S1):150-155. doi: 10.1111/j.1365-2869.1995.tb00205.x.

28. Åkerstedt, T., & Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. Int J Neurosci, 52(1-2):29-37. doi: 10.3109/00207459008994241.

29. Dawson D, Ian Noy Y, Härmä M, Akerstedt T, Belenky G. Modelling fatigue and the use of fatigue models in work settings. (2011). Accid Anal Prev. 43(2):549-64. doi: 10.1016/j.aap.2009.12.030.

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 questionnaire is quick, and the total score is easy to calculate. No special training is required to use the questionnaire. 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 questionnaire is quick, and the total score is easy to calculate. No special training is required to use the questionnaire. 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	Descrition
QUESTIONNAIRE	
Work Ability Index[5]	A comprehensive questionnaire that covers different areas of work ability. Can be used in conjunction with physical workload assessment to describe individuals' work ability. Filling out the questionnaire 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
QUESTIONNAIRES	
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 METHODS	
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, J.P. (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., Perelli, L.P. (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.