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Department of Medical Sociology – Institute of the
History, Philosophy and Ethics of Medicine

# Organizational Health Interventions and the Role of Effort and Reward for Process Evaluation, Health, and Work Ability

# DISSERTATION

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## DOCTOR of PHILOSOPHY

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**from Lauingen**

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# List of scientific articles for the publication-based dissertation

*First Article*

Montano D, Kuchenbaur M, Geissler H, Peter R. Working conditions of healthcare workers and clients' satisfaction with care: study protocol and baseline results of a cluster-randomised workplace intervention. BMC Public Health. 2020 Aug 25;20(1):1281. doi: 10.1186/s12889-020-09290-4

*Second Article*

Kuchenbaur M, Peter R. Assessing the Role of Collective Efficacy Beliefs During Participative Occupational Health Interventions. Front Public Health. 2021 Nov 25;9:797838. doi: 10.3389/fpubh.2021.797838

*Third Article*

Kuchenbaur M, Peter R. Quality of leadership and self-rated health: the moderating role of 'Effort-Reward Imbalance': a longitudinal perspective. Int Arch Occup Environ Health. 2023 Apr;96(3):473-482. doi: 10.1007/s00420-022-01941-w.

*Fourth Article*

Montano D, Kuchenbaur M, Peter R. Outcomes and process evaluation of a cluster-randomised participatory organisational intervention among German healthcare workers. BMC Health Serv Res. 2023 Mar 16;23(1):260. doi: 10.1186/s12913-023-09240-x

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# Abstract

Failed reciprocity in the workplace, for example, a lack of appreciation and support, can adversely affect physical and mental health. Using the Effort-Reward Imbalance (ERI) model, this adverse health relationship has been previously used to explain possible causes of coronary heart disease and depression. Especially in interactive service jobs such as nursing, failed reciprocity, in terms of lack of reward, seems comparatively significant for nursing workforces' health.

However, previous interventions to improve nurses' health have rarely addressed ERI, nor have they been conducted within a appropriate study design that accounts for rigorous outcome and process evaluation. Overall this dissertation is focused on the processes of ERI on health and health promotion in the context of an intervention that addresses nurses' work ability. Therefore, the relevance of effort and reward for nurses' workplace health and work ability is twofold. First, how ERI can influence nurses' health and intervention outcomes. Second, to what extent ERI affects the participative process of implementing interventions in this context.

Possible underlying mechanisms of ERI on health and health promotion in nurses are investigated within the context of the HALTgeben ("Higher Patient Satisfaction through Fair Working Conditions in Healthcare") study cohort. The HALTgeben study is a participative occupational health intervention study conducted over 36 months, and the primary endpoint is nurses' work ability. This publication-based dissertation comprises of four studies published in articles that are derived from this study.

The first article presents the study protocol of the HALTgeben study. It highlights the relevance of rigorous outcomes and process evaluation in the context of nurses' health and work ability, a so far understudied workforce. Previous intervention studies taking into account the model of ERI and with an advanced study design to assess the outcome and processes of the intervention are rather scarce.

The second article presents a pilot study that aims to develop and validate a questionnaire for assessing the overall quality of the group-based, participatory intervention. The questionnaire evaluated collective efficacy beliefs as an indicator of participants' engagement in designing and omplementing intervention measures. The article points out the relevance of

shared commitment in participatory interventions and the influence of lack of reward (ERI) on participants' appraisals towards positive intervention effects.

Another aspect of ERI and health that has been poorly studied so far is introduced in article three. The impact of quality of leadership and ERI on health has rarely been explored up until now. Supervisors, as significant others, play an important role in explaining physical health in the context of failed reciprocity. Quality of leadership is found to buffer failed reciprocity to some extent. However, if the imbalance of effort and reward is very high, the quality of leadership no longer explains adverse health effects in nurses.

Article four discusses the results of the outcome and process evaluation of the participatory intervention study. The results show that to improve work ability within the context of the ERI model, measures that attempt to enhance interpersonal exchange relationships should be addressed in particular. The evaluation of the measures of the HALTgeben intervention study showed that this aspect was barely addressed. Therefore, no overall significant change in work ability was identified.

In summary, ERI plays an important role in explaining health and health promotion processes in nurses. Besides demonstrating the interplay of lack of reward for intervention outcomes and health, ERI is also important for evaluating the process of implementing a participatory intervention study.

# Zusammenfassung

Fehlende Reziprozität am Arbeitsplatz, z. B. durch einen Mangel an Wertschätzung und Unterstützung bedingt, kann sich negativ auf die körperliche und geistige Gesundheit auswirken. Mit Hilfe des Modells der Effort-Reward Imbalance (ERI) wurde dieser negative Einfluss auf Gesundheit als Ursache für koronare Herzkrankheiten und Depressionen bereits ausführlich untersucht. Insbesondere in interaktiven Dienstleistungsberufen wie der Krankenpflege scheint fehlende Reziprozität durch das Ausbleiben entsprechender Gratifikationen für die Gesundheit von Pflegekräften vergleichsweise relevant zu sein.

Bisherige Interventionsstudien zur Verbesserung der Gesundheit von Pflegekräften haben jedoch nur selten das Modell von ERI zur Grundlage gehabt und wurden darüber hinaus kaum im Rahmen eines geeigneten Studiendesigns durchgeführt, welches eine adäquate Ergebnis- und Prozessbewertung ermöglicht. Die vorliegende Dissertation fokussiert sich auf die Auswirkungen von ERI auf Prozesse von Gesundheit und Gesundheitsförderung im Kontext einer Intervention zur Verbesserung der Arbeitsfähigkeit von Pflegekräften. Das Interesse an den Dimensionen von Anerkennung und Belohnung von Pflegekräften für deren Gesundheit und Arbeitsfähigkeit ist dabei zweifach. Erstens, wie ERI die Gesundheit der Pflegekräfte und die Ergebnisse der Interventionen beeinflussen kann. Zweitens, inwieweit ERI den partizipativen Prozess der Umsetzung von Interventionen in diesem Kontext beeinflusst.

Mögliche, zugrundeliegende Wirkmechanismen von ERI auf Gesundheit und Gesundheitsförderung bei Pflegekräften werden im Rahmen der HALTgeben-Studienkohorte ("Höhere Patientenzufriedenheit durch faire Arbeitsbedingungen im Gesundheitswesen") untersucht. Die HALTgeben-Studie ist eine partizipative Interventionsstudie zur Förderung der Arbeitsfähigkeit, die über einen Zeitraum von 36 Monate wurde. Die vorliegende, publikationsbasierte Dissertation besteht aus vier Studien, die in Artikeln veröffentlicht wurden, die aus dieser Studie abgeleitet wurden.

Der erste Artikel stellt das Studienprotokoll der HALTgeben-Studie vor. Er unterstreicht die Relevanz guter Ergebnis- und Prozessevaluation im Zusammenhang mit der Gesundheit und dem Arbeitsfähigkeit von Pflegekräften, einer bisher wenig untersuchten Berufsgruppe in diesem Zusammenhang. Bisherige Studien die das Modell der ERI berücksichtigen und über ein angemessenes Studiendesign zur Bewertung der Ergebnisse und Prozesse der Intervention verfügen, sind eher rar.

Der zweite Artikel stellt eine Pilotstudie vor die darauf abzielt, einen Fragebogen zu entwickeln und zu validieren, mit dem die Qualität der gruppenbasierten, partizipativen Intervention bewertet werden kann. Der Fragebogen bewertete die Überzeugungen von Teilnehmenden auf Basis des Konzepts kollektiver Wirksamkeitserwartung, welche als Indikator für das Engagement der Teilnehmenden im Design- und Implementierungsprozess der Interventionen dient. Der Artikel stellt die Bedeutung des gemeinsamen Engagements bei partizipativen Interventionen und den Einfluss fehlender Belohnung (ERI) auf die Einschätzung der Teilnehmer heraus.

Ein weiterer Aspekt von ERI und Gesundheit, der bisher nur wenig untersucht wurde, wird in Artikel drei vorgestellt. Die Auswirkungen der Qualität der Führung in Verbindung mit ERI auf die Gesundheit von Pflegekräften sind bisher kaum untersucht worden. Vorgesetzte spielen als Bezugspersonen sozialen Austauschs eine wichtige Rolle bei der Erklärung von Gesundheit im Zusammenhang mit gescheiterter Reziprozität. Es hat sich gezeigt, dass durch die Qualität der Führung ausbleibende Reziprozität (ERI) bis zu einem gewissen Grad abgemildert wird. Wenn jedoch das Ungleichgewicht zwischen Verausgabung und Belohnung sehr hoch ist, verliert die Qualität der Führung ihre Erklärungskraft für die Auswirkungen auf die Gesundheit.

In Artikel vier werden die Resultate aus der Ergebnis- und Prozessevaluation der partizipativen Interventionsstudie präsentiert. Die Ergebnisse legen nahe, dass zur Verbesserung der Arbeitsfähigkeit im Rahmen des ERI-Modells vor allem Maßnahmen ergriffen werden sollten, welche die sozialen Austauschbeziehungen verbessern können. Die Auswertung der Maßnahmen der HALTgeben Interventionsstudie hat gezeigt, dass dieser Aspekt bei den Interventionsmaßnahmen jedoch kaum addressiert wurde. Daher wurde insgesamt keine signifikante Veränderung der Arbeitsfähigkeit durch die Interventionsstudie festgestellt.

Zusammenfassend lässt sich sagen, dass ERI eine wichtige Rolle bei der Erklärung von Gesundheits- und Gesundheitsförderungsprozessen bei Pflegekräften spielt. Neben der Bedeutung für das Zusammenspiel fehlender Reziprozität für Interventionsergebnisse und Gesundheit ist ERI auch für die Bewertung des Prozesses der Umsetzung einer partizipativen Interventionsstudie bedeutsam.

# I. Prolog: Interaction, self-experience, and work

While there are various theories from different disciplines on individual development, they overall agree that behaviors acquired in early childhood have lasting effects on one's individuality and agency. Assuming anthropological premises of a certain world openness ("Weltoffenheit") for human beings, becoming one's self through cognitive learning processes in *interaction* comes directly to mind. From a sociological and social-psychological perspective, human self-awareness is a reflexive process (George Herbert Mead). Children, for example, understand themselves by receiving reinforcing feedback on their actions from so-called significant others, in this case, parents. According to Mead, self-experience predominantly succeeds in the context of interaction. Moreover, this experience of one's self enables us to become capable of prospective agency. For example, self-experience becomes self-efficacy through repeated, positive social reinforcement from significant others. Thus, it is obvious that a rewarding quality of social reinforcement is a decisive criterion of self-experience (Siegrist, 1996b). In summary, the process of self-experience defines the intentions and directions of one's actions, provides feedback on one's actions, and enables the continuity of self-experience.

It is assumed that these motivations to engage in positive self-experiences also exist beyond the context of primary socialization. This socio-emotional motivation refers to the efforts individuals make to participate in social fields for positive self-experiences. Socio-emotional motivations include the desire for agency, the need for reward and appreciation, and the need for belonging. Self-experiences allow individuals to transcend the family context and seek out other social realities that meet their self-regulatory needs (Siegrist, 1996b). One of the social fields that spans from early to late adulthood is the field of work. It is the only phase of life in which people are subjected to long-lasting and rigorous performance requirements. Therefore, work represents the vital link between the social structure of modern societies and the personal capacity of individuals to generate benefits (Siegrist, 2021a). In modern work relationships, employees and employers engage in a relationship of monetary and non-monetary exchange. In doing so, they adhere to the fundamental principle of socialization, the norm of social reciprocity. It states that a person who performs a service that is of benefit to one or more other persons, this person can expect a service of comparable benefit in return (ibid.).

Asymmetric exchange relationships due to labor market's unequal structuration of life chances can lead to adverse health effects. Comprehensive research in this context exists on the so-called social gradient of morbidity and mortality. In other words: the better an individual's socioeconomic position (SEP) in terms of level of income, level of education, and level of occupational position, the risk of premature death is less likely (Mackenbach, 2019; Marmot, 2004). The same applies to morbidity: the higher the life chances allocated by SEP the lower the burden of morbidity (ibid.).

However, as described above, the reciprocal process of exchange between employer and employee is not limited to a formal employment contract, which ensures that the material needs of participation in society and social security are met. The need for non-monetary forms of positive self-experience inherent in socio-emotional motivations appears to be just as important, as mentioned earlier. Working for a living, therefore, also entails the desire to be successful in a meaningful way and in gaining a sense of satisfaction. Thereby, the form of reward in exchange relationships is of particular relevance. Reward not only includes adequate payment in the form of a wage or salary, as assessed by SEP but also appreciation and support from significant others that meet the needs of positive self-experience (Siegrist, 2021b).

Comparing different job conditions with regard to both rewards in the form of monetary and non-monetary ways of reward, there are some qualitative differences between occupations. In the European Working Conditions Survey, occupational groups are clustered in comparison to each other with regard to different job quality criteria. In comparison with other clusters, the "under pressure" cluster scores worse on average for all job quality criteria. In particular, working intensity, working hours, and the social environment at work are of poor quality (Eurofound, 2021). In this cluster, the social environment job quality index is the lowest of all the indices due to the high prevalence of emotional demands and low support from supervisors or coworkers. Overall, the exposure of workers to emotionally demanding situations in this cluster is three times the European average (ibid.).

Within this cluster of occupations "under pressure", workers from public administration (23 %) and the health sector (26 %) are represented the most, as many occupations face low quality job conditions in these sectors, namely nurses. With regard to the economic situ-

ation, the 2008 economic crisis led to a series of neoliberal austerity measures that significantly reduce government expenditure in numerous nations. One of the measures imposed reduced staffing in the public health sector which may have significantly contributed to low quality job conditions in the nursing workforce (Llop-Gironés et al., 2021). In addition, the European Working Conditions Survey provides findings that the reduced quality in job conditions in occupations "under pressure", such as nurses, depends rather on social environment job conditions (emotional demands, low support by supervisors and coworkers) than on earnings (Eurofound, 2021), as Figure 1 for health professionals shows.

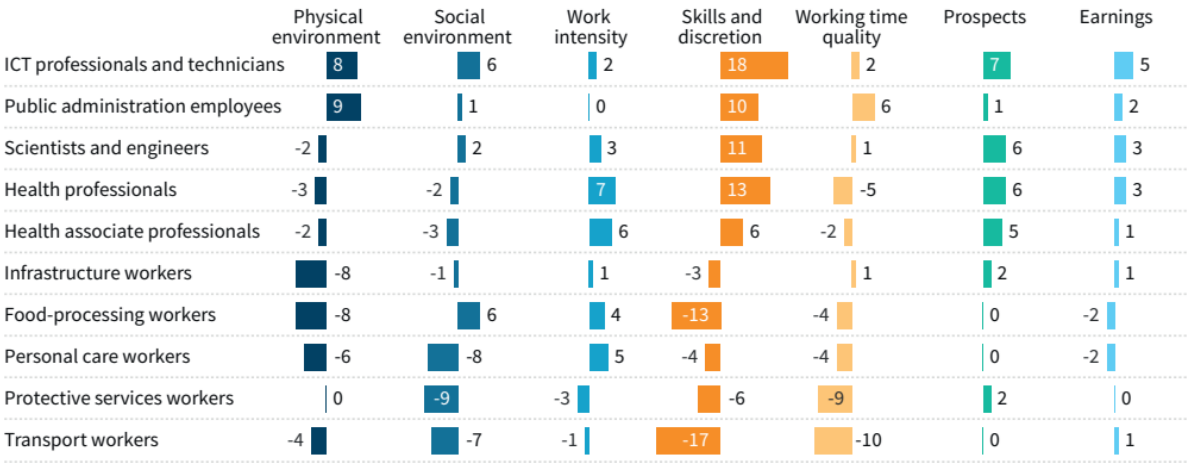


*Figure 1: Job quality score of occupations of critical occupations. Note: Values on the right side of each axis represent better-than-average scores while values to the left represent worse-than-average scores (Eurofound, 2021).*

Overall, lower quality job conditions can lead to higher levels of absence due to work-related illness, lower levels of engagement, and lack of sustainability of work, and where expectations in reciprocity are not met (Eurofound, 2021). Consequently, these circumstances not only affect individual employees but also have costs for employers and society. In summary, not only social transactions in the form of payment are costly, but adequate social reciprocity matters in job conditions concerning social environment (social support, appreciation, emotional demands) of work too.

These consequences of low quality in job conditions need to be addressed. Agents at all levels of action are required to keep these adverse health effects and the associated economic consequences as low as possible or, at best, to avoid them. There is evidence that labor and social policies at the societal macro level can lead to a reduction in poor job conditions (Lunau et al., 2020). However, these measures require sustained reinforcement at the national level and are very costly (Siegrist & Li, 2020). With regard to the anthropological premise of

fair social exchange and its relevance for positive self-experience and health described above, improving social exchange relationships directly via organizational interventions, appear to be plausible. However, there are very few intervention studies at the organizational level that aim to reduce the effects of failed reciprocity in social exchange relationships (ibid.).

Bearing this in mind, this thesis aims to describe the mechanisms of reciprocity in social exchange within the context of a participatory organizational intervention study with nurses. Of particular interest in this thesis is, (1) whether improving social exchange relationships can reduce adverse health effects concerning demands at work, as well as (2) examining the impact of these exchange relationships on the participatory design, implementation, and efficacy of the interventions.

# II. Synopsis

## 1. Determinants of physical and mental health and work ability in nurses

Nurses represent about 56 % of the global healthcare workforce (World Health Organization, 2020). Nursing is relevant to every aspect of healthcare problems, arising from epidemiological transitions such as aging populations, longer life expectancies, increases in non-communicable diseases, and multimorbidity of patients. Although this important contribution to these challenging health care problems, the nursing workforce has declined in recent years and nurse turnover is a serious issue (Halter et al., 2017; World Health Organization, 2020). Factors such as stress, burnout, work dissatisfaction, and (to a lesser extent) commitment, were the strongest predictors of turnover (Halter et al., 2017).

Stress, burnout, and work dissatisfaction can lead to adverse health effects. They are associated with physiological but also psychological diseases (Niedhammer et al., 2021) that pose a substantial and growing burden in terms of morbidity and death: Between 1990 and 2019, the prevalence of cardiovascular disease (CVD) increased by 26 % in the 28 European Union member states (EU28) (from 47.6 million to 59.9 million), with the increase being greater for men (36 %) than for women (18 %). From 1990 to 2019, the prevalence of depressive disorders increased by 11 % in the EU28 (13 % in men and 10 % in women) (Sultan-Taïeb et al., 2022). Concepts of stress, burnout, and work dissatisfaction that are related to the individual and social environment often focus on so-called psychosocial factors to explain the imbalance between demands of the physical and social environment, perceptions, and individual coping strategies (McVicar, 2003).

Psychosocial factors refer to the psychological and social aspects that impact an individual's emotions, actions, and well-being as a whole. For example, they comprise of a person's familial dynamics, social support networks, cultural background, and socioeconomic status (Siegrist & Marmot, 2004). Psychological components that may contribute to psychosocial context include a person's personality traits, coping strategies, emotional regulation abilities, and cognitive processes such as their beliefs and views. The quality of a person's network, their amount of social support, and their exposure to discrimination or poverty are examples of social variables (Martikainen et al., 2002). Altogether, these psychological and social aspects produce a context that determines the experiences and behaviors of an individual. Knowing a person's psychosocial working environment can be helpful in identifying possible risk factors

for physical and mental health issues and devising therapies that take into consideration the individual's needs and circumstances.

Combinations of psychosocial factors at work that are of particular relevance to employee health have been defined and examined by using theoretically and empirically based models. Several studies have examined the variables of the Demand-Control-Model, one of the earliest and most extensively used theoretical models, such as decision latitude, psychological demands, and job strain (combination of high demands and low latitude). Nevertheless, psychosocial work issues encompass a far greater number of exposures, such as excessive working hours, job instability, and Effort–Reward imbalance (ERI), and more recently, workplace bullying, organizational injustice, and work–family conflict (Niedhammer et al., 2021).

In comparison to other low- and mid-level occupations, the healthcare workforce experiences the highest exposure to psychosocial risks in the workplace (Botey Gaude et al., 2022; Eurofound, 2021). Due to the nature of their work, they are often exposed to physiological and psychological demands including long working hours and shift work. In addition to the demands at work, work organization, and job requirements, interpersonal relationships and values also pose particular psychosocial risks to the health of nurses due to their personal proximity to colleagues and patients (Eurofound, 2021). The Effort-Reward Imbalance Model is a model that in contrast to the Demand Control Model takes into account these factors in the context of working (Formazin et al., 2014; Jonge et al., 2000). Recent research across different workforces showed that in comparison, nurses report a significantly higher imbalance of effort and reward (Diekmann et al., 2020). Nursing is typically characterized by a high level of physical but also emotional strain (Aiken et al., 2001; Bakker et al., 2000; Mark & Smith, 2012). Nursing requires a high degree of competence, cooperation in a variety of scenarios, long working hours (Rosa et al., 2019), and emotional labor (Delgado et al., 2017; Hochschild, 2012). Furthermore, nurses are affected by disputes and issues with colleagues or supervisors, discrimination, emotional and physical workloads, coping with death and palliative patients, and their families (McVicar, 2003). In addition to characteristic domains such as demands at work and job contents, nurses are required to meet the demands of an interactive service job in terms of interpersonal relations (teamwork, contact with supervisor and colleagues, recognition and appreciation), values at the workplace (trust, justice, discrimination), and work-individual interface (job security, work-life-balance). The ERI model is sensitive to conditions of failed reciprocity, i.e., social situations in which exchange-based interaction relationships

are asymmetrical ("high effort/low reward"). Work tasks in nursing are characterized by a multitude of interpersonal relationships and interactions, which makes ERI a sensitive instrument for assessing relevant psychosocial factors. Table 1 shows different psychosocial domains in the workplace according to Formazin et al., 2014. In contrast to the Demand-Control-Support Model (Karasek, 1979), the ERI model primarily accounts for domains of interpersonal relationships and value at work.

| Domain | DCS Model | ERI Model |
|---|---|---|
| Demands at work | 3/9 | 4/9 |
| Work organization and job requirements | 3/7 | 0/7 |
| Interpersonal relationships and leadership | 3/12 | 5/12 |
| Work-individual interface | 0/2 | 1/2 |
| Value in the workplace | 0/2 | 1/2 |
| Offensive behavior | 0/2 | 0/2 |

*Table 1:Thematic coverage of psychosocial domains in the workplace in two common models of psychosocial occupational stress. Note: Fractions represent the amount of thematic coverage in each domain. Based on Formazin et al., 2014. DCS Model = Demand-Control-Support; ERI Model=Effort-Reward Imbalance.*

Experiencing reciprocity by appreciation, support, or agency is the foundation for an individual to experience a positive self. Failed reciprocity conversely leads to psychological and psychobiological mechanisms that can cause adverse health effects. These positive self-experiences and potential adverse health effects due to failed reciprocity will be discussed in the next section.

## 2. Theoretical and methodological aspects of failed reciprocity in the context of health and health promotion

For the model of ERI, the concept of social reciprocity represents a fundamental principle of interpersonal conduct and a language of social exchange. Social reciprocity is characterized by mutual cooperative investments based on the expectation of return when efforts are matched by equivalent rewards. According to the ERI model, failed reciprocity characterized by high effort expended and low reward obtained in return are likely to evoke recurring unpleasant feelings of disappointment and chronic stress reactions in exposed individuals. By contrast, positive emotions elicited by appropriate social incentives improve health and wellbeing (Siegrist, 1996a). This experience may lead to sustained autonomic and neuroendocrine activation.

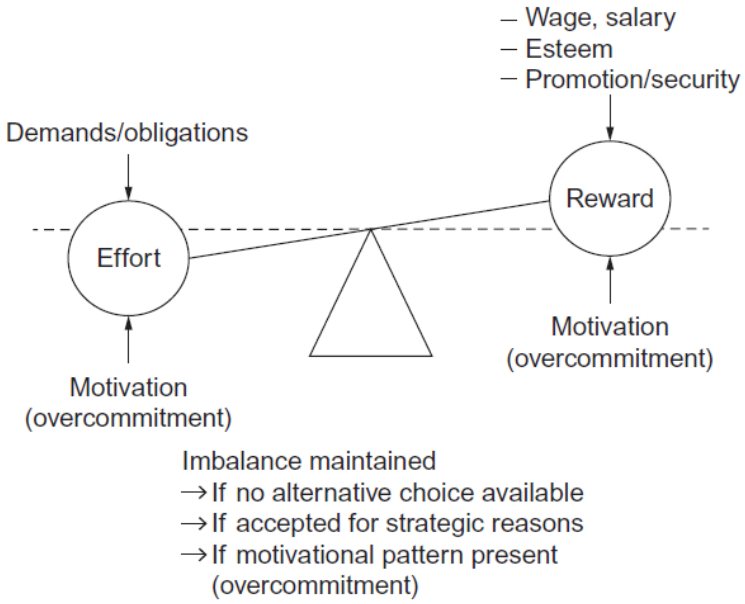


*Figure 2: Model of Effort-Reward Imbalance. Reprinted from (Siegrist, 2016). Copyright (2016) with permission from Elsevier*

It is hypothesized that the nucleus accumbens, anterior cingulate cortex, and insula are activated by the experience of ERI at work as a result of unfair exchange, trust violation, or false promise. Its activation inhibits the synthesis of dopamine and oxytocin (neurotransmitters linked with happiness and stress-buffering characteristics, respectively). In addition, activation of the insula is related to physical and emotional suffering, as well as intense visceral and sensory experiences. Together with the incidence of threats to a person's self or social standing, these processes of persistent activation may generate states of allostatic load across a number of the body's regulatory systems led by a highly aroused hypothalamic-pituitary-adrenocortical stress axis (Siegrist, 2016).

This state of arousal can contribute to the development of physical disease and mental disorders (Siegrist, 2005), for example coronary heart disease (Dragano et al., 2017). In the meta-analysis of Dragano et al. for a total of 725,799 person-years at risk, 1,078 coronary heart disease (CHD) events were documented (mean follow-up 9.8 years). When hazard ratios were adjusted for age and gender, effort–reward imbalance was associated with a 1.16-times higher risk of incident coronary heart disease (overall pooled hazard ratio: $1.16\ (95\ \%\ CI\ [1.01, 1.34])$ (Dragano et al., 2017).

For mental health problems related to occupational contexts (psychological distress, emotional exhaustion, and burnout) a meta-analysis by van der Molen et al. found that six

cohort studies provided evidence of a moderate quality that ERI increases the prevalence of mental health problems related to occupational contexts, with a pooled odds ratio (OR) of $1.91\ (95\ \%\ CI\ [1.70, 2.15])$ (van der Molen et al., 2020). No statistically significant differences between men and women were found. Depressive disorders in particular are also predicted by ERI. The pooled random-effects estimate of a meta-analysis by Rugulies et al. (2017) was $1.49\ (95\ \%\ CI\ [1.23 - 1.80])$.

The annually Disability-Adjusted Life Years (DALY) rate per 100,000 workers (Burden of disease) attributable to ERI in EU28 member states is $21.91\ (95\ \%\ CI\ [3.61, 40.22])$ for CHD and $67.30\ (95\ \%\ CI\ [40.27, 92.45])$ for depression. There are distinct differences between European states in terms of an east-west gradient (see also Hasselhorn et al., 2004) as well as in terms of the burden of disease rate (Sultan-Taïeb et al., 2022).

| Context | DALY | 95 % CI |
|---|---|---|
| CHD / Job-Strain | 16 777 | [4563, 28992] |
| Depression / Job-Strain | 35 176 | [21837, 48515] |
| CHD / ERI | 6 132 | [858, 11406] |
| Depression / ERI | 20 304 | [10904, 29704] |

*Table 2: Burden of Disease (DALYs) for CHD and Depression in Germany (year 2015) attributable to Job-Strain and Effort-Reward Imbalance. Note. CI = confidence interval, based on Sultan-Taïeb et al., 2022*

As shown in Table 2, the relationship between the burden of disease related to ERI and job strain is notably distinct for CHD. This may be because very few studies have examined the association between ERI and CHD. For instance, Niedhammer et al. included 107 studies on the association of job strain and CHD in their Meta-Review (Niedhammer et al., 2021), but there were only 15 studies on ERI and CHD, which is around one seventh of all studies.

An imbalance of effort and reward can also lead to impaired work ability. Work ability can be measured by proxy, e.g. by assessing sick leave or disability (Lunau et al., 2013) or by the work ability index (WAI), a self-report instrument. The WAI was developed in the early 1980s. The preceding question was about how long-term employees are able to sustain their degree of ability to work. In this context, the concept of work ability acknowledged a clear societal need for a modern, optimistic approach. The WAI assesses an individual's ability to handle his or her job demands by considering their current status of health (Ilmarinen 2009). The WAI is operationalized as a continuous score, ranging from 7 to 49 points, with higher scores indicating better work ability (ibid.).

A variety of studies have examined the relationship between ERI and WAI, however longitudinal studies in the context of the nursing workforce are scarce (Carmen Martinez et al., 2016; Li et al., 2011; Martinez et al., 2015; Stordeur & D'Hoore, 2007). The experience of an imbalance in effort and reward was one of the strongest predictors of impaired workability. In the European NEXT (Nurses early exit study) study cohort, ERI resulted in an intention to leave the nursing profession. Longitudinal observations of the influence of ERI on WAI in the general workforce are presented by Spanier et al. (2018). They emphasize that the experience of injustice at work (assessed by ERI and Organizational Injustice) has a negative influence on workability. Organizational Injustice (OIJ) (Elovainio et al., 2002) and ERI are complementary in explaining the effect of psychosocial strains on health outcomes or workability (Kivimäki et al., 2007). The impact of psychosocial strains caused by an unjust working environment is also stressed by Spanier et al., 2014; Spanier et al., 2017. Pension claims as a result of impaired WAI due to ERI are discussed in Wienert et al., 2017. The WAI mediates the intention for disability pension claims when efforts and rewards are imbalanced. Other studies (Bethge & Radoschewski, 2012; Bethge et al., 2012) also highlight the impact of failed reciprocity in the context of ERI on WAI. Bethge et al., 2012 conclude that potential occupational health interventions need to reduce the experience of reward frustration to increase work ability. Bethge & Radoschewski, 2012 suggest interventions that address leadership behavior. Using ERI, the sensitivity of WAI for asymmetric exchange relationships, such as in leader-follower-context, is taken into account. Bethge et al., 2012 recommend interventions within the context of German health circles, a participatory intervention model, that address personal, interpersonal, and organizational level stressors (Aust & Ducki, 2004).

Overall, both cross-sectional and longitudinal observations suggest that an imbalance of effort and reward can lead to impaired work ability. In the longitudinal analysis of nurses' work ability, it is worth noting that there is evidence that lack of social support (by supervisor or colleagues) may not be a confounding but an important risk factor for reduced work ability and therefore adverse health effects (Carmen Martinez et al., 2016; Martinez et al., 2015). Studies recommend that intervention studies should address personal, interpersonal, and organizational level measures that aim to reduce ERI (Bethge et al., 2012; Bethge et al., 2009) and other studies recommend focusing on interpersonal and organizational level interventions (Spanier et al., 2017). So far, this thesis has presented the consequences for employees' health and work ability if their efforts are not met by appropriate rewards. The psychological

and psychobiological processes that are upstream from that adverse health effects will be discussed in the following section.

A psychosocial environment where opportunity structures hinder individuals from the feeling of belonging, contributing, and acting, e.g. by support and positive feedback, can weaken their experience of a positive self. There are three transmitter systems for the distribution of rewards within the ERI model: money, respect, and career opportunities, including job stability (Siegrist, 1996b). Overall, all three contribute to a positive self-experience in the context of the psychosocial environment at work. ERI is based on a sociological thinking that understands social institutions as facilitators and shaping factors of human agency. Keeping this theoretical focus in mind, Siegrist and Marmot emphasize two general patterns of human motivations in relation to the social environment: first, the need for physical and mental well-being as a prerequisite for the organism's reproduction and the individual's productivity, and second, the need to experience a positive self. Positive self-experience is connected to well-being, but it depends on a social context that offers possibilities for belonging, agency, and contribution (Siegrist, 1996b; Siegrist & Marmot, 2004). Siegrist and Marmot define 'psychosocial environment' as an array of (1) options accessible to an individual to satisfy his or her demands for well-being, productivity, and (2) an individual's need for a positive self-experience. Self-efficacy and self-esteem are two dimensions of positive self-experience that are important for well-being and health.

Self-efficacy (SE) is conducive to emotions of mastery and control. SE is defined as a person's belief in their capacity to effectively execute the necessary behavior to achieve a goal or to successfully complete a task (Bandura, 2012). On a psychobiological level, the management of unpleasant stimuli and the expectation of a favorable outcome are regarded as essential for the activation of the hypothalamic-pituitary-adrenocortical stress axis and its long-term health effects. A psychosocial environment that fosters the experience of self-efficacy has positive benefits on health and well-being, whereas those confined to restrictive, control-limiting psychosocial environments have the opposite effect (Siegrist & Marmot, 2004). Similar assumptions are made regarding self-esteem. A psychosocial environment that is helpful to individuals in forming meaningful relationships with others and receiving positive feedback for well-executed tasks is conducive to self-esteem. Self-esteem enhances emotions of belonging, approval, and accomplishment. At the psychobiological level, there is evidence that

the mesolimbic dopamine system, a brain system implicated in motivation, reinforcement, and reward in personal and inter-personal well-being, plays an important regulatory function (ibid.). If efforts are not rewarded, reward-sensitive neural regions in the orbitofrontal cortex alter the quality and strength of emotions related to the experience, anticipation, or disappointment of a reward. If an individual's psychosocial environment stops them from experiencing belonging, contributing, and acting, they will experience recurring disappointment and dissatisfaction (Siegrist, 2005). Feelings of exclusion or failure may grow pervasive and lead to cognitions of being trapped in an unsatisfying psychosocial environment.

Thus far, this thesis has shown that an imbalance of effort and reward at work can have a multitude of physiological and psychological adverse health effects and a negative impact on work ability. In particular, psychological and psychobiological processes that result from the lack of appropriate rewards are the consequence of that imbalance and can manifest in a reduction of a positive self-experience. To reduce negative consequences on nurses' health and work ability, interventions that address psychosocial environmental characteristics have already been recommended earlier in this section. *This thesis aims to investigate the effects of health promoting and disease predisposing effects of ERI within an occupational health intervention*. Organizational-level interventions are the most recommended approach in the context of psychosocial working conditions and employees' health and well-being (Roodbari et al., 2022). The following sections examine research gaps of workplace intervention studies that address ERI, starting with a general overview of organizational intervention studies in context of ERI, followed by the relevance of ERI for intervention outcomes, as well as the role of supervisors in the context of ERI and health, and ERI in context of process evaluations.

## 2.1. Organizational intervention studies for health and well-being

Workplace interventions are “planned, behavioral, and theory-based actions that aim to improve employees' health and wellbeing by changing the way work is designed, organized, and managed” (Nielsen, 2013, p. 1030). Particularly in Europe, mainly in Denmark, organizational interventions are frequently carried out because there is a legal obligation to promote the safety and health of employees in every part of the workplace and this responsibility includes addressing the causes of poor safety and health (ibid.). Another factor is that organizational interventions are recommended by the European Union information agency for occupational safety and health (EU-OSHA) and International Labour Organization (ILO) (Nielsen & Abildgaard, 2013).

Organizational health interventions that integrate participative components like German health circles, as recommended in the context of interventions addressing ERI (see chapter 2.), are also rather scarce. Intervention studies that address psychosocial strains are mainly clustered into three levels of analysis. Interventions address either the individual level (e.g. stress management programs that attempt workers to deal with demanding situations), the level between the individual and the organization (measures that relate to the interface between individual and work), or at organization level (e.g. organizational policies and practices) (Giga et al., 2003; Siegrist, 1996b). However, categories slightly differ due to a lack of mutual exclusivity, depending on the intervention program (Giga et al., 2003).

Randomized controlled trials and quasi-experimental studies that address ERI can vary in design. Most intervention studies found have been non-participatory and have predominantly addressed the individual intervention level (see Table 3). Participatory intervention studies often address more than one intervention level simultaneously. Non-participatory interventions, in contrast, mainly address the individual level, focusing on cognitive-behavioral interventions. These findings are in line with the review by Ruotsalainen et al. (2015) and Giga et al. (2003).

| Study | Population | Intervention | Participatory (yes/no) | Intervention level |
|---|---|---|---|---|
| Arapovic-Johansson et al. (2017) | Healthcare workers | Productivity Measurement and Enhancement System | Yes | IO, O |
| Bourbonnais et al. (2011) | Healthcare workers | Participative intervention for psychosocial factors | Yes | IO, O |
| Gast et al. (2022) | Managers | Cognitive Behavioral Therapy on psychosomatic health | No | I |
| Gilbert-Ouimet et al. (2011) | White collar workers | Participative intervention for psychosocial factors | Yes | I, IO, O |
| Krause et al. (2010) | Call-Center Operators | Workstation interventions on upper body pain | No | I, O |
| Li et al. (2017) | Middle Managers | Cognitive Behavioral Therapy in the form of a group-oriented stress intervention seminar | No | I |
| Limm et al. (2011) | Middle Managers | Cognitive Behavioral Therapy in the form of a group-orientated prevention seminar | No | I |
| Manford et al. (2022) | General workforce | Cognitive Behavioral Therapy (group-based) | No | I |
| Nixon et al. (2022) | General workforce | Cognitive Behavioral Therapy (web-based) | No | I |
| Trudel et al. (2021) | White collar workers | Organizational changes | No | IO, O |
| Uchiyama et al. (2013) | Nurses | Participative intervention to improve work environment | Yes | IO, O |
| Unterbrink et al. (2012) | Teachers | Cognitive Behavioral Therapy (group-based) | No | I |

*Table 3: Randomized controlled trials and studies with quasi-experimental design addressing ERI. Note: I=Individual, IO=Individual-Organizational, O= Organizational based on Giga et al. (2003)*

Only a few intervention studies exist for nurses that aim to reduce psychosocial strain as a result of ERI (Arapovic-Johansson et al., 2017; Bourbonnais et al., 2011; Uchiyama et al., 2013). Except for the study by Arapovic-Johansson et al. (2017), the follow-up period in randomized controlled trials was below six months. As Ruotsalainen et al. (2015) point out in their review, the follow-up period should be at least one year to ensure lasting intervention effects over time. Due to a higher psychosocial strain in the intervention arm, Arapovic-Johansson et al. (2017) could not prove their hypothesis regarding the reduction of ERI. Uchiyama et al. (2013) also found no significant reduction in ERI post-intervention. A significant reduction in ERI was found by Bourbonnais et al. (2011) but the level of evidence is of lower quality due to quasi-experimental design.

Due to the lack of methodically sound interventions tailored for the nursing workforce, an organizational level intervention for health and well-being will be the focus of this thesis which aims to increase health by reducing psychosocial strain.

| Level | Interventional measures | | |
|---|---|---|---|
| | Effort | | Reward |
| | intrinsic | extrinsic | |
| Personal | Overcommit-ment | | |
| Interper-sonal | | | Lack of appreciation and support |
| Structural | | Physical and emotional work-load | Low reward due to low in-come and/or status control. (job promotion, change of position and occupation, status inconsistency, status discrepancy) |

*Table 4: Overview of levels and targets of interventional measures according to ERI-Model over three levels of analysis based on Siegrist, 1996b.*

Because of their job profile, nurses are involved in cognitive, emotional, and physical demanding interactions with colleagues, supervisors, and patients (see chapter 2.). ERI, as described above, is sensitive to psychosocial domains of interpersonal relationships and leadership in particular (Table 1). According to the psychosocial domains of ERI, Table 4 presents potential interventional measures in the context of effort and reward. This thesis, therefore, focuses on the role of effort and reward within the psychosocial domains of nursing. In the following sections, the relevance of ERI for the outcome of implementing a participatory organizational

level intervention will be examined, as well as the role of ERI for physical and mental health and process evaluation.

## 2.2. Outcome evaluation of organizational intervention studies for health and well-being

To address the risk of bias, a randomized-controlled trial design is regarded as the method of choice (Craig et al., 2008) for health interventions at work. However, the number of studies with positive outcomes using this rigorous design method is considerably smaller compared to studies that do not randomize (Biron et al., 2012a). A systematic review of non-randomized intervention studies in the context of occupational health in nurses showed that interventions at the individual level can reduce stress and burnout (Duhoux et al., 2017). In a meta-analysis by Ruotsalainen et al., 2015, only 2 of the 20 identified randomized intervention trials reported a significant reduction in stress experience. As Nielsen, Taris et al. point out, in intervention studies with randomized design, the methodological strictness may lead to a loss of focus on information relevant to the effectiveness of an intervention, as the focus changes from a formative to a summative evaluation (2010). Biron et al. accurately describe it as a question that has shifted from 'how and why does the intervention work?' to 'does the intervention work?' (2012a). The need for including data on the process and context of an intervention implementation becomes apparent in the context of this discussion (Nielsen & Abildgaard, 2013).

LaMontagne et al. concluded in their review that the literature found on occupational health interventions was mostly concerned with effect evaluation and provided poor information on process evaluation data (2012). More recently Montano et al. (2014) and Fox et al. (2022), as well as Egan et al. (2009) and Murta et al. (2007), address the relevance of process evaluation for occupational health interventions in their systematic reviews. Evaluating processes and context means taking into account individual, collective, and management perceptions (NytrØ et al., 2000). This change in perspective marks a shift towards the biopsychosocial model which also takes into account psychological and sociological factors in the context of health and illness (Nielsen, 2013). The need for understanding potential barriers and facilitators in implementing organizational level interventions is crucial for intervention success. Intervention success in the context of organizational health depends on a complex interplay of personal, interpersonal, and organizational factors (e.g. community and culture) (Weiner et al., 2009) which can be accounted for by process evaluation.

Research has shown that the role of employees and supervisors in organizational interventions needs to be reconsidered. Both groups should rather be seen as active agents of the intervention than as passive recipients (Nielsen, 2013). Important information may be overlooked by researchers that only evaluate whether organizational interventions components are delivered to employees and whether these components are evaluated positively or negatively (Nielsen & Randall, 2013). There is evidence that the type and amount of participation of employees and supervisors can be linked to intervention outcomes (Nielsen, 2013). Aust et al. (2010) found that employees reacted negatively to only having limited influence on an intervention, i.e. limited control over the intervention's scope, and consequently, they did not participate in intervention activities. The outcome was either no change or an increase in psychosocial strain. Nielsen et al. (2007) have shown that there is a positive association between influencing the intervention and job satisfaction after the intervention. Within the participatory intervention process, employees and line managers are collectively charged with creating intervention settings, selecting ways to identify adverse work conditions, and developing measures to reduce or eliminate adverse work conditions. Furthermore, employees' participation in workplace intervention studies is related to perceived organizational change (Nielsen & Randall, 2012). In her review, Nielsen (2013) discusses the aforementioned misperception of employees and supervisors in organizational interventions as passive recipients. From a theoretical perspective, social identity theory can explain why participatory processes in an intervention can promote the development of so-called in-groups, which in turn can provide stability, direction, and meaningfulness for the participants of an intervention (ibid). A similar perspective can be applied to the role of supervisors. From the perspective of social identity theory or on the basis of social exchange theories, the importance of favorable treatment by supervisors for well-being and positive attitudes towards an intervention can be explained very well. If employees and supervisors share these positive attitudes, then subsequent implementation of an intervention may be easier (ibid.). Nielsen claims that it is necessary to develop qualitative and quantitative instruments to assess employees' participation and supervisors' engagement to encourage participatory processes. A mixed method approach that combines both qualitative and quantitative methods in process evaluation is highly recommended (Biron et al., 2012b; Nielsen & Randall, 2013; Semmer, 2006).

The next two sections discuss the relevance of supervisors and employees for health and health promotion in the context of leadership and ERI, and in the context of process evaluation of a participative intervention study.

## 2.3. Role of leadership in the context of ERI and health

According to Siegrist (1996b), positive self-experiences such as self-efficacy and self-esteem are expressed, following Mead and Gehlen, in the social reinforcement of the intentionality of an individual's action. Therefore, significant others stabilize positive self-experience through social reinforcement such as appreciation, support, or agency. According to Mead, this allows individuals to experience one's self (ibid.). In the context of professional opportunity structures, supervisors can be seen as significant others. In a recent meta-review assessing key factors for job demands and job resources, leadership was identified as an essential factor in nurses' job resources (Broetje et al., 2020). Leadership in its capability to influence others (Haslam et al., 2015) plays a crucial role in the context of psychosocial risks at work and is considered significant for the health and well-being of employees (Cummings et al., 2018; Harms et al., 2017; Kuoppala et al., 2008; Montano et al., 2017; Skakon et al., 2010). Leadership is conceptualized in different ways. Research has focused on traits, behaviors, and specific styles (Nyberg et al., 2005). Regardless of which conceptualization is used, they all appear to be related to employees' health (Montano, 2016). Given the different conceptualizations, leadership can have beneficial and adverse health effects on employees. There are destructive leadership behaviors with adverse health effects (Schyns & Schilling, 2013), as well as leadership styles, e.g., 'transformational leadership style', that promote employees' health (Skakon et al., 2010).

Although the relationship between leadership and health or well-being has been widely studied, the relevance of ERI in this context has rarely been investigated. ERI is sensitive to various psychosocial domains (see Table 1) and particularly to factors of interpersonal relationships. Certain forms of leadership styles or behaviors reflect this interpersonal exchange of appreciation and support between supervisors and employees within a working context. According to one of the few existing studies by Weiß and Süß (2016), a cross-sectional study, a positive, transformational leadership style can reduce ERI and overcommitment in a convenience sample of the general workforce. These observations suggest that leadership behavior or style could effectively reduce ERI in the context of an occupational health intervention,

as recommended by Siegrist (1996b). Another cross-sectional study considers ERI as a mediator variable for the relationship between supportive leadership behavior and general health (Schmidt et al., 2014). No further studies examine the relationship between ERI, leadership behavior or style, and health.

Moreover, Montano et al. (2017) point out the lack of longitudinal studies in this context. For nurses in particular, few reviews exist that provide a summary of the relationship of leadership behavior or style with outcomes of health and well-being. Specchia et al. (2021) concluded in their review that job satisfaction in the form of a positive, empowering, and motivating work environment can be achieved by supportive leadership behaviors. Other reviews have come to similar conclusions regarding the influence of leadership behavior or styles on corresponding outcomes of health or well-being (Cummings et al., 2018; Niinihuhta & Häggman-Laitila, 2022). In summary, the role of ERI in leadership behavior or style and health or well-being has rarely been observed. On the other hand, a methodological gap can be identified since associations described in the context of ERI are limited to observations in cross-sectional studies. In the next section the role of failed reciprocity caused by significant others will be discussed in the context of process evaluation of participatory intervention studies.

## 2.4. Process evaluation of organizational interventions and the role of employees and supervisors

In 2002, Linnan et al. published the book "Process Evaluation for Public Health Interventions and Research", drawing attention to the essential relevance of process evaluation and describing key process evaluation components. Their conceptualization of five key components for process evaluation has influenced various research. Process evaluation is most successful when it considers the needs, desires, and concerns of potential system users (ibid.). Overall, two dominant and 2 to 3 less dominant research areas can be identified in the literature on process evaluation. The two dominant areas have developed independently of each other. While the former refers to the term ‘process evaluation,’ the second area claims the term ‘implementation science’. According to Linnan et al., implementation is a function of other components of process evaluation - a composite variable of reach, dose, dose received, and fidelity (2002). There is a number of frameworks for analyzing relevant components of process evaluation. The ‘Consolidated Framework for Implementation Research’ - CFIR is widely known within implementation sciences (Damschroder et al., 2009). Besides that, there are frameworks from Proctor et al. (2011), RE-AIM (Glasgow et al., 1999), TDF and EPIS (see

Moullin et al. 2020 for an overview) and in context of Linnan et al. (Baranowski & Stables, 2000; Egan et al., 2009; Nielsen & Abildgaard, 2013; Saunders et al., 2005). Both research areas provide reviews on how process evaluations are carried out within worksite health intervention. Research area one (Havermans et al., 2016; LaMontagne et al., 2007; Murta et al., 2007), referring to Linnan et al., builds on the model of demands and control by Karasek (1979) and area two (Durlak & DuPre, 2008; Wierenga et al., 2013) on the diffusion of innovation theory by Rogers (1995). In contrast, the relevance of ERI in the context of process evaluations has been underreported so far. To date, no research exists on the influence of ERI on the implementation processes of an intervention.

Within the CFIR framework, in particular, a variety of instruments have been established that can be used to assess relevant factors of implementation. There is psychometric evidence that supports CFIR instruments' constructs (Fernandez et al., 2018). The Society for Implementation Research Collaboration (SIRC) is currently working on a repository where such instruments will be made available. So far, these instruments are, among other languages, available in French and Chinese. While the research area centered around CFIR investigates instruments within a broad framework of different components of implementation, the focus within the research area centered around Nielsen et al. is more focused on aspects of individual perceptions, appraisal, and sense-making within the components of process evaluation according to Lazarus and Folkman (1984). Several studies highlight the specific role of individual cognitive processes regarding the success of an occupational health intervention. Employees are understood as active agents who contribute substantially to the success of the intervention through their appraisals, especially in participatory interventions. Appraisals also play an important role in the context of occupational health in general. They offer an explanation of individual reactions based on subjective evaluations of situations and objects in the context of stress (Lazarus & Folkman, 1984) and in occupational health interventions (Hasson et al., 2014; Randall et al., 2007). The role of supervisors (middle managers, line managers, etc.) play a central role in the context of these perceptions. Longitudinal perspective evidence shows that supervisors' engagement can contribute to the success of an intervention (Nielsen & Randall, 2009). For example, training supervisors can make the implementation of interventions within a team more effective (Nielsen, Randall et al., 2010, 2017).

However, psychometrically sound instruments within the context of Nielsen et al. are rather scarce. Most instruments within this research area are based on the concept of self-efficacy (SE) within the social cognitive theory. Positive self-experiences like SE can be conducive to belonging and contribution, but also opportunities for agency, as described in chapter 1. In this context, the role of employees' appraisals, as highlighted by Nielsen, could be influenced by the perceived absence or presence of opportunity structures that are of particular relevance within the ERI model. Up until now, this possible relationship has not yet been investigated. A review of German language implementation constructs for occupational health interventions by Kien et al. (2018) only found three instruments in the context of occupational health interventions. Instruments referring to Nielsen et al. were developed by Randall et al. (2009) for employees and Mosson et al. (2018) for supervisor engagement in interventions. For intervention studies with health circles or within a more participative context, as recommended in the beginning, no instrument exists now.

In summary, the participation of employees and supervisors in organizational interventions plays a relevant role in (1) ensuring the effectiveness of the intervention. They are, therefore, (2) pivotal for understanding the implementation processes of interventions for health and well-being. However, instruments to assess the relevant cognitive processes of these key occupational groups are rather scarce. It has not yet been investigated to what extent ERI affects the process of implementing an intervention by employees.

## 3. Thesis Objective

So far, this thesis has discussed the relevance of ERI for nurses' health and work ability. It has been pointed out the need for more methodically sound organizational health intervention studies that address the nursing workforce's specific job profile and psychosocial strains. Four research gaps (see Table 5) were identified in this context. To date, very few cluster-randomized participatory intervention studies for nurses exist. Furthermore, these studies require a comprehensive outcome and process evaluation that considers the particular role of employees and supervisors while implementing the intervention. In particular, the role of supervisors in the context of ERI and health remains unexamined. The role of employees' appraisals of a group-based participatory intervention while implementing also remains unexamined. This thesis presents four studies that are of particular relevance to these research gaps.

| N° | Research Gap | Chapter | Study |
|---|---|---|---|
| 1 | Participatory cluster-randomized intervention trials for nurses' health and work ability | 2.1 | I. |
| 2 | Role of employees' appraisals in group-based participatory interventions and influence of ERI | 2.4 | II. |
| 3 | Role of leadership in context of health and ERI in longitudinal perspective | 2.3 | III. |
| 4 | Rigorous outcome and process evaluation of a participatory cluster-randomized intervention trial | 2.2 | IV. |

*Table 5: Overview of research gaps identified with corresponding chapter and study*

Overall, this thesis is of particular relevance due to practical significance: So far, there are no quantitative process evaluation instruments for assessing employees' appraisals in the context of a group-based participatory intervention (gap 2). Moreover, this thesis is significant for theory development because the relationship between ERI, health, and leadership behavior has not yet been investigated (gap 3). Also, few cluster-randomized participatory intervention studies for nurses exist to date (gap 1). Finally, this thesis is of research significance for implementing a participatory occupational health intervention because of rigorous outcome and process evaluation (gap 4). *This thesis aims to demonstrate the significant role that effort and reward play in social exchange relationships and its influence on nurses' health and health promotion in the context of a participative occupational health intervention*.

# 4. Methods

The following two sections briefly present the study cohort and methods of measurements used to conduct **Studies I-IV**. Each of the studies will then be presented and discussed afterwards.

## 4.1. Study cohort

Samples for all four studies were derived from the HALTgeben ("Higher Patient Satisfaction through Fair Working Conditions in Healthcare") study cohort (Montano et al., 2020), a two-arm, cluster-randomized intervention study performed over three-time points of measurement. The study's aim was to reduce the psychosocial workload in healthcare workers by a participative occupational health intervention. The primary endpoint was the work ability of healthcare workers, the secondary endpoint patients' satisfaction with care.

The study population comprised of a group of hospitals in a metropolitan area, seven general and three specialized hospitals, and one elderly care center in a mid-sized urban area in Germany. Participants were only eligible to participate in the survey if they were healthcare employees older than 18 years and worked in a single ward most of the time. An attempt was made to census the healthcare worker population; consequently, all eligible employees were contacted by e-mail and invited to participate in the surveys.

Each employee who was contacted was given a booklet containing a concise description of the study, data privacy policies for the surveys, a registration form, and a consent form. Before study enrollment participants had to provide written informed consent and the name of the ward they work on. The information on wards was validated using hospital and geriatric care center-provided internal staff numbers. Therefore, the clusters were defined based on the information provided by the employees, taking into account organizational structures, and the type of health services offered by the relevant healthcare organizations. The cluster eligibility criterion was the unambiguous assignment to patient or geriatric care, as applicable. The enrollment deadline for healthcare professionals was October 31$^{st}$., 2019. The survey data was gathered from June to December 2019 (t0), September to December 2020 (t1), and August to October 2021 (t2). Different samples were derived from the cohort for the studies I-IV. **Study I** and **Study II** were conducted as cross-sectional examination at time point t0. **Study III** and **Study IV** account for all three time points, respectively.

## 4.2. Measures

Self-administered questionnaires assessed the information on psychosocial workload and health at all three time points. The questionnaire comprised of psychometrically validated instruments, using WAI (‘Work ability index’) (Hasselhorn & Freude, 2007), COPSOQ (‘Copenhagen psychosocial questionnaire’) (Nübling et al., 2005), ERI (‘Effort-Reward Imbalance’) (Siegrist et al., 2004), and SF12 (‘Short form health survey- health-related quality of life’) (Nübling et al., 2006). The implementation of measurements with two instruments will be described in the next sections due to their relevance to the thesis. Afterwards, the aims and results of **Studies I** to **IV** are presented.

# 5. Study I: “Working conditions of healthcare workers and clients’ satisfaction with care: study protocol and baseline results of a cluster-randomised workplace intervention”

Diego Montano, Marco Kuchenbaur, Heinrich Geissler & Richard Peter

## 5.1. Aim

Intervention studies that focus on increasing nurses' work ability are rather scarce, as described in chapter 1. Studies have shown that psychosocial factors such as high job demands and low job control can lead to musculoskeletal symptoms and burnout. Previous research has found that person-centered interventions like cognitive behavioral therapy (CBT) and mindfulness techniques can reduce burnout and job stress. However, organizational interventions are considered more effective in preventing health risks, but randomized controlled interventions are scarce. The study presents the protocol and baseline results of the cluster-randomized workplace intervention "HALTgeben" . The study aims to improve workers' work ability and client satisfaction with care by reducing their physical and psychosocial workload. The study is conducted in 11 German health service providers, and the results are reported according to the CONSORT Statement for cluster-randomized trials.

## 5.2. Results

The response rates for workers and patients at baseline were approximately $13\ \%$ and $53\ \%$, respectively. The intervention was implemented in 11 health organizations, covering 67 clusters and about $68\ \%$ of all wards, including various health service areas. The characteristics of clusters across organizations were balanced, with similar health service types in different hospitals.

The effective sample size ($N_{eff}$) and intracluster correlation coefficient (ICC) for workers' physical and mental work ability were estimated to be $N_{eff} = 345$ and $423$ and $ICC = .05$ and $.01$, respectively. The average cluster size in the workers’ sample was $6.53$, resulting in design effect estimates of $DE = 1.29$ and $1.05$ for the main outcomes. This indicates that effect sizes of at least $.30$ and $.27$ for workers' physical and mental work ability, respectively, can be estimated at $80\ \%$ power and $5\ \%$ significance levels. For the patients’ dataset, the estimates were $N_{eff} = 234$, average $ICC = .09$, $m = 19.5$, and $DE = 2.7$.

The results of the statistical analyses at baseline showed no baseline differences between the intervention and control groups regarding the study's main outcomes. Among participating workers, higher scores of effort-reward imbalance and overcommitment were associated with

lower scores of physical and mental work ability, with partial mediation by negative affect and physical and mental health perceptions. Among participating patients, there was no association between perceived effort-reward imbalance and overcommitment of healthcare workers at the cluster level and patients' satisfaction with care.

## 6. Study II: "Assessing the role of collective efficacy beliefs during participative occupational health interventions"

Marco Kuchenbaur & Richard Peter

### 6.1. Aim

In particular, the role of employees and supervisors for the effectiveness of an intervention study was discussed in chapter 2.3. To date, however, there are no forms of quantitative process evaluation that examine the relevance of employees' appraisals in group-based intervention studies for this effectiveness. Furthermore, there are no studies that examine the potential role of ERI. The article presents a pilot study of developing and validating a questionnaire to assess the overall quality of interventional activity within a group-based, participatory intervention, emphasizing collective efficacy beliefs as an indicator of participant engagement. The study addresses the need for shared commitment in participatory interventions. It points out the absence of content-appropriate questionnaires to assess shared commitment in participatory occupational health interventions within group settings. The article discusses the significance of process evaluations and the role of efficacy beliefs of employees in the success of complex occupational health intervention studies.

### 6.2. Results

A questionnaire was designed to assess participants' expectations according to the efficacy and future outcomes of participatory interventions in workshops. A questionnaire was distributed to 140 participants in 24 workshops, and exploratory factor analysis was performed on the resulting data. The analysis yielded a two-factor solution, with one factor representing workshop participants' expectations regarding the intervention's efficacy, and the other representing participants' expectations regarding the intervention's prospective outcomes and its implementation. Both factors showed adequate internal consistency and accounted for $39\ \%$ of the total variance. Additionally, a multilevel analysis showed that the lack of reward by the ERI model reduces the efficacy expectations of participants in workshops ($\gamma_{01} = -.39$, $p = .01$). In addition, a moderate correlation ($\eta = .57, p < .001$) was found between the number of interventional measures that emerged from each workshop and the workshop-related efficacy expectation.

# 7. Study III: "Quality of leadership and self-rated health: the moderating role of 'Effort-Reward Imbalance: a longitudinal perspective"

Marco Kuchenbaur & Richard Peter

## 7.1. Aim

The purpose of this study was to examine the relationship between leadership behavior and the physical and mental health of employees at work. To date, longitudinal studies are scarce within this context. The role of ERI in this context is also rather underreported. This study aims to overcome these limitations by examining the underlying mechanisms of the relationship between leadership, ERI, and health, while taking into account confounding variables such as age, gender, and workplace contexts. It is hypothesized that positive leadership behavior, characterized by appreciation and support, may promote positive self-experience and the experience of control, which may be conducive to health and well-being.

## 7.2. Results

A conditional growth linear mixed model (LMM) with time and subject as random effects were used to predict physical health. The model revealed a significant negative effect of ERI ($-7.56$ ($95\%$ $CI$ $[-14, -1.11], p = .022$)) and lack of quality of leadership ($-2.11$ ($95\%$ $CI$ $[-3.64, -.59], p = .007$)) on physical health, with a significant positive interaction term between the two. Several factors were accounted for in the model, including age, education, and work-family conflict, which contributed to a decline in physical health over time. Additionally, a test was conducted on simple slopes to investigate the moderating effects of lack of quality of leadership on the relationship between ERI and physical health. The negative impact of ERI on physical health was found to be higher when employees reported a higher quality of leadership. This study found that among employees who reported experiencing ERI, those who reported better leadership quality had significantly worse physical health than those who reported lower leadership quality. However, this study found that as the level of leadership quality decreases, it no longer plays a significant role in explaining a decline in physical health over time. This suggests that leadership quality may serve as a buffering resource for stress, but when stress levels become too high, their impact on physical health may be diminished.

## 8. Study IV: “Outcomes and process evaluation of a cluster-randomised participatory organisational intervention among German healthcare workers”

Diego Montano, Marco Kuchenbaur & Richard Peter

### 8.1. Aim

By modifying psychosocial working conditions in eleven German health service institutions, the "HALTgeben" intervention study intended to enhance healthcare employees' physical and mental work ability. The study was designed as a two-arm, cluster-randomized design, with eligible participants being 18 years and older and healthcare employees from a single ward. Using validated psychometric instruments, the primary outcomes were self-assessed physical and mental workability measured at baseline and two follow-up time points. Age, gender, physical and mental work ability, ERI, and information on ward transfers were considered for the study.

### 8.2. Results

The study examined the effects of an intervention on healthcare employees' self-assessed work ability. The results disproved the hypothesis that the intervention would improve work ability. In fact, employees in the intervention group reported less physical and mental work ability. Large correlations were also discovered between effort, low reward, overcommitment, and work ability. Levels of overcommitment demonstrated the marginal effects of effort and low reward on work capacity. The study revealed a correlation between ward transfers and a decline in work ability, particularly the mental component. The process evaluation revealed that most proposed interventions addressed the physical and environmental characteristics of the workplace; however, only a small proportion of measures were implemented.

However, the regression analysis results did not support the hypothesis of **Study IV** that the intervention would enhance work ability. In fact, intervention employees tended to report lower physical and mental work abilities. Large associations were identified between the ERI scales' effort, minimal reward, and overcommitment, and both physical and mental work ability. The intervention had no effect on psychosocial stress at work, as measured by the ERI scales.

The process evaluation revealed that the majority of proposed measures focused on the physical and environmental aspects of the workplace, while measures on an individual level were less prevalent. By the end of the intervention only 22 % of the proposed measures had been completed, and many of the proposed measures were difficult to classify. 69 % of healthcare

employees reported that the intervention did not result in any significant changes to their psychosocial working conditions. There were no significant differences between the intervention and control groups regarding the perceived impact of the intervention. The COVID-19 pandemic had no significant effect on the intervention or its results.

# 9. Discussion

The following sections compare the results of the four studies presented earlier with existing studies, discuss strengths and limitations, and present possible mechanisms behind the results of the studies. Finally, the practical relevance of the studies will be discussed and a conclusion will be presented.

## 9.1. Findings

**Studies I-IV** suggest that the imbalance of effort and reward in organizational health interventions plays a relevant role in explaining intervention success, work ability, and the health of nurses. Figure 3 shows the connection between **Study I-IV** via the imbalance of effort and reward for health and health promotion. In summary: Individuals' affective and cognitive processes that promote health or predispose disease are modulated by the interplay of socially driven motivations (e.g., appreciation and support) and social opportunity structures (e.g. roles, gratifications). **Study IV** showed that, as in **Study I**, work ability is strongly related to ERI. Interventions that address work ability should therefore include measures that change the imbalance of effort and reward. The process evaluation in **Study IV** showed that (1) the majority of proposed intervention measures focused on the physical and environmental characteristics of the workplace and (2) only $22\ \%$ of the $526$ measures were actually accomplished. Interventions that addressed physical and environmental characteristics focusing on working environments of hazardous nature in relation to workplace safety. In order to compensate for an imbalance of effort and reward, effort can be lowered by reducing demands and responsibilities, or reward can be increased by the three transmitter systems of money, respect, and career opportunities.

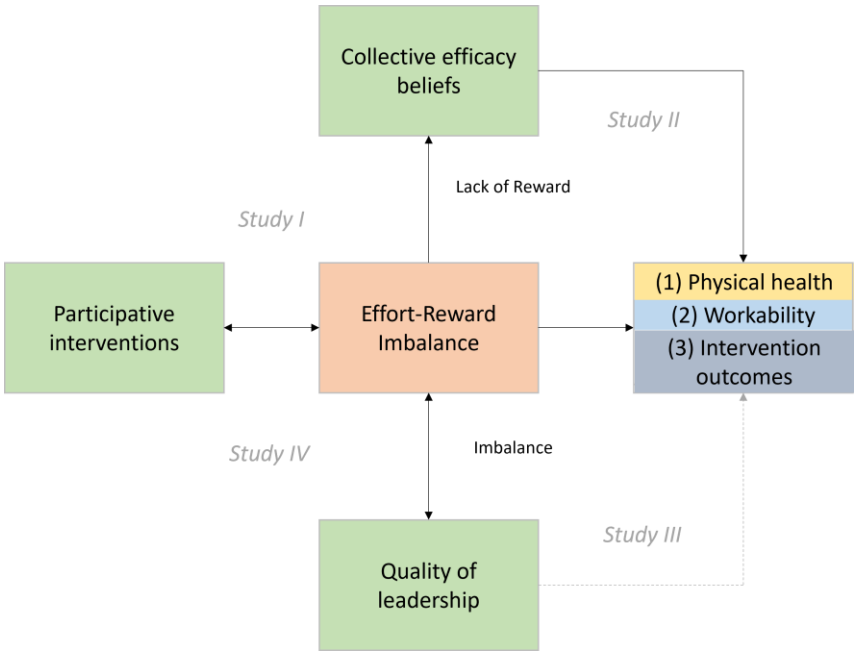


*Figure 3: Summary of relationships of single studies I.-IV. with ERI. (Designed by author).*

None of these three transmitter systems (Siegrist 1996b) were considered comprehensively by the intervention measures presented in **Study IV**. In fact, among the measures on the interpersonal level, many measures were not implemented at all. **Study IV,** therefore, was not able to identify any changes between intervention and control groups in terms of improvement in work ability or reduction in ERI. **Study II** shows how relevant ERI can be for intervention effectiveness too. The presence or absence of reward can be a prerequisite for employees implementing interventions with high collective efficacy beliefs. It has been shown that the number of proposed interventions was highest in workshop groups with high collective efficacy beliefs. Positive self-experiences through a balance of effort and reward are also relevant in the context of leadership behavior and employees' health. **Study III** showed that there is a moderating relationship between ERI and quality of leadership in the context of physical health. Up to a certain degree of experienced imbalance of effort and reward, the quality of leadership does have a buffer effect on physical health. However, this effect disappears if the perceived imbalance of effort and reward increases more intensely. As a result, a stronger experience of ERI overrides the influence of the quality of leadership on physical health. *The findings of the four studies implicate the overall relevance of the ERI model for outcome and process evaluation and health within the context of a participatory intervention study*.

## 9.2. Comparison with previous studies

**Study I** presents the study design of an intervention study for nurses using the model of ERI. Compared to previously conducted studies, **Study I** benefits from a longer, overall follow-up

time and a cluster-randomized study design, ensuring a high level of evidence. A comparison of the results in **Study I** of the psychosocial stress of nurses in the HALTgeben cohort with the general workforce shows that ERI in nurses is 0.85 (intervention group) and 0.89 (control group) respectively, above the average of 0.5 of a representative sample of the general workforce (Nuebling et al., 2022). Other intervention studies report similar results in their baseline measurements. On average, ERI ranges between 1.1 (Bourbonnais et al., 2011), and 0.8, 0.9 for the intervention and control groups, respectively (Arapovic-Johansson et al., 2017). **Study I** extends observations of previously conducted studies by implementing a comprehensive process evaluation, which the observations of **Study II** also contribute to.

**Study II** provides pilot observations of developing a questionnaire that assesses participants' appraisals of a participative intervention on the basis of collective efficacy beliefs. While the concept of efficacy beliefs has been used in comparable, previously designed questionnaires, **Study II** extends these by including collective efficacy beliefs for group-based, participatory intervention settings. The observations also underline the relevance of reward for increased collective efficacy beliefs, drawing from the ERI model. So far, this contribution has not been investigated. The explained variance in **Study II** achieved $39\,\%$ in comparison to $66.71\,\%$ (Randall et al., 2009), $36\,\%$ (Shea et al., 2014), and $75.1\,\%$ (Jung et al., 2010) in comparable studies. No other study that has described the design of an instrument for process evaluation of occupational health interventions has also used correlation analysis to examine preliminary evidence of the explanatory power of the implementation process. **Study II** was able to show that there is a correlation between a stronger efficacy expectation and the number of intervention measures.

**Study III** investigates the moderation of ERI on the long-term effect of quality of leadership on self-rated health. So far, the role of ERI in this context has only been observed in cross-sectional settings (Schmidt et al., 2014; Weiß & Süß, 2016). **Study III** extends previous observations by pointing out the relevance of reward frustration for self-rated health in relationships between supervisors and employees. Furthermore, compared to Schmidt et al. (2014), **Study III** used psychometrically sound instruments to assess leadership behavior. Taking adverse outcomes on physical health into account, **Study III** is in line with the findings of Montano (2016).

**Study IV** presents a comprehensive outcome and process evaluation of a participatory intervention study to increase nurses' work ability. The study adds an extensive process evaluation which other studies have neglected so far. In comparison with previous intervention studies in the context of nurses' health that assess psychosocial strain by ERI model, this study offers a high level of evidence because of the cluster-randomized design. There has only been one other study on nurses with this study design (Arapovic-Johansson et al., 2017). In comparison to Bourbonnais et al. (2011), **Study IV** was not able to show a significant change in the primary endpoint after intervention.

## 9.3. Possible underlying mechanisms of effort and reward for positive self-experiences

As pointed out in chapters 2, 6-9, positive self-experiences, e.g., self-efficacy, are relevant for promoting health, but in their absence, they also predispose disease. In the following, these emotional mechanisms of cognitive and affective reactions toward the imbalance of effort and reward will be discussed in **Studies II** and **III**. Additionally, it has been shown that ERI is sensitive to the specific job profile of nurses. As an interactive service job, nursing consists of various emotionally and cognitively demanding interpersonal tasks that are potentially prone to failed reciprocity. **Studies I** and **IV** present the design and results of a cluster-randomized intervention study that accounts for this psychosocial hazards.

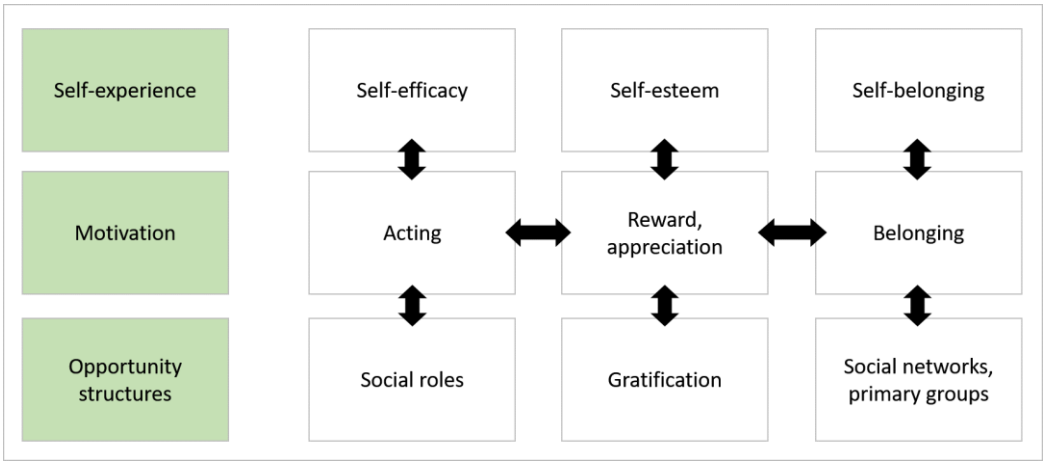


*Figure 4: Relationship of self-experience, motivation and opportunity structures according to Siegrist (1996b). Modified, with permission from Hogrefe.*

### *9.3.1. Possible underlying mechanisms in Study II and III*

**Study III** and **II** both show how the need for self-experience by self-efficacy and self-esteem, respectively, are affected by the opportunity structures of a rewarding psychosocial environment (see Figure 4). Experimental studies indicate that specific reward, including appreciative feedback, increase both self-efficacy and self-esteem and thus positively impact job satisfaction and performance (Kuhnen & Tymula, 2012; Wright & O'Halloran, 2013). **Study III** shows

that the quality of leadership, as part of the opportunity structure of the psychosocial environment, influences the motivation to experience a positive self by participating in the workplace context. Supervisors can guarantee the need for stabilizing workers' self-experience by rewarding feedback as a significant other (Siegrist, 1996b). In the absence of this form of reward, an imbalance of effort and reward is perceived, which reduces the opportunity for positive self-experience in the long run. A permanent lack of positive self-experience can result in negative emotions, which, in turn, can lead to adverse health effects (Siegrist, 1996b). While experimental settings related to ERI are scarce, single studies have demonstrated the psychobiological mechanism that leads to reduced health in the context of failed reciprocity. One experimental study using the strategy of esteem manipulation by positive verbal feedback on a given task showed that positive feedback resulted in adaptive autonomic nervous system responses that partially support the ERI model (Brooks et al., 2019). Regarding the long-term effects of these autonomic nervous system responses, the result of **Study III** on physiological health due to a lack of quality of leadership is quite plausible. In interactive service jobs such as nursing, esteem and other forms of reward play a central role as a social resource. Other factors of reward, such as job security, may not be of particular relevance, given the increasingly high demand for nurses in the labor market following a reduction in the nursing workforce in recent years. (see chapter 1, World Health Organization, 2020). van Vegchel et al. (2002) showed that nurses' health outcomes varied based on the three particular forms of reward. The strongest effects of a high effort–low reward imbalance were observed when esteem was used as an indicator for reward. Since **Study III** considered reward as a composite score and not as individual subscales, this may explain the moderation effect between ERI and quality of leadership. As reward comprises of more than the factor of esteem, the influence of quality of leadership on physical health is apparently somewhat limited. Beyond a certain level of imbalance between effort and reward, the quality of leadership no longer seems to have a buffering effect on adverse health effects. This is in line with the findings of van Vegchel et al., who identified a smaller but significant explanatory contribution to nurses' physical health by job security.

**Study II** on the other hand, shows that a lack of reward leads to reduced collective efficacy beliefs in a workshop groups' ability in mastering the task of designing and implementing intervention measures within a participative organizational intervention (see **Study I, IV**). As in **Study III**, the total score of reward was used, and no subscales of reward were

analyzed. Again following van Vegchel et al. (2002), it seems likely that a lack of reward is primarily due to the absence of appreciative feedback from supervisors. However, adding quality of leadership to the model did not result in any additional and significant explanation of variance. This suggests, however, that esteem facilitated by quality of leadership was indeed the primary factor of reward.

Furthermore, **Study II** shows that there is a correlation between collective efficacy beliefs and the number of intervention measures derived from the workshops of participatory intervention. Bandura (2000, 2003) states that supportive relationships can increase efficacy beliefs by modeling attitudes and problem-solving strategies and by providing coping resources. For transformational leadership and self-efficacy in the context of the nursing workforce, this link has been described by Salanova et al. (2011) and Nielsen et al. (2009). Self-efficacy is reported to mediate the relationship between transformational leadership and work outcomes such as job satisfaction and well-being. Even though, in **Study II**, a lack of reward seems to reduce the individually measured collective efficacy beliefs in the clusters, task performance (assessed by the number of interventional measures) seems to be related to the collective efficacy beliefs. This shows that the allocation of reward does not exclusively determine task performance. Task performance also depends on factors that can be understood within the broader context of Bandura's social cognitive theory (Bandura, 2001; Fearon et al., 2013). According to Bandura, previous tasks also provide a feeling of mastery of the current task. The questionnaire developed in **Study II** took this aspect into account. Thus, the questionnaire asked for appraisals of general feasibility as well as future feasibility. In addition, Bandura emphasizes the relevance of vicarious learning. New challenges are considered feasible when the working environment provides resources that promote a constructive and interactive way of implementing new tasks. Füllemann et al. (2015) emphasized in this context that shared participation within stress management courses can increase efficacy beliefs. Participants of **Study II** were asked to evaluate the support they received from their supervisors, available resources for implementation, and the commitment of other participants to the participatory intervention. Two further relevant social-cognitive factors of shared feelings of mastery are a heightened sense of positive emotion towards the task and forms of verbal persuasion. In the questionnaire, these factors were addressed by items that assess participants' appraisals of a commonly shared optimism and excitement within the intervention workshop groups. Mechanisms described in **Study II** and **Study III** showed that reward or the imbalance

of effort and reward, is related to positive self-experiences, especially efficacy beliefs or health-relevant outcomes. However, the question of which sub-dimension of reward contributed the most to the explanation in both studies remains open. Future studies should take a closer look at these reward sub-dimensions.

### *9.3.2. Possible underlying mechanisms in Study I and IV*

**Study I** showed a possible mediation by levels of negative affect on the impact of ERI on work ability according to the lower regression coefficients in models 2 and 3, respectively. This suggests that the effect of interest between ERI and work ability emerges because a state of negative affect arises from an imbalance of effort and reward (Siegrist & Marmot, 2004). Affective states of negative emotions arise from situations of failed reciprocity (as mentioned above). A study conducted in the context of dyadic interpersonal relationships also observed the negative influence of ERI on negative affect (Siegrist et al., 2020). Work ability, as a health-related measure, indicates that the current health status determines an individual's appraisal of its ability to work. The effects described in **Study I** suggest that both components of work ability are affected by an imbalance of effort and reward. Based on the definition of WAI as a health-related instrument for the assessment of subjective work ability, the model of ERI can be used to develop options for health promotion with regard to work ability. This approach is recommended by several longitudinal studies on the relationship between WAI and ERI, whereas ERI was the strongest predictor of work ability in each of these studies (Bethge & Radoschewski, 2012; Carmen Martinez et al., 2016; Spanier et al., 2018). Carmen Martinez et al. (2016) emphasized that neuroendocrine activation as a result of ERI leads to adverse health effects and impaired work ability. In this context, they recommend interventions that improve reward via the three transmitter systems (see chapter 2). **Study IV** also confirmed the relationship between ERI and WAI over time. In particular, low reward in combination with high levels of overcommitment led to impaired work ability in both the intervention and control arms. With regards to reducing the imbalance of effort and reward and increasing work ability, **Study IV** consolidates all measures developed in the context of the participative intervention.

| Level | Interventional measures Siegrist (1996b) | | | Classification (Giga et al., 2003) | |
|---|---|---|---|---|---|
| | Effort | Reward | | | |
| | intrinsic | extrinsic | | Intervention | N (%) |
| Personal | Overcommitment | | | Individual | 12 (2.3 %) |
| Interpersonal | | | Lack of appreciation and support | Individual-Organisation | 19 (3.6 %) |
| Organizational | | Physical and emotional workload | Low reward due to low income and/or status control. (job promotion, change of position and occupation, status inconsistency, status discrepancy) | Organisation | 253 (48.1 %) |
| Unclassifiable | | | | | 242 (46 %) |
| Total | | | | | 526 (100 %) |

*Table 6: Comparison of intervention levels according to Siegrist (1996b) based on ERI and intervention levels based on Giga et al. (2003) and summary of classified intervention measures in Study IV.*

Given what has previously been discussed, the focus on increasing reward and reducing effort in developing intervention measures seems appropriate within intervention studies addressing work ability. As Table 6 shows, however, there is a focus on interventions developed to address the organizational level of rewards within the ERI model. As described in **Study IV**, these interventions at the organizational level mainly address physical and environmental characteristics of the work environment, analogous to the ERI model, thus focusing on reducing the physical workload. As mentioned above, nurses' job characteristics demand a particular constellation of reward, namely the relevance of esteem over the two other factors within the transmitter system of reward (van Vegchel et al., 2002). Other intervention studies using the ERI model had different ratios of intervention levels. The study by Krause et al. (2010) offers interventions in a ratio of $3/1$ for individual intervention measures. The three intervention studies addressing the nursing workforce strongly focus on individual and organizational-level interventions. In the intervention study of Bourbonnais et al. (2011), the number of individual-organizational level interventions even outweighs the organizational intervention level. However, of the intervention studies addressing ERI in nurses, only Bourbonnais reported a statistically significant improvement after the implementation of the intervention. Another

intervention study with significant results after implementing interventions at the organizational level was conducted by Trudel et al. (2021). Trudel et al. showed that interventions at the organizational and individual-organizational levels significantly reduced the average blood pressure and prevalence of hypertension. The ratio of interventions at the organizational and individual-organizational levels was evenly balanced. The findings of these studies highlight two issues in the context of this thesis. First, as discussed in **Study IV**, the need to design interventions that correspond to the underlying mechanisms of psychosocial stress and act on these mechanisms is indicated. The job characteristics of nurses described above require modulation of intervention measures according to the transmitter system within the ERI model. The study by Bourbonnais shows that this modulation towards intervention measures that address esteem can lead to significant study results. Furthermore, as discussed in **Study I** with reference to Ruotsalainen et al. (2015), a certain follow-up time is necessary to observe a significant change in outcomes. Second, the intervention study by Uchiyama et al. (2013) shows that a certain amount of time is required until intervention measures addressing the reward factor esteem become effective. Referring to the experimental study by Brooks et al. (2019), positive feedback in the form of esteem manipulation may be psychologically effective with a certain time lag. The physiological response seems to occur rapidly, but the study showed that psychological perception was absent. Brooks, referring to Lazarus and Folkman (1984), highlights the relevance of the affective response in the evaluation of an event as a stressor in this context. In summary, on a psychological level, in order to achieve a clear perception of change caused by interventions, a change in cognitive appraisals is necessary. As discussed in **Study IV**, a change in attitudes requires strong stimuli which was not provided within the intervention measures of the project HALTgeben. Future studies should focus on the mechanisms of effort and reward to conduct effective interventions.

## 9.4. Strengths and limitations

All four studies (I-IV) were based on the HALTgeben cohort. Due to its design, there are considerable advantages compared to the disadvantages. In particular, allocation concealment is seen as a cornerstone for avoiding bias. In the HALTgeben cohort, participants were recruited prior to randomization, eliminating the risk of bias (Eldridge & Kerry, 2012) for **Study I**, **III,** and **IV**.

Overall limitations can be found in measurement. No lifestyle, anthropometric or biochemical variables were considered when carrying out analyses. Accounting for these variables is beneficial in validating the observations of self-report measures, according to Bradford-Hill-Criteria, on causality by detecting biological pathways (Hill, 2015). Furthermore, including biomarkers can be useful to enhance modeling by relevant confounders of psychosocial stress. Therefore construct validity by a mono-method bias cannot be ruled out in **Study I**, **III,** and **IV**. However, in **Study II**, a comprehension probing (Schuman, 1966) with interviewees who had given in/completed the questionnaire beforehand was conducted in order to test the validity of the developed questionnaire. This mixed-method approach represents a partial strength of **Study II**.

Furthermore, construct validity is also compromised by other factors. Social desirability is another problem that can arise from using self-report instruments (Moorman & Podsakoff, 1992). For this problem, no form of control was conducted which poses the problem of reactivity bias. However, negative affect was controlled for instead, representing another form of systematic bias regarding response styles in the context of ERI (Montano et al., 2016). Another compromise of construct validity may be due to a mono-operation bias: Taking into account the job characteristics of nurses, as emphasized above, the need for esteem is predominant within the reward structure of nurses (van Vegchel et al., 2002). Aspects of fairness, respect and shared decision-making in situations of social exchange become relevant. Instruments as the model of Organizational injustice (OIJ) (Elovainio et al., 2002) assess these aspects of reciprocity and can be used to extend the job-specific reward structure in this context. The OIJ consists of two components, procedural injustice, and relational injustice, which are complementary to the ERI model as a third form of so-called exchange injustice (Kivimäki et al., 2007). Supplementing the measurements of ERI with OIJ may help to identify additional, job-specific components of failed reciprocity in nurses. Beyond changing the understanding of how the imbalance of effort and reward works within the context of nurses' work ability (see chapter 2), interventions could have been tailored to meet these specific needs. Another possible form of mono-operation bias can be detected in **Study II**. To test for convergent validity of the questionnaire developed for assessing appraisals of participative intervention settings via collective efficacy beliefs, a psychometrically sound scale for assessing general collective efficacy or general efficacy should have been used. However, the test for validity of the questionnaire could be partially established via a correlation analysis (Boateng et al., 2018) since

the number of intervention measures designed by participants correlates with the dimension of efficacy expectation measured in the questionnaire. Another strength of **Study I** and **IV** is that there is no reactivity to the experimental situation in the baseline results of **Study I**, compromising the construct validity of the study design. Furthermore, the risk of treatment diffusion from intervention to control groups is also low due to the clustering of the wards in separate areas, different buildings or different hospitals.

Another aspect strengthening the external validity of **Study I** and **IV** is the use of measures for work ability (WAI) and physical and mental health (SF12) to assess potential intervention effects due to possible bias of interaction of causal relationship with different outcomes. Threat to external validity due to interactions of causal relationships with structural factors of the settings is also low because the intervention study was conducted in two different health care settings for nurses, hospitals as well as a nursing home.

Analyses in **Study III** and **IV** are of high internal validity because the risk of bias of an ambiguous temporal precedence is low due to a longitudinal study design. On the other hand, results from **Study II** are probably limited by selection bias due to a non-probabilistic sampling. Overall, **Study I**, **III** and **IV** are of high internal validity because the risk of instrumentation bias can be regarded as low as reliable instruments for measurement were used.

## 9.5. Practical relevance

**Study II** is of practical relevance when implementing a participatory, group-based intervention study as it assesses participants' cognitive appraisals of the efficacy and feasibility of the intervention measures. For practitioners, using these cognitive appraisals is of relevance because these appraisals can determine the success of an intervention. Furthermore, reward is a relevant predictor of participants' appraisal of the efficacy of the intervention measures in a group-based participatory intervention study. In order to successfully implement a group-based participatory intervention, practitioners should consider the relevance of rewards predicting participants' cognitive appraisals of intervention measures. This questionnaire is particularly relevant in participatory intervention study settings where appreciation and support are considered, namely studies that use the ERI model. **Study I** shows practitioners that the close relationship between ERI and WAI can provide leverage for intervention studies. The study suggests that a change in ERI is, therefore, likely to induce a change in WAI. Therefore, practitioners should consider the mechanisms of the ERI model while planning intervention

measures, in particular, increasing rewards and reducing efforts. Furthermore, **Study I** provides relevant information as a study protocol for the reproduction of studies in the context of cluster-randomized interventions. In particular, the information on power analysis can be helpful for this purpose. **Study III** shows the relationship between the quality of leadership and self-rated health. In this context, the training of supervisors should be further promoted. Furthermore, a strong imbalance of effort and reward affects the relationship of the quality of leadership and health. When the imbalance of effort and reward becomes stronger, the quality of leadership no longer plays a significant role in explaining self-rated health. This moderation effect shows that the quality of leadership does not cover all relevant transmitter systems of the reward component in the ERI model. For the quality of leadership to be effective as a health-related factor, other aspects of reward within the ERI model also have to be addressed. **Study IV** provides detailed information on the design of a participatory, cluster-randomized intervention study. In particular, **Study IV** offers insight into the relevance of defining intervention goals: The causal connections between proposed measures and intervention objectives were not determined and practitioners should be aware of this mechanism. Furthermore, continuous monitoring, evaluation, and adjustment of intervention processes have to be considered. No mechanisms were implemented to coordinate organizational change activities, revise ineffective intervention measures, or coordinate interventions across and within clusters. Practitioners should regard interventions as continuous change processes that need a feedback system regarding preparation, method selection, action planning, implementation monitoring, and evaluation. Adopting a project-based strategy involving specific duties, obligations, resource allocation, and timelines would significantly benefit workplace interventions by promoting actual changes to organizational structure and processes.

## 9.6. Conclusion and future directions

The aim of this thesis was to examine the relevance of failed reciprocity in social exchange relationships in job conditions for the health and health promotion of nurses. The context of the analysis was a participatory intervention study. The key analytical instrument used was the Effort-Reward imbalance (ERI) model.

Results of **Study I** indicate a strong correlation between effort-reward imbalance and work ability, a measure of the current status of health against the background of job demands. Therefore, it could be demonstrated how health-relevant social job conditions are for the nursing' workforce. However, understanding social exchange relationships also helps explain

outcomes and mechanisms within a participatory intervention study, the basis of this thesis. **Study II** showed how a lack of reward could affect individually assessed collective efficacy beliefs toward the effectiveness of the participatory intervention. **Study III** showed that the quality of leadership could partly explain social exchange effects on physical health. However, if the breach of the reciprocity norm or the reward frustration exceeds a certain level, the quality of leadership no longer contributes to the explanation of physical health. **Study IV**, on the other hand, showed that for health-relevant outcomes such as the workability of nurses, appropriate intervention measures have to be developed to address the imbalance of effort and reward, i.e., the norm of violated reciprocity in social exchange relationships. The results of the four studies have several implications for future research.

To use ERI as an instrument to analyze unfair social exchange relationships in the context of work means to adopt a perspective that takes into account not only reward factors in direct exchange relationships (via esteem) but also in indirect exchange relationships (e.g., via wage/salary and job promotion/security). As previous research has shown, pathways of interventions aiming to reduce unfair exchange relationships operate on different policy levels but can be observed as linked via the model of ERI (Lunau et al., 2020). Using the conceptual framework developed by Lunau et al. (2020), future directions investigating the relevance of effort and reward in the context of organizational health interventions will be discussed along the micro-, meso- and macro-level.

### *9.6.1. Micro level factors: interactional context*

In order to research the mechanisms of failed reciprocity in social exchange situations in nursing, different reward structures have to be taken into account[1]. As shown in the discussion of the mechanisms of **Study II** and **Study III**, health-related outcomes might differ concerning the constellation and combination of rewards. A factorial survey recently showed that rather 'soft' factors affect nurses' job decisions. Overall, nurses prefer job conditions characterized by a positive atmosphere within the team and time for patients more than monetary rewards (Kroczek & Späth, 2022). As van Vegchel et al. (2002) have shown, nurses, in particular, appear to receive sufficient rewards predominantly via the transmitter system 'esteem'. This observation needs to be investigated further in larger, longitudinal studies. **Study I** and **IV** could be

[1] According to the overview of intervention levels and targets presented in Table 4, the ERI model also includes another aspect that has been neglected so far, namely overcommitment. However, this is not subject of this thesis.

extended in assessing relevant reward structures of nurses via supplementing measurements with the OIJ model (see chapter 9.4). The relevance of reward in the context of efficacy beliefs in health promotion, as examined in **Study II**, should also be further investigated, and further psychometric testing of the developed questionnaire should be advanced in longitudinal studies with larger sample sizes. In this context, it seems valuable to identify which reward component is the main explanatory factor for the variation in efficacy beliefs as well. Quality of leadership, as investigated in **Study III** can be influential on the perception of social support, which can hinder nurses from their intention to leave (van der Heijden et al., 2010). Supervisors' positive behavior or style, as discussed in chapter 2.3 and chapter 9.3.1, can meet employees' socio-emotional needs, e.g., esteem via support and appreciation, and reduce their risk for adverse health effects. However, **Study III** also showed that the quality of leadership influences perceived failed reciprocity only to a certain extent. In this context, supplementing the measurements of **Study III** with instruments that directly assess supervisors' support seems useful for future research. The decomposition of reward factors might also provide information on which forms of supervisors' behavior or style affect the perception of failed reciprocity.

### *9.6.2. Meso level factors: structural factors at company level*

Another way of reducing an imbalance of effort and reward is to adjust efforts. The implemented interventions presented in Study IV predominantly addressed organizational factors among workplace stressors. Physical and environmental characteristics accounted for the vast majority, as described in chapter 9.3.2, with ergonomic measures for workplace improvements being predominantly implemented. In addition, work safety measures were also implemented, such as the availability of security officers and the access to emergency exits. However, these intervention measures do not directly reduce physical and emotional workloads, as shown in Table 4. According to the ERI model, physical and emotional workloads represent actual targets of interventions at the organizational level. Organizational development measures addressing working hours, work organization, work processes, communication culture, and training together account for only about $5\%$ of all intervention measures ($N = 524$).

The reduction of effort seems to be of major importance, especially because, for example, physical demands at work seem to go hand in hand with forms of rewards, addressing employees' esteem (appreciation and support). The presence of social support in the workplace, specifically in the forms of a coworker and supervisor support, was discovered to play

a moderating role in the relationship between physically demanding work and coronary heart disease (Clays et al., 2016). While job control did not have a significant impact, the study found that physically demanding work carried a notable risk of developing coronary heart disease (CHD) only for employees with a low level of social support at work. Conversely, individuals with a high level of social support in the workplace did not exhibit the same heightened risk for CHD associated with physically demanding work. This shows that the ergonomic measures presented in **Study IV**, aiming to improve the physical and environmental factors, could have been more effective had they been accompanied by interventional measures at an interpersonal level that aimed to improve employees' esteem through appreciation and support.

Other findings in this context recently showed that nurses' satisfaction with workplace policies and guidelines directly correlates with their satisfaction with supervisor behavior(Chang & Wang, 2023). Internal communication played a significant role in increasing satisfaction with supervisor leadership. Additionally, satisfaction with shift schedules and educational training are associated with overall satisfaction with supervisor leadership, while satisfaction with salary, benefits, and work environment did not show a significant correlation. Chang and Wang (2023) found that interventions should focus on good shift schedules, internal communication, improving training and development opportunities, and formulating acceptable policies and guidelines to enhance nurses' satisfaction with leadership quality.

### *9.6.3. Macro level factors: National policies and social status*

As the results of **Study III** show, rewarding workers' gains with esteem through support and appreciation in the form of qualitative leadership does not account for all variation in self-rated health. Siegrist (1996b) points out that interventions addressing status control on an organizational level are limited. Considering the ERI model, at least two of the three transmitter systems are related to external, societal forms of reward: money and job security. Social status links the socio-emotional motivations of experiencing agency, reward, and a sense of belonging with unequally patterned opportunity structures within a society (see Figure 4). A person's social status thus serves as an indicator of how far a positive self-experience (e.g., self-efficacy) can be realized (Siegrist, 1996b).

Cross-country comparative studies show that lower level occupational positions are associated with higher levels of stress. The first study analyzed data from 11 European countries using three indicators of occupational position (status, class, skill level) and found a social

gradient in stress levels (Wahrendorf et al., 2013), replicated in a more recent investigation of 16 European countries using educational degrees as a socioeconomic position (SEP) indicator (Lunau et al., 2015). Low occupational reward, including job security, promotion prospects, pay, esteem, and appreciation, consistently follow the social gradient across various European countries and occupational sectors. Nonstandard employment and changes in workforce size also affect occupational reward. Analyzing reward from a life course perspective reveals that workers in lower socioeconomic positions are more likely to experience precarious, irregular, and cumulatively disadvantaged career trajectories, which are associated with lower occupational reward in their current positions (Hoven et al., 2020; Wahrendorf et al., 2019). Stressful psychosocial working conditions disproportionately affect individuals in lower socioeconomic positions, and low occupational reward is strongly linked to socially deprived conditions. Understanding the impact of these conditions on the health and well-being of employed populations is crucial.

However, not only factors of the labor market can act as psychosocial stressors at work. National policies also indirectly influence the fairness of social exchange relationships at work. In Germany, the 'Occupational Health and Safety Act' was passed in 2013 which considers psychosocial work stressors in the context of workplace risk assessment. Based on data collected from 17 European countries, the study of Lunau et al. (2017) reveals that countries with comprehensive psychosocial risk management (based on surveys in European businesses) have lower levels of psychosocial risks among employees. In fact, approximately $30\ \%$ of the variation in psychosocial risks between countries can be attributed to the level of psychosocial risk management practices within each country. Furthermore, the study examined the specific factors contributing to this explanation of psychosocial risk. The results demonstrate that three key indicators of psychosocial risk management are strongly associated with higher levels of stressful psychosocial work: (1) the presence of procedures to address work stress, (2) access to information regarding the relevant contact person in case of work-related psychosocial problems, and (3) the availability of health and safety services provided by psychologists. These findings suggest that instead of perceiving failed social exchange as a solely individual issue, interventions should focus on implementing specific structural measures at the company's respective national level (ibid.). Future intervention studies should consider this when implementing interventions and may consider the aforementioned measures.

## 9.7. Summary

It has been shown that measures on a structural level of the respective company itself can also address such experiences of disadvantage, for example, through the strict implementation of a risk assessment, as required by law. Overall, regarding the aim of this thesis, failed reciprocity in social exchange relationships, described by an imbalance of effort and reward, plays a relevant role in participatory, organizational health interventions for the explanation of health and health promotion of nurses. Work ability as a health-related perception of work demands is closely related to experiences of failed reciprocity. Furthermore, experiences of failed reciprocity in the form of a lack of reward negatively impact participants' collective efficacy beliefs in group-based participatory interventions.

Furthermore, ERI moderates the relationship between physical health and quality of leadership. The relevance of quality of leadership should, therefore, not be neglected in the context of interventions, also in relation to lack of reward in collective efficacy beliefs. In addition, for successful implementation of interventions, it should be considered that the measures address dimensions of ERI to reduce the perception of failed reciprocity and enhance workability.

Future intervention studies should consider the relevance of effort and reward for outcome and process evaluation and further investigate underlying mechanisms. Interventions should address all three levels of intervention defined by the ERI model. Distal factors that are relevant within the ERI model should also be considered in future intervention studies.

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# III. Original research articles

## Article 1

Montano D, Kuchenbaur M, Geissler H, Peter R. Working conditions of healthcare workers and clients' satisfaction with care: study protocol and baseline results of a cluster-randomised workplace intervention. BMC Public Health. 2020 Aug 25;20(1):1281. doi: 10.1186/s12889-020-09290-4

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RESEARCH ARTICLE Open Access

# Working conditions of healthcare workers and clients' satisfaction with care: study protocol and baseline results of a cluster-randomised workplace intervention

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## Abstract

**Background:** In the present investigation the study protocol and the results at baseline of a workplace intervention are reported. It is hypothesised that the reduction of the physical and psychosocial workload of healthcare workers increases 1 their self-assessed physical and mental work ability, and 2. clients' satisfaction with care.

**Methods:** Two-arm, cluster-randomised trial. Outcome data on workers and clients are collected in questionnaires at baseline, and two follow-ups between 2019 and 2021. Participants of the interventions are healthcare workers of 11 healthcare providers in Germany. At baseline, the intervention arm comprised 22 clusters ($n = 174$ workers); the control arm, 47 clusters ($n = 276$). The intervention consists of interviews and workshops, in which employees propose measures aiming to reduce the physical and psychosocial load, and strengthen resources at work. The primary outcome is the workers' physical and mental work ability. The secondary outcome is the clients' satisfaction with care.

**Results:** There was no evidence of substantial differences between trial arms at baseline concerning the outcomes. The design effect estimates for physical and mental work ability were 1.29 and 1.05, respectively. At the end of the trial, effect sizes of at least 0.30 and 0.27 at the 80% power and 5% significance levels can be attained.

**Conclusions:** The results suggest that the implementation of the study design has been satisfactory. The intervention is expected to provide evidence of relatively small to medium-size effects of the intervention activities on the work ability of healthcare workers and the clients' satisfaction with care.

**Trial registration:** Registration trial DRKS00021138 on the German Registry of Clinical Studies (DRKS), retrospectively registered on 25 March, 2020.

**Keywords:** Work ability, Work stress, Effort-reward imbalance, Organisational interventions, Psychosocial load

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## Background

In Europe, nurses' intention to give up their profession have been found to increase with the perception of higher job-related efforts, lower rewards at work, and stronger overcommitment to job demands [1]. Meta-analytic results have indicated that psychosocial factors involving high job demands and low job control are associated with prevalent and incident musculoskeletal symptoms involving neck, shoulder and back pain among hospital nurses and nursing aides [2]. In addition, the so-called effort-reward imbalance [3], i.e., the combination of high efforts and low rewards obtained from one's work, has been related to larger odds ratios for the experience of burnout symptoms among nurses, particularly in Germany where higher levels of effort-reward imbalance at work have been reported [4]. A previous systematic review by Duhoux et al. (2017) on non-randomised workplace interventions aiming to promote the mental health of primary care nurses, revealed that burnout and job stress could be reduced by different types of person-centred interventions including cognitive behavioural and mindfulness techniques [5]. However, despite that organisational interventions are regarded as more effective strategies of health risk prevention, only one organisational intervention met the inclusion criteria in that systematic review. Furthermore, no randomised controlled interventions were included, even though the risk of bias in complex intervention studies can substantially be reduced by randomisation [6]. In the large meta-analysis by Ruotsalainen et al. (2015) on workplace interventions aiming to reduce the perceived job stress in healthcare workers, it was found that two organisational interventions comparing an intensive participatory programme for the improvement of working conditions to no intervention were not effective at reducing the workers' job stress levels [7]. In addition, according to the results reported by Ruotsalainen et al. (2015) participative, randomised workplace interventions with a follow-up time of more than 12 months were also extremely scarce: From the 21 organisational interventions found by the authors, only the study of Uchiyama et al. (2013) was a cluster-randomised controlled participatory intervention [8], whose effects, however, were measured immediately after the six-month intervention and, consequently, are of limited validity. Thus, to the knowledge of the authors and the literature aforementioned, the effectiveness of participatory organisational interventions in healthcare workers at the workplace has been barely investigated within the methodological framework of randomised controlled trials.

Hence, the present study contributes to research by presenting the study protocol and baseline results of a cluster-randomised workplace intervention among healthcare workers: "HALTgeben" ("Higher Patient Satisfaction through Fair Working Conditions in Healthcare"). The study HALTgeben is an organisational workplace intervention with healthcare workers conducted in 11 German health services providers which aims to improve the work ability of workers, and, thereby, the satisfaction with care of hospital patients and individuals in elderly care (i.e. the clients). It is hypothesised that the reduction of physical and psychosocial workload of workers increases 1. their self-assessed physical and mental work ability, and 2. clients' satisfaction with care. These hypotheses pertain the individual level (the self-assessment of work ability and clients' satisfaction with care), and the cluster level as well (average workload of healthcare workers in the clusters). In the following sections, the study protocol and the results at baseline are reported according to the CONSORT Statement for cluster-randomised trials (see also the Supplementary material 2 for the corresponding check-list) [9].

## Methods

### Study design

The study is a two-arm, cluster-randomised intervention with healthcare workers conducted in seven general and three specialised hospitals, and an elderly care centre in Germany, whose wards constitute the clusters. A cluster-randomisation design was required due to the fact that it is an organisational workplace intervention whose main target are wards, and the randomisation of individuals is not feasible, since, in principle, the set of measures implemented in the intervention wards may affect all workers therein. A cluster-randomisation design helps reducing the risk of contamination effects between intervention and control wards and, at the same time, accounts for the correlations of individual measurements being observed within clusters. Outcome data are collected at baseline and at two follow-up times (T1 and T2) in surveys containing validated instruments. Data collection at baseline was performed before the interventions began in the intervention arm. The first follow-up measurement T1 in the single wards will be conducted successively no later than 6 weeks after the implementation of the first measures aiming to reduce the workload of healthcare workers. The final measurement T2 in all wards will be performed 12 months after the last T1 follow-up. Baseline data collection on workers and clients took place between June and December 2019. The follow-up measurements at T1 and T2 will take place in 2020 and 2021, respectively.

### Participants

#### *Healthcare workers*

Eligibility criteria of individuals to participate in the workers survey were being employed as a healthcare worker, being older than 18 years, and working most of the time in a single ward only. A census of the

healthcare workers population was attempted, and, therefore, all eligible workers were contacted by mail and invited to participate in the surveys. Each contacted employee received a booklet with a brief description of the study, data privacy policies for the surveys, a registration sheet, and the corresponding consent form. Participants were asked to provide written informed consent prior to study enrolment and supply the name of the ward they usually work in. The information on wards was validated with internal lists provided by the hospitals and the elderly care centre. Hence, the clusters were defined based on the information supplied by the workers, the internal organisational structure and the type of health services provided in the healthcare organisations. Eligibility criterion for clusters was the unambiguous assignment to patient or elderly care, respectively. The enrolment of healthcare workers ended on 31 October, 2019.

### *Clients*

The eligibility criteria for participation in the client surveys were being older than 18 years, being able to give informed consent to participation, being a responsive patient, and having sufficient skills in the German language. Clients (i.e. patients and individuals in elderly care in residencies and at home) are contacted in the participating healthcare organisations and receive a booklet with a brief description of the survey and data privacy information. All clients are required to consent explicitly to participate in the study before data collection. At baseline, T1 and T2 follow-up, approximately 600 patients and 150 individuals in elderly care will be surveyed successively in a cross-sectional design in the intervention and control wards. Participation in the client surveys is anonymous. The outcome data on clients are collected by interviewers either as self-administered questionnaires, or personal interviews upon clients' request. The interviewers receive a three-hour training in survey methodology provided by the authors from Ulm University before data collection.

## The intervention

The intervention addresses healthcare workers only, and is performed by four consultants whose areas of expertise cover work design and organisational development. Even though the interventions target whole wards in the intervention arm, data on workload and work ability is available only from employees consenting to participate in the worker surveys (i.e., not all workers in the single intervention wards take part in the surveys). The intervention is based on the concept of work ability [10, 11] and focuses on the balance between the individuals' capacities and their work demands [12]. The main target of the intervention is to achieve that workers accomplish their work duties, by considering how individual characteristics and capacities of the individual workers may be aligned with the definition of work and task processes throughout different life phases. The consultants' approach specifies four age-dependent main career stages: entrance, development and transition, continuity, and exit [12]. It is assumed that each career stage requires appropriate task and work specifications. The intervention is implemented in four phases (Fig. 1). Phase 1: The consultants ask the participating organisations for information regarding the organisation as a whole such as main work tasks of targeted employee groups, shift schedules, reports on occupational risk assessments, age structure, work council agreements, and work and operating instructions. Phase 2: Voluntary employees and supervisors in the intervention wards are interviewed and asked, among others, for their assessment on workplace aspects such as work organisation and processes, age-critical work tasks and workload, psychosocial demands, and degree of cooperation with colleagues of different ages. The interviews are conducted by means of a semi-structured questionnaire with an open-answer format.

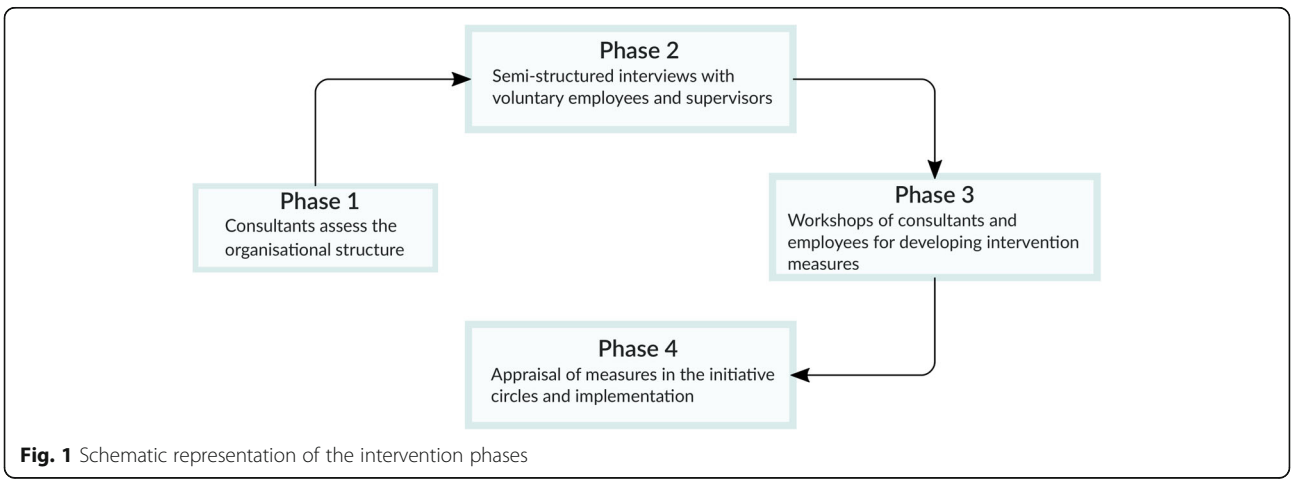


**Fig. 1** Schematic representation of the intervention phases

Phase 3: The consultants summarise the information provided by the organisations and the interviewed workers and supervisors according to the career stages mentioned above, and the five components of the work ability concept, namely, health capacity, occupational competence, attitudes and motivation, work organisation and management, and life-domain balance [11]. Afterwards, the interviewed workers are invited to participate in a workshop which lasts about 3 h. The consultants present and discuss the results in the workshop, and ask participants to propose measures aiming to enhance their work ability, improve their working conditions, and adapt the work environment to an ageing workforce. Phase 4: In each participating organisation so-called "initiatives circles" are implemented, in which the intervention measures proposed in the workshops are appraised regarding their feasibility. Members of the initiative circles may be managing board executives, managers of the healthcare departments, works council, and quality management or human resources representatives, who decide which measures can be implemented by the intervention wards themselves, and which require executive board approval. From a temporal perspective, the measures are categorised as short-term (e.g., ergonomic measures), medium-term (e.g., alignment of shift schedules according to workers' needs in the different life phases), and long-term (e.g., personnel recruitment, work processes between departments or occupations). From a content perspective, the measures are categorised as individual (e.g., exercise programmes), interpersonal (e.g., health-promoting leadership) and structural (e.g., modification of work processes) [13].

### Outcomes

The primary outcome is the self-assessed physical and mental work ability of employees. The secondary outcome is clients' satisfaction with care. In addition, since the intervention effects are assumed to be the consequence of the reduction of the psychosocial load at work, the effort-reward imbalance of workers will be considered in additional analyses in order to evaluate a potential mechanism by which the intervention may have an effect on work ability [3]. These analyses will rely on theoretical considerations of the work ability concept in which the health status of individual workers is believed to be a determining antecedent of the appraisal of one's own work ability [14]. All outcomes are measured by appropriate validated psychometric instruments freely available to scientists for research purposes. The questionnaires for healthcare workers comprise basic socio-demographic information, physical and psychosocial working conditions, work ability, and perceived physical and mental health (Table S1, Supplementary material 1). The questionnaires for clients include questions related to basic socio-demographic information, a set of scales measuring satisfaction with care, and a generic general health question (Tables S2 and S3, Supplementary material 1). Healthcare workers may fill out the questionnaires either online or as a paper-pencil version, and receive on request from the authors at Ulm University a short personalised report of their responses to the survey. The questionnaires for clients are available as a paper-pencil version only.

### Sample size

The sample size was calculated with the formulae provided by Dreyhaupt et al. (2017) [15], which considers the intraclass correlation coefficient (ICC), the average cluster size (m), the number of clusters (J), and the design effect (DE). The approach for calculating the sample size was to estimate the minimum effect attainable for a given sample and cluster size. An estimate of the ICC = 0.037 was taken from the intervention study of Mongini et al. (2012) conducted with a sample of Italian public servants [16]. Furthermore, it was assumed that a total of 50 clusters could be expected with an average cluster size of m = 5. Under these assumptions, a design effect DE = 1 + ICC*(m-1) = 1.33 was estimated, so that a total sample size of 500 participants was found to be required in order to detect a minimum effect of 0.30 at the 80% power and 5% significance levels. A total sample size of 500 individuals in a cluster-randomised design corresponds to an effective total sample size of 375 in a study with individual randomisation [15].

### Randomisation and implementation

Healthcare workers registered for the surveys by filling out a registration form addressed to Ulm University including personal information and the name of the ward they usually work in. Wards were then aggregated by the authors at Ulm University in clusters as described above, and stratified by hospital and elderly care ward. A list containing hospitals, clusters and number of registered participants was provided by the first author to the Institute of Epidemiology and Medical Biometry at Ulm University which generated the random allocation sequence and assigned clusters to interventions for the hospitals, independently from the authors at Ulm University and the consultants providing the intervention. The randomisation of clusters in the hospitals was performed in two steps with the statistical environment R. In the first step, the probability of being assigned to the intervention group was proportional to cluster size in each hospital, and a total of 10 clusters (i.e., one intervention cluster per hospital) were allocated to the intervention arm. Given the large variation of cluster sizes (Fig. 2), a sampling schedule proportional to size was required in the first step in order to ensure the generalisability of results by including the largest clusters in the hospitals, and to

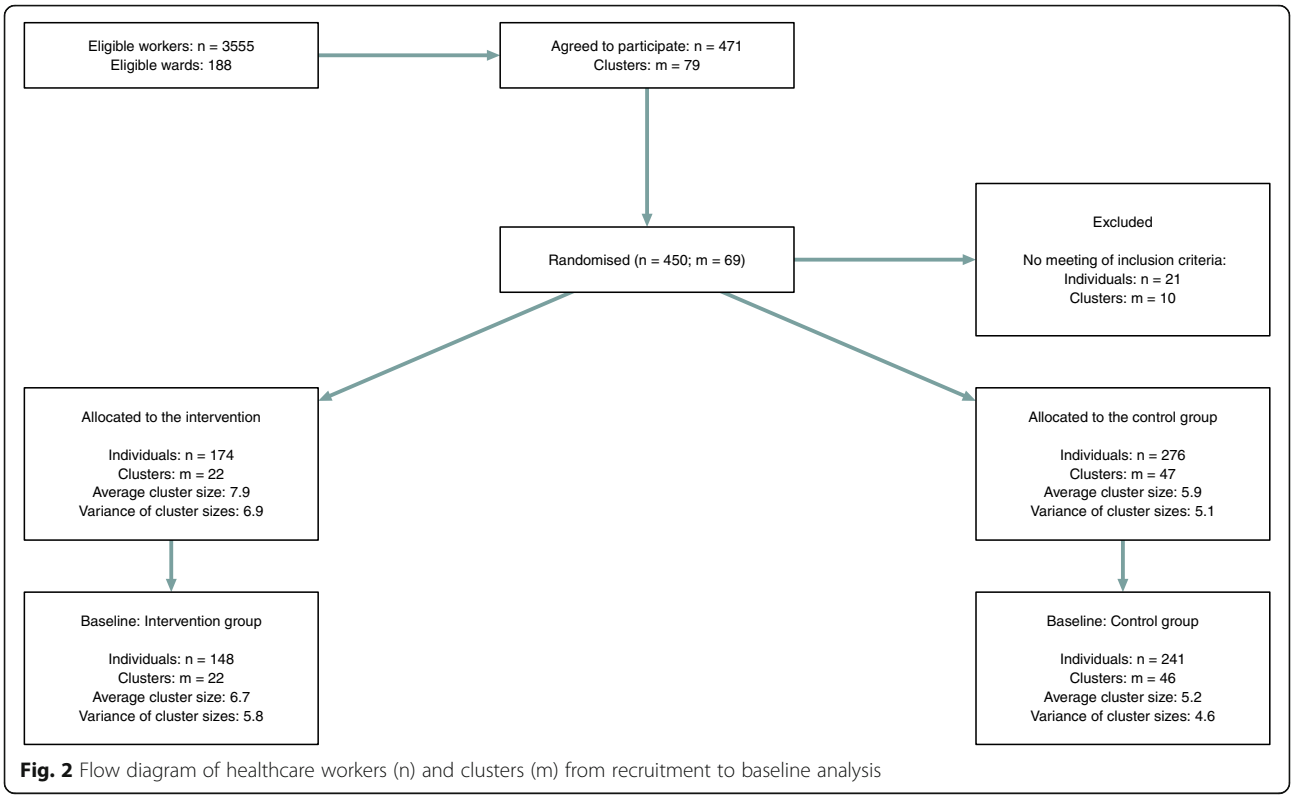


**Fig. 2** Flow diagram of healthcare workers (n) and clusters (m) from recruitment to baseline analysis

counter the expected power loss due to cluster and individual sample attrition in the subsequent follow-up measurements. In the second step, the random allocation proceeded by simple random sampling. However, given that only four consultants provide the intervention, a 1:1 allocation scheme for the remaining clusters was not feasible due to personnel limitations. Thus, the number of additional clusters in the intervention group in the hospitals was limited to 10. On the other hand, since the elderly care centre comprises only four wards, a simple random allocation in proportion 1:1 was performed in that case by the first author at Ulm University.

### Allocation concealment mechanism

Since the intervention targets whole wards, a complete blinding of participants and consultants in this study is not feasible. All healthcare workers in the intervention clusters, and probably also those in the control clusters, are aware of the allocation to the intervention and control arm, respectively. The consultants delivering the intervention know which clusters were allocated to the intervention arm, but are unaware of which clusters belong to the control arm in the hospitals. In order to reduce the risk of bias resulting from workers being aware to be either in the intervention or control arm, the baseline measurement was conducted before cluster randomisation and implementation of the interventions. In addition, the identification of clusters and the recruitment of participants took place prior to randomisation. Hence, neither the investigators at Ulm University nor the consultants had foreknowledge of the allocation results at the time of participant recruiting and cluster identification. Furthermore, the risk of contamination between intervention and control clusters in the hospitals and elderly care wards was reduced by the clustering of wards according to the specialisation area and the organisational structure of the participating organisations (e.g., separate building areas, different buildings or hospitals). Even though about 6% of participating workers reported working frequently in more than one ward, these workers actually shift between wards belonging to single clusters (e.g., wards within the cluster cardiology), so that there is practically no risk of contamination between the intervention and control arm by the time of random allocation. Survey data collection and analysis, and the process evaluation of the implementation are performed by the authors at Ulm University, independently from both the consultants responsible for delivering the interventions, and the participating healthcare providers. At the end of the study, voluntary wards in the control arm will be given the opportunity to implement the intervention.

### Statistical methods

The intervention effects on employees' work ability and clients' satisfaction with care will be estimated by means

of generalised linear mixed-effect (GLM) regression models [17] with two levels of nesting (clusters within healthcare organisations). The GLM models are appropriate for cluster-randomised trials, since they account for the clustered structure of data in a longitudinal design [18]. Missing data at the end of the study will be handled by imputation routines and sensitivity analyses [19, 20]. The mean scores of the psychometric scales will be computed with available items if no more than 30% of the items defining the scale are missing [21]. The ICC at baseline are estimated from the variance components of a random-intercept model with two levels of nesting (clusters within organisations). The baseline data are analysed with a series of GLM Bayesian regression models (also called hierarchical models) by means of Markov Chain algorithms as described elsewhere [22]. The goodness-of-fit was assessed by the Deviance Information Criterion (DIC). Lower values of the DIC statistic indicate a better model fit [23]. Given the role of the effort-reward imbalance as a potential mediating mechanism between the intervention and the main outcomes (see methods section), the associations between physical and mental work ability with effort-reward imbalance and overcommitment are investigated in three regression models with the workers dataset. Due to the fact that health in the work ability concept is thought to be a determining antecedent of one's own work ability perceptions, the fully adjusted models include two SF12-equivalent physical and mental health component scores [24]. In addition, for the patients dataset, the associations between the four indicators of satisfaction with care and the cluster-levels of psychosocial load of healthcare workers are estimated.

### Process evaluation

Process evaluations are highly valuable for understanding how discrepancies between the expected and observed outcomes may be related to context influences and implementation issues arising in complex interventions [6]. In the present study, the process evaluation of both implementation issues and context is based on the approach suggested by Linnan and Steckler [25], in which special consideration is put to the degree of receptivity and engagement of the workers to the intervention. Moreover, since previous research has shown that employees are more likely to participate in the activities of interventions, if they believe they can influence the intervention contents [26], group-related processes associated with the so-called collective self-efficacy [27] will also be taken into account. It is hypothesised that workers will be more engaged in the intervention, if they believe the group is capable of achieving the intervention goals (i.e., high collective self-efficacy). The evaluation will be based on information collected in questionnaires which were developed specifically for this intervention on the basis of previous literature reviews on process evaluation [28–30]. The questionnaires collect information on the assessment of the study participants on several process variables which have been identified in the pertinent literature as decisive for the attainment of intervention goals such as perceived support by management, conflict and collaboration in workshop groups, the expected personal benefit from the intervention, and the feasibility of intervention activities. Furthermore, according to those literature reviews, support from key stakeholders such as managers and supervisors may have a substantial impact on the intervention outcomes. Since most members of the initiatives circles described above have a leading position, specific questionnaires will be developed and deployed among the members of those circles. The adequacy of the newly developed questionnaires will be investigated in a pretest phase including cognitive Interviews and psychometric analyses.

## Results

The flow diagram of the number of individual participants and clusters from recruitment to baseline is provided in Fig. 2. Total response rates for workers and patients at baseline were about 13 and 53%, respectively. The socio-demographic characteristics of workers and clients, and the descriptive statistics of the main outcomes in both the intervention and control groups are reported in Tables 1 and 2. In the 11 health organisations participating in the intervention, total of 67 clusters were defined covering about 68% of all wards and including 24 health services areas such as anaesthesia, intensive care units, geriatrics, psychiatry, surgery, cardiology, paediatrics, urology, trauma surgery and emergency. Since most participating organisations are general hospitals providing a similar range of health services, the specific characteristics of clusters across organisations are rather balanced: It was found that for 57 clusters there were at least two clusters of a similar health service type in two different hospitals. For instance, for two intensive care clusters in two different hospitals, one intensive care cluster in one hospital was assigned to the intervention group, and the other cluster to the control group.

The estimates of the effective sample size ($N_{eff}$) and the ICC corresponding to the workers' physical and mental work ability were $N_{eff}$ = 345 and 423, and ICC = 0.05 and 0.01, respectively. The average cluster size in the workers sample was m = 6.53, which yields design effect estimates of DE = 1.29 and 1.05 for the main outcomes. Thus, it will be possible to estimate effect sizes of at least 0.30 and 0.27 at the 80% power and 5% significance levels, for the workers' physical and mental work ability, respectively. The estimates for the patients

**Table 1** Descriptive statistics of the healthcare workers datasets. Percent values for categorical variables, means and standard deviation in parentheses for continuous variables. Missing values per variable or scale

| Variable | Control | Intervention | Missing |
|---|---|---|---|
| **Healthcare workers (*n* = 386)** | | | |
| *Age* | | | 1 |
| Age 18–39 | 23.1 | 27.2 | |
| Age 40–54 | 52.5 | 46.3 | |
| Age 55 and older | 24.4 | 26.5 | |
| *Sex* | | | 5 |
| Male | 23.0 | 16.4 | |
| Female | 77.0 | 83.6 | |
| *Psychometric scales* | | | |
| Physical work ability | 3.15 (0.98) | 3.10 (0.91) | 4 |
| Mental work ability | 3.05 (0.94) | 3.04 (0.87) | 6 |
| Cognitive demands | 4.29 (0.46) | 4.32 (0.41) | 1 |
| Emotional demands | 3.81 (0.62) | 3.85 (0.57) | 2 |
| Low job control | 3.24 (0.65) | 3.14 (0.67) | 1 |
| Low predictability of work tasks | 2.87 (0.70) | 2.83 (0.73) | 1 |
| Role clarity | 2.16 (0.62) | 2.11 (0.70) | 2 |
| Role conflict | 3.12 (0.75) | 3.19 (0.77) | 1 |
| Low development chances | 2.30 (0.62) | 2.20 (0.63) | 1 |
| Efforts | 2.62 (0.69) | 2.58 (0.61) | 4 |
| Rewards | 1.84 (0.59) | 1.82 (0.53) | 23 |
| Effort-Reward Imbalance | 0.89 (0.40) | 0.85 (0.32) | 26 |
| Overcommitment | 2.59 (0.61) | 2.59 (0.56) | 2 |
| Supervisor behaviours | 3.16 (0.94) | 3.16 (0.95) | 3 |
| Unsupportive colleagues | 1.88 (0.67) | 1.94 (0.74) | 2 |
| Negative affect | 1.86 (0.64) | 1.77 (0.55) | 3 |

**Table 2** Descriptive statistics of the clients datasets. Percent values for categorical variables, means and standard deviation in parentheses for continuous variables. Missing values per variable or scale

| Variable | Control | Intervention | Missing |
|---|---|---|---|
| **Patients (*n* = 632)** | | | |
| *Age* | | | 4 |
| Age 18–49 | 22.9 | 17.5 | |
| Age 50–69 | 38.4 | 27.9 | |
| Age 70 and older | 38.7 | 54.6 | |
| *Sex* | | | 2 |
| Male | 47.1 | 50.0 | |
| Female | 52.9 | 50.0 | |
| Length of hospital stay (days) | 7.26 (7.84) | 6.90 (7.61) | 5 |
| *Psychometric scales* | | | |
| Trust | 3.71 (0.46) | 3.77 (0.38) | 4 |
| Support | 3.58 (0.57) | 3.68 (0.46) | 28 |
| Availability | 3.57 (0.51) | 3.64 (0.44) | 2 |
| Decisional control | 4.36 (0.56) | 4.35 (0.51) | 4 |
| **Individuals in elderly care (*n* = 150)** | | | |
| *Age* | | | 0 |
| Age 50–79 | 42.9 | 24.2 | |
| Age 80–89 | 50.0 | 49.5 | |
| Age 90 and older | 7.1 | 26.3 | |
| *Sex* | | | 0 |
| Male | 42.9 | 28.4 | |
| Female | 57.1 | 71.6 | |
| Years being in elderly care | 4.54 (3.74) | 3.96 (3.78) | 8 |
| *Psychometric scales* | | | |
| Trust | 3.29 (0.72) | 3.76 (0.43) | 7 |
| Support | 3.07 (0.82) | 3.60 (0.45) | 9 |
| Decisional control | 4.10 (0.89) | 4.47 (0.67) | 12 |
| Person-focused care | 3.19 (1.04) | 3.30 (1.20) | 10 |

dataset were $N_{eff}$ = 234, average ICC = 0.09, m = 19.5, and DE = 2.7. Since data of approximately 1200 additional patients will be collected cross-sectionally at the T1 and T2 follow-ups, a final effective sample size of approximately 234*3 = 702, and an average effect size of about 0.21 concerning patients satisfaction with care may be estimated at the 80% power and 5% significance levels. Finally, the power analysis for the elderly care dataset yielded an average ICC = 0.17, m = 30.7, and DE = 6.32, and an effective sample size of 24 per survey. Thus, for this dataset, at the end of the study, an effect size of about 0.66 can be estimated at the 80% power and 5% significance levels with a final effective sample size $N_{eff}$ = 74 of elderly care clients.

The results of the statistical analyses at baseline are reported in Tables 3 and 4 for workers and clients, respectively. There were no baseline differences between the intervention and control groups in the datasets regarding the main outcomes of the study. Among workers, it was found that higher scores of effort-reward imbalance and overcommitment are associated with lower scores of physical and mental work ability (Table 3). These associations seem to be partly mediated by the levels of negative affect, and physical and mental health perceptions, as indicated by the lower magnitude of the regression coefficients in the fully adjusted models (models 2 and 3 in Table 3, respectively). Among patients, the results did not suggest any association between the perceived effort-reward imbalance and overcommitment of healthcare workers at the cluster level and patients' satisfaction with care (Table 4).

## Discussion

The results at baseline suggest that the random allocation of clusters was satisfactory, since no substantial

**Table 3** Bayesian linear mixed models for the healthcare workers dataset (complete cases). Dependent variables: physical and mental work ability. Model 1 is adjusted for age, gender, and intensive care unit vs. other wards. Model 2 adjusts also for negative affect and organisation type (general hospital vs. getriatric and psychiatric hospitals). Model 3 is the fully adjusted model with physical and mental health component scores. Beta: regression coefficient, SE: standard error, and 95% CI: confidence intervals at the 95% level. ERI: effort-reward imbalance. DIC: deviance information criterion. $N = 346$

| Variable | Physical work ability | | | | | | Mental work ability | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 1 | | Model 2 | | Model 3 | |
| | Beta (SE) | 95% CI | Beta (SE) | 95% CI | Beta (SE) | 95% CI | Beta (SE) | 95% CI | Beta (SE) | 95% CI | Beta (SE) | 95% CI |
| Intercept | 4.79 (0.28) | [4.20; 5.29] | 5.00 (0.30) | [4.40; 5.59] | −0.18 (0.72) | [−1.61; 1.12] | 4.90 (0.27) | [4.38; 5.42] | 5.51 (0.28) | [4.90; 6.00] | 2.35 (0.68) | [1.07; 3.78] |
| Intervention (ref. control) | − 0.10 (0.11) | [− 0.32; 0.10] | − 0.09 (0.11) | [− 0.32; 0.12] | − 0.06 (0.11) | [− 0.28; 0.14] | − 0.05 (0.11) | [− 0.26; 0.16] | − 0.09 (0.11) | [− 0.31; 0.10] | − 0.04 (0.11) | [− 0.27; 0.15] |
| ERI | − 0.80 (0.17) | [−1.13; − 0.50] | − 0.59 (0.18) | [− 0.92; − 0.24] | − 0.24 (0.18) | [− 0.58; 0.09] | − 0.42 (0.17) | [− 0.74; − 0.10] | −0.12 (0.19) | [− 0.50; 0.24] | 0.01 (0.18) | [− 0.33; 0.37] |
| Overcommitment | −0.28 (0.11) | [− 0.50; − 0.09] | − 0.15 (0.12) | [− 0.38; 0.07] | − 0.04 (0.11) | [− 0.26; 0.18] | −0.56 (0.11) | [− 0.76; − 0.35] | −0.38 (0.11) | [− 0.62; − 0.19] | −0.25 (0.11) | [− 0.47; − 0.05] |
| DIC | 881 | | 874 | | 773 | | 863 | | 827 | | 793 | |
| Residual variance | 0.884 | | 0.874 | | 0.783 | | 0.866 | | 0.831 | | 0.800 | |

differences were observed between the intervention and control arm regarding the primary outcomes. According to the power analyses reported in the results section, one strength of the intervention is that effect sizes of at least 0.30 and 0.27 can be estimated at the 80% power and 5% significance levels, for physical and mental work ability of workers, respectively. Given that previous randomised organisational interventions have reported even larger effect sizes (standardised mean differences of − 1.23, − 0.55 and − 0.35) [7], the present study has

**Table 4** Bayesian linear mixed models for the clients datasets (complete cases). The models for the patients dataset are adjusted for age, gender, organisation type (general hospital vs. getriatric and psychiatric hospitals), general health, and education. The models for the elderly care dataset are adjusted for age, gender, general health, and education. Beta: regression coefficient, SE: standard error, and 95% CI: confidence intervals at the 95% level. DIC: deviance information criterion. Effort-reward imbalance (ERI) and overcommitment values correspond to the average of psychosocial load of workers at the cluster level

| **Patients ($n = 577$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Dependent variables:** | **Trust in carers** | | **Support by carers** | | **Availability of carers** | | **Decisional control over care** | |
| | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** |
| Intercept | 3.44 (0.65) | [2.16; 4.83] | 3.35 (0.69) | [2.16; 4.82] | 3.59 (0.64) | [2.42; 4.95] | 4.54 (0.68) | [3.35; 5.94] |
| Intervention (ref. control) | 0.03 (0.09) | [−0.16; 0.22] | 0.06 (0.09) | [−0.11; 0.23] | 0.04 (0.09) | [−0.16; 0.19] | − 0.01 (0.09) | [− 0.20; 0.16] |
| Physical work ability | 0.00 (0.07) | [−0.14; 0.13] | 0.01 (0.07) | [−0.13; 0.13] | 0.01 (0.07) | [−0.15; 0.13] | 0.02 (0.07) | [−0.13; 0.16] |
| Mental work ability | −0.00 (0.09) | [−0.17; 0.20] | 0.01 (0.10) | [−0.17; 0.20] | − 0.05 (0.09) | [− 0.23; 0.13] | −0.07 (0.10) | [− 0.26; 0.10] |
| ERI | 0.01 (0.25) | [−0.48; 0.47] | 0.11 (0.25) | [−0.34; 0.64] | 0.04 (0.26) | [−0.43; 0.56] | 0.32 (0.26) | [−0.26; 0.79] |
| Overcommitment | −0.01 (0.18) | [−0.36; 0.35] | − 0.11 (0.19) | [− 0.43; 0.28] | −0.09 (0.18) | [− 0.43; 0.29] | −0.22 (0.19) | [− 0.57; 0.17] |
| DIC | 902 | | 1044 | | 985 | | 1067 | |
| Residual variance | 0.550 | | 0.607 | | 0.583 | | 0.617 | |
| **Individuals in elderly care ($n = 96$)** | | | | | | | | |
| **Dependent variables:** | **Trust in carers** | | **Support by carers** | | **Decisional control over care** | | **Person-focused care** | |
| | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** | **Beta (SE)** | **95% CI** |
| Intercept | 2.96 (0.56) | [1.76; 3.97] | 3.09 (0.59) | [1.98; 4.30] | 4.19 (0.57) | [3.13; 5.31] | 3.69 (0.60) | [2.48; 4.83] |
| General health | 0.13 (0.12) | [−0.13; 0.35] | 0.08 (0.12) | [−0.15; 0.33] | −0.05 (0.12) | [−0.28; 0.19] | 0.05 (0.13) | [−0.20; 0.29] |
| Intervention (ref. control) | 0.38 (0.38) | [−0.31; 1.13] | 0.39 (0.39) | [−0.39; 1.12] | 0.22 (0.39) | [−0.50; 1.01] | 0.16 (0.38) | [−0.57; 0.86] |
| DIC | 212 | | 207 | | 221 | | 292 | |
| Residual variance | 0.899 | | 0.890 | | 0.908 | | 1.018 | |

sufficient power to detect substantial changes in the main outcomes.

A further strength of the study concerns the indication of an acceptable internal validity. Mainly successfully and widely tested questionnaires showing satisfying to good psychometric properties in previous studies [24, 31–35] and the present intervention as well (average Cronbach's alpha over all instruments 0.74, see Supplementary material 1), were applied to measure independent (e.g., workload) and dependent variables (e.g., work ability, clients' satisfaction). These measures allow comparisons of the present results with findings from other studies. Concerning the first study hypothesis, the results show associations of measures of effort-reward imbalance with work ability in workers. Hence, it is plausible to expect that a reduction of workload may result in increases of perceived work ability. In addition, the results indicate that these associations are mediated by perceived health (model 3 in Table 3). This mediation has been hypothesised previously, but has not been shown empirically so far [36]. However, the second hypothesis stating that the reduction of workload increases patients satisfaction did not receive support, since no cross-sectional associations were observed between workload and patients satisfaction (Table 4). Due to the low number of clusters in the elderly care centre, the second hypothesis cannot be investigated with the elderly care dataset.

Besides the consideration of the primary and secondary outcomes described in the methods section, by the end of the study further analyses may be performed in order to investigate how the intervention measures are related to specific working conditions. However, as far as the intervention measures are proposed by the workers themselves, the feasibility and scope of such additional statistical analyses will depend on the type and number of measures being actually implemented, the type of psychosocial factors potentially targeted by the interventions, and the extent to which specific intervention targets may be aggregated across clusters as individual, inter-personal and structural measures (see methods section). At the same time, the results obtained from the process evaluation will be used to inform the interpretation of results by focusing, among others, on the commitment of stakeholders, management and workers, and the potential role of collective self-efficacy expectations.

Because the overall participation rate in the intervention was rather low (13%), some basic socio-demographic statistics of the sample were compared to the corresponding values of the population of carers obtained from available hospital records. It was found that the participants are on average older than the whole population of hospital carers (46 vs. 43 years old), have a longer working experience (20 years vs. 14 years), and the proportion of males in the sample is slightly larger (17% vs. 22%). In view of these differences, the results of the present intervention should be interpreted with some caution regarding younger carers with less work experience.

Although the low participation rate at the individual level is an important limitation of the present study, several observations indicate that (1) participating workers are representative of the eligible healthcare workers, (2) the intervention measures are tailored to the workers' needs and, (3) consequently, they may be effective at improving the working conditions in the wards. First, the number of wards included in the intervention account for about 68% of all hospital wards. Hence, even though the participation rate at the individual level is low (13%), the ward coverage is high (68%). Second, as stated in the methods section, the intervention is performed at the ward level, and, hence, the number of workers taking part in, and receiving, the intervention is actually higher than the number of workers filling out the questionnaires. Thus, the intervention measures are expected to address the most relevant issues for all workers in the intervention wards. Finally, the intervention measures are proposed and prioritised by the workers themselves during the interviews and workshops. Consequently, it is likely that these measures are effective at improving the working conditions in the intervention wards.

## Conclusions

In conclusion, the results suggest that the implementation of the study design has been satisfactory so far. The intervention is expected to provide evidence of relatively small to medium-size effects of the intervention activities on the work ability of healthcare workers and on clients' satisfaction with care.

## Supplementary information

**Supplementary information** accompanies this paper at https://doi.org/10.1186/s12889-020-09290-4.

**Additional file 1: Supplementary file 1.** Additional descriptive statistics.

**Additional file 2: Supplementary file 2.** CONSORT check-list for cluster-randomised trials.

### Abbreviations

CI: Confidence interval; DE: Design effect; DIC: Deviance Information Criterion; ERI: Effort-reward imbalance; GLM: Generalised linear-mixed; ICC: Intraclass correlation coefficient; M: Average cluster size; $N_{eff}$: Effective sample size

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### Authors' contributions

DM prepared the introduction, methods, results, and discussion sections of the manuscript, and conducted the statistical analyses. MK edited the process evaluation description in the methods section. HG edited the

intervention description in the methods section. RP edited the introduction, methods, results, and discussion sections of the manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**
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**Ethics approval and consent to participate**
The present workplace intervention was approved by the Ethics Committee of Ulm University under the registration number 99/19. All participants provided written informed consent prior to study enrolment.

**Consent for publication**
Not applicable.

**Competing interests**
Diego Montano, Marco Kuchenbaur and Richard Peter at Ulm University declare no conflict of interest. Heinrich Geissler is consultant and declares no conflict of interest.

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# Assessing the Role of Collective Efficacy Beliefs During Participative Occupational Health Interventions

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**Background:** For group-based participatory interventions in the context of occupational health, no questionnaires exist to assess the participants' active engagement in the interventions. On the basis of the construct of collective efficacy beliefs, this study has developed a questionnaire with which the group-related efficacy beliefs can be assessed as a precondition for participants actively engaging in participative interventions.

**Methods:** Participants were drawn from a two-arm cluster-randomized intervention study to fill out the questionnaire. A Factor analysis and an initial psychometric calibration were performed. In a second step, the group-related properties of the questionnaire were validated using a Multilevel analysis.

**Results:** The factorial structure of the questionnaire is consistent with the theory of efficacy beliefs according to A. Bandura. Furthermore, the collective efficacy expectations of the interventions' participants are lowered in the absence of appreciation and support in the psychosocial environment of the worksite.

**Conclusions:** Assessing participant's quality of interventional activity in participatory interventions by collective efficacy can be valuable in understanding the amount of interventional activity. In addition, it is recommended to consider the influence of the worksite's psychosocial environment on collective efficacy beliefs when implementing participatory interventions.

**Clinical Trial Registration:** Registration trial DRKS00021138 on the German Registry of Clinical Studies (DRKS), retrospectively registered on 25 March, 2020.

**Keywords: participative intervention, collective efficacy beliefs, process evaluation, occupational health, questionnaire**

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## INTRODUCTION

An increased interest in process evaluations has emerged in recent years, particularly in complex occupational health intervention studies. This is due to the fact that process evaluations can be highly valuable for understanding how discrepancies between the expected and observed outcomes can be related to context and process of implementation of interventions (1). Whether or not a complex intervention is implemented effectively depends on the quality of intervention activities participants are committed to (2). In complex interventions such as participatory occupational health interventions, the quality of intervention activities is particularly important, as the intervention's success depends on the active engagement of the participants (3).

Human agency does not just begin with cognition over potential actions, but already with the expectancy of mastery of this certain action (4). The concept of so-called efficacy beliefs is a precursor of action and is influenced by individual and group-related factors that facilitate or potentially impede behavior. In case of strong efficacy beliefs, a person or group is convinced that his/her/their behavior will lead to a desired outcome. Efficacy beliefs can be assessed on an individual as well as on a collective level (5). Accordingly, as in participatory occupational health interventions, goal achievement oftentimes require the cooperation of all participants over a longer period of time, an interdependent effort by all participants is necessary for intervention activities (6). The benefit of assessing efficacy expectations in comparison to concrete behavior to indicate active engagement, is that efficacy expectations can be an indicator of the willingness to tackle difficult situations and, above all, to maintain their mastery (4).

In the context of occupational health interventions, Nielsen et al. (7) showed that employees' appraisals of the intervention influenced the relationship between participation and intervention outcomes. There is also empirical evidence that shared participation influences the belief in a so-called occupational self-efficacy (8). Research in the field of implementing standardized workplace interventions indicate that the intervention's activity of participants varies with the belief in individual mastery, i.e., self-efficacy (9). Furthermore, a general and comprehensive attempt to theoretically underpin implementation processes has already been made by May (10). He emphasizes the relevance of social cognitive psychology (i.e., efficacy beliefs) for understanding shared commitment to interventional activity. In addition, efficacy beliefs are part of the "Consolidated Framework for Implementation Research," a guideline for evaluating complex interventions (11).

Occupational health interventions represent a special category of interventions, as they require a shared commitment due to interdependence structures within organizations (12). The need for shared commitment becomes even clearer when looking at intervention programs that require high engagement from the participants themselves. In participatory interventions based on "Health circles" (3), participants are expected to be involved in the development as well as the implementation of intervention measures. Intervention measures originate from the suggestions of employees themselves, the process of implementation highly depends on participation, i.e., how engaged participants are in the intervention processes. To assess shared commitment as a precondition of collective action, a content-adequate questionnaire should be able to reflect the interactive, coordinative and synergistic dynamics of the task demands (6).

The literature for related questionnaires reveals that many of them are based on the conceptual basis of "Organizational readiness for change" (13), a related construct of efficacy beliefs (see **Table 1**).

Some questionnaires reflected the shared commitment toward implementation but not toward the beforehand necessary collective generation of intervention measures. The types of interventions addressed by the questionnaires are predominantly standardized programs, rather than interventions developed in a group based participatory process. A review of instruments and outcomes of implementing psychosocial interventions in worksites shows that there are only a few measures available in the context of occupational health interventions (18). All questionnaires found for the purpose of this paper (8, 14–17) are not sufficiently content-adequate for assessing shared commitment in participative, occupational health interventions within group settings like "Health circles" (see **Table 1**). Although

**TABLE 1 |** Content adequacy of existing questionnaires for assessing engagement in participative intervention.

| Questionnaire | Type of intervention | Participants | Attitude object | Conceptual basis | Adequacy |
|---|---|---|---|---|---|
| Jung et al. (14)* | Not specified | Participants from various branches | Health promotion capacity | Health promotion willingness | (+) Level of analysis: Organizations |
| | | | | | (–) Reflection of intervention generation process |
| Mueller et al. (15)* | Non-participative | Participants from various branches | Organizational change | Organizational readiness for change | (–) Type of intervention |
| | | | | | (–) Reflection of intervention generation process |
| | | | | | (+) Level of analysis: Organizations and Individuals |
| Randall et al. (16) | non-participative | Healthcare workers | Organizational-level stress management interventions | Appraisals of intervention process | (–) Type of intervention |
| | | | | | (–) Reflection of intervention generation process |
| | | | | | (+) Consideration of leadership support |
| Shea et al. (17) | not specified | Students | Organizational change | Organizational readiness for change | (–) Reflection of intervention generation process |
| | | | | | (–) Participants |
| | | | | | (+) Level of analysis: Organizations and Individuals |

**Listed in Review of Kien et al., "–" not a content-adequate aspect, "+" content-adequate aspect.*

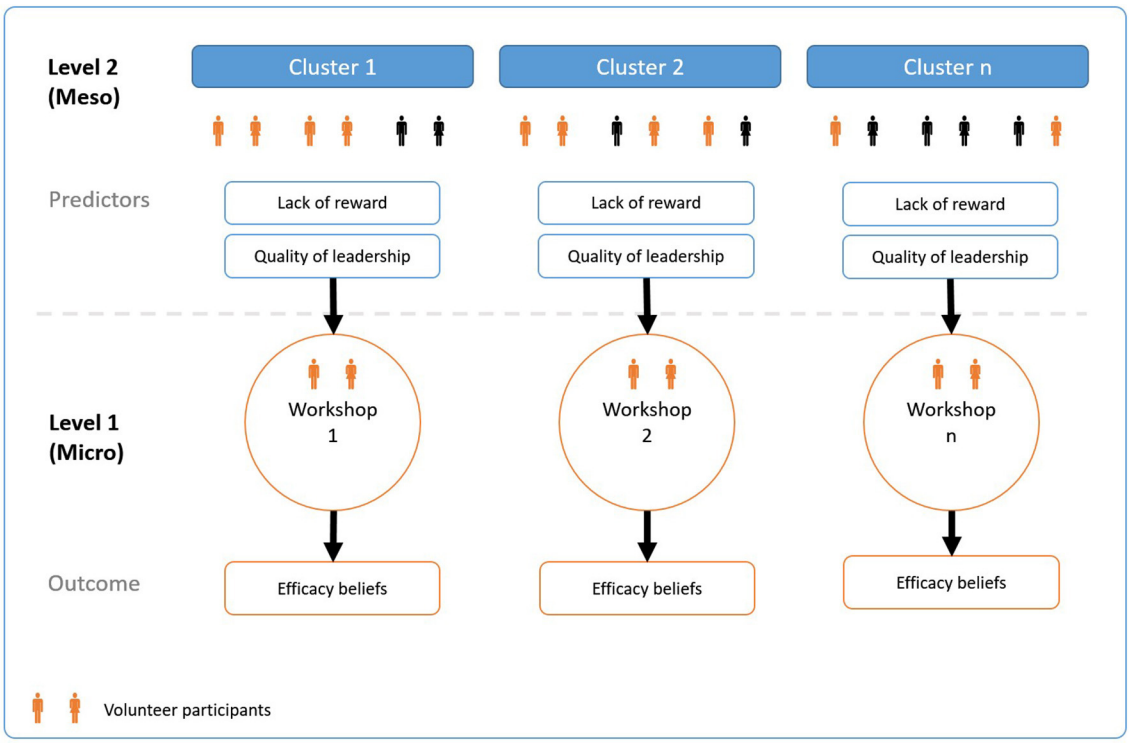


**FIGURE 1 |** Classification graph for the multilevel context of participative intervention groups.

the need for efficacy beliefs is taken into account by some questionnaires, they do not consider the dynamics mentioned by Bandura that characterize the shared cognition of a group that develops and implements interventions together. None of the found questionnaires for process evaluation addresses the role of collective efficacy beliefs to assess participants' shared beliefs of mastering the development and implementation of occupational health interventions exactly.

This paper presents a pilot study of the development and exploratory validation of a questionnaire which assesses participant's overall quality of interventional activity within a group-based, participative intervention program. We assume that collective efficacy expectation moderates the quality of the intervention activity of the participants (19–21). Furthermore, we assume that collective efficacy beliefs are influenced by the psychosocial environment of the workplace. In this study we define collective efficacy beliefs in group-based, participative interventions as the collectively shared beliefs in mastery of developing and implementing intervention measures for occupational health.

## METHODS

The study was conducted within the context of the main study, a prospective, two-arm, cluster-randomized intervention study with healthcare workers in seven general and three specialized hospitals, and an elderly care center in Germany, whose wards constitute the clusters (22). At baseline, the intervention arm comprised 22 clusters ($N = 174$ workers). The methodical procedure of this paper is a two-stage process. First, a questionnaire was developed to assess the efficacy beliefs of the interventions participants. In a second step, this questionnaire outcome was validated using a multilevel analysis (MLA) on the basis of validated instruments: the "Effort-Reward-Imbalance questionnaire" and "Copenhagen Psychosocial questionnaire" from the main study's baseline survey. All analysis was conducted with the statistical environment R.

**TABLE 2 |** Participants characteristics ($N = 125$).

| Variable | | Frequency | Percent | Missing | Percent | Mean | SD |
|---|---|---|---|---|---|---|---|
| Age | | 114 | 91.2 | 11 | 8.8 | 43.4 | 11.8 |
| Sex | Female | 92 | 73.6 | 8 | 6.4 | | |
| | Male | 25 | 20.0 | | | | |

## Conceptual Framework

Defining collective efficacy beliefs as a function of interventional activity entails the following: the perceived difficulty of intervention activity, the strength in terms of duration of the intervention and context-relevant factors of support. We assume that the psychosocial environment of the worksite can be characterized as the context-relevant source of impediments and

facilitators of efficacy beliefs (23). In general, the psychosocial environment of the worksite is determined by control and support (24). The model of "Effort-Reward-Imbalance" describes this environment as characterized by interpersonal relationships that are based on mutual cooperative investments, i.e., efforts and the expectancy of an equalization of these efforts, i.e., rewards. Positive self-experiences on the basis of a balance between efforts and rewards can be conducive to strong efficacy beliefs and therefore activity change (25). Likewise, support structures at the interpersonal level can also be conducive to activity initiation: Although Albert Bandura does not directly suggest the influence of leadership support on collective efficacy beliefs at worksite, some studies do show this relationship. Chen and Bliese (26) for example showed that leadership climate is a predictor of collective efficacy in particular. Furthermore, the role of supervisor-employee relationship has been identified as influential in determining employees' willingness to participate in health promotion programs (27). Employees often have no direct influence on social conditions and institutional practices in settings like the workplace. Leadership support represent a form of proxy control for collective agency in this context (6) and is therefore given special consideration.

By assessing participants' collective efficacy beliefs in the context of participative interventions at work, we can draw conclusions about the observed variation to theoretical assumptions about the questionnaire. By using the nested data structure of the pilot study, it is possible to check the questionnaire's accuracy in reflecting the collective efficacy beliefs of the participants in the intervention. Based on the theoretical considerations above, differences in the participants' efficacy beliefs should vary with the quality of the psychosocial environment at worksite. **Figure 1** illustrates the nested data structure and relationship between the two levels in the pilot study. The participatory interventions are organized in groups at level 1 and are derived from the organizational units of level 2, e.g., wards or departments. At this second level factors of control and support, as mentioned above, frame the psychosocial environment of interventions participants.

## Participants and Procedure

The participative intervention consisted of interviews and workshops, in which employees participated to develop measures of organizational change, reducing the physical and psychosocial burden. Participants ($N = 125$) were drawn from the intervention arm ($N = 174$) of the cluster-randomized intervention study (see **Table 2**). They voluntarily engaged in the workshops for developing intervention measures. All workshops ($N = 24$) were assigned to the corresponding clusters ($n_j = 22$), i.e., organizational units in which the interventions are implemented. Sometimes more than one workshop was conducted per cluster. At the end of the workshop, participants were asked to fill out the questionnaire. Demographic data was collected by assessing age and gender.

## Item Generation

For the construction of efficacy scales, an accurate analysis of the domain of functioning (developing and implementing interventions) is necessary (28). Detailed knowledge of the activities within the domain is useful to define factors over which people can exercise control in participative, occupational health interventions. For this purpose, a literature review was conducted in order to first characterize the domain of interventional activities by participants and second to gradate these task demands of the domain against facilitators and impediments of successful performance. Based on existing reviews (29–32), different clusters of the domain of functioning were identified. We considered all factors which are in potential control of those, engaging in a participative intervention. Out of 173 factors identified in the reviews, 63 factors were regarded as relevant for participative interventional activities (**Table 3**).

**TABLE 3 |** Functional aspects of developing and implementing interventions.

| Dimension | References | Item |
|---|---|---|
| Challenge of implementation | (29–31) | "I feel that our ward is capable to implement the interventions successfully" |
| Coherence | (29–31) | "The workshop's goal was present permanently" |
| Enjoyment and motivation | (29–31) | "I am looking forward to the changes in our organizations the interventions will bring" |
| Influence | (30, 31) | "All participants had the opportunity to voice their concerns" |
| Interaction | (29–31) | "Our ward actively engaged in the workshop" |
| Perception of the program | (29–31) | "Our team was distant toward the workshop (–)" |
| Support | (29–31) | "We'll receive support from our supervisor for implementing our interventions" |

Second, items were developed on the basis of this summary and reviewed by a team of independent scientists (MK, RP). All items were scored on a five-point Likert scale from "not at all" to "to a very high extent." In the end 26 items resulted and were clustered within seven content domains, reflecting the domain of functioning of developing and implementing participative interventions. Third, items were reviewed by a group of participants ($N = 8$) as part of a comprehension probing (33). Volunteers among workshops' participants were asked to discuss issues of understanding, practicability and purpose of the questionnaire on the basis of a semi-structured interview. Participants were interviewed after they filled out the questionnaire, discussions were transcribed verbatim.

## Exploratory Factor Analysis and Psychometric Properties

Raw data of item responses showed only few missing values per item. Missing values were excluded case-wise. Descriptive data analysis for item distributions, mean and standard deviation, minimum, maximum, and skewness was conducted for analyzing ceiling and floor effects. As ceiling effects were detected, it was decided to use a factor extraction- and estimation method where normal distribution is not a precondition. Furthermore, because anchors of the scales are not necessarily equidistant, it

was decided to treat items at an ordinal level of analysis. In cases of non-normal distribution of ordinal data, a suggested method of estimation is the method of unweighted least squares (ULS). ULS yields to more accurate estimations of factor loadings than maximum likelihood in this case (34). Factorability was assessed by calculating individual and overall Kaiser–Meyer–Olkin-Measure (KMO), items with an individual KMO below .70 were excluded (35). The factors were extracted out of a polychoric correlation matrix. For determining the number of factors to be extracted, a parallel analysis (36) was conducted on the basis of this matrix. Scale appropriateness was inspected with classical test theory. The scale score of the two subscales was obtained by calculating the scale mean score. Internal consistency was assessed by calculating Cronbach's alpha.

## Multilevel Analysis for Construct Validation

By using MLA, we aim to reveal the multilevel character of our questionnaire by decomposing its variance components that are determined by factors of the higher-level social structure of the worksite and of individual factors of the participants.

### Composition Model

As the questionnaire is based on the underlying assumption about a collective level of efficacy beliefs, we consider them as an attribute of the workshop group, shared by the respective members (5). Therefore, the composition model postulated here assumes an additive approach (37) to describe the interaction between the level of workshops (level 1) and its comprising clusters (level 2), representing worksite factors of the nested system. For construct validation, we considered level 2 predictors that are both theoretically plausible and, in addition, allow reliable aggregation on the basis of the intraclass correlation coefficient ICC (2). As a rule of thumb, all aggregated values above .50 were considered (38). Based on the criterion of reliable aggregation, the following subscales from the instruments used in the baseline survey were used as level 2 predictors.

### Effort-Reward-Imbalance

A predictor of beneficial efficacy beliefs in the context of a positive psychosocial work environment is the Effort-Reward-Imbalance (25). We considered "*Lack of reward*" ($\alpha = 0.79$) as a plausible predictor since it takes into account the components esteem and job promotion in relation to supervisors and colleagues (39). Items were measured on a four-point scale.

### Copenhagen Psychosocial Questionnaire

Another indicator to assess the characteristic of the participants' psychosocial environment is the "*Lack in quality of leadership*" ($\alpha = 0.92$) at cluster level. Quality of Leadership is part of the Copenhagen Psychosocial Questionnaire (40). Research has shown that supervisor behavior can influence the perception of collective efficacy (41). Items were measured on a four-point scale.

The corresponding values for MLA are computed by aggregation, using the arithmetic mean of individual level data that represent the cluster at the baseline survey of the main study. The reliability of the aggregation was checked by calculating the intraclass correlation coefficient ICC (2, 42) and the correlation between individual and aggregated values.

### Data Analysis Strategy

We used Multilevel analysis (MLA) with Maximum Likelihood estimation to predict level 1 efficacy beliefs by level 2 aggregated scale means with a random intercept model. Since there is no level 1 predictor, the level 2 predictor can only be added to the level 2 intercept equation. First of all, we formulated an unconditional model that decomposes the variance in efficacy into individual variation between workshop participants and group variation between the workshops.

$$\begin{aligned} \textit{Level 1: } Y_{ij} &= \beta_{0j} + r_{ij} \\ \textit{Level 2: } \beta_{0j} &= \gamma_{00} + u_{ij} \\ Y_{ij} &= \gamma_{00} + u_{ij} + r_{ij} \end{aligned}$$

The workshop-related, individual efficacy expectations $Y_{ij}$ are modeled as a function of the grand mean of the inter-workshop efficacy expectations and a residual term. Since the rules of composition suggest a random intercept model due to the lack of level 1 predictors, the level 2 predictors on cluster-level can be added to the intercept equation only. Accordingly, the equation for level 2 cluster-mean centered predictors indicate the following structure:

$$\begin{aligned} \textit{Level 2: } \beta_{0j} &= \gamma_{00} + \gamma_{01} ERI_{reward\_mean} \\ &+ \gamma_{02} \textit{Quality of Leadership}_{mean} + u_{ij} + r_{ij} \end{aligned}$$

Based on existing research, we expect that efficacy expectations will be influenced by cluster-related characteristics such as assessed by shared perceptions of a "Lack of reward" $\gamma_{01}$ in the clusters. Substituting the equation above, the following can be derived for level 1:

$$\begin{aligned} \textit{Level 1: } Y_{ij} &= \gamma_{00} + \gamma_{01} ERI_{reward_{mean}} \\ &+ \gamma_{02} \textit{Quality of Leadership}_{mean} + u_{ij} + r_{ij} \end{aligned}$$

# RESULTS

## Exploratory Factor Analysis and Scale Development

Of the 145 participants in the workshops we received 140 questionnaires (response rate = 0.97). A total of 125 participants in 24 workshops, represented by 22 clusters were used for exploratory factor analysis. Of these, 25 (18.6%) were male, 92 (75.0%) female. 6.4% did not indicate their gender. Fifteen cases were excluded due to missing values. Except for one item, all others were negatively skewed (see **Table 4**).

### Comprehension Probing

The participants rated the items as comprehensible and were able to anticipate the purpose of the questionnaire. The understanding of one item was classified as inconsistent because the wording was contradictory. For this reason, it was excluded from further analysis and development.

**TABLE 4 |** Item descriptive statistics and scale reliability analysis ($N = 125$).

| | Mean | SD | Skew | Kurtosis | Item difficulty | Item discrimination | α if deleted |
|---|---|---|---|---|---|---|---|
| **Workshop-related efficacy expectation**[a] | | | | | | | |
| Our team was distant toward the workshop (–) | 4.22 | 0.99 | −1.47 | 2.05 | 0.84 | 0.62 | 0.74 |
| The participants didn't made much proposals during the workshop (–) | 4.46 | 0.92 | −2.11 | 4.44 | 0.89 | 0.58 | 0.75 |
| All participants had the opportunity to voice their concerns | 4.76 | 0.51 | −2.45 | 7.24 | 0.95 | 0.47 | 0.77 |
| I was able to bring my demands to the discussion in the workshop | 4.53 | 0.56 | −0.94 | 1.5 | 0.91 | 0.54 | 0.76 |
| I expect my work situation worsening throughout the intervention (–) | 4.27 | 0.96 | −1.62 | 2.5 | 0.85 | 0.46 | 0.76 |
| The interventions reflect my personal demands | 4.26 | 0.62 | −0.64 | 1.48 | 0.85 | 0.48 | 0.76 |
| All participants supported the decisions made | 4.54 | 0.56 | −0.7 | −0.55 | 0.91 | 0.43 | 0.77 |
| Our ward actively engaged in the workshop | 4.43 | 0.81 | −2.17 | 6.46 | 0.89 | 0.32 | 0.78 |
| In the Workshop there were discussions about useful interventions for my team | 4.45 | 0.64 | −1.67 | 6.46 | 0.89 | 0.38 | 0.77 |
| I am sceptical toward the interventions (–) | 3.49 | 1.07 | −0.48 | −0.51 | 0.7 | 0.33 | 0.79 |
| The workshop's goal was present all the time | 4.46 | 0.67 | −1.33 | 2.55 | 0.89 | 0.37 | 0.77 |
| **Prospective outcome expectations**[b] | | | | | | | |
| The presented interventions can be implemented in future | 4.38 | 0.58 | −1.29 | 7.51 | 0.88 | 0.46 | 0.72 |
| I regard the interventions as useful for my ward | 3.98 | 0.77 | −0.94 | 1.23 | 0.8 | 0.54 | 0.7 |
| I expect that the interventions will reduce my problems at work | 3.99 | 0.77 | −0.86 | 1.02 | 0.8 | 0.49 | 0.71 |
| I feel that our ward is capable to implement the interventions successfully | 4.02 | 0.63 | −0.97 | 2.76 | 0.8 | 0.41 | 0.72 |
| Our ward is able to cope potential challenges of the implementation | 3.82 | 0.81 | −1.05 | 1.37 | 0.76 | 0.41 | 0.72 |
| We'll receive support from our supervisor for implementing our interventions | 3.99 | 0.9 | −0.85 | 0.17 | 0.8 | 0.38 | 0.73 |
| I am convinced that we in our department are giving each other sufficient support for the implementation | 4.05 | 0.71 | −1.05 | 2.18 | 0.81 | 0.4 | 0.72 |
| I am looking forward to the changes in our organizations the interventions will bring | 3.85 | 0.81 | −0.81 | 0.97 | 0.77 | 0.44 | 0.72 |
| I am positively affected by the interventions within my workspace | 4.16 | 0.71 | −0.92 | 1.62 | 0.83 | 0.3 | 0.74 |

[a]*Mean inter-item-correlation = 0.267. Cronbach's α = 0.783,* [b]*Mean inter-item-correlation = 0.249. Cronbach's α = 0.74; SD, Standard deviation.*

### Factor Analysis and Reliability

An initial, unweighted least square estimation of the factors (ULS) on the basis of a polychoric correlation matrix was conducted on the 26 items with orthogonal rotation (varimax). The overall KMO verified a "middling" sampling adequacy for the analysis (KMO = 0.73), five items were excluded due to mediocre individual KMO. Bartlett's test of sphericity, $\chi^2_{(25)} = 287.5214$, $p < 0.001$, indicated that correlations between items were sufficiently large. Parallel Analysis (36) suggested a two-factor-solution, concerning eigenvalues over Kaiser's criterion of 1. This two factors were retained in the final analysis. **Table 5** shows the factor loadings after rotation. Factor loadings of 0.40 and above were considered as salient for further scale development (43). Of the 26 items, 20 loaded saliently on one of the two factors. Items that cluster on the same factors suggest that factor 1 represents efficacy expectations toward the intervention in workshops, whereas factor 2 items represent prospective outcome expectations of the intervention and its implementation. This factor structure is consistent with the dichotomous scheme of efficacy beliefs, which distinguishes between efficacy expectations and outcome expectations (4). Both factors showed reasonable standardized internal consistency, factor 1 (α = 0.78) and factor 2 (α = 0.75), and acceptable values for the mean-inter-item-correlation within the range (0.15–0.50) (44), see **Table 4**.

### Model Fit

Since the scree plot was not completely unambiguous, a model with three factors was also calculated. The computed ANOVA test for the two-factor solution showed a better fit compared to the three-factor solution, considering the Bayesian information criterion (BIC). Furthermore, the decision was made in favor of a two-factor solution, since the interpretation of the meaning of factors is better according the fit with Bandura's concept of efficacy beliefs. The two-factor-model accounted for 39% of the total variance. A root mean squared residual (RMSR) of 0.08 was computed, which means that the average of overall residuals was just sufficient to meet the acceptable limit (45).

## Multilevel Analysis

For both "Lack of reward" [$ICC\ (2) = 0.54$] and "Quality of leadership" [$ICC\ (2) = 0.84$], a reliable aggregation of the scale means at level 2 was feasible. Age and gender of the participants were considered during modeling process. Both variables had no influence on the presented models. Both scales of the developed questionnaire were tested on the ability for a multilevel analysis, but only scale 1 could provide significant results: Analysis of the unconditional model 1 showed a 35% [$ICC\ (1) = 0.35$] variation in efficacy expectations due to the grouping in clusters (see **Table 6**). This confirms the assumption of a hierarchical data structure. A grand mean of workshop-related efficacy expectations ($\gamma_{00} = 4.32$, $p <$

**TABLE 5 |** Two-factor solution for the 20 Likert-scaled items ($N = 125$) after varimax rotation.

| | Factor 1 | Factor 2 | Communality | Uniqueness |
|---|---|---|---|---|
| **Workshop-related efficacy expectation** | | | | |
| Our team was distant toward the workshop (–) | 0.736 | | 0.552 | 0.448 |
| The participants didn't made much proposals during the workshop (–) | 0.726 | | 0.544 | 0.456 |
| All participants had the opportunity to voice their concerns | 0.682 | | 0.510 | 0.490 |
| I was able to bring my demands to the discussion in the workshop | 0.644 | | 0.505 | 0.495 |
| I expect my work situation worsening throughout the intervention (–) | 0.615 | | 0.390 | 0.610 |
| The interventions reflect my personal demands | 0.527 | | 0.542 | 0.458 |
| All participants supported the decisions made | 0.514 | | 0.491 | 0.509 |
| Our ward actively engaged in the workshop | 0.459 | | 0.278 | 0.722 |
| In the Workshop there were discussions about useful interventions for my team | 0.454 | | 0.393 | 0.607 |
| I am skeptical toward the interventions (–) | 0.448 | | 0.229 | 0.771 |
| The workshop's goal was present all the time | 0.419 | | 0.266 | 0.734 |
| **Prospective outcome expectation** | | | | |
| The presented interventions can be implemented in future | | 0.707 | 0.551 | 0.449 |
| I regard the interventions as useful for my ward | | 0.706 | 0.550 | 0.450 |
| I expect that the interventions will reduce my problems at work | | 0.703 | 0.503 | 0.497 |
| I feel that our ward is capable to implement the interventions successfully | | 0.558 | 0.338 | 0.662 |
| Our ward is able to cope potential challenges of the implementation | | 0.526 | 0.299 | 0.701 |
| We'll receive support from our supervisor for implementing our interventions | | 0.503 | 0.276 | 0.724 |
| I am convinced that we in our department are giving each other sufficient support for the implementation | | 0.497 | 0.280 | 0.720 |
| I am looking forward to the changes in our organizations the interventions will bring | | 0.448 | 0.277 | 0.723 |
| I am positively affected by the interventions within my workspace | | 0.394 | 0.239 | 0.761 |
| Total variance after rotation in % | 20 | 19 | | |

**TABLE 6 |** Variance component models for efficacy expectations in workshops ($N = 125$).

| | | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|---|
| **Predictors** | **Parameter** | **Estimates** | **CI** | ***p*** | **Estimates** | **CI** | ***p*** |
| (Intercept) | $\gamma_{00}$ | 4.32 | 4.18–4.45 | <0.001 | 5.6 | 4.61 to 6.59 | <0.001 |
| Lack of reward | $\gamma_{01}$ | | | | −0.39 | −0.69 to −0.09 | 0.01 |
| **Random effects** | | | | | | | |
| Individual level variance $\sigma^2$ | | | 0.13 | | | 0.13 | |
| Group level variance $\tau_{00}$ | | | $0.07_{\text{cluster}}$ | | | $0.05_{\text{cluster}}$ | |
| ICC | | | 0.35 | | | 0.26 | |
| *N* | | | $22_{\text{cluster}}$ | | | $22_{\text{cluster}}$ | |
| Observations | | | 125 | | | 125 | |
| Marginal $R^2$/Conditional $R^2$ | | | 0.000/0.346 | | | 0.097/0.336 | |
| **Model fit** | | | | | | | |
| AIC | | | | 136.21 | | | 132.37 |
| BIC | | | | 144.69 | | | 143.69 |
| Log likelihood | | | | −68.3 | | | −62.19 |

*Model 2: $\Delta\chi^2 = -6.1$ ($p < 0.001$); CI, confidence intervals at the 95% level; ICC, Intraclass correlation coefficient.*

0.01) was observed. A stepwise selection algorithm based on the Akaike information criterion (AIC) was performed to determine the best model fit (46). Model 2, which showed the best model fit, accounts for the "Lack of reward" at cluster level. Workshop-related efficacy beliefs (level 1) are reduced by a of "Lack of reward" in the level 2 clusters ($\gamma_{01} = -0.39$, $p = 0.01$). Thus, 29% of the variance between the level 1 workshops' efficacy beliefs could be explained by the shared perception of "Lack of reward" at level 2 (cluster).

## Correlational Analysis

The aim of the questionnaire is to explain the quality of the interventional activity in participative interventions. In

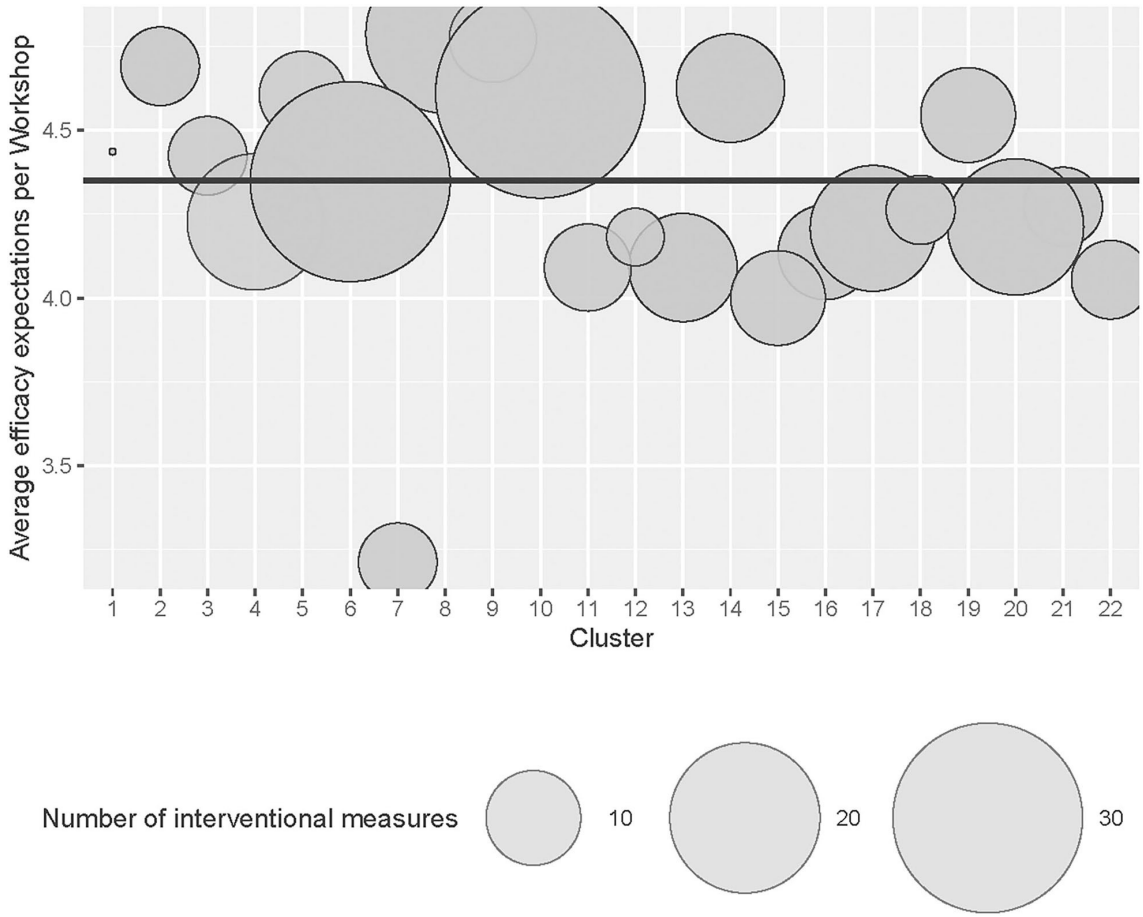


**FIGURE 2 |** Number of interventional measures across workshop groups (Cluster).

order to verify this by correlational analysis, the number of interventional measures that emerged from each workshop was correlated with the aggregated scale score of the 22 workshop groups' efficacy expectation. It is assumed that a higher overall efficacy expectancy of a workshop group is associated with a larger number of interventional measures (see also **Figure 2**). The analysis showed a moderately strong correlation between the number of interventional measures and workshop-related efficacy expectation ($\eta = 0.57$, $p < 0.001$).

## DISCUSSION

This pilot study intended to develop and evaluate a new questionnaire, assessing interventional action of participants of a participative, occupational health intervention. This was achieved by drawing on Bandura's concept of collective efficacy beliefs as a precondition of activity initiation.

The analysis showed that active engagement in participatory interventions is influenced by the psychosocial environment of the participants' worksite. The results of this study suggest that collective efficacy beliefs, as a precursor of interventional action, can map the resources for participant's contribution to the implementation of interventions (10). This is crucial for the understanding of how organizational change in participatory worksite interventions can be realized.

Although previous studies repeatedly emphasize the role of efficacy beliefs for the success of interventions, the actual interactive context in which occupational health interventions are developed has been neglected, since the used intervention measures are predominantly standardized (17, 18). The distinctive challenge of participatory interventions lies in group-based processes of collaboration, support, and potential conflict in the joint identification of intervention measures. These processes are crucial for the collective development of shared efficacy beliefs. To our knowledge, the participatory context of intervention groups in occupational health interventions has not been highlighted by any other study yet.

### Interpretation: Strengths and Mechanisms

The questionnaire's factorial structure is consistent with the dichotomous scheme of efficacy beliefs, which distinguishes between efficacy expectations and outcome expectations (4).

According to Bandura's theory, Factor 2 can be interpreted as outcome expectation, since the items are mainly used to assess the future feasibility of the interventions. Factor 1, on the other hand, represents the extent of efficacy expectations of the group reflecting the overall workshop situation with regard to facilitators and impediments.

A particular strength of the study is that the multilevel analysis could confirm the collective-level properties of the questionnaire: The workshop participants' shared perception of the efficacy expectation of the interventions was found to be determined by the psychosocial environment of the clusters, i.e., organizational units, which comprise the workshop. Workshop-related efficacy beliefs are reduced by a "Lack of reward" in the higher-level clusters ($\gamma_{01} = -0.39$, $p < 0.01$). Therefore, psychosocial environments that are characterized by the absence of mutual appreciation and respect can reduce a group's members opportunity to experience themselves in a positive way (25), which can affect the efficacy expectations toward an intervention. This finding is also in line with theoretical considerations on the internal and external locus of control (47), according to which expectancy of control is characterized by one's own behavior as well as by situational and structural factors.

Furthermore, the correlation analysis shows that the external criterion of the number of interventional measures is related to the workshop-related efficacy expectation. We can assume that the number of generated interventional measures is influenced by the shared efficacy expectation of the workshop's participants. We were able to show that collective efficacy beliefs can be an indicator for the outcome of participatory interventions.

The results of the study are further supported by the findings of a comprehension probing with semi-standardized questions to eight participants of the workshops. They rated the questionnaire as comprehensible and appropriate to assess the context. The overall objective of the questionnaire was clear to the participants.

## Limitations

Participants were recruited voluntarily. Higher motivated employees presumably agreed to participate in the workshops more often. In quite a few cases, however, the participants' direct supervisors were also present, which may have resulted in some positive skew in responding to the item on supervisor support. Mixed hierarchies within intervention groups may impede the ability to address problems they might have with the supervisor (3). Within comprehension probing, this was also pointed out by one interviewee.

The manifest aggregation of individual data by computing arithmetic means is associated with some problems (48). Latent aggregation methods realized by Multilevel structural equation modeling is a valuable alternative but not applicable in our context due to small number of cases within groups. Nevertheless, to ensure the reliability of the aggregation of the cluster-related individual data, correlations were calculated between both the aggregated scale means at the cluster level and the individual scale means.

Maximum likelihood estimation in the context of multilevel analyses requires adequate sample sizes. The number of groups is more relevant than the number of individuals in this context. In our pilot study though, the number of groups is limited to 22. A simulation study has shown that with a group number of 30, the accuracy of the regression coefficients is achieved. However, the standard error of the level 2 variance is underestimated by about 15% (49). Interpretation of the results should be made with caution.

Caution should be taken too, when interpreting the internal consistency. According to Cortina (50), the coefficient alpha is highly dependent on the number of items. For the interpretation of internal consistency, the average inter-item correlation should therefore also be taken into account. Since the attitude object of scale 1 and 2 represents the intervention measures in general, the value for the inter-item correlation for this broad construct can be regarded as acceptable according to Clark and Watson (44).

For further, more detailed psychometric assessment, future analyses with this questionnaire should include confirmatory tests with larger sample sizes.

## Practical Relevance

Since the questionnaire can be used to assess collectively-shared efficacy beliefs, its use is recommended for participatory interventions at worksite, where aspects of appreciation and support can influence the initiation of intervention activity (3).

# CONCLUSION

The questionnaire provides a contribution to the question of whether or not an initial interventional activity of the participants of a participatory occupational health intervention has taken place by referring to the construct of collective efficacy beliefs. Moreover, the role of the worksite's psychosocial environment in influencing participants' efficacy expectations was demonstrated. The questionnaire is appropriate for the group-based assessment of efficacy beliefs for participatory interventions in the field of occupational health.

# DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

# ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethikkommission der Universität Ulm. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MK prepared and edited the introduction, methods, results, and discussion sections of the manuscript, and conducted the statistical analyses. RP reviewed the introduction, methods, results, and discussion sections of the manuscript. All authors read and approved the final manuscript.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Article 3

Kuchenbaur M, Peter R. Quality of leadership and self-rated health: the moderating role of 'Effort-Reward Imbalance': a longitudinal perspective. Int Arch Occup Environ Health. 2023 Apr;96(3):473-482. doi: 10.1007/s00420-022-01941-w.

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ORIGINAL ARTICLE

# Quality of leadership and self-rated health: the moderating role of 'Effort–Reward Imbalance': a longitudinal perspective

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## Abstract

**Objective** Longitudinal studies on the influence of leadership behavior on employees' self-rated health are scarce. As a result, potential mechanisms describing the impact of leadership behavior on health have not been adequately investigated so far. The present study accounts for the influence of leadership behavior on self-rated health within the framework of the Effort–Reward Imbalance model.

**Methods** The study was conducted on the basis of a cohort which comprised a random sample of healthcare workers from ten different hospitals and one elderly nursing home in Germany. A 2-level repeated measurement model with random intercept and slopes was modeled, since it was aimed to account for individual as well as intra-individual variation of subjective health across three time points over 36 months. Beside 'Effort–Reward Imbalance' and 'Quality of Leadership' from the Copenhagen Psychosocial Questionnaire, physical and mental health was assessed by German version of the SF12 multipurpose short-form measure of health status.

**Results** 'Effort–Reward Imbalance' and a lack in 'Quality of Leadership' negatively affect self-rated physical health. No effect was found for self-rated mental health. Effort–Reward Imbalance significantly moderates the effect of 'Quality of Leadership' on self-rated physical health.

**Conclusion** The findings, and the interaction effects in particular, suggest that leadership behavior moderated by factors such as appreciation and support, influences self-rated physical health. The study therefore provides an interpretation for leadership behavior and its influence on employees' self-rated health within the 'Effort–Reward Imbalance' model.

**Keywords** Quality of Leadership · Self-rated health · Effort–Reward Imbalance · Moderation · Linear mixed model of change · Longitudinal study

## Background

Recent meta-analyses have shown that psychosocial hazards at worksite have an impact on both the physical, e.g., coronary heart diseases (Taouk et al. 2020) and mental health, e.g., psychological distress and depression (van der Molen et al. 2020) of employees.

Leadership in its function to influence other people (Haslam et al. 2015) plays an important role in the framework of psychosocial hazards at worksite. It is considered as relevant for the wellbeing and health of employees (Montano et al. 2017; Skakon et al. 2010; Harms et al. 2017; Cummings et al. 2018; Kuoppala et al. 2008). Due to heterogeneity in existing literature and a variety of conceptualizations of leadership are associated with health (Nyberg et al. 2005), leadership behavior has only been defined as the quality of the next higher managers' leadership in different contexts and domains (Burr et al. 2019). By taking this generic approach, the intention is to account for as many facets of leadership behavior as possible.

There is a large body of literature on the role of leadership behavior and style as a psychosocial risk factor for employees' health and well-being, but longitudinal studies in particular are scarce (Montano et al. 2017). Moreover, the conceptualizations of leadership as a construct are also very heterogeneous. Research has focused on particular traits of leaders as well as behaviors and styles (Nyberg et al. 2005). Characteristics of leaders manifests and affects a variety of

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levels of social interaction (Montano 2016). As a consequence, depending on the conception, leadership characteristics have protective but also risk-amplifying effects on the development of physical and mental health. So-called destructive leadership behaviors (Schyns and Hansbrough 2010), which manifest in abusive and manipulative behaviors of leaders, are linked to lower mental health and well-being (Schyns and Schilling 2013). On the other hand, there are leadership styles, e.g., 'transformational leadership style' that seem to have a protective effect on the mental health and well-being of employees (Nielsen et al. 2008). In terms of physical health, this protective effect is reported in relation to ischemic heart disease (Nyberg et al. 2009). Positive leadership behavior has also been reported to have protective effects on mental health (Madsen et al. 2014). What mechanisms may be associated with these findings?

Social support as a stress buffer can operate as active coping assistance through encouragement as well as through information and advice (Madsen et al. 2014). By providing employees with a sense of mattering, self-esteem, and belonging (Thoits 2011), supervisors may influence physiological arousal and distress by their function as similar others within interactions. Polite and considerate treatment by supervisors may be functional for the experience of control and support. In situations in which individuals have no direct control, for example within hierarchical structures in the workplace, positive self-experience can be made in the form of opportunities to exert influence, appreciation and support. In many aspects of life, individuals do not have direct control over mechanisms of change and therefore have to rely on proxy control to change their lives for the better. A leadership behavior which accounts for considerate and polite treatment in the context of the workplace can be regarded as a form of proxy control (Bandura 2012). Supervisors impact a psychosocial environment in which their employees can have positive self-experience and which consequently may influence their health and well-being.

Positive self-experiences triggered by positively connoted reciprocal relationships are contingent on a psychosocial environment in which experiences of belonging, acting, contributing and giving feedback, can be made by employees. The model of 'Effort–Reward Imbalance' (ERI) (Siegrist 1996a) describes these factors and their relationships in detail. Within the model of ERI, psychosocial environments are characterized by interpersonal relationships, based on a norm mutual cooperative investments, i.e., efforts and the expectancy of a response to these efforts, i.e. rewards. If this norm of reciprocity is violated on a frequent basis, the imbalance of effort and reward leads to a state of emotional distress and a negative self-experience (e.g., low self-esteem). In contrast, a psychosocial environment characterized by appreciation and support promotes positive self-experience and the feeling of control and successful agency which can be conducive to health and well-being (Siegrist and Marmot 2004). The absence of an experience of control and support can lead to adverse health effects: an imbalance of mutual commitment between employer and employee can influence strong negative emotions. This experience tends to sustained autonomic and neuroendocrine activation which links experiences of imbalanced social reciprocity to development of physical and mental diseases (Siegrist 2005), for example coronary heart disease (Dragano et al. 2017).

Studies that have previously examined the relationship between the mental and physical health of employees and the behavior of their supervisors suffer from a certain number of limitations. Beside a lack in longitudinal perspectives mentioned above, confounding variables like age, gender and workplace contexts, as well as an investigation of underlying mechanisms of the relationship between leadership and health were not considered (Montano et al. 2017; Harms et al. 2017). Some studies only surveyed the general state of health and not its physical and mental health components (Schmidt et al. 2018). Accordingly, a more established and detailed health status instrument was used for this study. The SF12 multipurpose short-form measure of health status offers a way to measure eight commonly represented concepts of health (Nübling et al. 2006) By locating leadership within the etiologically sound framework of the model of 'Effort–Reward Imbalance', an interpretation of the impact of leadership on physical and mental health will be provided. This study in particular investigates changes in both components of general health (physical and mental) over three time-points by focusing on the perceptions of quality of leadership in a cohort of healthcare workers. This study therefore rather focusses on specific manifestations of leadership behavior relevant to physical and psychological subjective health. Our first hypothesis is:

H1: Effort–Reward Imbalance (a) and lack in Quality of leadership (b) have a negative impact on self-rated physical and mental health over time.

Based on the mechanisms of control and support described above, we hypothesize that leadership quality interacts with ERI. As leadership quality is strongly associated with dimensions of social support and recognition by supervisors (ibid.) it is expected to moderate the impact of ERI on health. Thus, taking into account the mechanisms of ERI, an explanation has yet to be offered as to why leadership behavior influences subjective health (Montano et al. 2017):

H2: Effort–Reward Imbalance amplifies the experience of lack in quality of leadership and therefore the impact on self-rated physical and mental health.

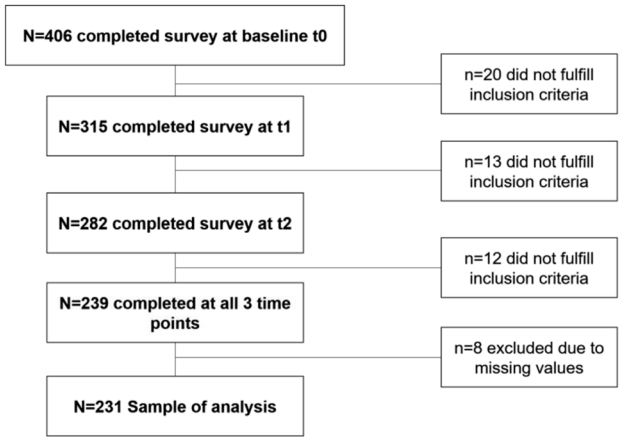


**Fig. 1** Flowchart of the 'HALTgeben' cohort ($N = 231$)

The aim of this study is to investigate the influence of leadership quality on subjective physical and mental health. An interaction effect with the ERI model is suspected.

## Methods

To test these assumptions, a cohort of healthcare workers was used. The cohort was surveyed at three time points over a period of 36 months to assess psychosocial hazards at worksite as well as subjective physical and mental health. All effects are modeled by using two-level 'Linear Mixed Effect Models' (Hoffman 2015) under the assumption of conditional growth.

### Study design and sample

The study sample was taken from the HALT geben study, which aims to reduce healthcare worker's physical and psychosocial workload (Montano et al. 2020). The study was designed as cluster-randomized intervention study. It surveyed participants in the cohort with a questionnaire at three time points with an interval of 12 months. The cohort comprised a random sample of healthcare workers from ten different hospitals and one elderly nursing home. Between healthcare workers in the hospitals and those in the elderly nursing home no significant differences in the perception of psychosocial hazards have been found. Eligible participants in the survey, were required to be health care workers, older than 18 years of age, and predominantly work in a single ward. All employees of the eleven facilities were contacted via mail. Participants were asked to give written consent before enrolling them. According to variation in cluster sizes, a sampling schedule proportional to the cluster sizes was established. The allocation was carried out by simple random sampling (Montano et al. 2020). In total, 450 participants who agreed to participate, received a questionnaire at baseline t1 after randomization.

The sample of analysis consisted only of all cohort participants who responded to the survey at all three time points ($N = 231$) (see Fig. 1). Of these individuals, 19.2% were under age 40, 52.7% were under age 55, and 28% were over age 55 at third time point.84.9 % of the participants were female (see Table 1).

### Measures

Sociodemographic information was collected at all three time points (age, gender), and in some cases only at the first time point (education). Because scales of COPSOQ and ERI cover a wide range of dimensions of psychosocial hazards at worksite (Formazin et al. 2014), they were used in combination. Information on all COPSOQ scales used, can be found in the supplementary file of the study protocol (Montano et al. 2020). A correlation matrix of the scales used in this study can be found as online supplementary information (Supplementary Table S1).

### Effort–Reward Imbalance

All three German version subscales were used to assess 'Effort–Reward Imbalance' (Siegrist et al. 2004; Siegrist 1996b) ('Effort': $\alpha = 0.80$, original: $\alpha = 0.79$; 'Reward': $\alpha = 0.79$, original: $\alpha = 0.85$; 'Overcommitment':$\alpha = 0.57$, orginal: $\alpha = 0.79$). Subscales were measured at all three time points. All items were assessed on a 4-point Likert-scale ranging from 1 = "not at all" to 4 = "very strong". For better interpretability in the statistical analysis, the subscale 'Reward' was negatively poled afterwards.

### Copenhagen psychosocial questionnaire

The German Version of COPSOQ (Nübling et al. 2005) was used to assess information at all three time points. 'Quality of Leadership' ($\alpha = 0.92$, original: $\alpha = 0.89$) was assessed on a five-point Likert-scale ranging from 1 = "to a very high extent" to 5 = "to a very low extent". For better interpretability in the statistical analysis, the scale was negatively poled so that higher values represent lower leadership quality and vice versa. 'Work-privacy conflict' ($\alpha = 0.83$, original: $\alpha = 0.90$) was assessed on a five-point Likert-scale ranging from 1 = "to a very high extent" to 5 = "to a very low extent".

**Table 1** Cohort characteristics: statistical comparisons over three time points ($N = 231$)

| Min/max | | *t*0 | | *t*1 | | *t*2 | | Test[2] |
|---|---|---|---|---|---|---|---|---|
| | | Mean/percent | SD | Mean/percent | SD | Mean/percent | SD | |
| Age | | | | | | | | $\chi^2 = 0.876$ |
| Up to under 40 | | 20.40% | | 18.50% | | 20.80% | | |
| Up to under 55 | | 53.90% | | 52.80% | | 53.70% | | |
| Over 55 | | 25.70% | | 28.70% | | 25.50% | | |
| Gender | | | | | | | | $\chi^2 = 0.042$ |
| Male | | 15% | | 14.80% | | 14.40% | | |
| Female | | 85% | | 85.20% | | 85.60% | | |
| Education | | | | | | | | $\chi^2 = 0.087$ |
| Higher education (12 years) | | 27.20% | | 25.90% | | 26.40% | | |
| Lower education (under 12 years) | | 72.80% | | 74.10% | | 73.60% | | |
| Physical health (SF12) | 14.1/63.4 | 43.92 | 8.865 | 42.806 | 8.949 | 42.065 | 9.198 | $F = 2.26$ |
| Mental health (SF12) | 20.8/70.3 | 45.767 | 10.796 | 45.361 | 9.814 | 45.104 | 10.45 | $F = 0.219$ |
| Quality of leadership[1] | 1/5 | 3.209 | 0.914 | 3.132 | 0.946 | 3.089 | 0.948 | $F = 0.883$ |
| Effort–Reward Imbalance | 0.3/3.4 | 0.905 | 0.35 | 0.857 | 0.383 | 0.844 | 0.372 | $F = 1.608$ |
| ERI Overcommitment | ¼ | 2.6 | 0.608 | 2.622 | 0.587 | 2.632 | 0.622 | $F = 0.147$ |
| Work-privacy conflict | 1/4 | 2.704 | 0.862 | 2.604 | 0.842 | 2.65 | 0.873 | $F = 0.711$ |
| Worksite characteristics | | | | | | | | $\chi^2 = 0.121$ |
| Intensive care/surgery | | 38.80% | | 40.30% | | 40.30% | | |
| Other | | 61.20% | | 59.70% | | 59.70% | | |

*SD* standard deviation

Statistical significance: $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

[1]Negatively poled: higher values indicate lower quality

[2]Statistical Tests: $\chi^2$-Test and ANOVA (analysis of variance)

## Physical and mental health (SF12)

Physical and mental health were assessed by using the German version of the SF12 multipurpose short-form measure of health status (Nübling et al. 2006; Ware et al. 1995) which is also used for the 'Socio-Economic Panel' (SOEP). The two subscales 'Physical component summary' ($\alpha = 0.82$, original:$\alpha = 0.89$) and 'Mental component summary' ($\alpha = 0.80$, original:$\alpha = 0.76$) were assessed on a five-point Likert-scale ranging from 1 = "always" to 5 = "never" or ranging from 1 = "strong" to 3 = "not at all", respectively. Four single items were transformed directly to the range of 0–100, for subscales with two items a mean value of the both was calculated (arithmetic mean) (ibid.).

## Statistical analyses

Two-level linear mixed effect models (LMM) with repeated measurement were estimated according to the longitudinal study design and continuous outcome variables. In comparison to repeated measurement ANOVA (Analysis of variance), one advantage is the estimation of effects with missing measurement points. Moreover, individually varying trajectories can be estimated for each subject (West 2014). A restricted maximum likelihood (REML) method was used to estimate the variance components because this method provides more accurate estimates than Maximum likelihood (MLE) estimation (Chen and Chen 2021; Hoffman 2015). All model estimates were adjusted for the confounding effects of age, gender, education, and workplace characteristic. For the analysis, a general structure for the random effect variance–covariance matrix, that allows the random intercepts and slopes to have different variances and to be correlated (Gałecki and Burzykowski 2013), is assumed. As this study is interested in observing a trend rather than a contrast, we formulated the following LMM as a multilevel model, where level 1 predicts variation within subjects over time and level 2 predicts variation between subjects. The specification of the null model will be as follows:

Level 1:

$$y_{ti} = \beta_{0i} + \beta_{1i}(\text{Time}_{ti}) + e_{ti}$$

Level 2:

$$\beta_{0i} = \gamma_{00} + U_{0i}$$

$$\beta_{1i} = \gamma_{10} + U_{1i}$$

Composite:

$$y_{ti} = (\gamma_{00} + U_{0i}) + (\gamma_{10} + U_{1i})(\text{Time}_{ti}) + e_{ti}.$$

Interaction effects were statistically examined by applying 'Simple slope analysis' (Aiken and West 2010) and graphically by generating 'Johnson-Neyman plots' (Bauer and Curran 2005). The scales of the psychometric instruments were calculated only if more than 70% of the items defining the scale were answered by the respondent. This assumption states that the missing 30% of the items are missing at random (MAR). The proportions of missing items are rounded up to the nearest integer (Schafer and Graham 2002). Calculations were performed with the statistical environment R, using the package "lme4" (Bates et al. 2015) to perform LMM analyses. Models' performances were evaluated with the package "performance" (Lüdecke et al. 2021).

## Results

### Descriptive results

For physical health, a comparison of means (ANOVA) showed a significant change over the three time points of measurement. The result showed that modeling a trend in change of physical health over time could be promising. Other characteristics remained stable over time. The mental health of the participants did not change significantly over time, which is why the modeling did not yield any results.

### Main effects

While checking the unconditional models (null model), time was found to be at least a fixed effect. The likelihood ratio test, comparing the null models showed no difference between the null model for a fixed or a fixed and random time effect, however, between both and the empty means random intercept model there was found a significant difference ($\chi^2 = 15.44[p < .001]$). Nevertheless, a consideration of time as random effect seems plausible, since self-reported health can change differently over time. The aim of the hypothesized model is to reflect both the average and the individual change in self-reported health over time. In the null model with fixed and random time effect, the $ICC = 0.68$ indicates that 32% of the variation lies within individual variance over time.

A conditional growth LMM (estimated using REML) was fitted to predict physical and mental health. The model included time and subject as random effects. Since modeling mental health in the context of ERI and leadership behavior has not shown results, only modeling physical health is considered below.

The total explanatory power of the model explaining physical health is substantial (conditional $R^2 = 0.67$) and the part related to the fixed effects alone (marginal $R^2$) is of 0.14. The model's intercept is at $67.36(95\%CI[60.25, 74.48], p < 0.001)$. For the main effects of interest, 'Effort–Reward Imbalance' $-7.56(95\%CI[-14, -1.11], p = 0.022)$ and lack in 'Quality of Leadership' $-2.11(95\%CI[-3.64, -0.59], p = 0.007)$ a negative significant effect can be reported. The interaction term of both, ERI and 'Quality of Leadership' is also significant and positive $1.55(95\%CI[0.01, 3.9], p = 0.049)$ (see Table 2). Model 2 was adjusted for several effects, with age $-1.17(95\%CI[-1.66, -0.67], p < .001)$, education $-2.18(95\%CI[-4.31, -0.05], p = 0.045)$, and work-family conflict $-1.67(95\%CI[-2.49, -0.84], p < 0.001)$ which significantly contributing in explaining the decline in physical health over time. To test which model fits the data better, a Likelihood ratio test was performed which showed that the adjusted model (Model 2) fits the data significantly better ($\chi^2 = 42.08[p < 0.001]$) than the unadjusted model (Model 1). Due to this result, Model 2 was adopted.

### Moderation effects

A test on 'Simple slopes' (Aiken and West 2010) at specific levels of the predictors (− 1 SD, mean, + 1 SD) was performed to examine moderation effects of lack of 'Quality of Leadership' on the relationship of ERI on physical health. This approach tests for the effect of the moderator variable at different, designated levels on the outcome variable while holding the predictor variable constant (Bauer and Curran 2005).

The negative impact of ERI on physical health was significantly stronger in cases where employees reported a better quality of leadership (− 1 SD below average): $-4.21(p = 0.017)$ (see Table 3, Fig. 2). Consequently, the worse the 'Quality of Leadership' behavior becomes, the less ERI impacts physical health negatively. Or in other words, if subjects are already experiencing an 'Effort–Reward Imbalance', leadership quality is no longer significantly affecting the relationship of ERI and physical health.

## Discussion

The current study used a LMM to model a linear trend in physical and mental health as a function of ERI and 'Quality of Leadership'. Results from the multilevel model have shown that ERI and lack in 'Quality of Leadership' have an adverse effect on physical health. For mental health these assumptions were not statistically significant. Furthermore,

**Table 2** Linear mixed effect models for dependent variable physical health ($N = 231$)

| Fixed effects | Model 0 | | | Model 1 | | | Model 2[2] | | |
|---|---|---|---|---|---|---|---|---|---|
| | Estimates | CI | *p* | Estimates | CI | *p* | Estimates | CI | *p* |
| (Intercept) | 43.74 | 42.61–44.88 | **< 0.001** | 55.03 | 49.27–60.79 | **< 0.001** | 67.36 | 60.25 – 74.48 | **< 0.001** |
| Time | − 0.92 | − 1.46 to − 0.39 | **0.001** | − 1.11 | − 1.65 to − 0.56 | **< 0.001** | − 1.13 | − 1.66 to − 0.59 | **< 0.001** |
| Quality of leadership[1] | | | | − 2.56 | − 4.10 to − 1.02 | **0.001** | − 2.11 | − 3.64 to − 0.59 | **0.007** |
| Effort–Reward Imbalance | | | | − 9.74 | − 16.00 to − 3.48 | **0.002** | − 7.56 | − 14.00 to − 1.11 | **0.022** |
| Quality of leadership x Effort–Reward Imbalance | | | | 1.89 | 0.34–3.44 | **0.017** | 1.55 | 0.01–3.09 | **0.049** |
| Random effects | | | | | | | | | |
| $\sigma^2$ | 27.84 | | | 27.22 | | | 27.44 | | |
| $\tau_{00}$ | 50.48 $_{id}$ | | | 46.36 $_{id}$ | | | 40.68 $_{id}$ | | |
| $\tau_{11}$ | 1.34 $_{id.zeit}$ | | | 1.66 $_{id.zeit}$ | | | 0.96 $_{id.zeit}$ | | |
| $\rho_{01}$ | 0.08 $_{id}$ | | | 0.08 $_{id}$ | | | 0.03 $_{id}$ | | |
| ICC | 0.66 | | | 0.65 | | | 0.61 | | |
| N | 231 $_{id}$ | | | 231 $_{id}$ | | | 231 $_{id}$ | | |
| Observations | 638 | | | 638 | | | 638 | | |
| Marginal $R^2$/ conditional $R^2$ | 0.007/0.662 | | | 0.044/0.666 | | | 0.144/0.665 | | |

CI confidence interval at the 95% level

Statistical significance: *p < 0.1; **p < 0.05; ***p < 0.01

[1]Negatively poled: higher values indicate lower quality

[2]Adjusted for age, gender, worksite characteristic, education, overcomittment, work-family conflict

**Table 3** Moderation analysis via 'Simple slope analysis' of Model 2 ($N = 231$)

| Level | Effort–Reward Imbalance | Quality of leadership[1] | Physical health | SE | *df* | *t* value | *p* | Sig. |
|---|---|---|---|---|---|---|---|---|
| −1 SD | 0.49 | Fixed | − 1.38 | 0.474 | 599.286 | − 2.908 | 0.003 | ** |
| Mean | 0.86 | Fixed | − 0.79 | 0.367 | 600.346 | − 2.169 | 0.030 | * |
| +1 SD | 1.23 | Fixed | − 0.21 | 0.465 | 588.033 | − 0.461 | 0.645 | |
| −1 SD | Fixed | 2.20 | − 4.21 | 1.758 | 609.300 | − 2.396 | 0.017 | * |
| Mean | Fixed | 3.14 | − 2.73 | 1.255 | 614.349 | − 2.180 | 0.029 | * |
| +1 SD | Fixed | 4.07 | − 1.26 | 1.076 | 600.518 | − 1.170 | 0.242 | |

*SE* standard error, *df* degrees of freedom, *Sig* significance

Statistical significance: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

[1]Negatively poled: higher values indicate lower quality

lack in 'Quality of Leadership' moderates the effect of ERI on physical health. The moderating relationship between ERI and lack in 'Quality of Leadership' offers an interpretation for the effect of leadership behavior on self-reported physical health. The results are in line with findings of previous studies, but go beyond in particular. Leadership behavior that's not supportive, appreciative and well organized has a negative impact on physical health. (Montano et al. 2017; Harms et al. 2017; Skakon et al. 2010). Vice versa, another study that is focusing on a cross-professional perspective show that certain forms of leadership behavior can reduce the perception of an 'Effort–Reward Imbalance' in employees (Weiß and Süß 2016).

In comparison to previous studies, the current study uses validated instruments for the assessment of self-rated health and applies a longitudinal study design to answer the question on how leadership behavior affects subordinates' health (Schmidt et al. 2018).

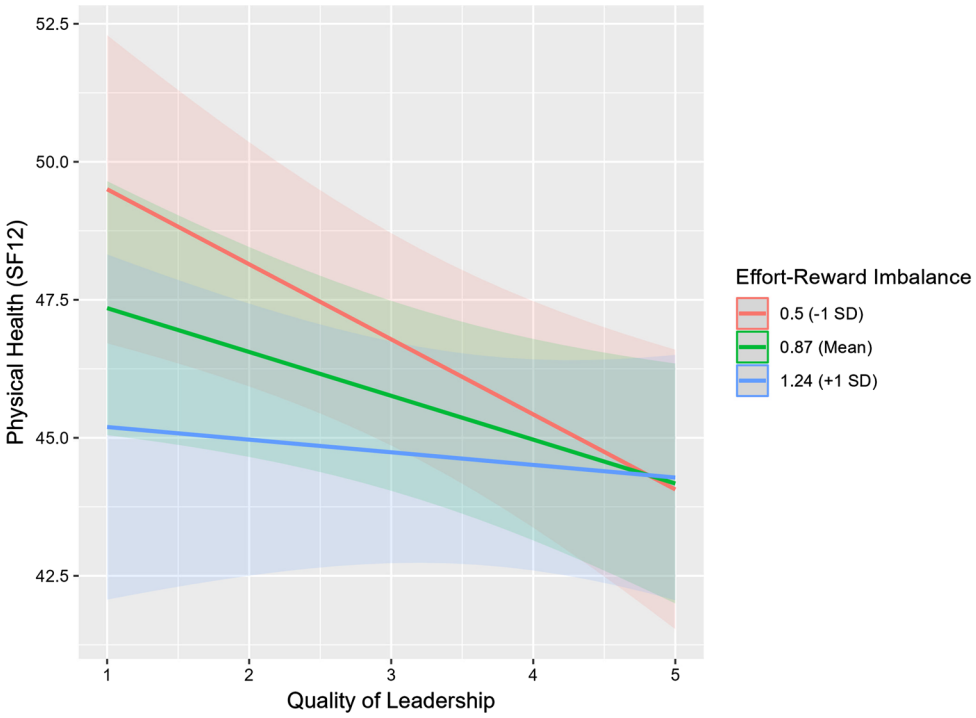


**Fig. 2** Moderation effect of Model 2 ($N = 231$). Moderation effect of ERI and 'Quality of Leadership' on physical health: the worse the 'Quality of Leadership', the less negative the effect of ERI on physical health. 'Quality of Leadership': higher values indicate lower quality.*SD* standard deviation

## Possible mechanisms

### Relationship of leadership quality and physical health

Results from the moderation analysis showed that participants' perception of an increasingly worsening leadership quality has negatively influenced the self-rated physical health as long as no 'Effort–Reward Imbalance' exists. According to Formazin et al., this suggests that there are certain dimensions of interpersonal relations in 'Quality of Leadership' which in turn cover dimensions of the 'Effort–Reward Imbalance' model (Formazin et al. 2014). The sub dimension of 'Rewards' in the ERI model is primarily characterized by factors of support and appreciation. As mentioned above, these forms of rewarding leadership behavior may foster a sense of mattering, belonging, and self-esteem (Thoits 2011), which positively affects neuronal and endocrine activation patterns. This in turn may have influenced perceptions of self-rated physical health to the positive or negative (Siegrist 2005).

## Moderation effect

Notably, among individuals with 'Effort–Reward Imbalance' physical health was significantly worse in cases where better leadership quality was reported than among individuals experiencing a lower 'Quality of Leadership' without having an 'Effort–Reward Imbalance'. Thus, physical health worsened more in cases where a better 'Quality of Leadership' was reported while Effort–Reward Imbalance was experienced. An increasingly lower 'Quality of Leadership' no longer plays a significant role in explaining a worsening in physical health over time, once individuals experience an imbalance of efforts and rewards.

One possible explanation for this relationship is that certain stress constellations between effort and reward may be so strong that 'Quality of Leadership' as a possible buffering resource (Cohen and Wills 1985) cannot influence the negative relationship between ERI and physical health. Results similar to these were reported by Schmidt et al. where they tested the moderation effect of job strain on the association between supportive leadership behavior and self-reported health (Schmidt et al. 2018). Harms et al. found that employees who are highly stressed are less likely to report a strong exchange between themselves and their supervisors (Harms et al. 2017). Vice versa, when 'Quality of Leadership' is very low, other stressors from the 'Effort–Reward Imbalance' framework become less relevant for explaining self-rated health because they are absorbed by this effect. This is an indicator of the potential, overall relevance of leadership behavior for employees' self-rated health.

## Relevance

The findings are relevant to better understand the mechanisms by which leadership behavior affects self-rated health. The framework of the 'Effort–Reward Imbalance' model offers an interpretation for this mechanism,

which has not yet been used in any previous study. The interaction effects contribute to a better understanding of the relationship between different factors of the psychosocial environment at worksite. Potentially, this may also provide guidance for interventions to improve self-rated health among employees. Based on our findings, an intensive training for supervisors on how to interact with their employees is recommended as a first step to improve employee's health.

### Strength and limitations

There are some limitations that should be discussed in the context of this study. No control for biomedical factors (Body-Mass-Index, comorbidity) or behavioral factors (sport, alcohol consume. smoking etc.) was conducted. Instead, a number of psychosocial factors were taken into account which were not considered in other studies. Due to repeated measurement, the problem of overestimation of effects of self-reported health and psychosocial risk factors is rather small. Another possible limitation is the restriction of the cohort to health care professionals, in this case nurses. A comparison with other branches has shown that nurses report a stronger imbalance of effort and reward than other professions (Bakker et al. 2000). In addition, the use of a generic instrument as the COPSOQ Questionnaire can be seen critically, as the 'Quality of Leadership' subscale does not cover all specific aspects of leadership behavior. On the other hand, this can be seen as a strength, as it is an attempt to offer a more general framework of assessment of leadership behavior that is not limited to specific research traditions and definitions of leadership. Due to low Cronbach's alpha for the subscale 'Overcommitment' an interpretation of this variable is only possible to a limited extent.

However, the present results do offer an interpretation of the relationship between leadership behavior and self-rated health. The moderation effect with 'Effort–Reward Imbalance' identified in the study has not been described before. Additionally, the models in this study were adjusted for various confounding variables. Age, gender and education were taken into account, along with worksite characteristics (i.e. type of ward) (Montano et al. 2017).

## Conclusion

It has been shown that 'Quality of Leadership' as a part of the psychosocial environment at workplace addresses, among other aspects, factors of appreciation and support. This is suggested by the interaction between ERI and 'Quality of leadership'. As long as no imbalance between efforts and rewards is perceived, the quality of leadership negatively influences self-reported physical health. Moderation analysis showed that, once an imbalance of 'Efforts' and 'Rewards' is perceived, the lack of 'Quality of Leadership' no longer has a statistically significant influence on self-rated physical health. A potential approach in the light of these findings is, for example, to provide extensive training for supervisors on how to interact with their employees.

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**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Code availability** The code used for analysis of the dataset is available from the corresponding author upon request.

## Declarations

**Conflict of interest** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Ethical approval** The studies involving human participants were reviewed and approved by 'Ethikkommission der Universität Ulm' registration number 99/19. The patients/participants provided their written informed consent to participate in this study.



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## Article 4

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RESEARCH

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# Outcomes and process evaluation of a cluster-randomised participatory organisational intervention among German healthcare workers

Diego Montano[1,2*], Marco Kuchenbaur[2] and Richard Peter[2]

## Abstract

**Background** In the present investigation the results of the outcome and process evaluation of a participatory workplace intervention are reported. The intervention aimed to increase the workers' self-assessed physical and mental work ability.

**Methods** The intervention was a two-arm, cluster-randomised trial with healthcare workers in 10 hospitals and one elderly care centre in Germany. Outcome data on workers were collected in questionnaires at baseline, and two follow-ups between 2019 and 2021. The intervention consisted of interviews and workshops, in which employees proposed measures for reducing the physical and psychosocial load and strengthening resources at work. Outcome data were analysed with linear-mixed regression models. The process evaluation was based on the thematic criteria proposed in previous literature and the collection of the type of intervention measures and their implementation status.

**Results** The regression analysis did not provide evidence of treatment differences or reductions of psychosocial load in the intervention wards. The process evaluation suggested that the measures did not address specifically the self-assessed work ability. In addition, there was no indication that the intervention measures were causally related to the intended goals.

**Conclusions** The planning and implementation of organisational interventions require a careful consideration of the definition of intervention goals, the theoretical rationale of the intervention and a project-oriented action plan during the delivery phase.

**Keywords** Effort-reward-imbalance model, Working conditions, Work ability, Occupational health, Participatory interventions

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## Introduction

Organisational workplace interventions in occupational health can be defined as changes in the working conditions, work processes, organisational policies and procedures, work tasks or the work environment in order to reduce health hazards or improve workers' well-being [1, 2]. In contrast, individual-oriented interventions aim to change individual behaviour, attitudes, skills or involve the use of personal equipment [3]. Participatory interventions are generally based on the idea that participants of the intervention should contribute their expertise to the determination of the intervention contents, design and implementation [4, 5]. Therefore, it is assumed that participatory organisational interventions are more appropriate for reducing occupational risks at the source and integrating the specific intervention contents into the work routines of the organisation [6].

However, organisational-level workplace interventions are complex social interventions, i.e., they involve several interacting components at both the individual and the aggregate social level which affect the intervention delivery and contents in an unpredictable manner [7]. The challenges associated with complex social interventions are not simply related to whether a particular set of intervention activities are effective or not, but to the circumstances under which those activities are planned, carried out and received by the target groups. Therefore, organisational interventions require not only an evidence-based approach which ensures that the planned measures are effective and the attainment of goals for the targeted groups are feasible [2, 8], but also an appropriate strategy which serves as a guide for the actual implementation of the intervention [9, 10]. At the same time, the complexity inherent to organisational interventions demands an evaluation of the expected outcomes in terms of effect size estimates and the intervention process itself as well. Whereas the outcome evaluation is usually performed by statistical analysis suitable for a specific study design, the evaluation of the intervention process is much more heterogeneous. Several process variables have been used in previous research to assess the implementation quality of interventions in occupational health including contextual factors, barriers and facilitators, initiation of the intervention, ownership, appropriateness, participation, protocol adherence, communication, management support and readiness for change, among many others [11, 12].

Health services providers in several European countries are currently confronted with some form of personnel shortage due to several factors including an ageing workforce and the relatively high levels of psychosocial risk and ensuing mental health symptoms including long working hours, job insecurity, burnout and stress in the health care sector [13]. Work in healthcare is concomitant with increased emotional demands [14], high cognitive and time demands [15] and low job rewards [16]. As a response to this situation in the health-care labour market, some health services providers have been implementing in recent years some form of age management practices to reduce the impact of this personnel shortage [17]. In a previous study with health care organisations in Germany, the UK and Finland, it was found that the most frequent age management measures concerned reductions of the working time or rearrangement of work scheduling [17]. Nonetheless, the findings suggested that health care organisations do not usually attempt to decrease work demands, modify the work environment or adopt a life-course approach with special emphasis on age and career phases or healthcare workers [17].

From a more general perspective, these type of age management programmes can be interpreted as occupational health interventions focusing on working time arrangements and shifting schedules of healthcare workers. However, there are several research gaps regarding the expected primary outcomes resulting from such programmes. For instance, the mechanisms are not specified whereby the rescheduling of working time arrangements should reduce personnel shortages in healthcare settings. Even though the redesign of shift work schedules may have some beneficial effects on outcomes such as work-life balance and work stress [18, 19], it is unclear whether previous age management programmes actually targeted such outcomes as antecedents of staff turnover or early retirement intentions. In addition, to the knowledge of the authors, previous age management programmes in healthcare settings have not been evaluated in randomised controlled trials and, therefore, there is a high risk of bias in the corresponding literature.

Hence, the present study contributes to previous research in occupational health interventions in two ways: First, the study presents the results of a participatory organisational intervention which explicitly addressed the age and career phases of healthcare workers to improve their perceived work ability and, hence, increase the chances of longer employment careers of workers. Second, the present study reports not only the effect size estimates of the intervention, it also focuses on the psychosocial load in terms of the Effort-Reward Imbalance (ERI) model and provides a detailed process evaluation which addressed the context and actual delivery of the intervention. The ERI model of work stress assumes that the perception of lack of reciprocity in terms of high efforts and low rewards at work elicit stress reactions [20]. The ERI model postulates also that failure to withdraw from work obligations, i.e., to be overcommitted to one's own work duties, represents

a health-adverse coping pattern [20]. Hence, the ERI model is based on three dimensions, namely, efforts, low rewards and overcommitment. Against this background the present study provides additional information which may help to understand the impact of the intervention on work stress and how and why the observed outcomes may have come about [2, 8, 10]. In addition, considering that the present intervention started before the declaration of the COVID-19 pandemic, it was possible to assess the potential impact of the pandemic on the primary and secondary intervention outcomes. This is important given the fact that healthcare workers may have been more exposed to a stressful work environment during the early stages of the Sars-CoV-2 outbreak [21].

## Methods

### Study design and data

The intervention "HALTgeben" ("Higher Patient Satisfaction through Fair Working Conditions in Healthcare") was conducted among healthcare workers in 11 German health services institutions, namely, seven general and three specialised hospitals and one elderly care centre. The intervention was motivated by the personnel management of these health services institutions following the invitation to participate in the study. These institutions were selected because they are located near the consultants' offices and have a sufficient number of workers and patients required to assess the effects of the intervention on the main intervention outcomes. The main aim of the intervention was to improve the self-assessed physical and mental work ability of healthcare workers by modifying the working conditions in the intervention wards. The intervention was conducted in a two-arm, cluster-randomised design whose study protocol and baseline results have already been published elsewhere [22]. Eligible participants were healthcare workers 18 years and older who worked most of the time in a single ward. All eligible healthcare workers were invited to participate in the study. The clusters were built by aggregating wards of similar medical disciplines (e.g., anaesthesiology, intensive care units, neurology, etc.) and located in separate building areas. Only wards in which at least one healthcare worker consented to participate in the study were included. The randomisation of clusters was performed with assignment probabilities proportional to size. A total of 10 cluster were allocated to the intervention arm. Results at baseline suggested that the random allocation of clusters was satisfactory, for there were no differences between the intervention and control arms regarding the primary and secondary outcomes [22]. The power analysis conducted at baseline showed that effect sizes of at least 0.30 and 0.27 for physical and mental work ability can be estimated at the 80% power and 5% significance levels. Given the effect size estimates reported in previous workplace interventions, the present study was found to have sufficient power to detect substantial changes in the main outcomes [22]. Primary outcomes were the self-assessed physical and mental work ability of healthcare workers who participated in the surveys.

The survey data used in the present study was collected in the intervention and control arms at baseline (T0) and two follow-up times (T1 and T2) between June to December 2019, September to December 2020 and August to October 2021, respectively. Healthcare workers who gave informed consent to participate in the surveys were able to fill the questionnaires either online or on paper. All workers in the intervention wards were given the chance to participate in the workshops delivered in the intervention (see below). However, not all workers in the single intervention wards took part in the surveys. Outcomes were measured by appropriate validated psychometric instruments comprising physical and psychosocial working conditions, work ability, and perceived physical and mental health (see [22] for more details on the scales). For the purposes of the present study the following data were considered:

1. age and sex.
2. The physical and mental work ability as measured with two items of the Work Ability Index Questionnaire "How would you appraise your current work ability in relation to the physical work demands?" and "How would you appraise your current work ability in relation to the mental work demands?", respectively, with answer format ranging from 1 to 5 as follows: 1: poor, 2: not good, 3. good, 4: very good and 5: excellent [23].
3. The scales of the ERI Questionnaire effort (6 items), reward (11 items) and overcommitment (6 items), with answer format: 1: strongly disagree, 2: disagree, 3: agree and 4: strongly agree [24].
4. In addition, information on ward transfers was collected at the T1 and T2 follow-ups since these could have resulted in confounding effects, especially due to the disruptions in the healthcare system during the first year of the COVID-19 pandemic in 2020.

### Statistical analysis

The intervention effects on the primary outcomes were estimated by means of generalised linear mixed-effects regression models [25]. Treatment differences between the two study arms were expected to be positive, i.e., it was hypothesised that the average self-assessed work ability of healthcare workers in the intervention arm would be higher than in the control arm. The regression

estimates were calculated with all data collected during the study period in order to adjust for potential confounding related to sample attrition (intention-to-treat approach) [26]. In addition, given that the intervention addressed the psychosocial load at work, the scales of the ERI questionnaire entered the analysis as moderating variables in order to assess the impact of the intervention on the psychosocial load in the intervention wards. The main hypothesis of the intervention study is assessed in model 1 by estimating the treatment effects. In model 2, the regression model 1 was expanded by including the three scales of the ERI questionnaire, namely, efforts, low rewards and overcommitment. Finally, the main and interaction effects of treatment assignment and the ERI scales are estimated in model 3. Even though the randomisation ensured the comparability of both intervention arms, all models take into consideration the potential confounding effects of ward transfers and age and sex as additional explanatory variables in order to explore systematic differences over time which may be attributable to increasing age or sex [27]. The confounding effects were assumed to affect primarily the intervention itself and the ERI dimensions. The regression models depicted in Fig. 1 were estimated in an intention-to-treat approach as stated above.

#### The intervention

The intervention was based on the concept of work ability which refers, in general, to the combination of the information about the workers' health status and their appraisal of their own ability to meet the job demands [28, 29]. The intervention was conducted by consultants working in the field of work design and organisational development. The intervention was conceived to help workers accomplish their work duties by considering how their individual characteristics and capacities may be aligned with the specific work and task processes. It was expected that this alignment would ultimately foster the perception of an increased work ability. The consultants' approach specified four age-dependent main career stages: entrance, development and transition, continuity and exit [30].

The intervention consisted of four phases:

1. *Phase.* The consultants assessed the organisational structure by collecting different sources of information such as work tasks descriptions of targeted groups, shift schedules or risk assessments.
2. *Phase.* The consultants conducted semi-structured interviews with voluntary employees and supervisors in the intervention wards to discuss about aspects of the work organisation and process, workload and psychosocial demands.
3. *Phase.* The consultants organised and moderated workshops lasting about 3 h in which the participating healthcare workers and supervisors were encouraged to propose measures to enhance the workers' work ability, improve the working conditions in the wards and adapt the work environment to an ageing workforce. The results of the semi-structured interviews were summarised by the consultants according to the main themes described by the interviewees and the main components of the work-ability model. For instance, the perception of interviewees concerning work tasks, duties, work processes, conflicts, individual capacities, leadership, motivation, career stages, health issues and potential solutions to the most pressing problems in the wards were presented at the beginning of the workshop. Workshop participants were then asked to discuss the issues mentioned in the interviews and to give their own view on these and other work-related matters which they considered important for their work ability and career stages (i.e., entrance, development and transition, continuity and exit).
4. *Phase.* The so-called "initiatives circles" were established which consisted of managing board executives, managers of the healthcare departments and repre-

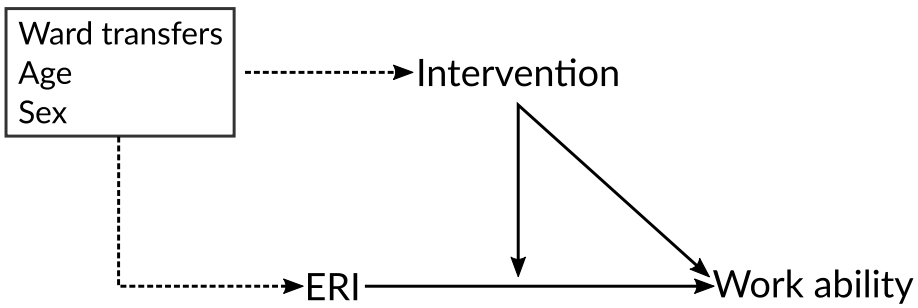


**Fig. 1** Graph of the assumed causal process in the statistical models. ERI: Effort-Reward Imbalance scales. Dotted line indicates potential confounding effects

sentatives of the works council, quality management or human resources department. The initiatives circles had the responsibility to appraise the feasibility of the intervention measures, and to accept or reject the measures proposed in the workshops, with the exception of measures which were affected by legal constraints (e.g., labour agreement stipulations). The initiatives circles decided which measures could be implemented by the wards themselves and which required further executive board approval.

The intervention approach assumes that the proposed measures made by the workshop participants would result in improvements of the working conditions in the particular wards. Against this background, it was expected that all healthcare workers in the intervention wards, even workers who did not take part of the workshops or interviews, would benefit from the implemented measures and, therefore, they would experience an increase of their self-assessed work ability.

### Process evaluation

The process evaluation was performed by the authors at the University of Ulm, independently from the consultants conducting the intervention. The appraisal of the implementation process followed the thematic list proposed by Egan and colleagues which includes the following criteria [10].

(1) *Motivation*. Who initiated the intervention?
(2) *Organisational change*. Was the intervention based on a theory of change?
(3) *Context*. In which context was the intervention embedded (e.g., political, managerial)?
(4) *Experience*. Did the individuals responsible for implementing the intervention have experience with organisational change or, if not, did they receive appropriate training?
(5) *Consultations*. Did the intervention include planning consultations?
(6) *Delivery*. Were there delivery collaborations among the participants?
(7) *Manager support*. Were managers supportive of the intervention?
(8) *Employee support*. Were employees supportive of the intervention?
(9) *Resources*. Which resources are required in implementing the intervention?
(10) *Differential effects*. Did the intervention have differential effects, e.g., some people benefiting more from the intervention, harmful effects, etc.?

The contents of the intervention measures proposed in the workshops were recorded by the consultants in a spreadsheet and forwarded to the authors located at the University of Ulm who classified the proposed measures according to the categories developed by Giga et al. (2003) [31]. In order to ease the presentation of results, the measures are reported according to the following categories:

(1) Individual-level intervention measures including participation and autonomy measures, person-environment-fit, reward schemes, role issues, employee assistant programmes, exercise and relaxation programmes.
(2) Organisational-level measures divided into:
    (a) physical and environmental characteristics (PEC);
    (b) selection and placement (SAP) policies;
    (c) training and education (TRA) programmes;
    (d) work processes and working time (WPT), and
    (e) other measures at the organisational level.

The classification was performed independently by each one of the authors of the present study and discrepancies were solved by discussion. Measures that could not be classified in one of the categories of Giga et al. were labelled "unclassifiable". The status of the actual implementation of the proposed measures by end June 2021 was reported by the consultants to the University of Ulm in three categories: implemented, not implemented and unknown. The impact of the intervention as perceived by the healthcare workers who participated in the surveys was measured by the single item: "To what extent has the research project HALTgeben brought about changes of your work situation?", with answer categories: improvement, not change at all, not aware of the intervention and worsening of the work situation.

## Results

### Statistical analysis

The descriptive statistics of the sample and the correlation matrix are provided in Table 1. Concerning the primary outcomes of the intervention, the results of the regression analysis did not provide support to the hypothesis that the intervention would improve the self-assessed work ability among healthcare workers in the intervention arm in comparison to the control arm. The estimated treatment differences obtained from model 1 did not reveal substantial differences between the self-assessed physical and mental work ability in the study arms (-0.07, 95% CI [-0.24; 0.09] and -0.05, 95% CI [-0.22; 0.11], respectively). In fact, workers in the intervention

**Table 1** Correlations at baseline, proportions (%) of selected variables and sample sizes of the intervention ($N_i$) and control arm ($N_c$). Cronbach's $\alpha$ of the scales (bold) on the diagonal of the correlation matrix. NA: Cronbach's alpha not defined for the single items WAI-P and WAI-M

| | WAI-P | WAI-M | Efforts | Low rewards | Overcommitment |
|---|---|---|---|---|---|
| WAI-P | NA | | | | |
| WAI-M | 0.45 | NA | | | |
| Efforts | -0.44 | -0.38 | **0.81** | | |
| Low rewards | -0.29 | -0.32 | 0.49 | **0.81** | |
| Overcommitment | -0.31 | -0.44 | 0.57 | 0.41 | **0.80** |
| Age (%) | 18-39y: 23; 40-54y: 48, 55y and older: 29 | | | | |
| Sex (%) | Male: 21, Female: 79 | | | | |
| $N_i$ | $t_0$: 240, $t_1$: 186, $t_2$: 167 | | | | |
| $N_c$ | $t_0$: 146, $t_1$: 116, $t_2$: 103 | | | | |
| Attrition | from $t_0$ to $t_1$: 22%, from $t_0$ to $t_2$: 30% | | | | |

WAI-P: physical work ability, WAI-M: mental work ability, NA: not available

arm tended to report lower physical and mental work ability (models 1 and 2 in Table 2). On the other hand, the results obtained in models 2 and 3 revealed large associations between the ERI scales efforts, low rewards and overcommitment and both physical and mental work ability. Whereas the efforts scale seemed to be more related to physical rather than mental work ability, the opposite was the case for the overcommitment scale whose effect size estimates were larger for mental rather than physical work ability (Table 2). Furthermore, the interaction effects model suggested that the intervention did not have any influence on the psychosocial load at work as measured by the ERI scales, given the fact that none of the interaction terms indicated large treatment differences (Table 2).

In order to ease the interpretation of the results obtained in the regression analysis, in particular for the interaction model, the marginal effects of efforts and low rewards on physical and mental work ability by levels of overcommitment are depicted in Fig. 2. It can be observed that the combination of high efforts and low rewards is associated with lower work ability levels, especially as the intensity of perceived overcommitment increases. For instance, given a low level of overcommitment (top panel row in Fig. 2), the level of work ability is high, especially for mental work ability and among

**Table 2** Generalised linear regression models. Dependent variables: physical and mental work ability, WAI-P and WAI-M, respectively. Regression coefficients and 95% confidence intervals in brackets. $N_{obs}$: number of observations, $N_{ind}$: number of individuals

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Variable** | **WAI-P** | **WAI-M** | **WAI-P** | **WAI-M** | **WAI-P** | **WAI-M** |
| Intercept | 3.53 [3.20; 3.86] | 2.97 [2.64; 3.30] | 5.02 [4.61; 5.42] | 4.86 [4.46; 5.26] | 4.98 [4.53; 5.43] | 4.67 [4.23; 5.12] |
| Age | -0.07 [-0.11; -0.04] | -0.01 [-0.05; 0.02] | -0.07 [-0.11; -0.04] | -0.01 [-0.05; 0.02] | -0.07 [-0.11; -0.04] | -0.01 [-0.05; 0.02] |
| Female (Ref. Male) | -0.22 [-0.43; -0.02] | -0.25 [-0.46; -0.05] | -0.07 [-0.25; 0.12] | -0.05 [-0.23; 0.14] | -0.06 [-0.24; 0.13] | -0.05 [-0.23; 0.13] |
| Intervention (Ref. control) | -0.07 [-0.24; 0.09] | -0.05 [-0.22; 0.11] | -0.08 [-0.23; 0.06] | -0.08 [-0.22; 0.07] | 0.05 [-0.60; 0.70] | 0.53 [-0.11; 1.17] |
| Intervention x efforts | | | | | -0.11 [-0.35; 0.13] | -0.13 [-0.36; 0.11] |
| Intervention x low rewards | | | | | -0.12 [-0.37; 0.14] | -0.08 [-0.33; 0.17] |
| Intervention x overcommitment | | | | | 0.14 [-0.11; 0.38] | -0.06 [-0.30; 0.18] |
| Efforts | | | -0.30 [-0.41; -0.18] | -0.19 [-0.31; -0.08] | -0.26 [-0.40; -0.11] | -0.14 [-0.29; -0.00] |
| Low rewards | | | -0.25 [-0.37; -0.12] | -0.27 [-0.39; -0.15] | -0.20 [-0.36; -0.04] | -0.25 [-0.40; -0.09] |
| Overcommitment | | | -0.16 [-0.28; -0.04] | -0.41 [-0.53; -0.30] | -0.22 [-0.36; -0.07] | -0.40 [-0.54; -0.25] |
| Not transferred (Ref. transferred) | 0.21 [0.03; 0.39] | 0.35 [0.17; 0.54] | 0.20 [0.02; 0.38] | 0.35 [0.17; 0.52] | 0.20 [0.02; 0.37] | 0.34 [0.17; 0.52] |
| No information on ward transfer | -0.06 [-0.37; 0.25] | 0.13 [-0.18; 0.45] | -0.01 [-0.33; 0.30] | 0.17 [-0.14; 0.48] | -0.02 [-0.33; 0.30] | 0.17 [-0.14; 0.48] |
| $N_{obs}$ | 916 | 915 | 869 | 870 | 869 | 870 |
| $N_{ind}$ | 385 | 385 | 377 | 378 | 377 | 378 |

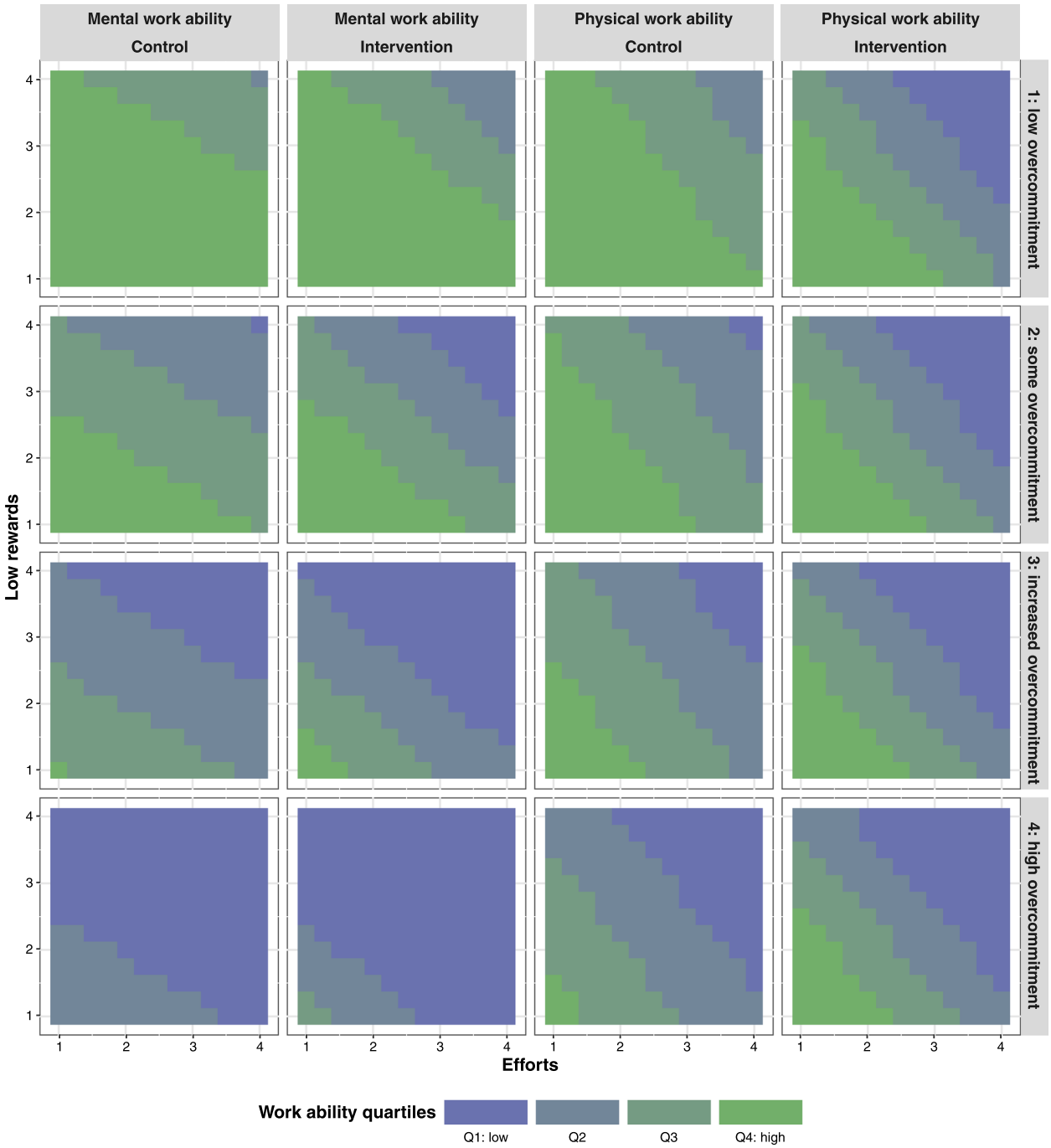


**Fig. 2** Estimated marginal effects of efforts, low rewards and overcommitment on physical and mental ability by treatment. Estimates obtained from regression model 3

workers in the control wards. On the contrary, given the highest level of overcommitment (bottom panel row in Fig. 2), the work ability is lowest, even if the job efforts are low and rewards high, i.e., even if the psychosocial workload remains at low levels.

Finally, the regression models revealed that healthcare workers who did not experience ward transfers reported higher work ability levels than transferred workers. However, the analyses did not suggest that the COVID-19 disruptions had a larger impact on work ability. In fact, there were only about 13% ward transfers during the

intervention period, with COVID-19 related transfers or changes accounting for only 30% of ward transfers. In total, only about 7% of the survey participants were affected by some COVID-19 related changes during the intervention. Hence, the results of the regression models concerning ward transfers indicate that transfers in themselves posed increased demands on transferred workers and, thus, may have contributed to lower work ability, especially for its mental component. On the other hand, while the analysis indicated that physical, but not mental work ability, decreases with increasing age, the role of sex was less consistent and seemed to be fully mediated by the psychosocial workload. This can observed by taking into consideration that sex did not contribute to the proportion of explained variance of the work ability components in models 2 and 3, in which the ERI scales are taken into account. Hence, the observed sex-specific differences regarding work ability are likely due to differences in the perception of the psychosocial workload as measured by the ERI scales.

### Process evaluation

The process evaluation revealed that the majority of proposed interventions addressed the physical and environmental characteristics of the workplace, namely, about 17% of the 524 measures recorded by the consultants. In contrast, individual measures accounted for just about 6% of all proposed measures. By the end of the intervention, only 22% of the measures were actually accomplished. However, the largest proportion of measures (about 46%) could not be appropriately classified due to the fact that, in most instances, it was not feasible to assess which work component was addressed by the measures. For example, there was a large number of "measures" recorded by the consultants which were actually either discussions on polemic topics, complaints about certain work situations or measures without a specific goal (see some examples of the type of proposed measures in Table 3). From the perspective of the healthcare workers who participated in the surveys, about 69% thought that the intervention did not brought about any changes to their working conditions (Table 4). Less than five workers thought that the intervention worsened their working conditions, whereas about a third was not even aware of the intervention. In general, there were practically no differences in the perceived impact of the intervention between the intervention and control arms. Beside some delays in the scheduling of appointments and the delivery of measures, there was no indication in the process evaluation that the

**Table 4** Healthcare workers' appraisal of the intervention effects on their own working conditions. Frequencies and proportions in parentheses

| Appraisal | Control | Intervention | Total |
|---|---|---|---|
| Improvement | 6 (4%) | 9 (9%) | 15 (6%) |
| No change at all | 106 (67%) | 74 (74%) | 180 (69%) |
| Not aware of the intervention | 46 (29%) | 15 (15%) | 61 (24%) |
| Worsening | less than 5 (–) | less than 5 (–) | less than 5 (–) |
| **Total** | 159 (100%) | 100 (100%) | 259 (100%) |

**Table 3** Examples of two proposed measures by intervention level

| ID | Measure | Level |
|---|---|---|
| 43 | Physiotherapy for healthcare workers should be offered | 1-Individual |
| 91 | Healthcare workers should be relieved from tasks not related to patients' care | 1-Individual |
| 107 | Special medical beds are needed for patients requiring intensive care | 2-PEC |
| 286 | A lift for the laboratory is needed; in general, the walk distances should be reduced | 2-PEC |
| 76 | Patient transport staff is needed for the night shift | 3-SAP |
| 314 | The composition of work teams should be considered when scheduling work | 3-SAP |
| 143 | Kinaesthetics training should be offered and discussed in human resources development talks | 4-TRA |
| 49 | Electrocardiogram advanced training for the whole ward should be offered | 4-TRA |
| 19 | The posture of healthcare workers should be improved when instructing mothers on breast feeding and conducting audiometry tests on newborns | 5-WPT |
| 33 | Fixed time slots should be defined for talking to patients and relatives in order to avoid interruptions of one's work duties | 5-WPT |
| 145 | Physicians should give feedback during team meetings | 6-Other organisational |
| 313 | The discussion of patient cases should be better organised, i.e., the meetings should begin and end on time, the discussion should be structured and moderated and some solutions or decisions need to be summarised | 6-Other organisational |
| 104 | Workshop participants discussed about the general mission of the hospital | 7-Unclassifiable |
| 21 | The offer of swimming facilities should be mentioned for new colleagues who are not familiar with it | 7-Unclassifiable |

PEC: Physical and environmental characteristics, SAP: Selection and placement, TRA: Training and education programmes, WPT: Work processes and working time

COVID-19 pandemic had a large impact on the intervention and its outcomes.

In terms of the appraisal of the implementation process regarding the thematic list proposed by Egan and colleagues, the process evaluation yielded following results:

1. *Motivation*. The intervention was motivated by the management of the participating health services providers.
2. *Organisational change*. The intervention lacked of a theory of organisational change and there were no strategies to follow-up and guarantee the actual delivery of measures.
3. *Context*. The implementation was performed in the context of the ageing workforce in the healthcare sector in Germany and the personnel strategy of the management of the participating providers.
4. *Experience*. There was no training for the individuals who were responsible for implementing the intervention, i.e., the workers, supervisors, line managers, and the personnel of the human resources and quality management. Most intervention measures were actually not implemented due to reasons including the rejection of some measures in the initiatives circles, the lack of clear responsibilities regarding the implementation, unclear goals of the measure or inappropriateness of the measure itself.
5. *Consultations*. There were planning consultations between managers and healthcare workers since the intervention was based on a participatory approach in which the measures were proposed by the workers themselves.
6. *Delivery*. In the course of the intervention, there were no delivery collaborations between managers, workers or any other relevant parties to monitor and ensure the progress of the implementation of the measures.
7. *Manager support*. Healthcare workers participating in the workshops believed that their mangers would support the intervention.
8. *Employee support*. Healthcare workers participating in the workshops had a relatively high expectation that the measures could be implemented in the wards.
9. *Resources*. The intervention approach did not consider the planning and allocation of resources. There was no guidance to assess the budgetary implications of measures.
10. *Differential effects*. Although there were differential effects of the intervention (Table 4), the workers' perception of the intervention was that it did not bring about any changes at all in the working conditions.

## Discussion

The statistical analysis did not provide support to the hypothesis that the intervention would improve the self-assessed physical and mental work ability of healthcare workers in the intervention wards. There was also no evidence that the intervention was beneficial for reducing the psychosocial load at work in terms of the efforts, rewards and overcommitment perceived by the workers receiving the intervention. Furthermore, the results obtained from the process evaluation did not suggest that the implemented measures were specifically addressing the self-assessed physical and mental work ability. Since the intervention lacked an evidence-based approach to organisational change, the actual delivery of the measures was not embedded in a systematic plan to monitor and ensure the implementation of measures. For the majority of healthcare workers (about 70%), the intervention study did not have any impact whatsoever on their working conditions. This finding indicates that the main pillar of the intervention, i.e., the organisation and moderation of single workshops with selected workers and supervisors in the wards, was not conducive to the pursued improvements of the self-assessed physical and mental work ability. Even though the disruptions related to COVID-19 resulted in few workers being transferred to the intensive care units, the findings suggested that that ward transfers as such had a negative impact on the self-assessed work ability, independently of the cause behind the transfer (Table 2). Although few wards reported that the COVID-19 related disruptions hindered or delayed the implementation of some measures, these was no indication that these disruptions prevented the delivery of the proposed measures in all wards and institutions.

The failure of the intervention to attain the proposed goals can be explained by taking into account some theoretical considerations pertaining to the conduction of complex social interventions. It seems that the main deficiency of the present intervention was the lack of an evidence-based set of statements providing the rationale of why certain intervention measures may be causally related to the expected outcomes. The intervention was rather vague concerning the specific causal mechanisms which were thought to lead to the expected outcomes. The recurrence to the work ability concept and the definition of specific primary endpoints were indeed explicit, but there was no decision guide for the relevant actors (workers, supervisors, management) as to the type of measures which would result in improvements of the self-assessed work ability of healthcare

workers. In particular, the analysis of the single intervention measures revealed that the healthcare workers participating in the workshops did not have a clear idea of what an intervention implies, namely, to change some aspects of the working environment [32, 33]. Most "measures" could not be related to specific changes of the working conditions, but were rather complaints, individual requests, anecdotes or issues being debated during the workshops (about 46% of all "measures", Table 5). Even though one of the strengths of the intervention was the participatory approach, there was not systematic approach of how to select the most effective measures leading to improvements of the self-assessed work ability. As a matter of fact, the analysis suggested that some wards may have even experienced a worsening of the working conditions (Table 4).

Moreover, despite the fact that the contents discussed during the workshops did focus on key issues including the adequacy of work processes, extent of job duties, leadership or health issues of healthcare workers in the intervention wards, the final decision on the implementation of measures was not always made by the workers themselves. In particular, measures which affected more structural aspects of the work environment, e.g., definition of work tasks, work load, coordination of work within and between wards, were competency of the initiative circles. From this perspective, the intervention approach did not explicitly defined feedback or consultation mechanisms between the wards and the initiative circles. Hence, it seems that the key limitation concerning the efficacy of the workshops as the centrepiece of the intervention was not primarily due to the specific contents and themes discussed in the intervention, but rather to different factors associated with the identification and selection of effective measures, the lack of a theoretical rationale for defining and prioritising the measures and the partial detachment of decision-making power from the intervention wards.

It has to be acknowledged that the receptivity and engagement of the healthcare workers themselves [34], as measured by the concepts of workshop-related efficacy expectation and prospective outcome expectations, was rather high, as additional analyses focusing on the collective self-efficacy beliefs of the workshop participants indicated [35]. There was some evidence suggesting that the higher the workshop-related efficacy expectation, the larger the number of proposed measures was. Hence, it seems that the intervention activities were strongly supported by workers and supervisors. Since collective self-efficacy refers to people's shared beliefs in their collective power to produce desired results by collective action [36], there seemed to have been sufficient receptivity and engagement among workers to bring about changes in the working conditions at the ward level. However, as stated above, the participation of workers was not embedded in a general framework of causal mechanisms relating the proposed measures and the intended goals and, therefore, there was indeterminacy regarding the results to be expected from the collective action efforts. In addition, the intervention approach consisted of a single workshop and, therefore, it did not provide continuous support throughout the intervention period to enable workers revise the adequacy of measures and ensure their delivery in the intervention wards.

The analysis of the associations between the psychosocial workload and the physical and mental work ability did not provide evidence that the intervention resulted in a reduction of job efforts and overcommitment, or in the improvement of the rewards obtained at work in the intervention wards. Nonetheless, these results emphasised once more that these psychosocial risk factors had a large impact on the perceived work ability and, consequently, confirmed previous research findings obtained

**Table 5** Intervention level of measures and their implementation status in the intervention wards

| Intervention level | Implementation status | | | Total |
|---|---|---|---|---|
| | Accomplished | Not accomplished | Unknown | |
| 1-Individual | 8 (26%) | 23 (74%) | 0 (0%) | 31 (6%) |
| 2-PEC | 17 (19%) | 67 (76%) | 4 (5%) | 88 (17%) |
| 3-SAP | 4 (14%) | 19 (66%) | 6 (21%) | 29 (6%) |
| 4-TRA | 7 (14%) | 40 (82%) | 2 (4%) | 49 (9%) |
| 5-WPT | 11 (19%) | 41 (72%) | 5 (9%) | 57 (11%) |
| 6-Other organisational | 12 (43%) | 15 (54%) | 1 (4%) | 28 (5%) |
| 7-Unclassifiable | 59 (24%) | 175 (72%) | 10 (4%) | 244 (46%) |
| **Total** | 118 (22%) | 380 (72%) | 28 (5%) | 526 (100%) |

PEC: Physical and environmental characteristics, SAP: Selection and placement, TRA: Training and education programmes, WPT: Work processes and working time

with larger samples of the employed population in Germany and Finland which reported substantial associations between the effort-reward-imbalance ratio and the general work ability [37, 38]. Moreover, the observation that high efforts and low rewards are related to an increased likelihood of sick leave [39] and the intention to claim disability pension [37] underlines the importance of maintaining lower levels of psychosocial workload. At the same time, these findings point to potential causal mechanisms which may inform the design of future organisational interventions which explicitly address the work characteristics specifically associated with job efforts, rewards and overcommitment. On the basis of previous interventions it can be expected that such an evidence-based approach may be more effective in attaining beneficial outcomes at the individual and organisational level [40, 41].

### Implications

By taking into consideration the results of the present participatory organisational intervention, it can be concluded that at least three major criteria may help organisations and researchers with the design and planning of more effective participatory organisational interventions.

1. *Definition of the intervention goals.* The present intervention pursued to improve the self-assessed physical and mental ability. However, the concept of work ability is rather an attitude, i.e., a cognitive appraisal process of one's prospects of coping with the physical and mental job demands [42]. The intervention approach implicitly assumed that this cognitive appraisal could be changed by delivering the modifications proposed by the healthcare workers. However, previous research in social psychology has indicated that the modification of attitudes is a challenging task which requires strong stimuli and effective environmental modifications [43]. Even though it appeared plausible to assume that the self-assessed work ability could be changed by modifying the working conditions as proposed by the workers, the actual causal pathways of how those proposed measures would serve the intervention goals were not identified. In addition, it was assumed that the measures proposed in the workshops would be beneficial for all workers in the wards, independently of whether they participated in the workshops or not. However, since the workers participating in the survey were in rare instances also participants of the workshops, the lack of treatment effects indicates that this assumption was not tenable, i.e., no spillover of benefits were observed for all workers in the intervention wards. Accordingly, workplace interventions should carefully take into consideration the feasibility of achieving the goals and, accordingly, identify the set of modifications which may be causally related to the intended goals.
2. *Intervention approach.* The process evaluation indicated that the intervention limited itself to the preparation of some activities including the establishment of initiatives circles, the conduction of interviews and the organisation and moderation of single workshops. However, the intervention approach did not take into consideration that workplace interventions require continuous monitoring, evaluating and adjusting of the intervention processes and contents [5, 9]. As the process evaluation revealed, the delivery of the intervention was unsuccessful since no mechanisms were installed to manage the organisational change activities, i.e., to check and revise contradictory or ineffective measures, bypass unforeseeable events (e.g., COVID-19 pandemic) or facilitate the coordination of the intervention measures within and across wards [8]. Over time, the intervention efforts waned and the majority of proposed measures were not implemented. Consequently, any approach to conduct organisational interventions should be conceived as an ongoing organisational change process based on a feedback system including at the very least the phases of preparation of the intervention, selection of methods, action planning, monitoring of the implementation and evaluation [9].
3. *The action plan.* The intervention did not provide explicit guidance regarding timelines for the implementation of measures or the allocation of resources necessary to deliver the measures. The vagueness of the goals was accompanied thus by the vagueness of action plans to implement the proposed measures. The intervention failed to identify the specific activities which were needed in order to bring about specific organisational changes such as procurement of resources, budgeting, the clear delegation and assignment of tasks and responsibilities or the mechanisms used to maintain and enforce the measures [8]. Form this perspective, workplace interventions would greatly benefit by adopting a project-based approach in which tasks, responsibilities, resource allocation and timelines are specifically determined in order to bring about actual changes in the organisational structure and processes.

### Strengths and limitations

The major strengths of the present intervention are the study design and the extensive process evaluation. In contrast to other organisational interventions which are

prone to confounding due to several factors including lack of control groups, randomisation or treatment contamination [1], the results of the present study are robust given the successful implementation of a cluster-randomised controlled design [22]. In addition, the process evaluation was based on previous literature and included group and individual levels of variation [35] which allowed an in-depth analysis of the most important factors which may have contributed to the observed results. On the other hand, there are two major limitations. First, the information on the intervention measures proposed in the workshops was collected by the consultants and not by independent observers. Even though the information on the workshop contents and implementation status was systematically collected, there were ambiguities in the description of single measures. However, since the measures were classified independently by each author of the present study, the impact of those ambiguities can be considered low. Second, due to organisational constraints it was not feasible to collect detailed information of the work in the initiatives circles. Hence, the analysis of the decision-making process leading to the acceptance or rejection of measures could not be performed.

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**Authors' contributions**
DM prepared and analysed the data and wrote all sections of the manuscript. MK prepared the data on process evaluation. RP edited the introduction, methods, results and discussion sections of the manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**
The datasets generated and analysed during the current study are not available to third parties due to the German data protection regulations under which this intervention was conducted.

## Declarations

**Ethics approval and consent to participate**
The study was approved by the Ethics Committee of the University of Ulm under the registration number 99/19. The intervention was registered on the German Registry of Clinical Studies (DRKS) with number DRKS00021138. Written informed consent was obtained from the participants prior to participation in the study. All methods were carried out in accordance with relevant guidelines and regulations.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare that there is no conflict of interest.

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