National Research Centre for the Working Environment (NFA)

International Evaluation of Academic Impact 2020-2023

Report from an international expert panel, October 2024.

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Executive summary

The Danish *National Research Centre for the Working Environment* (NFA) is an independent research institute under the Danish Ministry of Employment, conducting research as well as counselling to the authorities, research dissemination, and researcher education. This evaluation comprises the academic quality and relevance of NFA's activities in the period 2020-2023. It addresses NFA's performance and aims to help improvement. It was performed by an international expert panel appointed by the Board of Governors of the NFA, and based on background material provided by the NFA, bibliometric data from Web of Science, review of a selection of NFA's publications, and interviews with NFA staff.

The panels conclusions are generally very positive. The research at NFA is highly relevant to occupational health issues as outlined in the national goals and strategies as well as according to NFA's strategy and different research programmes. Overall, the volume and citation impact of NFA's scientific output is high compared to five organizations in the same area of research in other countries, for which we have comparative data. Moreover, NFA researchers are active in national and international scientific communities within the different areas, including extensive international co-authorship. They participate in international research collaborations on specific projects and overall, the international research collaboration is high and adequate. As for education, NFA contributes well to educate future occupational safety and health researchers through supervision of master- and PhD-students. Keeping up the involvement in teaching activities is still challenging.

NFA's strengths: Research at NFA is generally excellent and of relevance for the field. The scientific output of the NFA is high, also in high level journals, when considering the number of researchers at the centre. NFA clearly has the highest profile in selecting good quality journals among all six organisations on which we have collected data. Furthermore, NFA has systematic working methods and processes that ensure a high scientific quality, and all research units strive to focus their research on issues that are of relevance to occupational health in Denmark and internationally. This is achieved by building relationships with key stakeholders in the community and industry to help define key issues and research questions.

NFA's challenges: Developing research lines and retaining staff are key concerns and challenges for the NFA in the years ahead. Continuously applying for funding is fundamental to the NFA's research operation. Topics of grant applications are often determined by the particular funders, they are not necessarily the topics of key stakeholders and the national strategy, and the NFA needs to handle these potential tensions when developing research lines and recruiting staff. It can furthermore be a challenge to retain talented researchers, as researchers can be frustrated by the constant struggle for funding and find it difficult to acquire the needed funds for developing their research topics. There are also general challenges related to PhD education outside universities, and career development support at the post-doc level appears scant, as do the support infrastructures for grant submissions, ethics/GDPR and data use agreements.

The panel's key recommendations include:

- Continue pushing for high research quality standards and providing a good environment for scientific discourse. Contributions to international conferences should continue to be highly encouraged. Journal selection should depend more on quality and relevance than on Journal Impact Factors. It is also preferable to monitor direct citations of articles rather than looking at citation impacts of journals.

- To enhance relevance: (1) Increase cross-disciplinary work/collaboration across NFA programmes, (2) strengthen collaboration with relevant Nordic universities and agencies, (3) and with Danish hospitals and clinics, and develop research/expand expertise on (4) effects of AI on occupational health and safety, (5) intervention research and implementation science including stakeholder involvement (6), and increasingly incorporate economic research in all areas.
- Introduce systematic mentoring of postdocs and junior researchers, and facilitate a PhD network across NFA.
- Introduce measures to help project initiation and implementation, including access to seed money and professional assistance in grant writing/submissions, ethical applications and the establishment of data use agreements.

1. Background of the evaluation

1.1 Objectives and Terms of Reference

The Danish *National Research Centre for the Working Environment* (NFA) is an independent research institute under the Danish Ministry of Employment. Its core tasks include research, dissemination of research, researcher education and counselling and services to the authorities. The research strategies, programmes and organisation of NFA are described in Chapter 2.

The aim of this evaluation is to learn from and improve NFA's institutional performance. The Terms of Reference for the evaluation asks for assessments of the academic quality and relevance, for the period 2020-2023, and for recommendations for improvements, covering NFA's research, research dissemination, and education:

- "To assess the academic quality and relevance of NFA's research, research dissemination, and education.
- To provide specific recommendations on how NFA can strengthen the quality, relevance, and academic impact of its research, research dissemination, and education."

The ToR furthermore asks for the following questions to be addressed:

"Research:

- Is the research's academic quality of a high standard and scope compared to similar research groups nationally and internationally?
- To what extent is the research focused on solving relevant and prioritized occupational health issues outlined in NFA's research programs?
- To what extent are themes in NFA's research programs and project portfolio within NFA's research areas - both applied and funded - aligned with priorities in strategic frameworks such as, national agreements and strategies,
- To what extent are the research-related networks and connections with strong research communities at universities and other research institutions in Denmark and abroad relevant and sufficiently developed?

Research Dissemination:

- Do researchers participate adequately in the most relevant conferences and other forums for international knowledge exchange and professional debate?
- Do researchers participate adequately in international research collaboration on specific projects?

Education:

- Does NFA contribute adequately to the education of undergraduates, post-graduates and Ph.D. students in the field of occupational safety and health, thus also contributing to educate future occupational safety and health researchers?
- Does NFA contribute adequately to teaching at universities, in the joint Nordic education of researchers, at other seminars, etc.?"

The full Terms of Reference for the review are in Appendix 1. The societal impact of NFA's consulting and services is evaluated in a separate report.[1]

1.2 The composition and work of the evaluation panel

The Board of Governors of the NFA appointed an international panel to conduct the evaluation, consisting of:

- Liv Langfeldt (Chair of the panel), Research Professor, NIFU - Nordic Institute for Studies in Innovation, Research and Education. Oslo, Norway
- Judy Arnetz, Professor, Department of Family Medicine, Michigan State University, Michigan, USA
- Jenny Selander, Associate Professor, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden
- Gunnar Sivertsen, Research Professor, NIFU - Nordic Institute for Studies in Innovation, Research and Education, Oslo, Norway
- Emile Tompa, Senior Scientist, Institute for Work and Health, Toronto, Canada
- Jens Wahlström, Associate Professor, Department of Public Health and Clinical Medicine, Umeå University, Sweden

Christina Drange (Research Assistant, NIFU) served as secretary to the evaluation panel.

The panel was formally appointed December 2023 and has had seven digital panel meetings as well as a two-day meeting with the NFA in Copenhagen (10-11 June 2024).

1.3 The evaluation procedure and criteria

A major focus in the panel's work has been to assess NFA's academic performance in its relevant comparative contexts, i.e. comparing within fields of research, and taking into account changes in the NFA research portfolio. The panel has combined qualitative peer review and professional bibliometrics with the aim to provide "informed peer review" and to be in line with the DORA Declaration (https://sfdora.org/) and the Leiden Manifesto (http://www.leidenmanifesto.org/).

The panel assigned responsibilities for assessing the NFA's research programmes among its members according to key competencies. This also included some cross-reading to cover interdisciplinary work.

The criteria and principles for assessments included:

- *General criteria for evaluating the research programmes:* The key criteria for evaluating the research have been its contribution to the field of research and the international academic literature, i.e., its importance for the field in filling gaps, developing new methods or perspectives and moving the field forward, and the research's importance for society (in terms of addressing topics in the National strategy for working environment research). The assessments are based on reading of selected publications, publication and dissemination lists, research programmes and

[1] Lavis JN, Saunders R & Lykke M (2024): International evaluation of the societal impact of NFA.

project portfolio, and the criteria are adapted to the individual research programmes/units.

- Criteria for evaluating *research collaboration and dissemination*: For evaluating collaboration and dissemination, we have considered scope and relevance of local, national and international collaboration, participation in key networks in the relevant fields, and presentations at relevant/key conferences.
- Criteria/principles for evaluating *researcher education*: In assessing the NFA's educational activities we have taken into account that it is not a higher education institution and that teaching is an add on role for researchers that serves as an entry for them to identify, recruit and mentor new researchers with the intent of building capacity for applied research in areas related to NFA research programmes.
- Methods and standards/principles for the *bibliometric analyses*: NFA is compared to five similar organizations in other countries with regard to the field-normalized citation impact of the scientific articles and their journal profile. External co-authorships are used to describe the major collaborating institutions and countries. The indicators used are explained in Chapter 3.1.

1.4 Documentation and material for the evaluation

Relevant background material was provided by the NFA, including:

- NFA's by-laws
- Evaluation reports on scientific and societal impact for the period 2014-19 and the board's follow-up statements (2021 and 2022)
- National occupational safety and health agreements and strategies for the evaluation period
- NFA's Institutional Strategy 2020, Institutional Strategy 2021-2024, communication strategy, and research-to-practice strategy
- NFA's research programmes 2020-2023
- NFA's performance management contracts 2020-2023
- NFA's action plans for research programmes 2022-2023
- List of publications from 2020-2023
- Data on NFA's portfolio of funding applications and funding allocations
- NFA's annual reports and annual statements for the evaluation period

Register data 2020-2023 by research programme included:

- List of Employees
- List of lectures/talks
- Researcher education: List of courses taught and members of assessment committees (Ph.D.)
- List of PhD projects, bachelor's and master's theses
- List of conference contributions
- Peer reviewed articles
- Peer reviewed reports
- Journal articles (not peer-reviewed)
- Other publications
- Collaborations and networks

Full list of provided material is in Appendix 2.

Reviewed publications: The panel asked the NFA to identify the publications from the evaluation period which they consider to be the most important contributions, including up to 10 publications per research programme. The list of reviewed publications and the criteria of selection are in Appendix 3.

Interviews, Copenhagen, 10-11 May 2024, comprising:

- NFA's director and deputy director
- The four Heads of Research Programmes at NFA
- Four senior staff members Working environment economics (WEE)
- Five senior staff members Chemistry and microbiology (C&M)
- Three senior staff members Accidents and Safety Culture (A&SC)
- Five senior staff members Psychosocial Working Environment (PWE)
- Four senior staff members Ergonomic Working Environment and Musculoskeletal Disorders (E&M)
- Five junior staff members
- Five PhD students

2. The National Research Centre for the Working Environment

2.1 NFA's aims and strategy

NFA' strategy for 2021-24 is outlined in a document from March 2021[2] that differs from the previous strategy document from December 2018[3] in two significant ways: The new strategy is much more elaborated than before, and it is more focused on societal relevance, collaboration and impact, and on intervention studies and on implementation of results from research. While the previous strategy was relatively more focused on research and its outputs, the new strategy expresses new developments in three pathways:

1. *Research* is still prioritized, however with an emphasis that it should be innovative, transdisciplinary and respond to societal needs. As examples, a goal is set to increase by 20 percent the research portfolio with interventions, associated impact, and process and economic evaluations, and to base all projects on stakeholder consultations. The four traditional thematic areas (chemical environment, ergonomic environment, accidents and safety, and psychosocial working environment) are still prioritized together with an increased attention to working environment economics.
2. A main change is the increased focus on *societal impact* with clear aims to achieve and measure increased activity and success in this dimension. The aim is also to develop new methods for societal impact management. As examples, a goal is set to increase societal communication in digital media by 80 percent and to improve societal impact in general by 20 percent. NFA also sets out to be a nationally and internationally recognized contributor to ideas and methods in research-to-practice approaches and research.
3. The third prioritized area is developing a more *sustainable organization* regarding external funding, research culture, and green technology and economy. As an example, an aim is to receive a minimum of 50 percent of the external grants from sources other than the Danish Working Environment Research Fund.

The Danish government has a national strategy for working environment research (2020)[4] that can be seen as reflected in NFA's present strategy. The national strategy highlights research on a high international level that provides a robust knowledge base that allows for evidence-based preventive measures. The same four main thematic areas are prioritized together with economic aspects of the working environment. It also asks for knowledge about what is done in the working places to implement the knowledge, and there is a new emphasis on implementation research and on societal interaction and dissemination of results.

The governmental strategy is reflected in NFA's strategy for *long-term effects:*

- Contributing, along with other actors, to identifying, exploring, preventing and dealing with current and future challenges and opportunities in the working environment in Denmark

[2] *Strategi for Det Nationale Forskningscenter for Arbejdsmiljø 2021-24*, *Marts 2021*: https://nfa.dk/om-nfa/nfas-strategi/afsaet-for-nfas-strategi/
[3] *Strategi for Det Nationale Forskningscenter for Arbejdsmiljø 2019-2022, December 2018*: https://nfa.dk/media/fa3dtlyo/nfas-strategi-2019-2022.pdf
[4] *National strategi for arbejdsmiljøforskning*, Beskæftigelsesministeriet, Oktober 2020: https://bm.dk/media/15268/strategi-for-arbejdsmiljoeforskning.pdf

- Supporting the fulfilment of national targets for the working environment
- Contributing to realizing the national research strategy for the working environment
- Creating societal impact by supporting the evidence base for the development of the working environment in Denmark.

The new emphasis on implementation research and on societal interaction in all phases of the research process, which we find in the current national strategy and in NFA's own strategy, probably demands more resources in terms of time and funding than traditional research projects conducted without the same attention to how they are followed up in practice. The implication is that scientific productivity in traditional terms (number of articles in leading journals) cannot be expected to increase. A wider set of criteria and indicators needs to be applied.

2.2 Previous evaluations

The previous evaluation of the NFA was completed in 2021. It concludes that the scientific quality of research produced by the NFA varies from very high to excellent. The evaluation states that the number of articles in international peer reviewed journals, as well as in journals with high impact factors is very high considering the number of researchers at the NFA. The previous evaluation also notes that the number of articles increased, as well as authorships and impact factor of the journals.

The 2021 evaluation also endorsed a recommendation from the evaluation before (2014), that the centre prioritise publishing more comprehensive articles, in order to contribute more to the advancement of knowledge. In addition, the previous evaluation suggests incorporating more qualitative indicators to better evaluate the quality of research at the centre.

The evaluation from 2021 argues that the research produced at the NFA is highly relevant to employees, as it concerns work-related health and safety issues. It further recommends that the centre strengthens its expertise in microbiology, general toxicology and occupational safety, as well as maintaining strong ties with clinical occupational medicine.

Regarding the dissemination of scientific knowledge, the previous evaluation states that dissemination through articles and conference presentations is very satisfactory. Furthermore, it affirms that researchers at the NFA do participate in education outside the centre, but that this could be done to a larger extent and would be beneficial both for the recruitment of researchers and to provide students and practitioners with up-to-date knowledge. A reason why this is not widely done is that financing is not provided for such activities, however the centre is still able to recruit young, qualified researchers even without widespread participation in educational activities.

2.3 Research programmes and the organisation of NFA

The NFA's activities are regulated by the Sector Research Act, and the institution's statutes. The centre has its own board, where the chairman is appointed directly by the Minister of Employment. The strategy is implemented through research programmes covering the strategy period. The research activities are currently organised in six research programmes:

- Chemistry and microbiology, C&M (Research programme 2021-24)
- Ergonomic working environment and musculoskeletal disorders, E&M (Research programme 2021-24)
- Psychosocial working environment, PWE (Research programme 2021-24,)
- Accidents and safety culture, A&SC (Research programme 2021-24)

- Working environment economics, WEE (Research programme 2022-24)
- Analysis and data, A&D (Research programme 2021-24)

While C&M and E&M are separate departments, WEE and A&D are hosted together in one department. Similarly, PWE and A&S are hosted together in one department.

Both Working environment economics and Analysis and data are cross-cutting research programmes, and are intended to methodologically support, or enhance the other research programmes with new types of analytics and data. The research programmes are developed by the research directors, and research management and other employees are also involved. For each research programme, annual action plans are formulated, and research directors provide a written status report on their progress to the main management every six months.

For each research programme there is a programme document, with a vision, focus areas, priorities, capabilities, and an overview of its organisation leadership and competencies for the period 2021-2024.

The research programmes vary greatly in the number of researchers employed in each programme, in addition to what they require in terms of resources, physical equipment and tools. For example, 'Chemical and microbiological exposures' likely require laboratory equipment, while 'Working environment economics'/'Analysis and data' rely more on licences for statistical software programs. Table 2.1 illustrates the size differences between the programmes. Psychosocial working environment had the largest increase in the period, with 11 more FTEs in 2023 than in 2019. Working environment economics/Analysis and data had the largest relative increase from 7 to 11.5 FTEs.

Table 2.1 NFA research staff members 2019 to 2023. Full time equivalents per year.

Research unit/programme	FTEs 2019	FTEs 2020	FTEs 2021	FTEs 2022	FTEs 2023
Working environment economics (WEE)/Analysis and data (A&D)	6.9	7.9	8.5	9.3	11.5
Chemistry and microbiology (C&M)	36.6	36.0	37.8	39.4	43.2
Ergonomic working environment and musculoskeletal disorders (E&M)	25.1	28.7	25.6	24.6	27.2
Psychosocial working environment (PWE)	24.3	25.5	23.6	27.5	35.4
Accidents and safety culture (A&SC)	7.0	7.0	6.8	6.4	6.6
Total FTE	99.8	105.1	102.3	107.2	123.9

Source: NFA's personnel database.

Table 2.2 shows that the public block grant increased between 2020 and 2023 but has been lower compared to the period between 2010-2016. Earmarked public grants and external funding have both increased steadily. Since 2020, external funding as a percentage of total funding has hovered between 35-38%. Total NFA costs exceeded total funding 2019-2022 but there was a positive result in 2023.

Table 2.2 NFA's funding and costs 2010-2023

Income mil. DKK (annual prices)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Public block grant (GB)	70.8	83.3	80.2	68.4	62.6	62.3	59.4	56.0	55.9	56.3	51.5	50.4	49.4	55.8
Public earmarked grants (research dissemination)	9.0	9.0	13.0	14.0	19.1	17.3	19.2	19.4	19.7	9.8	20.1	20.2	26.3	27.3
Knowledge centre (VFA/SI)	35.4	31.8	33.2	32.7	33.8	33.0	1.9	4.2	4.0	4.1				
External funding	31.0	34.9	25.7	31.1	32.2	32.4	42.5	50.7	52.6	47.1	38.6	43.5	46.8	52.1
Other income	5.4	1.8	2.3	5.2	5.8	7.7	2.4	1.8	2.4	2.4	0.5	0.6		
Total funding	**151.6**	**160.8**	**154.4**	**151.4**	**153.5**	**152.7**	**125.4**	**132.1**	**134.6**	**119.7**	**110.7**	**114.7**	**122.5**	**135.2**
External funding in % of total funding*	20.4	21.7	16.6	20.5	21.0	21.2	33.9	38.4	39.1	39.3	34.9	37.9	38.2	38.5
External + other funding in % of total funding	24.0	22.8	18.1	24.0	24.8	26.3	35.8	39.8	40.9	41.4	35.3	38.4	38.2	38.5
Total costs including VFA/SI	**145.2**	**146.3**	**153.9**	**149.5**	**146.2**	**150.5**	**118.2**	**125.5**	**129.3**	**125.8**	**112.9**	**118.2**	**125.9**	**127.2**
Result	6.4	14.5	0.5	1.9	7.3	2.2	7.2	6.6	5.3	-6.1	-2.2	-3.5	-3.4	8.0

Sources: NFA/The yearly Finance Acts and NFA year reports.

Notes: Public block grants cover NFA's basic costs, household, administration, co-finance etc. Public earmarked grants are temporary grants on the annual Finance Act with specific scientific targets. The Knowledge centre (VFA) was a separate grant (institution) under NFA's management. The funding included an earmarked grant (SI) from 2008 to 2015. From 2016 to 2018, SI was externally funded with approximately 5 mill. DKK each year (included in external funding). VFA closed in 2020.

Positive numbers in the 'results' field indicates financial surplus. Different guidelines for accounting practices used over the entire period.

*Includes funding that has been attributed to NFA specifically. The accounting practice for handling saved funding was changed in 2011 and from 2019 and onwards.

3. Evaluation of NFA's research

3.1 Quantitative analyses based on scientific publications

This section covers the scientific publications from NFA during the evaluation period, their citation impact, and the profile of the journals they were published in. The analysis is meant to inform the evaluation about the overall scientific impact of the research at NFA. NFA is compared to five other institutes with similar profiles and to the world average by using data from Clarivate's Web of Science for benchmarking. The analysis is only done at the organizational level. The internal programmes and their representative publications are treated with qualitative assessment in this report.

Scientific articles provide information about co-authors in other institutions and countries and about sources of funding for the published projects.

3.1.1 Scientific production

Lists with a total of 735 scientific publications (original articles and reviews) from 2020-2023 were attributed to NFA in collaboration between NFA and NIFU following the criteria from earlier evaluations: The publication was registered in the local information system in the given year and had minimum one author from the current staff at the institute.

Among the 735 publications, 701 (95 percent) have been published in journals that are indexed for Web of Science (WoS). An example of a journal not covered by WoS is *Tidsskrift for Arbejdsliv* where six articles from NFA were published during the period. Our analysis will concentrate on the 701 articles in WoS that can be used for international comparison. *Table 3.1* shows the relations of the articles to the areas of research within NFA.

Table 3.1. Distribution among the programmes within NFA of 701 WoS-indexed scientific articles from 2020-2023. Some articles have authors from more than one programme. The sum is thereby 741 articles.

Programme	**Articles**
Chemistry and Microbiology (C&M)	273
Ergonomic Working Environment and Musculoskeletal Disorders (E&M)	238
Psychosocial Work Environment (PWE)	164
Working Environment Economics (WEE; A&D)	33
Accidents and safety culture (A&SC)	29
Other	4

Figure 1 below shows the total number of WoS-indexed scientific articles from NFA per year of registration and of publication. As mentioned above, the year of registration is the criterium for inclusion in the evaluation. Some publications may be published the year after.

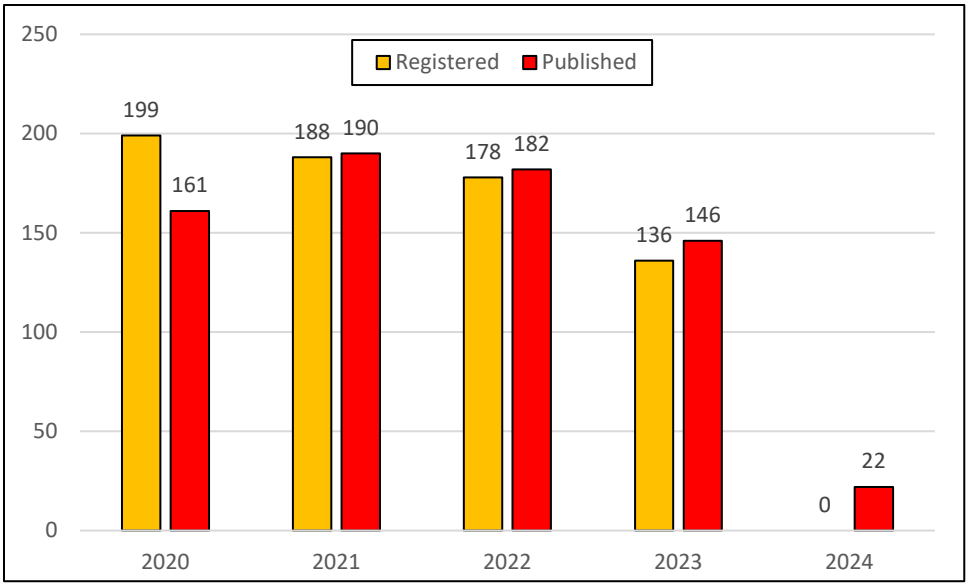

Figure 1. The number of WoS-indexed scientific articles from NFA by year of registration and publication.

The International Evaluation 2014-19 (2021) of NFA documented in tables 4.1 and 4.2 on page 23 shows that the scientific production of NFA has steadily increased during 2009-2019 reaching 193 scientific articles in 2019. These numbers included publications not indexed in Web of Science. Our *Figure 1* shows that the increase continued in 2020 and then stabilized with a decreasing tendency. This trend can be interpreted in relation to changes in NFA's strategies and external expectations in recent years, see section 2.1. More emphasis on societal impact and implementation of science-based recommendations in working environments may have required a reorientation of targets and resources. In addition, the number of publications is an indicator of *activity*, not of scientific impact.

3.1.2 Scientific impact

The previous evaluation of NFA (2021) used the *Journal Impact Factors* (JIF) based on Clarivate's Journal Citation Reports (JCR) as an indicator of their scientific impact: "The evaluation panel found, that although the impact factor can only constitute a proxy measure of quality, at the present it is the most operational proxy measure available." However, other measures are available if data from Web of Science (not JCR) are used directly to determine and compare the actual citation rates for *individual articles* within journals. We will briefly explain our reasons for the shift of indicators and source of data in this report.

The distribution of citations among articles published in the same journal in the same year is always very skewed. Most articles are seldom or not cited while a few publications receive most of the citations. *Journal Impact Factors* are calculated by dividing the number of current year citations to the items published in the journal during the previous two years. This is in principle a calculation of the average citation rate within the journal. Averages are poor representations of skewed distributions. Our example of a highly cited journal in *Figure 2* shows that a third of the articles have received between 0 and 3 citations while the most cited article has received 370 citations.

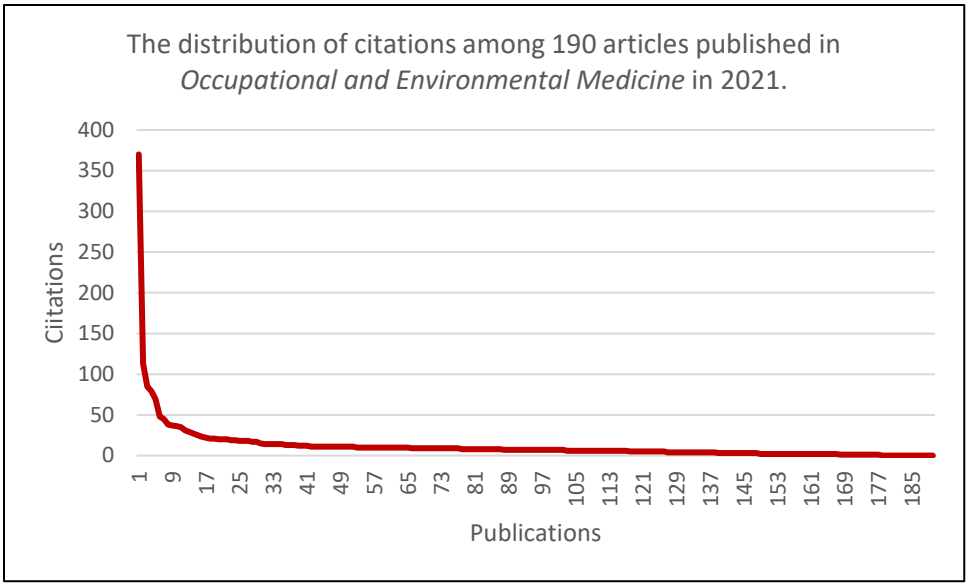

Figure 2. An example of the skewed distribution of citations among articles in a journal in the same year. 190 articles from 2021 in Occupational and Environmental Medicine *were cited until June 2024.*

The skewed distribution of citations is one of the reasons for the warnings against using Journal Impact Factors in research evaluations as expressed in the DORA declaration (https://sfdora.org/), the Leiden Manifesto (http://www.leidenmanifesto.org/), and the Agreement on Reform of Research Assessment (https://coara.eu/).

Instead of Journal Impact Factors we will use two well-established indicators of *article-level citation impact* that allow for comparisons among institutions and countries across fields of research. One is the *Relative Citation Ratio* where the number of citations to an article is compared to the average citation rate of all articles that were published in the same year in the same field of research. The National Institute of Health in the USA uses this indicator (https://www.metrics-toolkit.org/metrics/relative_citation_ratio/). The second indicator determines whether an article is among the 10 percent most cited articles of all articles in the same year and field of research. An example of its use is the Leiden Ranking of Universities (https://www.leidenranking.com/). Both indicators compare with the world average and can be used to compare institutions with similar but different research profiles.

We will compare NFA with five other organizations that operate in the same area of research. Four were selected among the members of *PEROSH – Partnership for European Research in Occupational Safety and Health* and the similar American institute was added to these four. Data were extracted from Web of Science and limited to articles published in the three years 2020-2022 to allow for some time to be cited. The six organizations compared, and the number of articles studied, are:

- BAuA – Germany: Federal Institute for Occupational Safety and Health, **87 articles**
- CIOP-PIB – Poland: Central Institute for Labour Protection - National Research institute, **224 articles**
- FIOH – Finland: Finnish Institute of Occupational Health, **535 articles**
- NFA – Denmark: National Research Centre for the Working Environment, **600 articles**
- NIOSH – USA: National Institute for Occupational Safety and Health, **839 articles**
- STAMI – Norway: National Institute of Occupational Health, **287 articles**

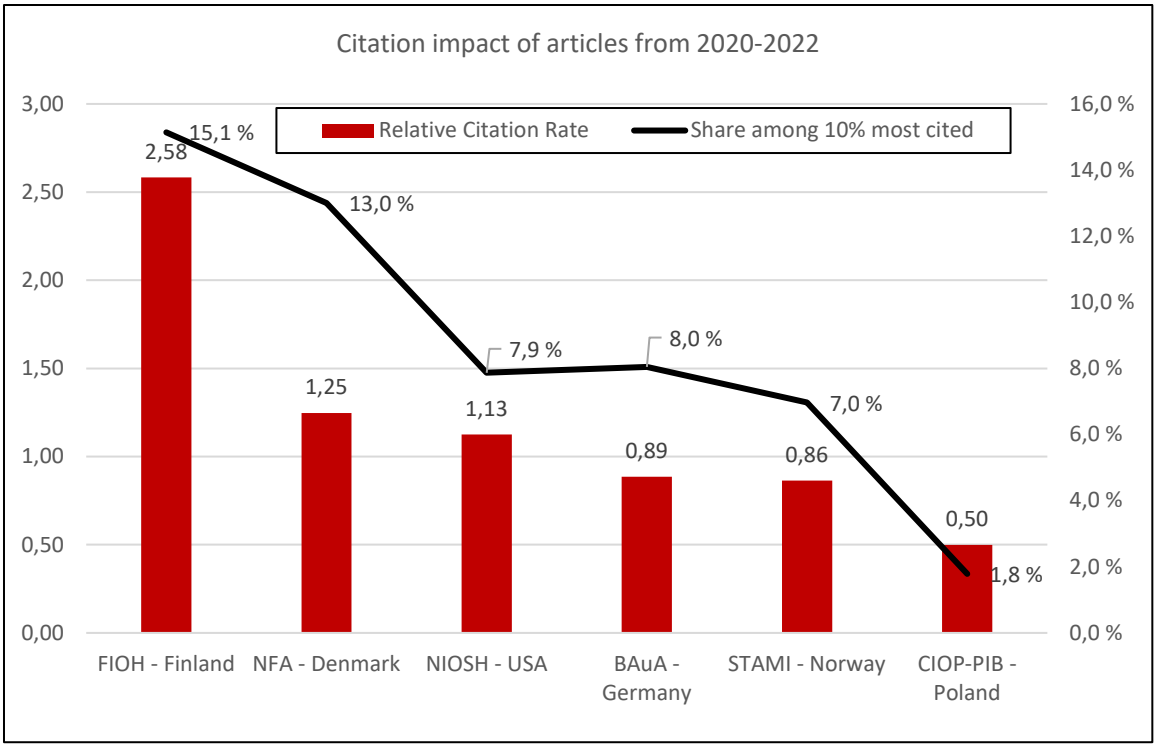

Figure 3. Comparison of scientific impact as measured by two indicators of citation impact among six organisations with similar profiles as NFA.

Figure 3 shows that NFA ranks second after the Finnish institute by the two indicators of scientific impact. The world average for the Relative Citation Rate is 1.00. NFA's publications are on average cited 25 percent above the world average. A share of 13 percent of NFA's articles are among the ten percent most cited in the fields of research that they were published in.

The indicators in *Figure 3* address the *core purpose of this evaluation*, to assess the *scientific impact* of the research at NFA. However, these indicators can only *inform* the evaluation. They cannot be decisive. The reason is that impact on subsequent research is the one dimension of research quality that can be captured by measuring citation impact. There are other dimensions: "Research quality is a multidimensional concept, where plausibility/soundness, originality, scientific value, and societal value commonly are perceived as key characteristics."[5] Consequently, the results in *Figure 3* do not measure research quality in general. The quality of research is better assessed by reading the publications.

3.1.3 The quality of the journals

While Journal Impact Factors are useless when the aim is to retrospectively measure the impact of published articles, they can be used prospectively in a strategy to publish in good journals. The general citation impact of a journal as such is an indication of its influence in the field of research. This influence may be determined by its reputation among researchers, which is based on the experiences with its contents and editorial procedures and the participation in the journal of the most influential researchers in the field. To ensure research quality, NFA works actively to provide guidance to the staff about high quality journals in the different thematic areas.[6] We will therefore

[5] Aksnes, D. W., Langfeldt, L., & Wouters, P. (2019). Citations, Citation Indicators, and Research Quality: An Overview of Basic Concepts and Theories. *Sage Open*, 9(1). https://doi.org/10.1177/2158244019829575

[6] See for example *Oversigtsrapport over tematiske top-5 tidsskrifter for videnskabelig production på NFA*, December 2021.

supplement the indicators above of article-level citation impact with a measurement of the reputation of the journals that NFA has published in during 2020-2023, again by comparing with the five other institutes.

Here, we also differ from the previous evaluation (2021) by using an alternative to Journal Impact Factors. We will firstly explain why. The most frequently used journal by NFA (54 articles in the period) is the *International Journal of Environmental Research and Public Health (IJERPH)*. It has a relatively high impact factor (known to be based on many self-citations) but at the same time, there are worldwide worries about the quality of the editorial procedures of the journal. The publisher, MDPI, runs with a business model aiming to publish large numbers of paid-for articles. The example shows that Journal Impact Factors do not necessarily represent journal quality.

As an alternative, Finland has a national system for using *community-based qualitative journal assessment*. Experts in each field of research classify their journals at three levels with Level 3 as the highest. A study has been demonstrated that the Finnish ranking is more precise than Journal Impact Factors in predicting the outcome of article-level peer review assessment in the British national research assessment exercise.[7] Norway runs a similar national system with community-based qualitative journal assessment. Denmark did as well until 2021, but the Danish ranking lists are preserved. We compared the lists and made a *Nordic* ranking of the journals that the six institutes have published in:

- Level 3 includes all journals that are highly ranked in all three countries.
- Level 2 includes journals that are highly ranked in at least one country.
- Level 1 represents the rest.

We then extracted publication data from Web of Science from the period 2020-2023 for the same six institutes that we compared in the citation analysis above. We limited the dataset to journals with articles from at least two of the institutes in the period. We then counted the number of articles per Level of the journals and estimated the percentage distribution with the result shown in *Figure 4*.

[7] Pölönen, J., Engels, T.C.E, Guns, R. (2023). Journal metrics as predictors of Research Excellence Framework 2021 results: Comparison of impact factor quartiles and Finnish expert-ratings. STI Conference 2023. https://dapp.orvium.io/deposits/64a824eb6918850a35e07fee/view

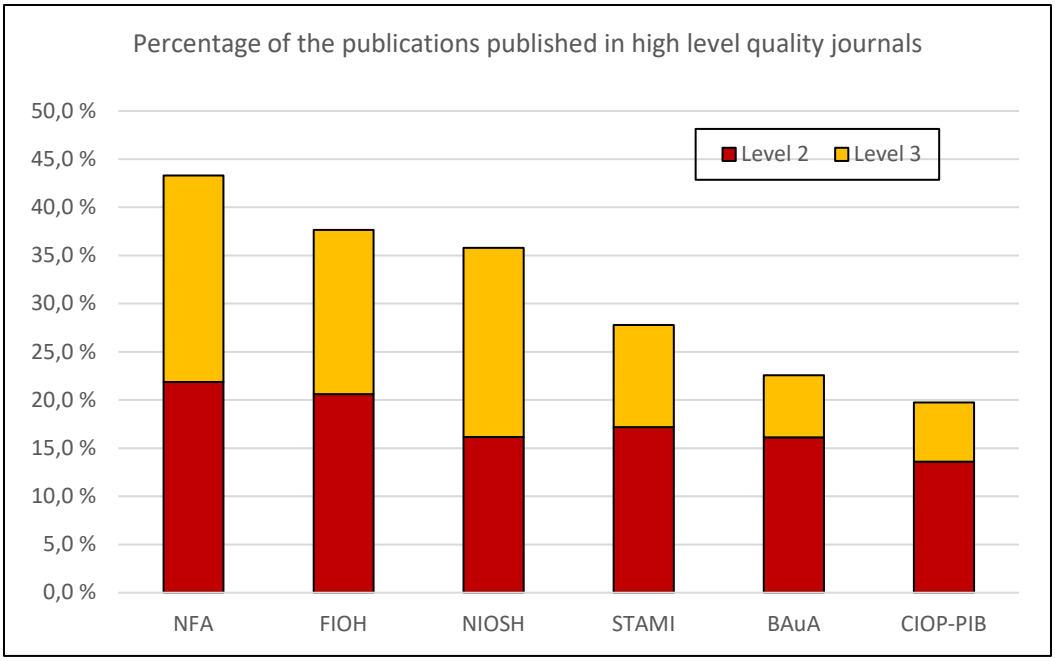

Figure 4. Percentage of publications published in journals that are highly ranked journals by Danish, Finnish and Norwegian experts in the field. Level 3 represents journals that are highly ranked in all three countries while Level 2 represents journals that are highly ranked in at least one of the countries.

NFA clearly has the highest profile in selecting good quality journals among all six institutes. *Table 2* shows how the most frequently used journals by NFA are ranked in this comparison.

Table 2. The most frequently used journals by NFA and how they are classified by using Nordic levels.

Journal	NFA articles	Nordic level
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	54	1
SCANDINAVIAN JOURNAL OF WORK ENVIRONMENT & HEALTH	40	2
BMC PUBLIC HEALTH	20	1
INTERNATIONAL ARCHIVES OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH	20	1
ANNALS OF WORK EXPOSURES AND HEALTH	17	1
INTERNATIONAL JOURNAL OF HYGIENE AND ENVIRONMENTAL HEALTH	13	3
PLOS ONE	13	1
ENVIRONMENTAL RESEARCH	12	3
NANOIMPACT	11	1
NANOTOXICOLOGY	11	3
OCCUPATIONAL AND ENVIRONMENTAL MEDICINE	11	3
SAFETY SCIENCE	11	3
SCIENTIFIC REPORTS	11	1
BMJ OPEN	10	1
ENVIRONMENT INTERNATIONAL	10	2
PARTICLE AND FIBRE TOXICOLOGY	10	1

3.2 Qualitative assessments by Research Programme

3.2.1 Working Environment Economics (WEE and A&D)

Strategy and aims of the research unit/programme

As noted on the NFA's website, the *Working Environment Economics* programme is a new emerging field of research at NFA and worldwide. Indeed, the *Working Environment Economics* programme was only established in 2022. It works closely with the *Analysis & Data* programme, also relatively new, though its members have a long history of working with the NFA. The latter is intended to serve the analysis and data needs of all research programmes at the centre. Given the two programmes work together and are both cross-cutting, we consider the two programmes together in this report.

NFA's vision for economic research is to create an active research programme which can contribute to better understanding the economic aspects of the working environment and integrate economic methods and knowledge of economic consequences in working environment research and working environment policy, more broadly speaking. The 2021-2024 Strategic Plan notes that the *WEE and A&D* programme will give priority to the development of models for economic evaluation of working environment efforts and for assessing the social, industry and business economic consequences of working environment efforts. This work is intended to inform efforts in policy, industry and company levels, with a focus on their economic potential.

The four specific objectives noted in the 2021-2024 Strategic Plan are particularly relevant to the *WEE and A&D* programme given that it is a new addition to the NFA roster of research programmes. The four objectives are:

1. The NFA is recognized as an international leader (top 3) within up to four selected research themes per research area.
2. The NFA has developed internationally recognized models for economic evaluation of working environment efforts.
3. The NFA's research portfolio with interventions, with associated impact, process and economic evaluations, must be increased by 20% during the strategy period.
4. The NFA's research projects must be based on stakeholder consultations.

The analysis and data focus are on register (administrative) data analyses, labour market outcomes and the prediction of risk, as well as new analytics, with a particular focus on machine learning, big data analysis and generally enhancing the institute's preparedness for new technologies. The main areas of research include quantitative methods, with an aim to contribute with expertise in projects across the institute, and data management and infrastructure, with the aim of modernizing the institute's data infrastructure, and consolidating the statistical analysis software at the institute.

Topics and methods

The *WEE and A&D p*rogramme includes five priority areas:

1. Expand the existing knowledge about effects and cost-effectiveness of different interventions aimed at improving the working environment.

2. Develop methods to calculate the economic consequences of working environment measures on society and industry level.

3. Develop methods for economic evaluations of measures and interventions in the field of working environment, including complex interventions and inclusion of values regarding welfare and equality.

4. Develop a new labour market-specific target, productivity-adjusted working years, which more completely includes the effect of the working environment and work environment interventions on productivity.

5. Investigate a possible connection between corporate organizational structure, working environment and economic factors such as earnings.

The plan is to 1) develop a framework for economic evaluation for the working environment area which can be applied to all future research projects where it provides meaning to include economic evaluation; 2) critically examine existing theoretical framework for economic evaluation of working environment interventions to identify potential for improvement; 3) develop empirical methods and models to calculate economic consequences of working environment interventions and measures on society and industry level; 4) conduct working environment economic research in areas where there is a knowledge gap (e.g., by focusing on different aspects of measuring the effects on productivity as a result of concrete working environment factors and working environment interventions; and 5) build research collaboration with leading national and international research environments of interest working environment economics.

Collaborations

To advance the 2021-2024 *WEE and A&D* programme Strategic Plan, the NFA hired a professor in mid-2021 and a researcher in 2022, and then planned to recruit a further four employees with an economics profile during 2022, including PhD students. As of spring 2024, key staff were in place and working actively to advance the programme. Given the meaningful but limited critical mass of people, time and expertise available in the programme, it is critical to capitalize on both internal (i.e., across research programmes) and external collaborations.

Internal Collaborations: A key starting point for collaboration is within the organization itself, across research programmes, since economic evaluation and analysis of data are, by their nature, areas that often builds on research in other applied disciplines. It is critical that the *WEE and A&D* team build strong ties with other research programmes at NFA. In fact, serious consideration should be given to including an economic analysis into all NFA projects whenever possible. Such analyses are critical to informing policy decision making at the workplace and policy systems (sector, industry, government) levels. The publications provided to the review panel suggest a healthy balance of internal collaborations with the other NFA programmes, specifically with the *E*&M, *PWE* and A&SC programmes. Missing was collaborations with the C&M programme. Many of these collaborations were on the analysis and data front, though some were economic analyses. In interview with the research programme members held in June 2024, it was noted that these efforts are ongoing and may take time for strong ties to be established.

External Collaborations: Figure 9 in chapter 4 shows the frequency by articles of collaboration with external organizations. Paper collaborators are primarily from northern Europe (University of Copenhagen and Aarhus University at the top), with a few from outside of Europe. It is great to see such diversity of collaborations. Economics analysis/evaluation by its nature requires consensus building in international circles to establish agreed on analytic norms for specific decision contexts, and in the case at hand, for work environment economic analysis. Efforts have been made in this area by various international groups in the past couple of decades, but there is still much work to be done. Thus, the opportunity is ripe for the *WEE and A&D* Programme to capitalize on, particularly

since there are few concentrations of these efforts within any one research centre in the international context.

The inaugural conference of the *Working Environment Economics* programme in December 2022 entitled "*The Crossroads of Labor-Market and Health Economics*" provided a platform to begin an international dialogue with researchers in this field and forge relationships and collaborations. In attendance were 30 delegates from around the world. Drawing from this conference and beyond, longer-term collaborations on topics related to working environment economics could be sought with researchers and their affiliated organizations participating in these forums.

Projects

Given the *WEE and A&D* Programme is a new one, and that their work is often a component within a broader inquiry (i.e., transversal and collaborative), programme specific grant funding may not be as critical a part of the Programme's activities. The seven project funding envelopes associated with this programme cover topics ranging from mental and physical health conditions, work environment monitoring, morbidity indexing, and sickness absence. The 33 papers published over the 2021-2024 period represent an even broader array of topics, though only a few are directly about work environment economics. More targeted focus on projects and papers on the four *WEE and A&D p*rogramme topics will hopefully develop over the near future as the programme matures. In terms of funding, an approach to consider is having an economic analysis/evaluation component included in as many grant applications submitted by other programmes at NFA as possible. Interview with research staff suggest that getting credibility with other programmes at the NFA has been a challenge, given this Programme's newness. It was also noted that the multi-year government grant supporting this programme will soon run out so, going forward, collaborative grantsmanship may be critical.

Assessments and comparisons

The current output of the *WEE and A&D* programme is modest but substantive for a small group, and given that it recently started up, this in understandable. One key publication on 'The labour market costs of work-related stress' (Scandinavian Journal of Work, Environment & Health 2023) was noted in the list of key publications provided to the review panel. This is a very strong study in a top tier journal, so it bodes well for the work environment economics research of this programme. The use of large data set linkages and longitudinal micro-level data are an ideal platform for work in this space. The statistical methods are strong and are underpinned by a well-developed conceptual framework. The topic, work-related stress, is an important contemporary issue in advanced economies and one of the major sources of productivity loss. The focus on monetizing the losses in a stylized fashion provides important information for workplace and systems actors on the magnitude of losses. Ideally, the next generation of such work will focus on evaluating interventions that look to mitigate these costs, including their cost-benefit.

Additional economic analysis/evaluation papers are found within other programmes, namely the E&M programme and related management systems issues in the A&SC programme. Some of these publications are in specialized journals, such as Construction Management and Economics, which is understandable, and other in more widely scoped journals in the field. Overall, it would be good to see more cross NFA programme studies, where solution focused interventions are evaluated, including their effectiveness, cost-effectiveness, and labour-market outcomes.

Key publications in the analysis and data area provided to the review panel (8 in total) are more extensive. They are published in high-end, respected journals such as the Scandinavian Journal of Work Environment & Health, International Archives of Occupational and Environmental Health,

Occupational and Environmental Medicine, and BMC Public Health. Topics range in focus from physical and mental health issues to labour-market participation. This breadth of topics is inevitable and appropriate, give the cross-cutting nature of analysis and data research.

Going forward, the types of journals to consider for publication that lend themselves to economic evaluation/analysis include public health, environmental medicine, ergonomics, injury prevention, epidemiology, disability management, social sciences. Many of the top tier journals in these areas are already in the roster of current publication venues used by members of this program.

Comparison of output from the WEE and A&D programme with other research centres in Europe and around the world is difficult, as there are few researchers working in this space, and modest concentrations of efforts in any one place. Overall, it seems the programme is off to a good start in terms of output, with need to build up capacity and focus going forward.

Recommendations

Going forward, collaborations within NFA across Programmes; within Denmark across research centres and university departments; and within Europe and internationally with research centres and university departments will be critical for the WEE and A&D Programme to establish itself a leader in the field. Collaborations at each level serve different purposes. Internally, there are many opportunities to layer economic analyses in projects across all NFA programmes. Around the world, there is only a small contingent of researchers working on economics of the working environment. There is much need for capacity building, advancing methods, and improving quality, which bodes well for opportunities to make an important mark on the international scene and be recognized as a leader. It would be wise to continue supporting collaborative projects and periodic conferences/symposiums to help build strong ties. A more intentional focus on the targeted work environment economics topics identified in the strategy would also be appropriate in the coming period to bolster output, research toolkits, and international recognition. Some additional recommendations:

- Build collaborations with stakeholders in public policy and private industry
- Focus on mentorship of new academics in the field of working environment economics, as expertise in this space is a rare commodity, creating a challenge for sustainability of capacity
- Focusing on improving quality and standardization of economic analyses/evaluations
- Develop frameworks and methods to advance the analytical toolkit used in the field

3.2.2 Chemistry and Microbiology (C&M)

Strategy and aims of the research unit/programme

New national goals were set out for the Danish work environment in the tripartite agreement in December 2020. One of the four goals was: “Safe and healthy work with chemistry - fewer must be exposed to dangerous chemicals at the work site”. Based on this goal, NFA developed the overall aim of the Chemistry and Microbiology programme in NFAs strategy 2021-2024. The research activities will give priority to research that develop, implement and evaluate preventative measures. To do preventative work, state- of the art risk assessment needs to be made, based on research on the connection between chemical and microbiological exposures and health. Knowledge on which substances and exposures that are most dangerous and widespread in Danish workplaces are needed. The overall aim for the programme also includes development and validation of tools for the

risk assessment, new measurement methods and standardization, intervention and international knowledge acquisition.

Topics and methods

To operationalize the NFAs overall strategy, action plans were developed. In the 2023 action plan the following goals are set.

Action plan Chemistry and Microbiology (C&M) 2023:

1. Knowledge of microorganisms and bioaerosols - including workplace measurements, risk assessment and development and evaluation of preventive measures
2. Knowledge of measurement, characterization and quantification of chemical exposures in the work environment (including internal/external dose).
3. Knowledge of biological mechanisms for particle-mediated toxicity and determination of causal relationships in the chemical work environment.
4. Knowledge of particle toxicology and risk of cancer, cardiovascular diseases and effects on reproduction as important health effects
5. Knowledge of detailed physical/chemical characterizations of particles - e.g., chemical composition, solubility tests in relevant media, analysis of coatings and dust tests - and the use of these data for risk assessment
6. Development of animal-free models to test acute pulmonary toxicity of particles and chemicals as an important tool for risk assessment.

The action plan reflects the NFA overall aim for the C&M programme, but the focus differs slightly between the overall NFA plan and the action plan. In the overall NFA plan, priority is set on prevention and implementation, while the action plan mostly focuses on knowledge-oriented goals. However, during the onsite interviews at NFA (June 2024), it became clear that the programme indeed focuses on prevention and implementation, so it is mainly the written goals in future action plans that needs to be revised. Intervention and implementation are indeed firmly set in the organisation.

Collaborations

Internal collaboration: In the NFA strategic document 2021-2024, It was concluded that "*a special characteristic of NFA is the great breadth of research*" and that "*the potential of working interdisciplinary must be explored and realised. This must be done internally at NFA and in collaboration with other research environments*." However, few joint publications and applications exist between C&M and the other programmes. This can partly be expected, since the area is lab oriented, and it is mainly in the epidemiological field that collaborations across programmes come more easily. But an ergonomic, psychosocial, or safety angle are of relevance to consider, especially when studying cardiovascular or pregnancy disorders. In addition, a collaboration with the *Working Environment Economics* programme should be possible even with C&M based methods. During the interview, it became apparent that at least the programme leaders were collaborating and building future interdisciplinary studies. The joint seminar series, joint lunches and other cross programme activities also aided in building network and finding collaboration across programmes within NFA.

External collaboration: An extensive external collaboration exists between the C&M programme and several key national and international entities as seen in Figure 6. chapter 4. Most joint manuscripts were published with the University of Copenhagen, followed by Aarhus University and the Technical University of Denmark. Indicating a strong connection between the most important universities in Denmark. The programme has also collaboration with a key clinical partner, Bispebjerg Hospital within occupational medicine as well as strong Nordic, European and International partners within

the research area. Since the NFA agenda specifically want to target Danish work conditions, it is imperative to have a strong interdisciplinary collaboration between Danish universities and clinics, and this is clearly the case for this programme (see figure 6, chapter 4).

NFA are included in important networks within the occupational field: PEROSH, ICOH, NOROSH and NIVA as well as many more. In the networks specified for the C&M programme, the Danish authorities are well represented. Important Nordic networks (NEG) and several societies and research centres are also covered. This, all together, creates an impressive research and education network. In the NFA strategy, it states that stakeholders must be involved before, during and after the research process. It is unclear whether these ambitions were met or not. But, at least one manuscript with interventions within the C&M area was presented in the annual report of 2023 and it is clear that more are on its way. Many of the crucial networks for stakeholders on the society level are in place, more networks with companies and occupational health services might be needed.

Projects

The C&M programme is still the largest programme at NFA. In 2023, it had the equivalent of 43,2 full time staff members. Which correspond to about 35% of the total research staff time at NFA. Researchers at the C&M programme sent in a total of 115 proposal to funders and so far, have got 38 projects granted (29 non-concluded proposals and 48 rejected). This corresponds to a 44% success rate (see table 4.2). Among the 94 C&M projects in the current period, only 12 do not contain collaborating partners. The rest of the projects have one or more funded partners in Denmark or abroad. The C&M researchers contributed to 104 conference contributions during 2020 to 2023. This is substantially more than the other programmes at NFA.

Assessments and comparisons

In 2020-2023 273 articles indexed by Web of Science have been published by researchers at the C&M programme. That corresponds to 39% of NFAs total publications. The manuscripts are published in significant journals and cover a vast area within occupational research. In total, this is quite an impressive read. A special focus on respiratory disease, pregnancy related disorders, mechanisms, exposure assessment and tool development are seen. These are very relevant and important areas. Nano material, combustion products, particles, a wide range of chemicals and important metals are covered. A stronger focus on the waste management area is visible in later publications, which implies a stronger focus on the green transition. Ten publications were selected as specifically important outputs during the assessment period. These publications also reflect a variety of sub-areas within this complex and vast research area. It has papers within toxicology and epidemiology, has different NFA-authors and key collaborators onboard and are published in relevant and prestigious journals. These articles as well as the total amount of manuscripts in C&M area have an emphasis on respiratory outcomes, a signature area of NFA. However, in the strategy document cancer and cardiovascular outcomes are also specified and a few more manuscripts on these outcomes would be desirable. Overall, the publication quality and quantity are well over the expected amount of output from equivalent organisations.

In the annual report 2023, the NFA states that the C&M programme will continue in 2024 to focus on occupational measurements within a number of different Danish industries. This applies, among other things, to waste management and green transition and demolition within the construction industry. The work on establishing a register for workplace measurements will continue. This is very important for the Danish society and can contribute to more accurate risk assessments in the future. The publications already show that C&M are fulfilling the programme aims and are moving the research filed forward in a desired way.

Recommendations
The C&M programme is an excellent programme that has important international collaborations and is targeting the right areas of research. Interdisciplinary research and research focused on intervention and implementation are dominating the NFA current research agenda. The C&M programme is not yet bearing the fruit of this change in agenda, by displaying enough articles and funding where this focus is present. Change takes time and it is important not to damage the already well-set research that is conducted at the C&M programme, by moving too fast. But in the end, it is important that the number of manuscripts and funded studies that include an interdisciplinary approach and that conduct research on intervention and implementation increases to meet the overall NFA agenda.

The continuation of the work on establishing a database of work site measurements is very important. The review panel would suggest constructing a common structure across programmes here to also collect individual measurements and questionnaire data on the physical and psychosocial work environment to be able to have an exposome approach when assessing the total occupational exposure patterns in Danish workplaces and when connecting the exposome data (through occupational codes) to health outcomes. Biological markers relevant to cardiovascular, respiratory, reproductive and/or cancer outcomes should also be collected. A large-scale interdisciplinary field study will save resources in the data collection and will enable exposome studies.

A substantial amount of the manuscripts included in the overall publications list for the C&M programme include studies on the environmental exposure patterns in residential areas or health effects from lifestyle or demographic factors. These areas will have some bearing on the occupational studies, to widen the knowledge of particle physics, confounder adjustments and disease pathways. But, it makes the review panel wonder if C&M have the right collaborators in these external partners. An even stronger focus on connections with other occupational researchers within these strong collaborators would be beneficial for NFA.

3.2.3 Ergonomic Work Environment and Musculoskeletal Disorders (E&M)

Strategy and aims of the research unit/programme
The vision formulated from the E&M programme is to produce research-based knowledge of high quality and innovative thinking that contributes to preventing loss of working capacity and promoting good, healthy long working lives for employees with physically demanding work.

Physically demanding jobs and musculoskeletal disorders, and their combination, are some of the most important reasons for premature withdrawal from the labour market. When the incidence of musculoskeletal disorders increases with age, one would – all other things being equal – expect even more employees in Danish workplaces that are characterized by physically demanding jobs to have a reduced work ability. For that reason, there is a need for strengthened health promotion, prevention and rehabilitation of musculoskeletal disorders in Danish workplaces.

Overall, the research programme identifies important areas, which are in line with NFAs overall strategies for the period and are targeting scientific areas that are important on a global scale.

Topics and methods
The way to move towards the vision has been formulated in eight areas of development including increased knowledge about health effects from combined exposures in physically demanding jobs, taking into account organizational and psychosocial factors. There are also specifically areas targeting

development of how to measure exposure, use of “big data”, and how new technologies (including AI and exoskeletons) both can be used and how they can affect workers. Workplace interventions and economic effects from an employer and society perspective are also included.

The six focus areas, which are partially overlapping with the areas of development described above, are:

1. Combination effects
2. A long healthy working life – prevention of impaired work ability
3. Innovative measurements of ergonomic working environment
4. How to organize healthy work
5. Prevention-competence/culture for MSDs in the workplace
6. Use of new technology and aids

According to the action plan for 2023 there are several activities within each of the six focus areas. Examples are reports in Danish which will form the decision basis for Trygfondens future focus on a safe working life now and in the future, new research grants, projects directed at the use of Exoskeletons and how AI can help improve the physical working environment. Here are also activities aimed at increasing the competence of the research group regarding implementation and evaluation of workplace interventions described.

Collaborations

The importance of working with stakeholders such as employer and employee organisations in the labour market, as well as with specific industries is emphasized in the research programme and this has also been pursued in several projects during the evaluation period.

Internal collaborations: Review of the E&M programme publications and projects revealed substantial collaboration with other NFA programmes and especially the PWE programme.

External collaborations: Figure 7 in chapter 4 shows the most frequent external organizations that co-authors are affiliated with in scientific publications. In the research programme the E&M programme has listed a number of prioritized external collaborations. Specific consortiums like ProPASS, SeniorWorkingLife, PEROSH and some internationally recognized researchers are listed and when reviewing scientific papers and grant applications it is clear that this has been fulfilled. There are other collaborations within specific areas like the importance of physical activity for different health risks with for example one paper published in the European Heart Journal, which is a prestigious high ranked journal (2022). This was a national collaboration with researchers from other scientific fields. Within the field of physical activity and work there are also other collaborations with internationally leading researchers that resulted in publications. Another example is the focus on older workers and a long working life with the project *The SeniorWorkingLife Study* that is now in its third phase (SAL III, 2022-2025) and is led by one of the professors in the programme.

Projects

During the evaluation period, the number of employees in the E&M programme have been quite stable at around 26 full-time equivalents (FTEs) with an increase from 24.6 in 2022 to 27.2 in 2023. The E&M programme submitted a total of 66 grants during the review period 2020-2023. Of these 66, eight included internal collaborations with other research programmes at NFA and four of those were submitted during 2023, showing an increased internal collaboration. The majority (82%) of the grants were submitted to Danish funding agencies, specifically The Working Environment Research Fund (AMFF, n=28). Among the funded grants, five were funded from international funding agencies.

During the interviews at NFA the MSD group presented their strategy to be more active in the dialogue with funding sources that previously have not funded research in work environment and musculoskeletal health. The opening up of this avenue offers new possibilities and is promising.

Assessments and comparisons

The E&M programme listed ten publications from the evaluation period, which they consider to be the most important contributions to research in the area. The selected publications illustrate the excellence and breadth of research conducted within the E&M programme, both in terms of topics and methods.

The publications have different study designs with four being register studies (all with first author from NFA), three different types of reviews (first author from NFA on two), two intervention studies (first author from NFA on one) and one is a study of cost-effectiveness and return-on-investment of a participatory ergonomics intervention (first author from NFA). Two of the studies include sustainable work and senior workers which is an important area for society. One of the register studies also includes exposure assessment based on direct measurements which is an important feature to better understand exposure-response associations and important to advance and inform future intervention studies. In 5 of the 10 studies there are international collaboration with co-authors from the Netherlands, Norway, Sweden and U.K.

Overall, there are 238 publications listed from the E&M programme between 2020 and 2023, which reflects a high output regarding the number of researchers in the programme. When categorizing these papers in broader themes, most publications were in the area of physical activity and associations with some kind of health outcome. This was followed by publications studying treatment effects of various physical exercise (i.e., different kinds of strength training and rehabilitation), and the category with the third most publications were in the field of different exposure assessment studies (i.e., different ways of measuring exposure) and various ways to analyse exposure data.

When comparing the research output from the E&M programme to similar national and international research groups it stands out as both innovative and of high quality, both regarding methodology and productivity. The group has pursued, from a societal perspective urgent question, ways to increase work life participation in all ages and also with a focus on older workers due to the expected increase in statutory retirement age. The group has also conducted work environment interventions and evaluated them both with regard to health and economic outcomes. Additionally, a focus on a more holistic approach to interventions at the workplace to achieve more sustainable changes that increases health and decreases ill-health of workers due to organizational, psychosocial and physical (biomechanical) factors in the work environment have been launched.

A targeted role as senior consultant, as understood being designated to increase stakeholder dialogues and with a focus on R2P (research to practise), is new since the last evaluation period and is deemed by the review panel to be an important role to increase stakeholder engagement, both in terms of companies and organisations directly involved in research studies and in contact with possible funding bodies.

The E&M programme significantly contributes to the knowledge of ergonomic work environment and musculoskeletal disorders in perspectives of the more traditional perspective of prevention and reducing risks but also in the perspective of health promotion. The relevance of the research is high, both in the national and international perspective, and is assessed as excellent.

Recommendations
In the previous evaluation (2014-2019) of NFA it was stated that the E&M programme had developed their research from focusing on individual-level interventions and exercise programs, to participatory intervention projects, including ergonomics and technical measurements, as well as organisational and psychosocial factors. In some extent this progress has continued, still there are quite a few publications with individual-level interventions. It is recommended to continue developing the focus on work environment factors and workplace interventions, with evaluations of the implementation process and economic outcomes. Regarding the area of older workers, it is recommended to also expand research into interventions and implementation. Collaboration with other programmes within NFA as well as other national and international researchers and groups are important and is recommended to be continued. The stakeholder engagement has developed positively during the evaluation period and the review panel recommend the E&M programme to further develop this.

3.2.4 Psychosocial Work Environment (PWE)

Strategy and aims of the research unit/programme
The programme strategy for 2021-2024 states that the vision for the PWE research is to create knowledge that will contribute to worker health, work ability, and satisfaction, and facilitate the development of healthy and safe workplaces. This will be the foundation for a long and productive working life for workers in the Danish labour market. By conducting research of the highest possible international quality, the group strives to identify work-related risk and protective factors for psychosocial disorders (e.g., stress, anxiety, depression, sleep disorders) and develop, implement, and evaluate interventions to prevent and mitigate them.

Topics and methods
The research programme outlines six main focus areas:

1. Negative actions in the workplace, e.g., violence, threats, sexual harassment, bullying, negative work culture
2. Scheduling and facilitation of work hours, e.g., work schedules and risks of health disorders and work-related injuries
3. Combination of psychosocial factors at work, e.g., work resources (positive work factors) and work stressors (negative work factors) as they relate to health and well-being
4. Inclusion and retainment, e.g., psychosocial and organizational factors that contribute to keeping workers in the workforce
5. Development of research theories and methods, e.g., theories and methods that improve understanding of the effect of the psychosocial work environment on worker health and labour market participation
6. Work environment interventions, processes, and mechanisms/prerequisites, e.g., the effects of psychosocial work interventions on worker health and retention, and the processes, conditions, and contexts in successful interventions

These areas are well-aligned with NFA's overall research goals for the review period and reflect key areas in current global psychosocial research. The PWE programme aims to build a strong knowledge base that will be of value to national policy makers, authorities, occupational health professionals, and workplaces, and works in close collaboration with those central stakeholders.

Within these 6 areas, the PWE group aspires to becoming an international leader for research in 3 main areas:

1. Surveillance, analysis, and development of process and outcome evaluation of interventions to reduce negative actions in the workplace

2. Health and safety risks due to work time scheduling (e.g., night work, shift work) and development and testing of practical tools for improving scheduling
3. Epidemiological studies of associations between the psychosocial work environment, especially stressful situations, and development of depressive and anxiety disorders, using job exposure matrices and data registries.

The research programme encompasses two overriding approaches. The first is surveillance and analysis of causal relationships between the psychosocial work environment, somatic and mental health and health disorders, and employment. The second is evaluation of the effects of, and processes involved in, interventions aimed at improving the psychosocial work environment.

Collaborations

In their research programme for 2021-2024, the PWE group outlined their goals for collaborations both within Denmark and internationally. The programme emphasizes the importance of working with task forces of community stakeholders with interests in specific areas. This collaboration is deemed critical so that the results of the research will be relevant and put to practical use.

Internal collaboration: Review of the PWE programme's publications and projects revealed substantial collaboration with some of the other NFA programmes. A number of articles were published in collaboration with colleagues from the Working Environment Economics and Accidents and Safety Culture programmes. Regarding projects, the majority of grant applications were collaborations with the Accidents and Safety Culture programme, with a few including the Ergonomics and Musculoskeletal Disorders programme as well.

External collaboration: The unit collaborates with researchers in Denmark, other Scandinavian countries, and globally to maintain and strengthen their position in the psychosocial work environment research field. Within Denmark, the unit works closely with the Departments of Psychology and Public Health, University of Copenhagen, as well as with the Departments of Occupational and Environmental Medicine at Bispebjerg and Frederiksberg Hospitals, Copenhagen, and the Department of Occupational Medicine, University of Aarhus. They have also worked with the Danish Center for Social Science Research and the Danish Cancer Society Research Center.

Internationally, the PWE programme participates in several consortia and EU-supported network projects, including OMEGA-NET, MENTUPP, WINC, and IPD-WORK. During the evaluation period, they have collaborated with researchers from other Nordic countries (Finland, Norway, Sweden), Europe (Belgium, France, Germany, Italy, Switzerland, The Netherlands, U.K.), Asia (China, Japan, Korea), Australia, Canada, and the U.S. Figure 8 in chapter 4 shows the most frequent external organizations that co-authors are affiliated with in scientific publications.

Projects

During the review period, the PWE programme saw an increase in full-time equivalents (FTEs) employed in the unit, from 25.5 in 2020 to 35.4 FTEs in 2023. The programme had a total of 71 grants during the review period 2020-2023; of these, 19 were funded prior to 2020. Nearly half (n=33) of the grants were funded by Danish public funding agencies, specifically The Working Environment Research Fund (AMFF, n=22) and the Work Environment in Denmark (AT, n=10). Five projects/WPs were EU-funded projects (MENTBEST and MENTUPP) that represent international collaborative projects related to efforts to improve mental health in the workplace. Many funded projects included collaborators from Danish universities, including University of Copenhagen, Technical University of Denmark, Aalborg University, and University of Southern Denmark.

Funded grants during the evaluation period covered a wide range of topics, ranging from negative acts in the workplace (violence, bullying, sexual harassment), work time/shift work and the digital economy, work stress, and psychosocial factors related to long-term sickness absence. All projects centred on the impact of psychosocial factors on worker health and productivity.

Assessments and comparisons

The group published 164 articles during the review period (2020-2023) and produced 58 conference abstracts. Many of these were epidemiological studies that examined psychosocial work factors and the risk of diseases and disorders, including depressive disorders, cardiovascular disease, diabetes, dementia, pregnancy-related outcomes, sickness absence and labour market participation. Methodologically, the publications include several systematic/umbrella reviews and/or discussion papers, large-scale cohort studies, and a small number that describe and evaluate workplace interventions. The latter reflect the research programme's growing expertise and innovation in intervention development and implementation science. These studies are of particular importance, as the previous NFA evaluation specifically recommended research that would increase knowledge of the significance of the implementation context and the occupational health and safety organization in intervention implementation.

The availability and utilization of national registers of large cohorts of Danish employees provide a unique and important component of the research conducted by the PWE group. High-quality epidemiological papers published during the evaluation period utilized the Danish Working Hour Database, the Danish Register for Evaluation of Marginalisation (DREAM), the Work Environment and Health in Denmark (WEHD) survey, the Job Exposure Matrix Analyses of Psychosocial Factors and Healthy Ageing in Denmark (JEMPAD), the Danish Work Environment Cohort Study (DWECS), and the Danish Work Life Cohort Study (DaWCo).

Publications during the evaluation period reflect the PWE programme's focus areas and represent an excellent fit with NFA's mission to contribute to healthy and safe work environments. Within Denmark, these studies are of relevance to the workforce, occupational health researchers and professionals, and policymakers. The global significance of the research is evidenced by the high degree of international collaboration, with co-authors from other nations in a majority of the articles.

The PWE research programme is focused on solving occupational issues that are prioritized in NFA's research programme and are relevant both nationally and internationally. The publications during this review period reflect a level of excellence that places the PWE unit at or above the level of achievement and influence of similar research groups in Europe and beyond. The significance of the umbrella and systematic reviews cannot be overstated, as they provide a synthesis of the current evidence concerning specific topics that is critical to informing next steps in research, policy, and practice in both Denmark and internationally. A prime example is a 2023 umbrella review/discussion paper in *The Lancet* on work-related mental health conditions and workplace interventions. Equally important and impressive are the studies based on the unique Danish registers that provide longitudinal cohort data on very large numbers of Danish employees and citizen social benefits. As few nations house data of this calibre, the research produced by the unit can have important implications for workers in many other parts of the world. An excellent example is a 2021 study in *Lancet Public Health* that used three Danish registers to examine emotional demands at work and risk of long-term sickness absence.

The high quality and relevance of the unit's research and evidence of international collaboration indicate that this NFA research group plays a major role in the national and international development of knowledge of the psychosocial work environment and its impact on worker health,

wellbeing, productivity, and organizational sustainability. The work is empirically and methodologically innovative, is published in respected and high-impact journals in the field, and even some recent papers have already been frequently cited.

Recommendations

Two previous international reviews recommended increased collaboration with researchers from the Accidents and Safety Culture unit. This seems to have been initiated during this review period. With systematic reviews and register studies, the unit has a firm foundation for continuing to expand its work in developing and evaluating workplace targeted interventions aimed at enhancing the psychosocial work environment and worker health and wellbeing. Increased collaboration with the Working Environment Economics programme for cost-benefit analyses of interventions is also recommended. Considering the fundamental importance of psychosocial factors in working environments, collaboration with the Chemistry and Microbiology and Ergonomic/Musculoskeletal Disorder programmes is also encouraged.

3.2.5 Accidents and Safety Culture (A&SC)

Strategy and aims of the research unit/programme

In their research strategy for 2021-2024, the Accidents and Safety Culture (A&SC) programme underscores that work-related accidents are a prioritized area in the national strategy for work environment research. The vision with the research is to generate new and innovative knowledge that can be translated into concrete actions, tools, and guidelines that will contribute to increasing work safety and decreasing risks for accidents within the nationally prioritized industries. The risks of occupational injuries are highest in the construction, transportation, water sewage and waste, and agricultural branches that are characterized by a changing pattern of risks. Jobs that are characterized by more stationary workplaces face a different type of accident risk related to the introduction of new technology and work routines. The research projects are designed on the principle of Knowledge Transfer and Exchange (KTE), which encompasses processes that aid in the transfer of relevant research to stakeholders. With this as a foundation, the A&SC programme strives for research results to have both a practical and societal impact.

Topics and methods

The research strategy describes three main focus areas that aim to investigate:

1. Why certain groups of workers are at increased risk for accidents. This area includes etiological studies aiming to assess associations between organizational and workplace factors and accidents, and the mechanisms that can explain those associations.
2. Intervention research, i.e., which external and internal approaches in work environment efforts contribute to a strong safety culture. This includes development and evaluation of practical tools for evaluating proactive measures.
3. How evidence-based interventions can be moved from research to practice, i.e., research on intervention implementation, evaluation, and dissemination.

The focus areas are based closely on the national strategy for work environment research and strive to gather the three types of evidence, i.e., causal connections between work environmental exposures and worker health; approaches that can prevent and/or mitigate exposures; and implementation and evaluation of interventions. The research programme describes the use of quantitative, qualitative, and mixed methods approaches in the unit ’s work.

Collaborations

The A&SC programme's goal is to develop research collaborations both nationally and internationally to uncover emergent risks that can impact the field of occupational safety culture and accidents. These collaborations will also provide new insight and solutions that can contribute to prevention efforts.

Internal collaboration: Within the NFA, the A&SC programme describes plans for synergistic work involving the work environment economics (WEE) programme in studies of digitalization, which presents both opportunities and challenges for work safety, as well as in studies of the economic performance of organizations that implement work environment certification. During in-person interviews, members of the A&SC group reported a high level of internal collaboration with other programmes at NFA. The group's expertise in qualitative methods, as well as their expertise in measuring and evaluating safety culture, facilitates collaboration across programmes.

External collaboration: Figure 5 in chapter 4 shows the most frequent external organizations that co-authors are affiliated with in scientific publications. Within Denmark, the research programme describes collaboration with the Occupational Medicine Clinic in Herning; the Center for Youth Research at Aalborg University; the University of Southern Denmark's Institute for Global Sustainable Production and Department of Technology and Innovation; and occupational health professional groups. The A&SC programme also emphasizes the importance of working closely with relevant stakeholders, such as those in the construction and other prioritized industries, including both union and employer organizations. This collaboration is especially important when it comes to development and implementation of interventions and studies of the growing use of virtual and digital technologies. Internationally, the group conducts research in collaboration with researchers from Australia, Canada, Ireland, the Netherlands, Sweden, the U.S. and the UK. This speaks to the relevance and significance of the unit's research both nationally and internationally. They aim to maintain and strengthen collaborations with four networks/consortia:

1. PEROSH, a network of 14 European occupational safety and health institutes
2. KTE Network on Research to Practice (R2P), a collaboration with the Institute for Work and Health, Toronto, Canada; and National Institute of Occupational Safety and Health (NIOSH) and the Centers for Disease Control and Prevention (CDC), USA
3. SIPAW, collaboration with Gothenburg University, Sweden; Delft University, The Netherlands; Technion Institute of Technology, Israel; and Duke University, North Carolina, USA.
4. Scandinavian Safety Climate Network.

Projects

With an average of 6.7 full time equivalents employed over the review period, the A&SC programme is smaller than other NFA research programmes. The programme had 18 active projects during the review period (2020-2023), with most funded by The Working Environment Research Fund (AMFF, n=9) and the Work Environment in Denmark (AT, n=4). Most of the grants include collaborators from within Denmark, including Aalborg University, Copenhagen Business School, Roskilde University, and the construction industry. Three of the 18 grants include international collaborators from the U.S., Germany, the UK and Ireland.

Assessments and comparisons

The A&SC unit published 29 papers and presented 20 abstracts at scientific conferences during the review period (2020-2023). The papers reflect the unit's main areas of focus, i.e., increasing

understanding of why certain worker groups are at increased risk of accidents/decreased safety; internal and external efforts that contribute to a strong safety culture; and translating evidence-based research findings into practice. Several of the programme's publications concern occupational safety and health (OSH) in the construction industry, but the group has also published studies on safety practices among newly-employed workers, young workers on digital labour platforms, ageing male workers, and workers in sectors at high risk for workplace violence. The A&SC programme has investigated tools supporting implementation of OSH programmes, employee perceptions of safety culture, as well as studies of how managers and organizations manage accident prevention and development of safe practices. The latter include studies of OSH coordinators and the efficacy of certified OSH management systems.

Methodologically, the publications are quite diverse and reflect a breadth of skill and knowledge in the unit. Papers during the evaluation period include systematic or scoping reviews, qualitative studies, and mixed method studies. Review studies make an important contribution to the field in that they provide a synthesis of the most current evidence-based knowledge. Some of the review papers make important contributions to the field regarding workplace accident prevention, the context and management of OSH management systems, and the impact of virtual design and construction technology on the OSH construction industry.

The construction industry is a major area of focus for the SC&A research programme. Using a variety of methods, including field notes and observations, literature reviews, expert surveys, and case studies, the articles on construction published during the evaluation period illustrate efforts to uncover the determinants and mechanisms of successful OSH implementation in the industry.

Several studies from the evaluation period were innovative and illustrate the efforts in expanding safety culture and accident research and working to move the field forward. Topics include the potential of virtual design and construction (VDC) technologies to identify and prevent OSH risks in the construction industry; how occupational health and safety management systems work based on the Occupational Health and Safety Assessment Series (OHSAS) 18001 standard; and OSH among young workers in the platform economy. Considering the drastic changes in employment conditions (i.e., increased remote and hybrid work) in the aftermath of the COVID-19 pandemic, this research is cutting edge and highly relevant to Danish society and to other nations experiencing similar trends of digital and remote work. The programme also participated in an international effort to develop proactive safety indicators for safety, health, and wellbeing at work that was part of the International Social Security Association's (ISSA) Vision Zero strategy.

The programme's research is of high quality and is well-aligned with NFA's mission to contribute to safe and healthy work environments, and Denmark's national goal of developing strong safety cultures at workplaces to reduce accidents. There is a clear focus on occupational groups at increased risk for accidents, including health care workers, young workers, and those working in construction. Systematic literature reviews and studies of virtual design, the digitalization of the labour market, as well as efforts to develop and evaluate policy initiatives (e.g., Vision Zero) and occupational health and safety certification systems and standards (OHSAS 18001) reflect a rich and impactful body of research. The utilization of diverse methods, both quantitative and qualitative, is impressive. Research results are published in well-respected journals within the field.

Recommendations

The prior review recommended that the Accident and Safety Culture programme study the effects of "megatrends" affecting our societies, environments, and workplaces and work to develop practical

solutions to those issues. The programme has answered that call in their focus on young workers in the platform economy and the digitalization of work.

The unit has developed expertise and both national and international collaborations related to their research on the construction industry. Going forward, it is recommended that the unit continue efforts to diversify their research into safety culture and accident prevention in other high-risk sectors. Continued collaboration with the other NFA research programmes is recommended, including development of joint projects with the Working environment economics programme.

4. Research collaboration, networks and conferences

4.1 External collaboration

The overall NFA external collaboration pattern based on published articles revels a strong and extensive network of collaborating partners and researchers within Denmark and across Europe. Most articles have been published together with the University of Copenhagen (208), followed by Aarhus University (109) and the University of Southern Denmark. The foreign university with the highest number of collaborative articles is the University of Valencia (42), followed by the University of Zaragoza (31) and University of London (29). The clinical entity with highest number of publications is Odense University hospital (20), followed by Rigshospitalet (19) and Bispebjerg Hospital (17).

This strong collaboration pattern is also true for all programmes, except Accidents and safety culture, that have a strong national collaboration but could strengthen the international collaboration a little bit more, se figure 5.

The analysis of external collaboration is based on authors and affiliations as published in NFA's 701 WoS-indexed scientific articles from 2020-23 – see section 3.1.1 above. We provide a separate analysis for each of the five programmes.

Accidents and safety culture (A&SC)

Among the 29 articles from this programme there are 5 (17 %) with authors in other countries. The countries that contribute to these articles are the Netherlands (3), Canada, Sweden and USA (2), and Australia, Finland, France, Germany, Ireland, New Zealand, and the United Kingdom 1). *Figure 5* shows the institutions outside of NFA that are present in more than one article.

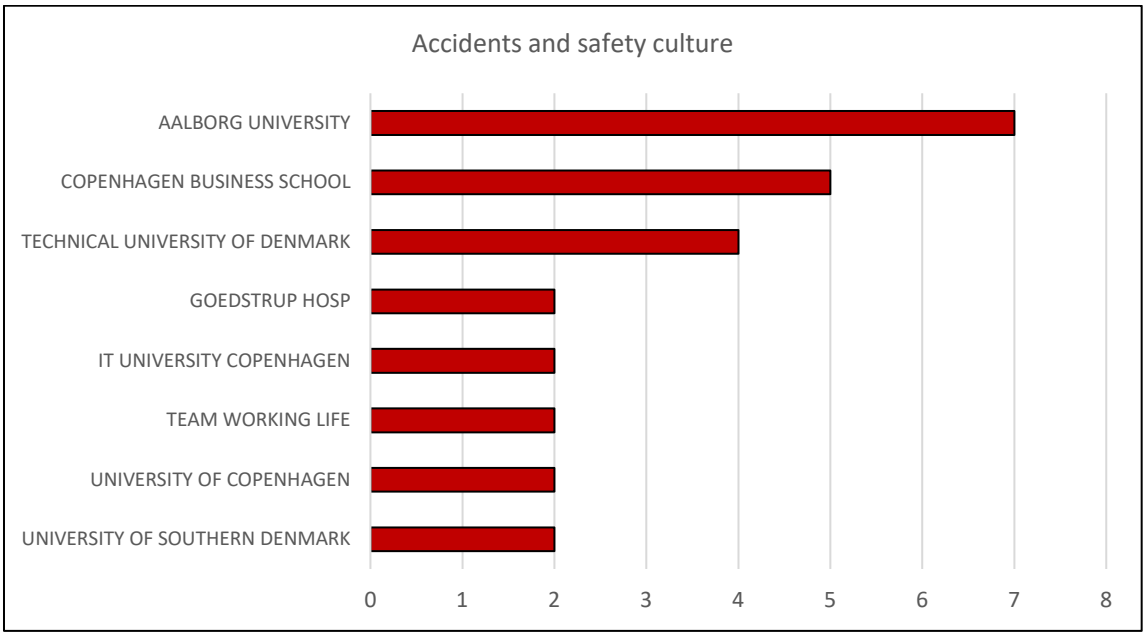

Figure 5. Number of articles by collaborating institution in articles from the programme Accidents and safety culture.

Chemistry and Microbiology (C&M)

Among the 273 articles from this programme there are 184 (67 %) with authors in other countries. The most frequent countries are Sweden (58), Germany (53), United Kingdom (53), Spain (51), Netherlands (48), Norway (44), Italy (39), Switzerland (35), Finland (34), France (34), Canada (31), USA (31), and Belgium (22). *Figure 6* shows the institutions outside of NFA that most frequently appear in the articles.

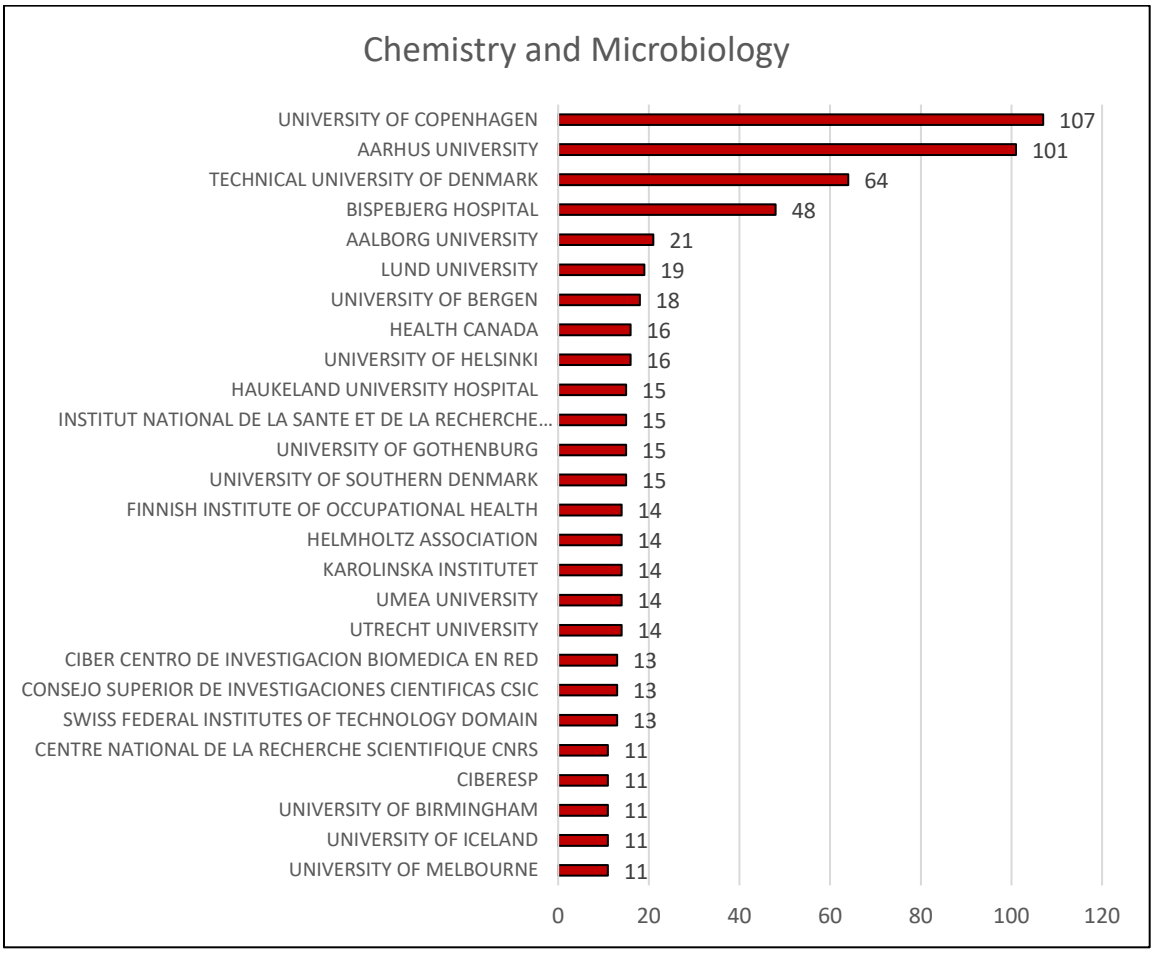

Figure 6. Number of articles by collaborating institution in articles from the programme Chemistry and Microbiology.

Ergonomic Working Environment and Musculoskeletal Disorders (E&M)

Among the 238 articles from this programme there are 161 (68 %) with authors in other countries. The most frequent countries are Spain (65), Australia (32), Sweden (30), Chile (28), United Kingdom (29), USA (18), Netherlands (17), Norway (16), and Iran (9). *Figure 7* shows the institutions outside of NFA that most frequently appear in the articles.

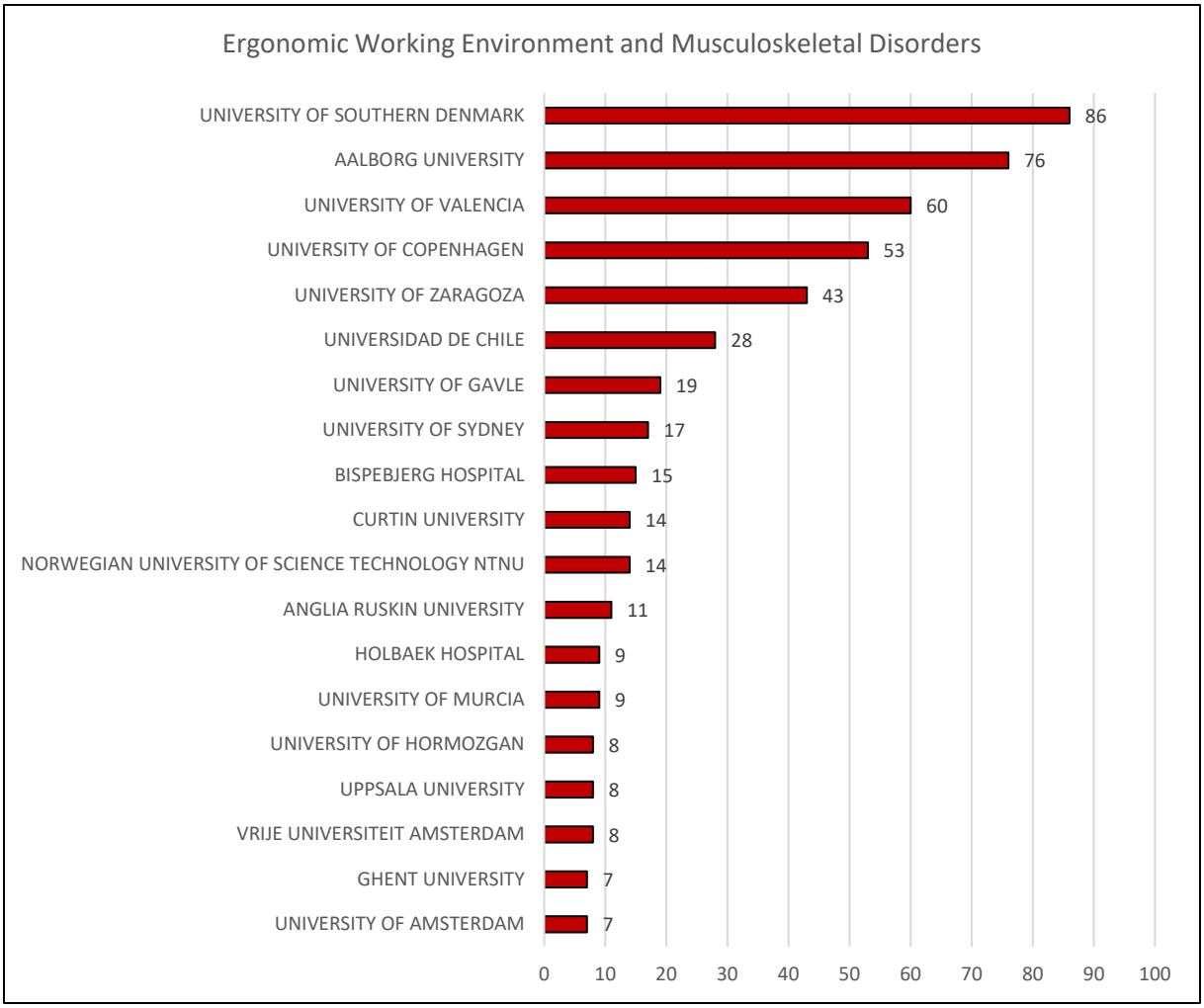

Figure 7. Number of articles by collaborating institution in articles from the programme Ergonomic Working Environment and Musculoskeletal Disorders.

Psychosocial Work Environment (PWE)

Among the 164 articles from this programme there are 88 (54 %) with authors in other countries. The most frequent countries are Sweden (40), Finland (36), United Kingdom (35), USA (34), Germany (29), Australia (16), Belgium (16), Netherlands (16), Spain (12, France (11), and Ireland (11). *Figure 8* shows the institutions outside of NFA that most frequently appear in the articles.

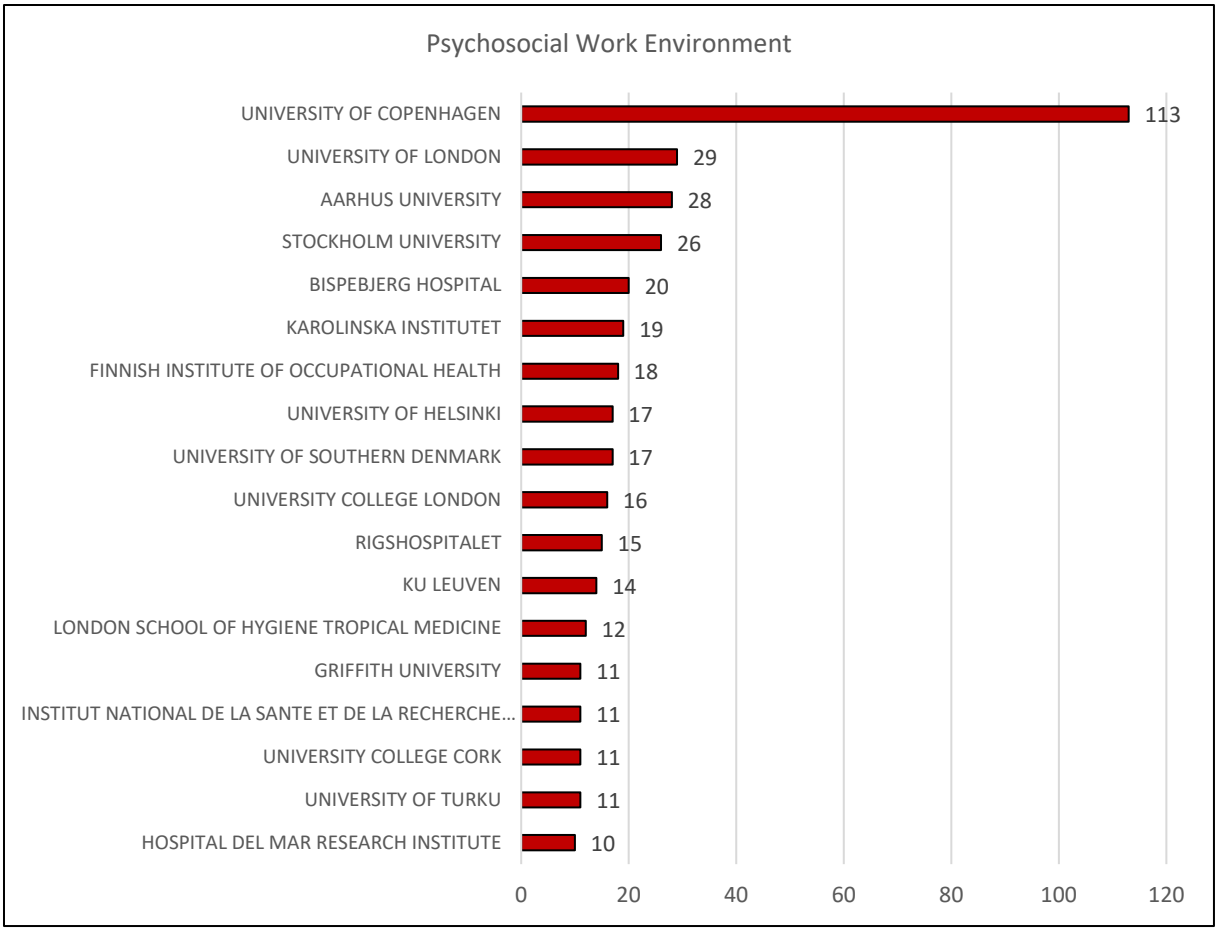

Figure 8. Number of articles by collaborating institution in articles from the programme Psychosocial Work Environment.

Working Environment Economics (WEE and A&D)

Among the 33 articles from this programme there are 23 (70 %) with authors in other countries. The most frequent countries are Norway (11), Sweden (10), United Kingdom (9), and Germany (6). There are five articles with affiliations in Australia, Finland and Iceland, four in Spain, and three articles with affiliations in France, the Netherlands and the USA. *Figure 9* shows the institutions outside of NFA that most frequently appear in the articles.

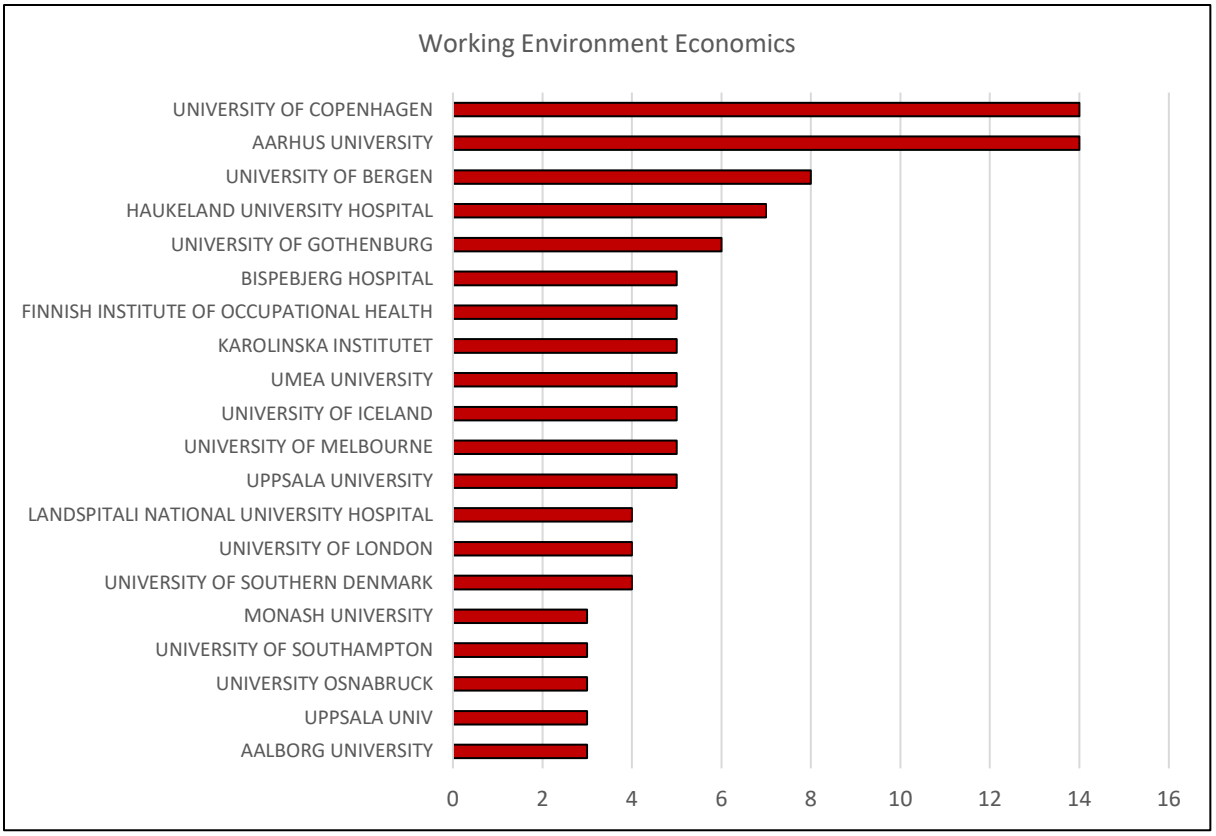

Figure 9. Number of articles by collaborating institution in articles from the programme Working Environment Economics.

4.2 Projects and project collaboration

The research programmes/units often jointly apply for project grants (47% of proposals 2020-2024). All 'Accidents and safety culture environment' proposals were collaborations with other NFA programmes. With one exception, all Psychosocial working environment proposals included such collaboration (Table 4.1). Only 8 of the 167 project proposals with multiple research programmes/units within NFA, included C&M.

Table 4.1 NFA's project proposals (2020-23) by research area and success.

Research programme/unit	Rejected	Funded	Non-concluded proposals	Total proposals	**Success rate %
Working Environment Economics (WEE; A&D)	4	5	0	9	55.6
Chemistry and microbiology (C&M)	48	38	29	115	44.2
Ergonomic working environment and musculoskeletal disorders (E&M)	29	23	14	66	44.2
Psychosocial working environment (PWE)	0	1	0	1	100.0
Multiple programmes involved*	67	55	45	167	45.1
Total	148	122	88	358	45.2

Note: The data contains uncertainties about the registration practice of re-submissions of proposals. This may affect the calculation of the success rate.
*164 of these proposals include Accidents and safety culture. 164 include 'Psychosocial working environment'.
78 include 'Working Environment Economics'/'Analysis and data'. 14 include 'Ergonomic working environment and musculoskeletal disorders'. 8 include Chemistry and microbiology.
** Funded as percentage of concluded proposals.

The overall success rate of the submitted proposals by the NFA is relatively high. The internal review process within NFA, to peer-review and only send in the best proposals, probably contribute to this. The success rate when sending in international collaborations suggests a strong international network. The commissioned research still has the highest success rate and sum up to 24% of the funded projects, se table 4.2.

Table 4.2 NFA's project proposals (2020-23) by funding source and success

Funding source	Rejected	Funded	Not concluded	Total proposals	**Success rate %
Commissioned research (Dansk rekvireret forskning)	5	29	17	51	85.3
Public foundations (Danske offentlige fonde)	28	16	13	57	36.4
Public foundations/AMFF*	63	33	15	111	34.4
Private foundations (Danske private fonde)	26	22	23	71	45.8
International funding	26	22	20	68	45.8
Total	148	122	88	358	45.2

Note: The data contains uncertainties about the registration practice of re-submissions of proposals. This may affect the calculation of the success rate.
*AMFF is The Working Environment Research Fund.
** Funded as percentage of concluded proposals.

A large part of the funded projects includes external collaboration (76%, Table 4.3). As would be expected, there is more international collaboration in projects with international funding.

Table 4.3 NFA's projects (2020-23) by funding source and collaboration.

Funding source	No external collaboration	DK (only) collaboration	Other countries (only) collaboration	Partners DK and abroad	Total
Danske offentlige fonde	37	70	1	12	120
Danske private fonde	17	22	0	1	40
EU	0	3	33	18	54
Intern	0	1	0	0	1
Nordiske fonde	0	0	9	2	11
Udenlandske fonde	2	2	8	1	13
Total	56	98	51	34	239

'Collaboration' delimited to project participation involving funding. For example, co-authorship not involving funding is not included.

All NFA research programmes/units are involved in both national and international research collaboration, and a majority of their projects are collaborative (Table 4.4). The C&M research programme has the highest level of international project collaborations.

Table 4.4 NFA's projects (2020-23) by research programme/unit and collaboration.

Research Programme/unit	No collaboration	DK (only) collaboration	Other countries (only) collaboration	Partners DK and abroad	Total
Working Environment Economics (WEE; A&D)	2	3	1	1	7
Accidents and safety culture (A&SC)	5	9	2	2	18
Chemistry and microbiology (C&M)	12	25	34	23	94
Ergonomic working environment and musculoskeletal disorders (E&M)	16	24	5	4	49
Psychosocial working environment (PWE)	21	37	9	4	71
Total	56	98	51	34	239

'Collaboration' delimited to project participation involving funding. For example, co-authorship not involving funding is not included.

4.3 Conference contributions

NFA's conference contributions include conference abstracts and papers and vary by year and research programme. Overall, there is an increase after the Covid pandemic. Still, from Working environment economics there is no registered conference contributions in 2022 or 2023. Total numbers for the period indicate that relative to their size (FTEs), Chemistry and microbiology and Accidents and safety culture are very active at academic conferences, which is positive for networking and research dissemination.

Overall, the conferences attended includes multidisciplinary conferences within work and health, such as ICOH and slightly more method-based conferences as EPICOH, or EuroTOX as well as conferences with a narrow scope such as WINC and Nanosafe. This provides a mix of all important aspects of the NFA work, providing an excellent network for learning and dissemination.

Table 4.5 Registered conference contributions* 2020-2023, by research programme/unit.

Research programme/unit	2020	2021	2022	2023	Total
Working Environment Economics (WEE; A&D)	3	3	0	0	6
Chemistry and microbiology (C&M)	17	23	29	35	104
Ergonomic working environment and musculoskeletal disorders (E&M)	3	2	9	8	22
Accidents and safety culture (A&SC)	2	0	13	5	20
Psychosocial working environment (PWE)	3	7	24	24	58
Other	0	1	4	0	5
Total	28	36	79	72	215

* Contributions are not registered consistently, and data contains uncertainties. The submitted data includes 145 abstracts for conferences, 48 conferences papers and articles, and 22 conferences abstracts in journals. The NFA has also provided a list of 855 lectures at conferences, seminars, meetings and other events in the evaluation period. These are not included in the table.

4.4 Participation in partnerships and networks

The NFA participates in a broad range of partnerships and networks, including both collaboration institutional partnerships and networks and individual memberships in collaborations and networks. It includes Danish, Nordic, European and international collaboration, and research and user-oriented collaborations with the most important entities. Not seldom with a more advanced connection, such as advisory board member. These networks include partnerships in PEROSH, ICOH, NOROSH and NIVA, which are the most important networks for research, research dissemination and education within the work and health field. Several specialised national and international networks are also covered, providing input to new guideline values for chemicals though NEG, research dissemination in WINC and stakeholder input from the Danish government and many more. Overall, an impressive network. A list of NFA's partnerships and networks is provided in Appendix 4.

5. Educational activities

The *statutes for the NFA* says that NFA is to have strategic collaboration agreements with Copenhagen University, Aarhus University, DTU and possibly other universities, to enable scholarly synergies within research and education. It furthermore states that NFA, in collaboration with universities, should help ensure that research-based knowledge on the working environment is used in relevant researcher and master education.

Supervision: NFA staff have supervised 6 Bachelor, 39 Master and 54 PhD students in the period. The three largest research programmes/units supervised 14 to 22 PhD students each, whereas the two smallest programmes/units supervised 3 PhD students in total (Table 5.1). NFA staff also served on assessments committees for 15 PhD theses in the period (including 7 different NFA staff members). In the previous evaluation of the NFA (2019), educational activities were an area that required improvement. In the research programmes for A&SC, PWE and E&M, it is explicitly stated that the NFA aims to educate qualified and competent experts in the relevant fields themselves. It is further important to note that the WEE and A&D programme has recently been established and has limited supervision capabilities at this moment.

Table 5.1 Students supervised by NFA staff (including students with end date 2020 to 2026).

Research programme/unit	Bachelor	Master	PhD
Working environment economics (WEE and A&D)		6	2
Chemistry and microbiology (C&M)	4	14	22
Ergonomic working environment and musculoskeletal disorders (E&M)		13	14
Psychosocial working environment (PWE)	2	6	15
Accidents and safety culture (A&SC)			1
Total	6	39	54

Teaching: The data provided to the panel lists 127 teaching contributions by NFA staff in the evaluations period. Most of it is in PWE (78 contributions) and C&M (34 contributions). The staff within PWE did much more teaching in the first half of the period (64 contributions) than the last (14 contributions). Most of the PWE teaching the previous years was through a course offered twice a year at the University of Copenhagen, but has not been offered the latter years, which explains the decline in this area. We also note that the decline within PWE gives a fall in the overall NFA teaching figures for the period (Table 5.2). Notably, the table only gives partial overview of NFA staff's teaching activities. We lack data on their teaching conducted in their (adjunct) positions at universities but note that 13 NFA staff members hold university positions.[8]

[8] PhD students' university positions are not included in this figure.

Table 5.2 NFA staff's registered teaching contributions*, 2020 to 2023.

Research programme/unit	2020	2021	2022	2023	Total
Working environment economics (WEE; A&D)					0
Chemistry and microbiology (C&M)	10	5	10	9	34
Ergonomic working environment and musculoskeletal disorders (E&M)	2	2	5	3	12
Psychosocial working environment (PWE)	29	35	4	10	78
Accidents and safety culture (A&SC)		1	2		3
Total	41	43	21	22	127

* Contributions are not registered consistently, teaching conducted as part of NFA staff' affiliation with a university is not included, and there may also be general underreporting of teaching activities. Most registrations appear to be single lectures or one-day events, whereas a few are courses over multiple days (3 cases) or months (2 cases in C&M). Whereas several teaching activities are repeated, and registered, multiple years, in one case (from C&M) a multiyear activity is registered only once and counted once in the table.

Research capacity building in terms of mentoring the next generation of work environment researchers is a critical role for research centres such as the NFA. The unique nature of applied research in a specialized field such as the work environment makes it difficult for a new researcher to develop an interest and ability in a research program in this area without opportunities for mentorship by academics in such a centre. Thus, in-house mentorship is critical for sustainability of capacity. Further, recruitment of the best students is only possible if centre academics are connected to and involved in university life through teaching and collaborative work.

The mentorship and teaching profiles noted in Tables 5.1 and 5.2 provide a high-level view of the distribution of efforts in these areas. Noteworthy are the difference across programmes, likely due to the size of the academic compliments in each programme, but also to the programme newness/maturity and relationships with universities. Two programs – *WEE and A&D* and *A&SC* – had only 2 and 1 PhD students, respectively, and 6 and 0 MA students, respectively. This is dramatically different from the other three programmes. Given that the research programmes of work environment economics and safety culture are very specialized, attention is warranted to identifying ways to expand student opportunities in the two programmes, going forward. Registered teaching contributions were equally disparate across programmes. *WEE and A&D* and *A&SC* programmes had zero and 3 units respectively over a 4-year period. As noted, teaching is a primary means by which academics connect with young/new talent.

In interviews with researchers, the review panel heard about some of their challenge of mentorship and teaching. In particular, the dependency of soft, project funds for all research required an ability to bill time to projects, even for mentorship activities. We heard that teaching was generally only possible if teaching time was paid for through the universities. Additional, ability to sit on and/or direct thesis committees varied based on the specifics of appointments. Going forward, more attention may be given by senior leadership to negotiating better opportunities and conditions for NFA researcher contributions to university activities, such as time buy outs for university teaching and related activities, and more diverse opportunities for student mentorship. Additionally, NFA researchers might consider expanding their roster of collaborations, considering building ties with academics in others university departments and other universities (including adjunct positions) to tap into a broader range of methods, expertise, and talent.

In interviews with PhD students working at the NFA, the review panel received very positive commentary about the student experience at the centre. It was noted that students felt the

opportunities for mentorship, particularly in multidisciplinary, applied research on work environment issues was unparalleled. They noted that the universities focus on basic sciences and methods, whereas the NFA focuses on applied research in work environment issues. Thus, this type of training cannot be had at the university. An aspect of applied research that is particularly unique and inspiring is the opportunity to be part of stakeholder relations. The students also noted that it takes a different mindset to do this type of work, so it may not be a good fit for everyone.

Career paths in academia can vary from career paths at a research centre like NFA where transdisciplinary research is undertaken. As such, PhD students emphasized the importance of securing mentorship opportunities at the NFA. In general, the students found NFA mentorship of high quality. Mentors are dedicated and offered good career planning support. The collegiality at NFA was also noted as a positive aspect. Students felt that people at the NFA are always willing to give time, and they were encouraged to have discussions and support each other. They felt there is a sense of community, and they are valued and belonged. Their work was seen as well integrated with NFA research. There was also mention of a journal club and efforts to support cross programme PhD forum, though the latter was not currently active.

Overall, the review panel found that the training, mentoring and educational activities of NFA researchers was a very positive aspect of the centre. The review team encourages continued efforts in these activities with an eye to selectively, and strategically expanding them as needed.

6. Overall assessments, conclusions and recommendations

6.1 Overall assessments and conclusions

Overall assessment

Research: The research at NFA is generally excellent and highly relevant to occupational health issues as outlined in the national goals and strategies as well as according to NFA's strategy and different research programmes. NFA's scientific output is highly cited and appears in good quality journals compared to five other organizations in Norway, Finland, Germany, Poland and USA that operate in the same area of research. All research programmes are active in national and international scientific communities within the different areas, which is shown by collaboration in scientific articles and new research proposals. Researchers from NFA are also represented in a number of important international networks like PEROSH and WHO/ILO.

Research Dissemination: Participation in international conferences has increased after the Covid-19 pandemic, though for some of the smaller programmes the conferences activity is low and varies much between years. All of the research programmes at NFA participates in international research collaborations on specific projects and overall the international research collaboration for NFA is extensive and highly relevant.

Education: NFA contributes well to educating future occupational safety and health researchers through mentoring and supervision. The NFA staff's role in mentoring and teaching is critical to recruitment and capacity building in Danish work environment research.

Strengths

Considering the number or researchers at the centre, the scientific output of the NFA is high in numbers of scientific articles in international peer reviewed journals. Their scientific impact in terms of citations is high compared to similar organizations in Norway, Finland, Germany, Poland and USA that operate in the same areas of research with similar missions. NFA has a high profile in selecting good quality journals.

The number of scientific articles per year has stabilized and seems to slightly decrease recently, but this might be related to the new strategy for increased societal interaction in all phases of research and more emphasis on implementation studies. Scientific quality is more than the citation impact of published scientific articles and in the interviews with the different researchers it appears that quality is a guiding light for the researchers at NFA. There are systematic working methods and processes that ensure a high scientific quality both in terms of how results from the research are disseminated, before publishing reports and scientific articles, work with new research applications and in the development of the employees' skills and competence.

All of the NFA research units strive to focus their research on issues that are of relevance to occupational health in Denmark and internationally. This is achieved by building relationships with key stakeholders in the community and industry to help define key issues and research questions. Close collaboration with researchers both within Denmark and internationally contributes to strong

research communities within NFA. Within Denmark, research themes are well-aligned with strategic frameworks and national agreements for occupational health. Researchers at NFA are also active in multiple European and international research partnerships

Challenges

In this section the review panel addresses five challenges identified through document review and conversations with NFA staff.

As noted in the last evaluation (2014-2019) the public block grants decreased from 2010 to 2020. In the current evaluation period, the block grant has been stable at around 50 million DKK 2020-2022 and finally 56 million DKK in 2023. A stable and well-balanced governmental funding is essential for ensuring retention of permanent senior positions (professors and senior researchers) and highly skilled support-functions to meet the goals of the national research strategy. The consequence of lower block funding is that more time will need to be dedicated to securing external funding, which will take time away from core activities. Hence, retaining staff and developing research lines are two key challenges for the NFA.

Retaining staff: While grant funding is a requirement in most academic settings, research faculty often have fully funded positions with time set aside for teaching, research and administrative tasks. This is not the case at research centres like the NFA. External funding needs to be acquired to cover research time, and teaching (if any) is done outside NFA working hours, either in adjunct university positions or individually paid. While experienced researchers can manage the constant struggle for funding, albeit with stress and frustration, junior research staff find it difficult to acquire the needed funds for developing their own research topics. Thus, it is a challenge to retain the most talented researchers and support. We note that NFA has lost people to private companies and other places because of less job security and less competitive pay levels.

Developing research lines: Beyond block grants, funding is required from public and private external grants to support research programmes. In short, ongoing funding proposal submissions are fundamental to the continuation of NFA's research operation. Individual research units decide on research topics, but projects must align with the NFA's overall strategy and the Danish national strategy which can necessitate a need to shift research topics. In developing research topics, working with stakeholders is of key importance to help focus on the most relevant topics. In contrast, grant applications subject matter is determined by what funders are interested in, which may not be the topics of interest to key stakeholders and aligned with the national strategy. This can create a tension between areas of focus and researcher competence. Further, it is a challenging to build or recruit new talent through time-limited, external project funding. Moreover, many external funding opportunities are not very large, so project size is limited and the need to cover researcher salaries limits the number of investigators that can be involved and further restricts the size of projects. Additionally, the small size of external funding envelopes constrains the number of external collaboration and/or collaboration across research programmes within NFA. A particular concern is the capacity for NFA to do intervention research. In the last few years there has been a shift towards a focus on intervention research and implementation science from both NFA leadership and NFA stakeholders. Intervention studies are expensive, take time to implement, and are difficult to fund. Additionally, funders and stakeholders prioritize results and tools (which can lead to intervention studies), but academics need to publish to maintain their credibility. Intervention research papers also take a longer time to write and get published.

Other challenges concern PhD education, skill-development and support infrastructures.

PhD students: Mentorship of PhD students is part of the NFA's requirement and vital for recruiting new talents. As NFA is not a grant awarding institution, the PhD education is a collaboration with universities and parts of the grants for PhD students go to the student's university academic home. In addition to having an NFA supervisor, students retain supervisors at their respective universities. Hence, supporting PhD mentorship may be challenging for the NFA, given limited funds and different scholarly cultures. The evaluation panel considers these to be general challenges of PhD mentorship outside university and that the NFA *is* aware of it and handling it well.

Skill-development and junior researchers: NFA has several processes and structures that ensures research quality and skill-development for researchers at different levels, including weekly seminars, relevant courses and informal talk in a supportive research environment. Moreover, collaboration with other research institutions and international conferences help to improve researchers' skills and knowledge. However, some junior researcher felt they had too little time for competence development (e.g. learning new methods). Additionally, a systematic support structure for researchers at the post-doc level appears to be an area that could be improved upon.

Infrastructure: Researchers reported that much time goes to administrative tasks such as ethical applications and establishment of data use agreements. Large EU projects are very resource intensive and there is no IT structure to collect big data across nations. Key account managers help in organizing grant projects but there are no expert grant-writers to help with submissions.

6.2 Recommendations

This section presents the evaluation panel's overall recommendations. Suggestions for improvements are also found in the review of the research programmes (Section 3.2) and educational activities (Chapter 5).

Research quality: An overall recommendation from the evaluation panel is to continue pushing for high standards and providing a good environment for scientific discourse, including weekly seminars, peer-review processes, international conferences, relevant courses and informal talk. Based on the detailed bibliometric analysis in this report, it is suggested that journal selection should depend more on quality and relevance than on Journal Impact Factors. It is also preferable to monitor direct citations of articles rather than looking at citation impacts of journals.

Research collaboration: The NFA should consider strengthening the collaboration with relevant Nordic universities and agencies, since these have a great understanding of work environments similar to Danish settings and have similar data and goals. It is a bit surprising that these does not rate higher in the collaboration patterns of publications during the assessment period. The same goes for the Danish hospitals and clinics, that should be able to provide an important clinical relevance to the publications.

Relevance and cross-disciplinary work: Collaboration across programmes within NFA should be further enhanced to facilitate more multidisciplinary research projects. Many exposures co-exist in the work environment and are partly co-dependent on each other. A poor psychosocial work environment with inadequate organisation and social support at the workplace can lead to an increased exposure to chemicals, particles, physically strenuous and/or more accidents at work by

skipping routines and safety measures to save time or because they are lacking. Sent in applications show a strong collaboration between Accidents and safety culture, Psychosocial working environment and the Working environment economics programmes. But less strong between Chemical and Microbiological working environment and the Ergonomic working environment and musculoskeletal disorders and the other programmes. NFA has a unique opportunity to work cross-disciplinary on this. This applies to all aspects of NFA work, from the measurement of exposure, the exposure-response quantifications to the intervention studies. Moreover, some consideration should be given to developing research on the effects of artificial intelligence (AI) on occupational health and safety. The evaluation panel also advise to expand in-house expertise in intervention research, implementation science, and economic research.

Mentoring and career development: There appears to be no systematic mentoring of postdocs and junior researchers. While NFA career demands are outlined and clear to the researchers and they have a supportive research environment, there is no dedicated mentor with whom they can discuss their career plans and their strategies for reaching the demands. We recommend introducing systematic mentoring. This should help individual career development, integrate the juniors more in academic activities and networks, and make NFA a more attractive research environment for early career researchers. Moreover, the PhD students would profit from a PhD network across NFA.

Enabling project initiation and implementation: The panel sees a need for easier access to seed money for pilot projects which would provide preliminary data for larger-scale projects for which NFA would seek external funding. Furthermore, there is need for professional assistance in grant writing and submissions, and tasks such as ethical applications and establishment of data use agreements.

Appendices

Appendix 1 Terms of Reference for the evaluation of academic impact of NFA 2020-2023

Appendix 2 Materials for the panel for academic impact

Appendix 3 Publications selected for review

Appendix 4 Partnerships and network

Det Nationale Forskningscenter for Arbejdsmiljø

Terms of Reference for the evaluation of the academic impact of the National Research Centre for the Working Environment (NFA) 2020-2023

2. oktober 2023

J.nr. 2023-80/63

Ledelses- og kommunikationssekretariatet
LMT

1. Background and Purpose

This evaluation will be conducted in accordance with the executive order on evaluation of government research institutes.

The Danish National Research Centre for the Working Environment's (NFA) core tasks include research and associated activities such as dissemination of research results, education of researchers and counselling of and service to the authorities. According to Section 2 of the Sector Research Act, NFA must conduct research at the highest international level.

This evaluation concerns the academic impact of research, academic research dissemination, and education at NFA, while a separate evaluation will be conducted for the societal impact of NFA's consulting to and services rendered to authorities as well as policy and workplace-oriented communication.

The overall purpose of the evaluation is to learn from, and improve, NFA's institutional performance. The evaluation should infer judgment against the highest international level within occupational safety and health research as evaluation standard.

Scientific quality, relevance, and impact are the foundation for achieving the greatest possible utilization of NFA's research and research dissemination among authorities, occupational safety and health professionals, and workplaces - and thus ensuring societal impact.

The specific purposes of evaluating the academic impact therefore are:

- To assess the academic quality and relevance of NFA's research, research dissemination, and education.
- To provide specific recommendations on how NFA can strengthen the quality, relevance, and academic impact of its research, research dissemination, and education.

The evaluation covers the period 2020-2023.

2. Evaluation Approach

During the evaluation period, NFA has systematized its research documentation practices. Therefore, the evaluation can benefit from drawing on a quantitative analysis based on bibliometric data, as well as a qualitative assessment of the methodological and substantive quality of the research.

Accordingly, it is proposed that the evaluation is conducted as follows:

- A quantitative analysis of the academic impact of NFA's research and research dissemination based on bibliometric data on publications, citations, research collaboration networks, and co-publications.
- A qualitative analysis of the academic quality of NFA's research, research dissemination, and education based on existing documentation and data collection at and in regards to NFA.

Explicit evaluation standards for quality, relevance, and academic impact should be established in accordance with highest international level within each research area. Consequently, the applied methodology should be described in the evaluation report.

The evaluation should be presented in a report containing a description and assessment of NFA's achievements, as well as recommendations for improvements.

The evaluation panel should be composed of international and national experts with in-depth knowledge of NFA's research areas, including 'psychosocial work environment,' 'ergonomic work environment and musculoskeletal disorders,' ' occupational safety culture and accidents,' 'chemical work environment,' and 'occupational safety and health economics.' Additionally, the panel should have expertise in bibliometric analysis and skills specific to research evaluation. The evaluators are expected to be familiar with and acknowledge the principles of various scientific traditions.

The panel should be independent of the Danish Ministry of Employment, including NFA. The board of NFA appoints the panel upon recommendation from the Innovation Fund Denmark.

3. Evaluation Tasks

The evaluation should address the following questions, among others:

Research:

- Is the research's academic quality of a high standard and scope compared to similar research groups nationally and internationally?
- To what extent is the research focused on solving relevant and prioritized occupational health issues outlined in NFA's research programs?
- To what extent are themes in NFA's research programs and project portfolio within NFA's research areas - both applied and funded - aligned with priorities in strategic frameworks such as, national agreements and strategies,

- To what extent are the research-related networks and connections with strong research communities at universities and other research institutions in Denmark and abroad relevant and sufficiently developed?

Research Dissemination:

- Do researchers participate adequately in the most relevant conferences and other forums for international knowledge exchange and professional debate?
- Do researchers participate adequately in international research collaboration on specific projects?

Education:

- Does NFA contribute adequately to the education of undergraduates, postgraduates and Ph.D. students in the field of occupational safety and health, thus also contributing to educate future occupational safety and health researchers?
- Does NFA contribute adequately to teaching at universities, in the joint Nordic education of researchers, at other seminars, etc.?

4. Background Material

NFA will provide the necessary background material such as:

- NFA's by-laws
- Evaluation reports on scientific and societal impact for the period 2014-19 and the board's follow-up statements (2021 and 2022)
- National occupational safety and health agreements and strategies for the evaluation period
- NFA's Institutional Strategy 2020, Institutional Strategy 2021-2024, communication strategy, and research-to-practice strategy
- NFA's research programs 2020-2023
- NFA's performance management contracts 2020-2023
- NFA's action plans for research areas 2022-2023
- Bibliometric data on NFA's publications, citations, networks, etc., during the strategy period
- Data on NFA's portfolio of funding applications and funding allocations
- NFA's annual reports and annual statements for the evaluation period

5. Procedure

An independent academic consultant will assist the evaluation panel during the visit to NFA and in preparing the evaluation report. NFA will provide practical assistance to the evaluators, such as facilitating contact with relevant stakeholders, arranging meetings, and providing relevant documentation.

6. Completion

The evaluation should be presented in the form of a report that includes a summary of conclusions and recommendations, by no later than October 1 2024. The evaluation should also include an overall conclusion of the evaluations of societal impact and academic impact.

The detailed timetable for the process will be agreed upon with the evaluators once they are appointed.

7. Funding

The expenses for the evaluation will be covered by the Danish Ministry of Employment.

Appendix 2 Materials for the panel for academic impact

ACADEMIC EVALUATION

* Vigtigste dokumenter
FED - tilføjet 21. marts 2024 / 8. april 2024 / 18. April 2024 / 25. juni 2024

	Document name	Description	(da/en)
1	**Governing and strategic documents**		
1.1	Vedtægt for NFA	The statutes for NFA	Da
1.2	NFA's strategi 2019-2022	NFA's Strategy 2019-2022	Da
1.3	NFA's strategi 2021-2024*	NFA's Strategy 2021-2024	Da
1.3a	**NFA's strategi 2021-2024 (engelsk)**	**NFA's Strategy 2021-2024 (in English)**	En
1.4	Kommunikationsstrategi	Communication Strategy 2021-2024	Da
1.5	Research to practice strategi	Research-to-Practice Strategy 2020	Da
1.6	NFA's mål- og resultatplan 2020	NFA's target and result plan 2020	Da
1.7	NFA's mål- og resultatplan 2021	NFA's target and result plan 2021	Da
1.8	NFA's mål- og resultatplan 2022	NFA's target and result plan 2022	Da
1.9	NFA's mål- og resultatplan 2023	NFA's target and result plan 2023	Da
1.10	NFA's årsrapport 2020*	NFA's annual review 2020	Da
1.11	NFA's årsrapport 2021*	NFA's annual review 2021	Da
1.12	NFA's årsrapport 2022*	NFA's annual review 2022	Da
1.13	**NFA's årsrapport 2023***	**NFA's annual review 2023**	Da
1.14	NFA's årsberetning for 2020	NFA's annual report 2020	Da
1.15	NFA's årsberetning for 2021	NFA's annual report 2021	Da
1.16	NFA's årsberetning for 2022	NFA's annual report 2022	Da
1.17	**NFA's årsberetning for 2023**	**NFA's annual report 2023**	Da
1.18	**NFA governance**	**NFA governance**	Da/En
1.19	**Working Environment Economics and Data and Analysis**	**Working Environment Economics and Data and Analysis**	En
2	**Job structure and descriptions**		
2.1	Cirkulære om stillingsstruktur for videnskabeligt personale ved sektorforskningsinstitutioner	Circular on job structure for scientific staff at sector research institutions	Da
2.2	Funktionsbeskrivelser*	Function descriptions at NFA	Da
3	**Previous evaluation reports**		
3.1	Evalueringsrapport om NFA's akademiske aftryk for perioden 2014-2019.*	The international evaluation of the scientific impact of NFA for 2014-2019.	En
3.2	Evalueringsrapport om NFA's samfundsmæssige aftryk for perioden 2014-19.	The evaluation of NFA's societal impact for the period 2014-2019.	Da
3.3	Engelsk resume af rapportens konklusioner og anbefalinger.	Summary in English of the report's conclusions and recommendations.	En
3.4	Bestyrelsens redegørelser om opfølgning på evaluering af videnskabeligt og samfundsmæssigt aftryk (2021)*	The document is a statement of the Board of NFA regarding the recommendations presented in evaluations of the scientific impact and the societal impact to the Minister of Employment.	Da
4	**National strategies and agreements**		
4.1	Trepartsaftale om prioriterede nationale mål for arbejdsmiljøindsatsen (2020) inkl. bilag 1-5*	Tripartite agreement on prioritized national goals for working environment efforts incl. annex 1-5 (2020)	Da
4.2	National strategi for arbejdsmiljøforskning, Beskæftigelsesministeriet 2020.*	National strategy for working environment research, Ministry of Employment 2020.	Da
4.3	Aftale om en fremtidssikret arbejdsmiljøindsats og indsats mod social dumping (2023) incl. faktaark*	Agreement on a future-proof working environment and efforts against social dumping incl. fact sheet (2023)	Da
4.5	Et nyt og forbedret arbejdsmiljø (Beskæftigelsesministeriet, 2018)	Ministry of Employment Expert panel on new and improved working environment. Appendix material incl. themes: Occupational safety and health goals closer to workplaces, A targeted regulatory effort by authorities, Improved and more understandable occupational safety regulation, and Research, knowledge production, and dissemination closer to workplaces.	Da
5	**Research programs, action plans and research area descriptions**		
5.1	Forskningsprogram for Analyse og Data 2021-2024*	Research program for Analytics and Data 2021-2024	Da
5.2	Forskningsprogram for Arbejdsmiljøøkonomi 2022-2025*	Research program for Work Environment Economics 2022-2025	Da
5.2a	**Forskningsprogram for Arbejdsmiljøøkonomi 2022-2025* (Engelsk)**	**Research program for Work Environment Economics 2022-2025 (in English)**	En
5.3	Forskningsprogram for Kemi 2021-2024*	Research Program for Chemistry and Microbiology 2021-2024	Da
5.4	Forskningsprogram for MSB og Ergonomisk Arbejdsmiljø 2021-2024*	Research program for Musculoskeletal disorders 2021-2024	Da
5.5	Forskningsprogram for Psykosocialt arbejdsmiljø 2021-2024*	Research Program for Psychosocial Work Environment 2021-2024	Da
5.6	Forskningsprogram for Sikkerhedskultur og arbejdsulykker 2021-2024*	Research Program for Safety Culture and Occupational Accidents 2021-2024	Da
5.7	Handleplan for 2022. Forskningsområde: Analyse og Data	Action plan for 2022: Analysis and Data The purpose of these action plans is to concretize the intentions of the research program into a number of concrete objectives and actions.	Da
5.8	Handleplan for 2023. Forskningsområde: Analyse og Data	Action plan for 2023: Analysis and Data	Da
5.9	Handleplan for 2022. Forskningsområde: Kemi	Action plan for 2022: Chemical working environment	Da
5.10	Handleplan for 2023. Forskningsområde: Kemi	Action plan for 2023: Chemical working environment	Da
5.11	Handleplan for 2022. Forskningsområde MSB og Ergonomisk Arbejdsmiljø	Action plan for 2022: Musculoskeletal disorders and physical working environment	Da
5.12	Handleplan for 2023. Forskningsområde MSB og Ergonomisk Arbejdsmiljø	Action plan for 2023: Musculoskeletal disorders and physical working environment	Da
5.13	Handleplan for 2022. Forskningsområde: Psykosocialt arbejdsmiljø	Action plan for 2022: Psychosocial working environment	Da
5.14	Handleplan for 2023. Forskningsområde: Psykosocialt arbejdsmiljø	Action plan for 2023: Psychosocial working environment	Da
5.15	Handleplan for 2022. Forskningsområde: Sikkerhedskultur og arbejdsulykker	Action plan for 2022: Occupational accidents and safety culture	Da
5.16	Handleplan for 2023. Forskningsområde: Sikkerhedskultur og arbejdsulykker	Action plan for 2023: Occupational accidents and safety culture	Da
5.17	Description from evaluation 2020: Chemical working environment	Description of Research Area from evaluation in 2020: Chemical working environment	En
5.18	Description from evaluation 2020: Musculoskeletal disorders and physical working environment	Description of Research Area from evaluation in 2020: Musculoskeletal disorders and physical working environment	En
5.19	Description from evaluation 2020: Occupational accidents and safety culture	Description of Research Area from evaluation in 2020: Occupational accidents and safety culture	En
5.20	Description from evaluation 2020: Psychosocial working environment	Description of Research Area from evaluation in 2020: Psychosocial working environment	En
6	**Other background material**		
6.1	Bibliometrisk materiale om NFA's publikationer, citationer mv. i strategiperioden*	Bibliometric data about NFA's publications, citations etc. in the strategy period	Da
6.3	Notat om definition af interventionsforskning	Memo on definitions of intervention research	Da

Appendix 2 Materials for the panel for academic impact

6.4	Notat om definition af Top 5-tidsskrifter*	Memo on definition of Top 5 Journals	Da
6.5	**Skema fra PEROSH-benchmarking**	**Overview of PEROSH benchmarking (Partnership for European Research in Occupational Safety and Health)**	**En**
6.6	**Kommissorium for evalueringspanelet for det samfundsmæssige aftryk**	**Terms of reference for the evaluation of the societal impact**	**En**
6.7	**Liste over medarbejdere**	**Employees**	**En**
6.8	**Liste over ph.d.-projekter, bacheloropgaver og kandidatspecialer**	**List of PhD projects, bachelor's and master's theses**	**En**
6.9	**Oversigt over finansiering og fordeling af årsværk**	**Overview – annual accounts and staff over time**	**En**
6.10	**Fokusområder i forskningsartikler**	**Themes in research articles**	
7	**Scientific publications and activitites**		
7.1	**De 10 vigtigste publikationer fra hvert forskningsområde i evalueringsperioden (2020-2023)** ***Udvælgelseskriterier er specificeret i notatet***	**The 10 most important publications from each research area in the evaluation period (2020-2023)**	**Da**
7.2	**Skriftlige konferencebidrag (posters, papers, conference abstracts for conferences, conference abstracts in journals, conference articles)** ***Dataudtræk fra Pure***	**Conference contributions (posters, papers, conference abstracts for conferences, conference abstracts in journals, conference articles)**	**En**
7.3	**Lektørbedømte rapporter (peer-reviewed)** ***Dataudtræk fra Pure***	**Peer-reviewed reports**	**En**
7.4	**Tidsskriftsartikler (ikke peer-reviewed)** ***Dataudtræk fra Pure***	**Journal articles (not peer-reviewed)**	**En**
7.5	**Andre publikationer (comment/debate, contribution to book/anthology, editorial, letter, online publication)** ***Dataudtræk fra Pure***	**Other publications (comment/debate, contribution to book/anthology, editorial, letter, online publication)**	**En**
7.6	**Mundtlige præsentationer (lecturer, keynote speaker, invited speaker)** ***Dataudtræk fra Pure***	**Oral presentations (lecturer, keynote speaker, invited speaker)**	**En**
7.7	**Undervisning** ***Dataudtræk fra Pure***	**Teaching**	**En**
7.8	**Medlem af bedømmelsesudvalg (ph.d.)** ***Dataudtræk fra Pure***	**Member of assessment committees (Ph.D.)**	**En**
7.9	**Ansøgninger og hjemtagninger 2020-2023**	**Grant applications 2020-2023**	**Da**
7.10	**Oversigt over forskningsprojekter og samarbejdspartnere**	**Research projects and collaborations**	**Da**
7.11	**Partnerskaber og netværk**	**Partnerships and networks**	**En**

Det Nationale Forskningscenter for Arbejdsmiljø

NOTAT

De ti vigtigste publikationer fra hvert forskningsområde i evalueringsperioden (2020-2023)

22. marts 2024

J.nr. 2023-80/63

Ledelses- og kommunikationssekretariatet
KFJ

Spørgsmål fra panelet

Panelet har bedt NFA udvælge de ti publikationer fra evalueringsperioden for hvert forskningsområde, som NFA anser for at være de vigtigste bidrag til forskningsområdet. Panelet ønsker også en kort beskrivelse af kriterierne for udvælgelse af de ti artikler.

Kriterier for udvælgelse

Publikationerne er udvalgt ud fra følgende kriterier:

- Empirisk, teoretisk eller metodisk nybrud
- Flest citationer
- Journal Impact Factor
- Samarbejde med globalt førende forskere på området
- Bredde i typen af forskning på området

De gældende udvælgelseskriterier er angivet under hver artikel.

Arbejdsmiljøøkonomi

Da der er tale om et nyt forskningsområde på NFA, er der endnu ikke publiceret mange artikler på området.

Den vigtigste publikationer fra evalueringsperioden (2020-2023) er:

1. **Pedersen J**, **Graversen BK**, **Hansen KS**, **Madsen IEH**. 2023. The labor market costs of work-related stress: A longitudinal study of 52 763 Danish employees using multi-state modeling [Epub ahead of print]. Scandinavian Journal of Work, Environment & Health. https://doi.org/10.5271/sjweh.4131
    a. Empirisk, teoretisk eller metodisk nybrud

Analyse & Data

De 9 vigtigste publikationer fra evalueringsperioden (2020-2023) er:

1. **Pedersen J**, **Bjorner JB**, **Andersen LL**. 2022. Physical work demands and expected labor market affiliation (ELMA): Prospective cohort with register-follow-up among 46 169 employees. Scandinavian Journal of Work Environment & Health. 48(8):641-650. https://doi.org/10.5271/sjweh.4050
    a. Empirisk, teoretisk eller metodisk nybrud

2. **Pedersen J**, **Framke E**, **Thorsen SV**, **Sørensen K**, **Andersen MF**, **Rugulies R**, Solovieva S. 2023. The linkage of depressive and anxiety disorders with the expected labor market affiliation (ELMA): A longitudinal multi-state study of Danish employees. International Archives of Occupational and Environmental Health. 96(1):93–104. https://doi.org/10.1007/s00420-022-01906-z
    a. Empirisk, teoretisk eller metodisk nybrud

3. **Pedersen J**, **Schultz BB**, **Madsen IEH**, Solovieva S, **Andersen LL**. 2020. High physical work demands and working life expectancy in Denmark. Occupational and Environmental Medicine. 77:576-582. https://doi.org/10.1136/oemed-2019-106359
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer

4. **Bjerregaard SS**. 2023. Exploring predictors of welfare dependency 1, 3, and 5 years after mental health-related absence in danish municipalities between 2010 and 2012 using flexible machine learning modelling. BMC Public Health. 23(1):224. https://doi.org/10.1186/s12889-023-15106-y
    a. Bredde i typen af forskning på området

5. **Hannerz H**, **Holtermann A**, **Madsen IEH**. 2021. Musculoskeletal pain as a predictor for depression in the general working population of Denmark. Scandinavian Journal of Public Health. 49(6):589-597. https://doi.org/10.1177/1403494819875337
    a. Empirisk, teoretisk eller metodisk nybrud

6. **Hannerz H**, Albertsen K, Nielsen ML, **Garde AH**. 2021. Long working hours and psychiatric treatment: a Danish follow-up study. Scandinavian Journal of Work, Environment and Health. 47(3):191-199. https://doi.org/10.5271/sjweh.3936
    a. Empirisk, teoretisk eller metodisk nybrud

7. **Hannerz H**, Burr H, Nielsen ML, **Garde AH**, **Flyvholm M-A**. 2023. Mental illness rates among employees with fixed-term versus permanent employment contracts: A Danish cohort study. International Archives of Occupational and Environmental Health. 96(3):451-462. https://doi.org/10.1007/s00420-022-01936-7
    a. Empirisk, teoretisk eller metodisk nybrud

8. **Nielsen HB**, **Kirchheiner-Rasmussen J**, **Dyreborg J**, **Larsen AD**, **Madsen IEH**, **Pedersen J**, **Garde AH**. 2023. Trajectories of marginal part-time work and risk of depression. Does job or income insecurity mediate the relation?. Scandinavian Journal of Work, Environment & Health. 49(4):271-282. https://doi.org/10.5271/sjweh.4091
    a. Empirisk, teoretisk eller metodisk nybrud

Ergonomisk arbejdsmiljø

De 10 vigtigste publikationer fra evalueringsperioden (2020-2023) er:

1. **Holtermann A**, Schnohr P, Nordestgaard BG, Marott JL. 2021. The physical activity paradox in cardiovascular disease and all-cause mortality: The contemporary Copenhagen General Population Study with 104 046 adults. European Heart Journal. 42(15):1499-1511. https://doi.org/10.1093/eurheartj/ehab087
    a. Journal Impact Factor, Empirisk nybrud, Flest citationer

2. **Rasmussen CDN**, **Sørensen OH**, van der Beek AJ, **Holtermann A**. 2020. The effect of training for a participatory ergonomic intervention on physical exertion and musculoskeletal pain among childcare workers (the TOY project) - a wait-list cluster-randomized controlled trial. Scandinavian Journal of Work, Environment and Health. 46(4):429-436. https://doi.org/10.5271/sjweh.3884
    a. Empirisk nybrud, Bredde i typen af forskning på området

3. **Gupta N**, van Dongen JM, **Holtermann A**, Van der Beek A, **Stevens ML**, **Rasmussen CDN**. 2022. Cost-effectiveness and return-on-investment of a participatory ergonomics intervention among childcare workers: An economic evaluation in a randomized controlled trial. Journal of Occupational and Environmental Medicine. 64(6):533-539. https://doi.org/10.1097/JOM.0000000000002510
    a. Empirisk nybrud, Bredde i typen af forskning på området

4. **Gupta N**, **Bjerregaard SS**, Yang L, Forsman M, **Rasmussen CL**, **Rasmussen CDN**, Clays E, **Holtermann A**. 2022. Does occupational forward bending of the back increase long-term sickness absence risk? A 4-year prospective register-based study using device-measured compositional data analysis. Scandinavian Journal of Work Environment & Health. 48(8):651-661. https://doi.org/10.5271/sjweh.4047
    a. Empirisk nybrud, Metodisk nybrud, Bredde i typen af forskning på området

5. Cillekens B, Lang M, van Mechelen W, Verhagen E, Huysmans MA, **Holtermann A**, van der Beek AJ, Coenen P. 2020. How does occupational physical activity influence health? An umbrella review of 23 health outcomes across 158 observational studies. British Journal of Sports Medicine. 54(24):1474-1481. https://doi.org/10.1136/bjsports-2020-102587
    a. Empirisk nybrud, Bredde i typen af forskning på området, Journal Impact Factor, Samarbejde med globalt førende forskere på området, Flest citationer

6. **Andersen LL**. 2023. Health promotion and chronic disease prevention at the workplace. Annual Review of Public Health. https://doi.org/10.1146/annurev-publhealth-060222-035619
    a. Bredde i typen af forskning på området, Journal Impact Factor

7. **Pedersen J**, **Bjorner JB**, **Andersen LL**. 2022. Physical work demands and expected labor market affiliation (ELMA): Prospective cohort with register-follow-up among 46 169 employees. Scandinavian Journal of Work Environment & Health. 48(8):641-650. https://doi.org/10.5271/sjweh.4050
    a. Empirisk nybrud, Bredde i typen af forskning på området

8. Sandal LF, Bach K, Øverås CK, **Svendsen MJ**, Dalager T, Stejnicher Drongstrup Jensen J, Kongsvold A, Nordstoga AL, Bardal EM, Ashikhmin I, Wood K, **Rasmussen CDN**, Stochkendahl MJ, Nicholl BI, Wiratunga N, Cooper K, Hartvigsen J, Kjær P, Sjøgaard G, Nilsen TIL, Mair FS, Søgarrd K, Mork Pj. 2021. Effectiveness of app-delivered, tailored self-management support for adults with lower back pain-related disability: A selfBACK randomized clinical trial. JAMA Internal Medicine. 181(10):1288-1296. https://doi.org/10.1001/jamainternmed.2021.4097
    a. Empirisk nybrud, Metodisk nybrud, Bredde i typen af forskning på området, Samarbejde med globalt førende forskere på området

9. **Sundstrup E**, **Seeberg KGV**, **Bengtsen E**, **Andersen LL**. 2020. A systematic review of workplace interventions to rehabilitate musculoskeletal disorders among employees with physical demanding work. Journal of Occupational Rehabilitation. 30:588-612. https://doi.org/10.1007/s10926-020-09879-x
    a. Bredde i typen af forskning på området, Journal Impact Factor, Flest citationer

10. **Andersen LL**, **Pedersen J**, **Sundstrup E**, **Thorsen SV**, **Rugulies R**. 2021. High physical work demands have worse consequences for older workers: Prospective study of long-term sickness absence among 69 117 employees. Occupational and Environmental Medicine. 78(11):829-834. https://doi.org/10.1136/oemed-2020-107281
    a. Empirisk nybrud, Bredde i typen af forskning på området, Flest citationer

Kemisk arbejdsmiljø

De 10 vigtigste publikationer fra evalueringsperioden (2020-2023) er:

1. **Hammel SC**, Andersen HV, Knudsen LE, **Frederiksen M**. 2023. Inhalation and dermal absorption as dominant pathways of PCB exposure for residents of contaminated apartment buildings. International Journal of Hygiene and Environmental Health. 247:114056. https://doi.org/10.1016/j.ijheh.2022.114056
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Journal Impact Factor, Bredde i typen af forskning på området

2. Halappanavar S, van den Brule S, Nymark P, Gaté L, Seidel C, Valentino S, Zhernovkov V, **Danielsen PH**, De Vizcaya A, Wolff H, Stöger T, Boyadziez A, **Poulsen SS**, **Sørli JB**, **Vogel U**. 2020. Adverse outcome pathways as a tool for the design of testing strategies to support the safety assessment of emerging advanced materials at the nanoscale. Particle and Fibre Toxicology. 17:Article 16. https://doi.org/10.1186/s12989-020-00344-4
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Journal Impact Factor, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

3. **Gutierrez CT**, Loizides C, Hafez I, **Brostrøm A**, Wolff H, Szarek J, **Berthing T**, **Mortensen A**, **Jensen KA**, Roursgaard M, **Saber AT**, Møller P, Biskos G, **Vogel U**. 2023. Acute phase response following pulmonary exposure to soluble

and insoluble metal oxide nanomaterials in mice. Particle and Fibre Toxicology. 20(1):4. https://doi.org/10.1186/s12989-023-00514-0

   a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

4. **Madsen AM**, **Frederiksen MW**, **Jacobsen MH**, **Tendal K**. 2020. Towards a risk evaluation of workers' exposure to handborne and airborne microbial species as exemplified with waste collection workers. Environmental Research. 183:Article 109177. https://doi.org/10.1016/j.envres.2020.109177
   a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Journal Impact Factor, Bredde i typen af forskning på området

5. **Madsen AM**, Raulf M, Duquenne P, Graff P, Cyprowski M, Beswick A, Laitinen S, **Rasmussen PU**, Hinker M, Kolk A, Gorny RL, Oppliger A, Crook B. 2021. Review of biological risks associated with the collection of municipal wastes. Science of the Total Environment. 791:148287. https://doi.org/10.1016/j.scitotenv.2021.148287
   a. Flest citationer, Journal Impact Factor, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

6. **Fonseca AS**, Viitanen A-K, Kanerva T, Säämänen A, Aguerre-Chariol O, Fable S, Dermigny A, Karoski N, Fraboulet I, Koponen IK, Delpivo, A Vilchez Villalba, S Vázquez-Campos, **Jensen ACØ**, **Nielsen SH**, **Sahlgren N**, **Clausen PA**, **Larsen BXN**, **Kofoed-Sørensen V**, **KA Jensen**, **Koivisto J**. 2021. Occupational exposure and environmental release: the case study of pouring TiO and filler materials for paint production. International Journal of Environmental Research and Public Health. 18(2):e418. https://doi.org/10.3390/ijerph18020418
   a. Flest citationer, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

7. **Holmfred E**, Loeschner K, Sloth JJ, **Jensen KA**. 2022. Validation and demonstration of an atmosphere-temperature-pH-controlled stirred batch reactor system for determination of (nano)material solubility and dissolution kinetics in physiological Simulant lung fluids. Nanomaterials. 12(3):1-29. https://doi.org/10.3390/nano12030517
   a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Bredde i typen af forskning på området

8. **Sørli JB**, Låg M, Ekeren L, Perez-Gil J, Haug LS, **Da Silva E**, Matrod MN, Gützkow KB, Lindeman B. 2020. Per- and polyfluoroalkyl substances (PFASs) modify lung surfactant function and pro-inflammatory responses in human bronchial epithelial cells. Toxicology in Vitro. https://doi.org/10.1016/j.tiv.2019.104656
   a. Flest citationer, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

9. **Sejbaek CS**, Flachs EM, Carøe TK, Meye HW, Frederiksen M, Frydendall KB, Wolkoff P, **Clausen PA**, **Hougaard KS**, **Schlünssen V**. 2022. Professional cleaning and risk of asthma – a Danish nationwide register-based study. Scandinavian Journal of Work Environment & Health. 48(2):127-136.
    a. Journal Impact Factor, Bredde i typen af forskning på området

10. **Andersen MHG**, **Saber AT**, **Frederiksen M**, **Clausen PA**, **Sejbæk CS**, Hemmingsen CH, Ebbehøj NE, Catalan J, Aimonen K, **Koivisto J**,Loft S, Møller P, Vogel U. 2021. Occupational exposure and markers of genetic damage, systemic inflammation and lung function: A Danish cross-sectional study among air force personnel. Scientific Reports. 11:17998. https://doi.org/10.1038/s41598-021-97382-5
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Samarbejde med globalt førende forskere på området, Bredde i typen af forskning på området

Psykisk arbejdsmiljø

De 10 vigtigste publikationer fra evalueringsperioden (2020-2023) er:

1. **Rugulies R**, **Aust B**, Greiner BA, Arensman E, Kawakami N, LaMontagne AD, **Madsen IEH**. 2023. Work-related causes of mental health conditions and interventions for their improvement in workplaces. The Lancet. 402(10410):1368-1381. https://doi.org/10.1016/S0140-6736(23)00869-3
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Samarbejde med globalt førende forskere på området

2. **Garde AH**, Begtrup L, Bjorvatn B, Bonde JP, Hansen J, **Hansen ÅM**, Härmä M, **Jensen MA**, Kecklund G, Kolstad HA, **Larsen AD**, Lie JA, Moreno CR, Nabe-Nielsen K, Sallinen M**.** 2020. How to schedule night shift work in order to reduce health and safety risks. Scandinavian Journal of Work, Environment and Health. 46(6):557-569. https://doi.org/10.5271/sjweh.3920
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Samarbejde med globalt førende forskere på området

3. **Aust B**, **Møller JL**, Nordentoft M, Frydendall KB, **Bengtsen E**, Jensen AB, **Garde AH**, Kompier M, Semmer N, **Rugulies R, Jaspers SØ.** 2023. How effective are organizational-level interventions in improving the psychosocial work environment, health, and retention of workers? A systematic overview of systematic reviews [Epub ahead of print]. Scandinavian Journal of Work, Environment & Health. 49(5):315-329. https://doi.org/10.5271/sjweh.4097
    a. Empirisk, teoretisk eller metodisk nybrud, Samarbejde med globalt førende forskere på området

4. **Rugulies R, Sørensen K**, Tecco CD, Bonafede M, Rondinone BM, Ahn S, Ando E, Ayuso-Mateos JL, Cabello M, Descatha A, Dragano N, Durand-Moreau Q, Eguchi H, Gao J, Godderis L, Kim J, Li J, **Madsen IEH**, Pachito DV, Sembajwe G, Siegrist J, Tsuno K, Ujita Y, Wang J, Zadow A, Iavicoli S, Pega

F. 2021. The effect of exposure to long working hours on depression: A systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury. Environment International. 155:106629. https://doi.org/10.1016/j.envint.2021.106629

   a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Samarbejde med globalt førende forskere på området

5. **Larsen AD**, **Nielsen HB**, **Kirschheiner-Rasmussen J**, Hansen J, **Hansen ÅM**, Kolstad HA, **Rugulies R**, **Garde AH**. 2023. Night and evening shifts and risk of calling in sick within the next two days – a case-crossover study design based on day-to-day payroll data. Scandinavian Journal of Work, Environment & Health. 49(2):117-125. https://doi.org/10.5271/sjweh.4074
   a. Empirisk, teoretisk eller metodisk nybrud

6. **Clausen T**, **Sørensen JK**, **Dalsager L**, Karlsen IL, **Kristiansen J**. Do different job demands interact as predictors of long-term sickness absence? A register-based follow-up on 55 467 Danish workers. Occupational and Environmental Medicine 2023;80(1):7-13. https://doi.org/10.1136/oemed-2022-108444.
   a. Empirisk, teoretisk eller metodisk nybrud

7. **Madsen IEH**, **Svane-Petersen AC**, Holm A, Burr H, **Framke E**, Melchior M, Rod NH, Sivertsen B, Stansfeld S, **Sørensen JK**, Virtanen M, **Rugulies R**. Work-related violence and depressive disorder among 955,573 employees followed for 6.99 million person-years. The Danish Work Life Course Cohort study. Journal of Affective Disorders 2021;288:136-144. https://doi.org/10.1016/j.jad.2021.03.065.
   a. Empirisk, teoretisk eller metodisk nybrud

8. **Framke E**, **Sørensen JK**, Alexanderson K, Farrants K, Kivimäki M, Nyberg ST, Pedersen J, **Madsen IEH**, **Rugulies R**. Emotional demands at work and risk of long-term sickness absence in 1.5 million employees in Denmark: a prospective cohort study on effect modifiers. Lancet Public Health 2021;6(10):e752-e759. https://doi.org/10.1016/S2468-2667(21)00185-7.
   a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Samarbejde med globalt førende forskere på området

9. **Meng A**, **Borg V**, **Clausen T**. Enhancing the social capital in industrial work teams: results from a participatory intervention. Industrial Health 2020;58(5):433-442. https://doi.org/10.2486/indhealth.2020-0015.
   a. Empirisk, teoretisk eller metodisk nybrud

10. **Jaspers SØ**, Andersen DR, Karlsen IL, Pedersen AHM, Andersen LPS, Conway PM, **Aust B**, Dyreborg J. Contextualizing violence prevention – How contextual aspects influence the implementation of a violence prevention initiative in prisons and psychiatry. Scandinavian Journal of Work and Organizational Psychology 2022;7(1):1-16. https://doi.org/10.16993/sjwop.141.
   a. Empirisk, teoretisk eller metodisk nybrud

Sikkerhedskultur og arbejdsulykker

De 10 vigtigste publikationer fra evalueringsperioden er:

1. **Karlsen IL**, **Kristiansen J, Jaspers SØ**, **Rasmussen L**, **Laursen LL**, **Bengtsen E**, **Aust B**. 2023. Reduction of aggressive behavior and effects on improved wellbeing of health care workers and people with dementia: A review of reviews. Aggression and Violent Behavior. 71:101843. https://doi.org/10.1016/j.avb.2023.101843
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

2. **Ajslev JZN**, **Møller JL**. 2023. The art of role-switching–positioning practices and the relational roles of OSH coordinators in the Danish construction industry. Construction Management and Economics. https://doi.org/10.1080/01446193.2023.2195195
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

3. **Dyreborg J**, Lipscomb HJ, Nielsen KJ, Törner M, Rasmussen K, **Frydendall KB**, **Bay H**, Gensby U, **Bengtsen E**, Guldenmund F, **Kines P**. 2022. Safety interventions for the prevention of accidents at work: A systematic review. Campbell Systematic Reviews. 18(2):e1234. https://doi.org/10.1002/cl2.1234
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer, Samarbejde med globalt førende forskere på området

4. **Ajslev JZN**, Nimb IEE. 2022. Virtual design and construction for occupational safety and health purposes – A review on current gaps and directions for research and practice. Safety Science. 155:105876. https://doi.org/10.1016/j.ssci.2022.105876
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

5. Nielsen ML, Laursen CS, **Dyreborg J**. 2022. Who takes care of safety and health among young workers? Responsibilization of OSH in the platform economy. Safety Science. 149:105674. https://doi.org/10.1016/j.ssci.2022.105674
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

6. **Ajslev JZN**, **Møller JL**, **Andersen MF**, Pirzadeh P, Lingard H. 2022. The hierarchy of controls as an approach to visualize the impact of occupational safety and health coordination. International Journal of Environmental Research and Public Health. 15(5):2731Occupational
    a. Empirisk, teoretisk eller metodisk nybrud, Samarbejde med globalt førende forskere på området

7. **Jeschke KC**, Waldorff SB, **Dyreborg J**, **Kines P**, **Ajslev JZN**. 2021. Complaining about occupational safety and health: A barrier for collaboration between managers and workers on construction sites. Construction Management and Economics. 39(6):459-474. https://doi.org/10.1080/01446193.2021.1924388
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

8. **Møller JL**, **Kines P**, **Dyreborg J**, **Andersen LL**, **Ajslev JZN**. 2021. The competences of successful safety and health coordination in construction projects. Construction Management and Economics. 39(3):199-211. https://doi.org/10.1080/01446193.2020.1818800
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor

9. Zwetsloot GIJM, Leka S, **Kines P**, Jain A. 2020. Vision Zero: Developing proactive leading indicators for safety, health and wellbeing at work. Safety Science. 130:Article 104890. https://doi.org/10.1016/j.ssci.2020.104890
    a. Empirisk, teoretisk eller metodisk nybrud, Journal Impact Factor, Flest citationer, Samarbejde med globalt førende forskere på området

10. **Madsen CU**, Kirkegaard ML, **Dyreborg J**, Hasle P. 2020. Making occupational health and safety management systems 'work': a realist review of the OHSAS 18001 standard. Safety Science. 129(104843):6-32. https://doi.org/10.1016/j.ssci.2020.104843
    a. Empirisk, teoretisk eller metodisk nybrud, Flest citationer

Appendix 4 NFA's participation in partnerships and networks

1) Overall/interdisciplinary partnerships and networks

NFA collaborations/partnerships:

- PEROSH: Partnership for European Research in Occupational Safety (14 Occupational Safety and Health institutes)
- ICOH: International Commission on Occupational Health
- NOROSH: Nordic Association of Occupational Safety and Health (publish/edit *Scandinavian Journal of Work, Environment & Health*)
- The Nordic Institute for Advanced Education in Occupational Health (NIVA)

Network participation/memberships:

- Sheffield Group: International network of Directors General for OSH research institutions
- Evidence for Work: Global Network for Evidence Synthesis in Occupational Safety and Health, Work Participation and Well-being
- IiO: Improvement in Organization network
- Network for realist evaluation (Netværk for realistisk evaluering)
- TrygFonden's network about security/safety in work life (TrygFondens netværk om tryghed i arbejdslivet)

Representation in committees/working groups/similar:

- The Nordic Council of Ministers' Committee for Working Environment (Nordisk Ministerråds Arbejdsmiljøudvalg)
- The Knowledge Council for Prevention (Vidensråd for forebyggelse)
- Advisory Board SeniorWorkLife (SeniorArbejdsLiv)

2) Area specific partnerships and networks/representation

Psychosocial working environment

- Working hours in the Nordic countries (WINC)
- Working Time Society (WTS)
- The Copenhagen Stress Research Center (Københavns Stress Forskningscenter)
- International Network on Work, Health and Ageing Re-search (IDEAR)
- Centre for Working Life Studies (CSA)
- WHO and ILO initiative on "WHO/ILO Joint Estimates of Work-Related Burden of Disease and Injury"
- Working group on the development of recommendations and inspiration for preventing, managing and learning from challenging behavior in elderly care (the Danish Health Authority)

Ergonomic working environment and musculoskeletal disorders

- The Prospective Physical Activity, Sitting and Sleep consortium (ProPASS)
- Goldilocks Work network

Chemical working environment

- The Danish Environmental Protection Agency

- Council for Better Hygiene / Prevention and Health (Rådet for Bedre Hygiejne)
- Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals (NEG)
- Interest group for gas analysis (iGAS)
- Copenhagen Work and environmental research centre on reproduction (AMoRe)
- Scientific advisory board for environment and health for the Danish national board of health
- Danish Society for Toxicolocy and Pharmacology
- Scientific advisory board for the Danish government (Helbredsoplysningsrådet)
- The Danish Society of Engineers professional society on Work Environment (IDA Arbejdsmiljø)
- Danish Standard DS/S-154 – CEN TC352
- Danish Standard DS/S-418 – CEN TC352
- OECD WPMN and Test Guidelines
- Advisory board of Modular Exposure Models for OSH Risk Assessment in Chemical Safety (MEMORA)
- Advisory board of Stoffenmanager