

Psychosocial risks in the working environment – approaches to formative risk assessment

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Published online: 4 November 2023

Cite as: Paulus S, Scheidegger A, Rabensteiner J, Egger T. Psychosocial risks in the working environment – approaches to formative risk assessment. *ScienceOpen Research*. 2023. (DOI: 10.14293/S2199-1006.1.SOR.2023.0002.v1)

Keywords: Risk assessment, subject science, transactional stress model, psychosocial risks, system dynamics

ABSTRACT

The following explanations are based on the central reference points and results of the basic research project on psychosocial risks in the world of work, which was funded by the Swiss National Science Foundation (SNSF). The aim of this project was to develop a formative risk assessment of psychosocial risks in the world of work with a special focus on the dynamic interdependencies between gainful employment and care work as well as structural work stress and subjectively perceived work stress. The result of this project is a theoretical-generic model of a formative risk assessment, which can be specifically configured for different stakeholder groups and was operationalized as a psychotherapeutic medical product via the Innosuisse project "SELBA" (Self Recognize, Understand, Change and Monitor Work Stresses and Strains).

In Switzerland, absenteeism due to mental illness has reached a record high. The increase in 2022 is almost 20% compared to the years of the pandemic 2020 and 2021, according to the effectiveness study on reintegration measures by the life insurance company for corporate pension provision PK Rück. However, this is more of a structural trend than a catch-up effect after the COVID-19 pandemic [1]. To this end, stress monitoring carried out by Health Promotion Switzerland found that 28.2% of respondents in the workplace are burdened beyond their resources and 30.3% state that they are emotionally exhausted [2]. Also in view of the fact that the Swiss State Secretariat for Economic Affairs (SECO) implemented the main agenda of the Federal Labour Inspectorate on the topic of "Psychosocial risks at work" from 2014 to 2018, a trend or the socio-political relevance has been recognised which focuses on or will focus on the topic of mental health and preventive health care. The effects of work-related stress (depression through fatigue, heart attacks) cause individual suffering, and costs arise in the form of work-related absenteeism. The Swiss Health Promotion Agency estimates 7.6 billion Swiss francs per year). This not only indicates relevance to business, but also the challenges that arise for health-preventive measures in the context of occupational health management as well as in research [3]:

Whereas during industrialisation it was necessary to ensure the physical integrity of wage workers through occupational health and safety measures, one of the greatest challenges in the current

discussion on the future and development of the work environment is to maintain the mental health of employed people. For skilled workers, an essential task is to prevent psychosocial risks.

EPISTEMOLOGICAL CHALLENGES AND RESEARCH GAPS

In addition to the societal and operational challenges of preventing psychosocial risks, there are also *epistemological challenges and research gaps*, such as recognising the causes of psychosocial risks or of risk constellations. The question here is how to identify and assess psychosocial risks. Since the cause of negative workload is often not due to purely work-related stress, but is related to problems specific to one's life situation, lack of social resources or self-harming behaviour due to role requirements or financial constraints [4].

Current interest in knowledge lies in understanding how *structural workloads* (acceleration of work tasks, deregulation of working conditions, working climate, etc.) correspond to *stress specific to one's life situation* (compatibility, scarce social resources, precarious housing situation, etc.) and *subjective work-related stress* and *coping strategies* (ways of dealing with stress) in order to derive how *constellations* hazardous to health arise and how an *assessment* of these risk constellations can be carried out [5,6].

A research gap in this context in assessing psychosocial risks is to reflect on the circumstance of stress as a *dynamic*, i.e.

transactional risk constellation as well as one that changes over time [7]. That is to say, depending on perception, the same workload can lead to distress or eustress [8,9] and a coping strategy with regard to the cause of stress can in turn improve or exacerbate it, depending on the strategy. Thus, a method of assessment, which combines stress factors with subjective assessments and perceptions through a coherent approach, must be used. Accordingly, only the contextualisation of the subjective perception of workloads offers a framework for evaluation and gives room for creative scopes for reducing stress that is perceived subjectively. Therefore, when assessing psychosocial risks, you are also faced with the challenge of analysing the specific situations in each case in order to determine whether and in what way the respective stress, resources and coping strategies of individuals make it possible to overcome conditions that stand in the way of succeeding in everyday life [10].

The following research question is derived from this starting point, which will be dealt with in the following article:

- *How can people affected by stress and their facilitators, as part of risk assessment, recognise, understand, observe and change multifactorial risk constellations that arise from the interaction of structural workloads, subjective work-related stress and health-threatening and health-preserving coping strategies?*

STUDY DESIGN

Since 2019, an interdisciplinary research team has been working on this issue together with Klinik Gais, Group Valenz for Psychosomatic Rehabilitation on the Swiss Basic Research Project (SNSF) “*Psychosocial Risks in the Work Environment. Evidence-based risk assessments of interdependencies between structural workloads and subjectively perceived work-related stress*” and on the application-based innovation project (Innosuisse) “*SELBA*” (Recognising, understanding, changing and monitoring workloads and work-related stress).

The series of projects aims, on the one hand, at developing foundations for multifactorial models for risk assessment beyond existing research gaps and, on the other hand, implementing these findings in practice. This means that in the 1) SNSF project, a theoretical model of a risk assessment was developed, which is based on quantitative and qualitative data and developed participatively with burnout patients, doctors, psychologists and consultants, in order to be able to capture the interdependencies between structural workloads and subjectively perceived work stress. This theoretical generic model of risk assessment was operationalized in a prototypical application in 2) the Innosuisse project “*SELBA*”.

About 1. SNSF)

In the SNSF project, the most important work stresses and work strains were described by means of data mining and statistical analyses of 44000 consultation dossiers of a service provider for occupational health counselling and the Swiss Household

Panel (long-term study since 1999 on the living conditions of the population in Switzerland). These results were verified and validated or falsified by means of qualitative interviews with patients, physicians, psychologists and counsellors. In addition, dynamic patterns of stress and coping strategies were investigated. As a result of the project, a generic model of a risk assessment of psychosocial risks was developed, which can identify dynamic interdependencies of work stress and health-endangering coping strategies [11].

About 2. Innosuisse)

In the Innosuisse project “*SELBA*”, this generic risk assessment model was operationalized as an assessment product for patients with work-related stress disorders. Accordingly, patients with work-related stress disorders represent the primary user group. The secondary user group is therapists providing psychiatric-psychotherapeutic treatment. The entire usability engineering process of *SELBA* was designed with the involvement of patients with work-related stress disorders who were either being treated as outpatients or inpatients at Klinik Gais AG. At each step of the process, it was ensured that the patients were directly involved. This means that the needs of the user groups were systematically collected during all development cycles. According to the statement of the Ethics Committee of Eastern Switzerland dated 10.03.2021, the *SELBA* project is not subject to the Human Research Act and therefore does not require approval by the Ethics Committee. *SELBA* was only used if the treating therapists considered it to be goal-oriented for the individual treatment of the patients. Only patients who had previously agreed to a declaration of consent participated in the project. In addition to patient safety and as part of the development process, a risk management system in accordance with EN ISO 14971: Medical devices; an application of risk management to medical devices was established for *SELBA*. All risks with regard to threats to patient safety were reduced to such an extent that they are below the defined risk acceptance threshold.

The methods chosen for the project were individual interviews, focus group discussions and workshops. A heterogeneous sample was deliberately formed, with both patients who were already in the clinic for the first time and patients who had been hospitalized for work-related stress disorders for the first time. The focus of the interviews was the inherent dynamics of work-related stress disorders and intervention options. Therefore, elicitation methods from the practice field of System Dynamics were chosen for the focus group discussions. The practice of System Dynamics is suitable for structurally understanding complex, dynamic processes and deriving possibilities for intervention. Workshop scripts were used for data collection, which correspond to the methodological state of the practice for participatory modelling. These interviews were evaluated in terms of the needs of the users. In addition, there were model-building workshops to deepen the findings, as well as review meetings. The goal of the *SELBA* clinical validation was, first, to verify that the implemented designs and specifications met

the identified needs of the users. Second, it evaluated whether SELBA met its intended purpose and basic performance and safety requirements. A particular focus with respect to performance and safety requirements was placed on usability as part of the clinical validation. In particular, SELBA was evaluated with regard to the evaluation criteria of low-threshold, ease of use, aesthetics, adherence, subjective assessment of benefit, and feasibility (in the clinical setting), based on [12]. In total, 47 interventions were designed with patients in this way (For a detailed description, see Clinical Evaluation Report; [13]).

As a result of these projects, a software-based *formative risk assessment* was developed. I.e., a risk assessment that helps recognise, understand, modify and monitor risk constellations, conceptualised as research from the subject's point of view [14] or as an *assessment for learning*. Formative risk assessment allows those suffering from stress and their facilitators (work scientists, psychotherapists or coaches, etc.) to develop learning processes on both sides in order to make salutogenetic coping strategies and the development of certain resources and conditions applicable due to specific risk constellations. If this formative risk assessment is applied periodically and its results are continuously reflected on, a learning loop is created in which participants can recognise how life situations change and can learn which measures, means and living conditions work.

In this context, challenges in recognising and evaluating psychosocial risks and, accordingly, research desiderata will be presented in the following in order to present solution strategies subsequently. To this end, section 1 discusses the challenges of recognising psychosocial risks, the recording of temporally dynamic developments of psychosocial risks and the assessment of psychosocial risks. Following this, the model and the epistemological bases and definition of a formative risk assessment, which was developed as an approach to dealing with the aforementioned challenges, will be determined in section 2. Section 3 describes how this formative risk assessment was operationalised as part of a case study. Section 4 concludes the paper with an evaluation and implications of formative risk assessment for further developing occupational health and safety.

CHALLENGES IN IDENTIFYING AND ASSESSING RISK ASSESSMENTS

With regard to the current transformations of working conditions, the *stress factors* acceleration, deregulation, digitisation, delimitation and the effect of exhaustion are stated as coordinates of post-industrial modernisation [15]. Possible consequences of stress through stress-related workloads are "mood disorders, anxiety, high blood pressure, nervous stomach pain, increased risk of heart attack, decreasing performance, increased number of errors" (DIN EN ISO 10075-1). Overall, the measurability and assessability of psychosocial risks have developed into a research area, especially in the context of burnout syndrome, and in doing so, the current state of research also describes research desiderata with regard to 1) recognition, 2) temporal development and 3) evaluation of psychosocial risks.

Recognition of psychosocial risks

There are different questionnaires and measurement procedures in the ergonomic sciences (cf. Copenhagen Psychosocial Questionnaire [COPSOQ], European Workplace Assessment [EWOPCLASS], Instrument for Analysing Stress-Related Activity [ISTA], Procedures for Determining Regulatory Obstacles in Working Activities [RHIA], and much more) to prepare risk assessments. These procedures are often oriented towards objectively measurable or comparable workloads. Accordingly, time pressure, ambiguity regarding work tasks, problems related to organising work are often stated as stress factors. Sociological studies emphasise that workloads not only cause individual stress, but also have an impact on the life situation and are associated with the dissolution of boundaries with regard to the work-life balance. Gender-sensitive research studies in this context show that the dissolution of boundaries favours the dissolution of traditional normal working and gender relations, and leads to individualisation with social isolation and patchwork identities at the same time. In this context, this is referred to as the 'decentralisation of lifestyle' (Beck [16]: 540, [17]). Gender-sensitive occupational studies show that unsecured care options for children or relatives that need care make the flexible organisation of everyday life and especially care work more difficult or impossible and that flexibilization for maintaining a common everyday family life can lead to a chronic lack of time [18]. In this way, it can be stated that workloads are related to situational, role and gender aspects. This is why it is important, as Vanis et al. conclude in their study on Swiss working conditions (2017), that psychosocial and physical stress should be analysed together and studies oriented towards multifactorial burdens (ibid. [19]: 148). According to Baumgartner/Sommerfeld [6], an assessment is required that "allows you to create a lifestyle regime and its implications for integration into the company and identify the possible starting points for the interventions" (Baumgartner/Sommerfeld [6]: 253). In this respect, the challenge in recognising stress lies in recording interdependencies between structural and social components (e.g., time pressure and bullying), between gainful work and care work or between stress and lack of resources in order to find out which constellations and coping strategies have a positive or negative influence on health. Accordingly, deficits can also be identified with regard to the practice of risk assessments. These are mainly due to the incorrect identification of *psychosocial* stress factors. In their study on risk assessment in a European comparison, Janetzke/Ertel [20] conclude that the previous instruments of risk assessment must be extended in this regard by additional or dynamic perspectives of processes (ibid.: 81, see also Jürgens et al. [21]: 156, Beck et al. [22]).

Temporally dynamic developments of psychosocial risks

If you extend the stress-strain concept [8] with the results of gender-sensitive research on employment to the extent that not only stress at work creates work-related stress, but that interactions with situational stress factors can potentiate health impairments, then one can conclude that a risk constellation

can be understood as a complex dynamic process: in work systems (gainful employment; the area of production on the one hand, care work; the area of reproduction on the other hand), there are certain situational structures and characteristics, which influence each other and over time create recurring, reinforcing, weakening or balancing life situations or risk constellations. Looking at the temporally dynamic developments of burn-out diseases in particular, those affected describe their own state of health as worsening over a longer period of time (in some cases, the period of time is many years). In a psychotherapeutic setting, this temporal trend is described as a spiral of depression [23]. In other words, the persons concerned often speak of a self-reinforcing momentum which leads to distinctive tipping points or moments of decompensation, which can hardly be stopped without external help. These dynamics can be reconstructed in models using system dynamics [24].

The challenge in recording the temporally dynamic developments of psychosocial risks is to monitor them over a longer period of time. Even time-sensitive occupational research procedures, such as the Düsseldorf model of the health circle, offer regular and temporally limited discussion groups on workloads in gainful employment, but these procedures nevertheless only provide snapshots of gainful employment. Only regular monitoring of the dynamic interactions in everyday life can adequately map the problems of the activity-effect relationships of the temporally dynamic developments of psychosocial risks. In other words, the development of societal ways of life is not based on a unique stimulus-reaction mechanism of stress/strain, but should be characterised at least as activity-cause-effect-relations, since intrusive-operative activities change the reality of the creation of living conditions in such a way that brings about causes, the effects of which lead to either health-preserving or health-threatening ways of life (Holzkamp [25]: 166). Simply put, depending on the activity or ability to act, dynamic interdependencies of risk or health management constellations develop over time.

As a requirement for a sustainable reproduction of work capacity, the recognition of dynamic activity-cause-effect relationships of situational stresses and strains, in which the subject themselves proves to be a central component of regulating their own ability to act, also emerges. This creates a further perspective for a research desideratum.

Assessment of psychosocial risks

Another challenge lies in assessing risks, since the same stressors or workloads, such as quantity or intensity of work, can be perceived, interpreted and evaluated subjectively and in different ways [8,9]. Thus, a method of assessing risks, which combines stress factors with subjective assessments and perceptions through a coherent approach, must be used. Occupational research procedures and evaluations are often based on body-related measurement data (cortisol levels, CO₂ emissions, etc.) and DIN standards. Sensory impressions and subjective assessments as well as individual life situations, on the other hand, are of little importance conceptually in

occupational research procedures. An example of this is the risk assessment of noise as a workload:

In occupational scientific procedures, noise is described as a mechanical output, which depends on the duration of the propagation of a given acoustic energy from a sound source and does not arise from the sensory processing of the hearing person. I.e., average levels indicate a health risk and DIN standards regulate this according to working conditions. But with tolerable sound values below the official value that is harmful to health, 85 dB(A) (cf. Determining the noise exposure level at the workplace DIN EN ISO 9612), such as through keyboard clattering, telephone conversations, children playing, high-pitched but not too loud beep tones, etc., additional detection and evaluation methods are required to detect subjectively disturbing noises that cause stress, since noise pollution is difficult to influence on an individual level (it is usually impossible to avoid hearing them) and also depends on individual dispositions (do ambient noises disturb the person while working or not). Accordingly, qualitative experiences and the subjective description of inadequate (acoustic and architectural) actual states are lacking when it comes to recording and assessing noise [26]. Conversely, this means that workloads have to be contextualised by the individual in order to produce measurement data, comparisons, conclusions or derivations. In this way, in addition to psychosocial perceptions, the subjectivity and the individual implications/interpretations of stressors move into the centre of such an analysis, which is oriented towards sensory perception, since operational or social structures can be constructed intersubjectively and, at the same time, also limit the subject's freedom of interpretation and freedom to act. In this respect, the subject influences operational and social structures through their interpretations and actions [27,28]. Accordingly, this also applies to the process of risk assessment; reconstructing a risk should be conceived at the same time as an intervention, because reconstructing the risk influences the risk itself. From these three described research desiderata, one can deduce that the challenge of assessing psychosocial risks is to primarily reflect on interactions between structural workloads and subjective work-related stress over time. Perceiving and feeling stress as well as them being part of society are essential approaches to describing interactions between structural workloads and subjective work-related stress over time. Accordingly, only the contextualisation of the subjective perception of objective workloads offers a framework for evaluation and gives room for creative scopes for reducing stress that is perceived subjectively. This means a continuation of occupational scientific analysis procedures towards subject-oriented participation procedures [10], which is further described below on the basis of the formative risk assessment model.

FORMATIVE RISK ASSESSMENT MODEL

As a research desideratum, the previous challenges and research desiderata can be used to describe a *multifactor analysis* of the interdependencies between structural workloads and subjectively perceived work-related stress, which

illustrates the effects of the conflict areas of psychosocial risk factors and health-threatening and health-preserving coping patterns associated with them. For working out this research desideratum, the following research methods were used in the aforementioned projects in order to develop the basis for an epistemological model of a formative risk assessment and its application (methodology and the respective results of the individual research steps are not discussed in more detail here): by means of data mining on the basis of the Swiss Household Panel as well as on data from the consulting firm ICAS, findings on the quantitatively most common risk constellations were described. The evaluation of data mining was reviewed and supplemented by 5 expert interviews as well as 9 guideline-based interviews with those affected about the temporally dynamic developments of psychosocial risks in order to determine meaningful constructions of interrelationships and health-endangering and health-maintaining coping patterns. In the further course of both projects, a strategy was followed to not only question the interviewees in the sense of a subject-scientific approach, but to make them co-researchers. A total of 47 contacts with patients were thus established in the form of further interviews, group discussions and in particular modelling and design workshops. With Klinik Gais entire psychosomatic team and the psychiatric-psychotherapeutic management team, research colloquia and also group discussions, modelling and design workshops were established. The workshops formed the formative risk assessment's core of the modelling process. The iterative and user-centred development process was designed according to the criteria of the design thinking method.

Accordingly, the aim of the development formed in this way was not only to gain insight into different manifestations of psychosocial problems, but also to understand individual contexts that refer to specific life situations (the courses of diseases in connection with compatibility problems, role conflicts, etc.) and thus a cooperative exploration of typical patterns and strategies of action in the context of work-related stress diseases in the form of activity-cause-effect relationships, in order to finally develop a jointly supported model that captures different risk constellations over time. The model was called SELBA (Recognising, Understanding, Changing and Monitoring Workloads and Work-related Stress [Selbst Arbeitsbelastungen und Arbeitsbeanspruchungen erkennen, verstehen, verändern und monitoren]).

Epistemological basis for formative risk assessment SELBA

From the transdisciplinary discourse on the practice of "Policy Analysis and Design" for formative risk assessment, the following below illustrates which principles are part of a formative risk assessment. "Policy Analysis and Design" comes together through discourses on occupational science (and disciplines involved in it, such as occupational medicine, psychology, and occupational social work), psychotherapy and the practice of system dynamics.

The theoretical development, as well as empirical participatory development of the SELBA model for risk assessment, clearly shows that stress is perceived and processed differently by subjects. I.e., stress is subjective [27] and transactional [9]: micro-dynamics in individual courses of a disease and (successful) coping strategies cannot be generalised entirely, as stress has to be assessed by the individual. In the course of the project, the hypothesis arose that causal structures of psychosocial risks are based on individual transactions, which can be reconstructed in systemic and psychodynamic models if they are developed subjectively and contain time-sensitive information. From a system dynamics perspective, this time sensitivity can also be described as path dependency or a sequence of transitions. Over a longer period of time, the perception of stress or the subjective meaning of working conditions usually changes and is stabilised by self-regulating mechanisms; during comparatively short periods of time, this state changes in a self-amplifying and self-dynamic way, whereupon it stabilises again and the further development is stabilised again by self-regulating mechanisms [29]. In order to understand the transactional structure of the interactions of structural workloads and subjectively perceived work-related stress as well as the development over time, it is essential to gain insight into the complex dynamic interaction of self-regulating and self-amplifying mechanisms. How this can be achieved is discussed in the discourse on the practical development of system dynamics, which deals with understanding and changing complex dynamic processes with multifactorial, circular, non-linear, time-delayed and accumulating causal relationships [24]. Previous studies show, on the one hand, that a subject-scientific analysis of the dynamics of work-related stress diseases by means of system dynamics is fundamentally feasible ([29]; Homer 1985 [30]; Veldhuis et al. 2020 [31]) allowing for a profound understanding of the complex dynamic processes associated with the assessment of psychosocial risks. On the other hand, the aforementioned studies also show that it was necessary to reconstruct the complex interrelationships of effects subjectively; this must be taken into account when developing a framework for formative risk assessment. In this respect, a framework for formative risk assessment has been developed, which includes the following elements:

Explicit modelling

A basic concept for researching and modifying complex dynamic problems in which human decisions play an essential role are "**mental models**" [32]. Mental models are an inner image of risk constellations, which are shown externally in the actions and reasons for actions of the stakeholders' risk constellation. In order for mental models to change, a space must be created for a discourse in which subjective significances of risk constellation can be explicitly made, discussed, explored and changed. Practitioners of system dynamics use jointly developed "**visual boundary objects**" [33] to develop and analyse jointly supported explanations and solutions to complex dynamic problems in heterogeneous groups across borders. In the context of

the practice of a formative risk assessment, the development of low-threshold visual boundary objects represents an element that stimulates transdisciplinary communication between affected subjects themselves, between subjects and experts from different disciplines as well as between experts from different disciplines. An illustration of the subjectively reconstructed risk constellation can be created in order to increase the effectiveness of the coordinated processing of risk constellations. I.e., boundary objects on the one hand allow for a different use of information by different groups, but on the other hand, have enough jointly supported content so that a common understanding about them can be reached.

The practice of developing co-constructive models of risk constellations in open communities (i.e., jointly supported visual boundary objects) is referred to by [34] as **community-based system dynamics**. These models can be individually adapted and modified, so that processes of empowerment are also promoted.

Policy design

When “visual boundary objects” are jointly developed, explored and changed and these are exchanged with the subjective mental models, this can be described as a policy design process [35]. Policy design processes are applied at different levels and can have different leverage effects. If, for example, individual patterns of meaning or behaviour or individual objectives are addressed, this corresponds to a change in individual parameters or material or information flows at a higher system level and develops a comparatively low leverage effect, but possibly a considerable one from the subject’s point of view. However, by means of the community-development processes of risk constellations or boundary objects described above, a policy design process can also be stimulated through the practice of formative risk assessment, which unfolds greater leverage effects and changes collective patterns of meaning and action in a health-promoting manner.

Self-exploration through identifying and updating problems

Both the discourse on the practical development of system dynamics [36] and on psychotherapy [37] show that dynamic complexity can be better understood and mastered if problem-specific rather than comprehensive explanations are sought for a risk constellation or for a “dynamic problem” (in system dynamics discourse). This means that a formative risk assessment starts with the most urgent (dynamic) problem from the patient’s point of view. At the same time, it must be thought of as a cyclical process in which there is openness, over time the problem – and thus the description of the risk constellation – is updated if it changes from the patient’s point of view. Self-monitoring or “**assessment for learning**” serves as an element of formative risk assessment for practising new policies (modes of meaning and action), but also for model validation [36], as well as a boundary object to reconstruct and understand complex dynamic risk constellations. In turn, its aim is to update the problem, thereby completing the elements

of a circular process of formative risk assessment. (Self-)exploration always takes place from a time perspective in order to make the inherent dynamics of the risk constellation tangible. Formative risk assessment is aimed at expansive learning as an “assessment for learning” (Holzkamp [38]: 183). This means that within the process of formative risk assessment, the affected persons themselves learn what conditions their situation and how they can expand their capacity to act in order for their life situation to be less vulnerable to external factors. However, this also means that the professional users (occupational scientists, psychotherapists, coaches, etc.) know the interests of the learners (people affected by stress) in order to be able to design learning processes in a participatory and individual manner. Risk assessments from the point of view of the persons affected by stress are therefore not intrapsychic-cognitive activities, but a specific form of social action, in which learning develops as a learning loop vis-à-vis everyday activities (Holzkamp [38]: 188).

Definition of formative risk assessment SELBA

As a result of the framework, formative risk assessment is defined based on the principles described. The question arises in which form visual boundary objects are made explicit and accessible to discourse, research and the learning process.

In the discourse on system dynamics, different forms of representation are used, depending on the application. As the most imprecise and low-threshold form of representation, diagrams are used that merely visualise system elements and mechanisms of action; as the most precise form that can be analysed by means of computer simulation, the models are described as a system of differential equations. This form offers the advantage that the inherent dynamics of the dynamic process described can be calculated from the structural effects of the system and analysed mathematically. However, it has the operational disadvantage that subject-specific modelling is associated with considerable effort, especially since it has to be updated regularly in a formative process. Therefore, a mathematically abstract description is used below for defining the risk constellation, which allows for necessary precision and spells out the focus on the inherent dynamics of the risk constellation, which result from working and living conditions, subjective significances and reasons for action.

Definition A *formative risk assessment* is a collaborative process in which risk constellations are explicitly modelled, visualised, researched, and updated. Constellations of risks include the variables of state (conditions: ability to work, working conditions, resources), changes in the subject’s own dynamic state due to (subjective and collective) significances and reasons for action (policies, institutionalised and informal coping strategies). The aim of the process is to ensure that the subject’s work capacity can be reproduced sustainably. This process allows you to compare and adapt the subjective reconstruction with complementary perspectives. These can be different technical perspectives, or comparisons of perspectives

within the framework of collective appropriation processes of risk constellations. In the process, personal risk limits and personal risk indicators are developed and observed. The process includes analytical steps in which risk constellations are compared with specific empirical data and reflected; it includes transformative steps in which patterns of interpretation and action are changed.

Risk constellations as a model of the inherent dynamics of working conditions, resources and the ability to work.

Risk constellations K occur in everyday life in employment and care work systems and their interdependencies. A risk constellation K refers to a person k and a point in time t_0 . K is an inter-subjectively constructed model that is specifically valid for k at the point in time t_0 . Formulated as a system dynamic model, a risk constellation $K(k, t_0)$ can be described with the following symbolism:

$$\left(\frac{dx}{dt}(k, t), \frac{dP}{dt}(k, t) \right) = r_{k, t_0}(x(k, t), P(k, t))$$

where

- $x(k, t)$ is a variable of state that describes the **work conditions** and the remaining **resources** of k at the point in time t . I.e.:
 - The state of health of k at the point in time (symptoms and vulnerability)
 - The social resources of k
 - The economic resources of k
 - The skills and competencies of k , for example, health literacy, budget literacy, etc.
 - A description of the social relations and roles (self- and external attributions) of k in and outside gainful employment
 - A description of the conditions under which k is employed and does care work at the point in time t_0 . This includes a description of the working conditions as described in a conventional risk assessment.
- $P(k, t)$ is a state variable which describes the **work ability** of k at the point in time t
- r_{k, t_0} is a mathematical function that expresses k 's hypothesis at the point in time t_0 to the causal contexts which, in its view, decisively influences the self-dynamics of $x(k, t)$ and $P(k, t)$. Specifically, the formulation of r_{k, t_0} is based on k 's insight into how he/she and other stakeholders relevant to the risk interpret physical and social conditions, how these stakeholders derive and justify actions based on these, and how these **significances** and **reasons for action** in turn change x and P , and thus affect the working conditions, resources and ability to work
- A description of formalised and informal rules under which decisions are taken concerning the development of k 's ability to work (decisions by k and by other persons causally linked to k 's ability to work). This includes rules on how k and other relevant persons typically interpret working

conditions at the point in time t_0 and typically justify decisions. It also includes, for example, institutionalised rules, affect logics or coping strategies.

In this model, $\left(\frac{dx}{dt}(k, t), \frac{dP}{dt}(k, t) \right)$ are the temporal rates of

change of the variables $(x(k, t), P(k, t))$ that, through function r_{k, t_0} are derived from the state $(x(k, t), P(k, t))$ with their own dynamics.

Operationalisation This characterised definition of a formative risk assessment in turn enables operationalisation, which was applied in both secondary and tertiary prevention within the framework of SELBA. Methodically translated or operationalised, a formative risk assessment has to go through the following steps (Engeström [39]; see also the epistemological bases described above in the text):

1. **Explicit modelling** of risk constellations through visualisation, community development (discursive research, raising of questions, analysis of the past and current situations, modelling of common solutions)
2. **Policy design** (change of risk constellations, discussion of contradictions, resource activation)
3. Empirical **(self-)exploration and updating of risk constellations** (planning, implementing and testing the (new) practice, validation of models, joint reflection of the process)

SELBA: OPERATIONALISATION OF THE FORMATIVE RISK ASSESSMENT (CASE STUDY)

The SELBA project is rooted in a clinical context and focuses on the aftercare process of people suffering from chronic employment-related or care work-related stress. Since stress-related diseases have a high recurrence rate – depending on the type of treatment, the risk of relapse in the first year after completing therapy is between 30% and 40% – SELBA begins in the follow-up process. The primary target group in the SELBA project are patients who suffer from work-related stress disorders and are in inpatient therapy at Klinik Gais, who, by means of formative risk assessment SELBA, monitor their work integration or risk constellation after staying at the clinic. If a deterioration of mental health is observed, appropriate interventions and preventive measures must be initiated by trying to influence the individual risk constellations in a positive way. The goal of SELBA is to achieve a significant reduction in the relapse rate by understanding the interactions of structural workloads and subjectively perceived work-related stress with formative risk assessment.

The development of formative risk assessment within the framework of psychiatry and psychotherapy offers the advantage that modelling and the discursive discussion and research of risk constellations for the person suffering from stress can be developed within a protected framework. Formative risk assessment was implemented in this project as a blended therapy process

that combines face-to-face treatment with software-based interventive elements. This allows patients to observe their thoughts, feelings, behaviour, life and work situations between therapy sessions and use them in face-to-face psychotherapy. This blended approach allows for designing a process that combines the elements of formative risk assessment and offers the possibility to connect to the existing clinical setting. A key element in the SELBA process is the ability of patients to take on the role of co-researchers in all steps of formative risk assessment. This in turn has the challenge that the design of the SELBA process and the SELBA software must have enough flexibility so that it can be adapted to the individual living situations as well as heterogeneous interests and needs of the patients.

The following developmental hypotheses have developed from this case and the definitional building blocks of formative risk assessment:

With formative risk assessment SELBA, patients can do the following:

- Model their subjective risk indicators and individual risk limits with the therapists within the context of therapeutic discussions on the basis of the interactions of structural workloads and subjective work-related stress and monitor them over time after leaving the clinic.
- Identify dysfunctional coping strategies with the therapists and develop functional coping strategies to counteract future risk constellations.
- Explore, model, evaluate, change and update their future psychosocial risks themselves using the visualisation and operationalisation of their risk constellations.

This means that the regular use of SELBA can promote the observation, structural workloads, individual workloads, (missing) resources and health-promoting or health-damaging actions, the understanding of dynamic activity-cause-effect relationships or of personal risk situations.

Subsequently, the implementation of formative risk assessment based on the developed process and software solution by using the aforementioned points for operationalisation: 1. Explicit modelling, 2. Policy design, 3. Self-exploration and updating of risk constellations will be presented.

Explicit modelling

The explicit modelling of own risk constellations takes place by modelling or creating individual explanatory models of risk constellations and individual early warning signs with regard to work-related stress.

In the **Early Warning Signs** software module, users can record their personal psychological and physical symptoms over time, which are shown or intensified according to the deterioration of their mental health.

In the **Explanatory Models** software module, a free space is available for arranging various elements of the risk constellations (see definition above). Here, users can correlate the stressors, meanings, coping strategies and resources that are

important to them through spatial positioning and visualise cause and effect relationships. For the selection of stressors, meanings, coping strategies and resources, users have a state-of-the-art list at their disposal. This is based, among other things, on the DIN EN ISO 10075-1 guideline of work arrangements with regard to mental workload, the GDA guideline risk assessment (2017), Operationalised Psychodynamic Diagnostics (OPD-2), the Beck Depression Inventory (BDI II), the psychometric procedure "Brief Cope" as well as specific elements from therapy manuals, checklists and questionnaires on stress analysis and management, such as ISTA and RHIA (see above). These elements can be used to create an individually configurable arrangement of risk constellations. Figure 1 shows an example of an explanatory model. In the example, entries from different real test subjects are combined in such a way that no conclusions can be drawn about the identity of a specific patient. The stressors represent the external stimuli or the working conditions to which the employed persons and carers are exposed. These are, for example, time and target values or multitasking requirements that affect the employed persons in the form of time and performance pressure and can trigger negative feelings of stress in them. In the example, conflicts, high workload and poor work-life balance are mentioned. It should be noted that the patient has access to the aforementioned list of proposals, but assigns an element to the classes stressor, significance, coping strategy or resource itself or in dialogue with the therapist. The meanings represent personal perceptions, norms and values as well as interpretations of the stressors. These can also include emotions and expectations. Figure 1, for example, specifies anger or "I have to manage this", but also "my needs are important to me": significances that have been assessed as important by the users. The functional and dysfunctional coping strategies reflect the way a person deals with the stressors, their significances, or (missing) resources (e.g., "alcohol," "progressive muscle relaxation," or "setting limits"). Resources represent all means, such as means of working, funds, etc., or personal skills, such as balance, knowledge, etc., on the basis of which goals can be pursued, stressors and requirements mastered or activities carried out (for a more in-depth description of the composition of this stress model cf. Paulus et.al. [10]). Figure 1 shows how the elements were arranged in the free space in the therapy. The elements were correlated in the boundary object in this way. The outside individual does not clearly understand how these relationships are to be interpreted, but in the transdisciplinary development process, the importance of having these opportunities was stressed. The image modelled in this way can be described as a boundary object, a kind of basic model that reconstructs the reciprocal relationships between the elements and the resulting inherent dynamics.

Modelling of the explanatory model takes place dialogically during psychotherapeutic treatment. One goal is to work with patients in identifying the negative interpretations and long-term coping strategies that prove to be dysfunctional, and to develop alternative options for action to improve patients' life and work situations. Psychotherapists play a key role in

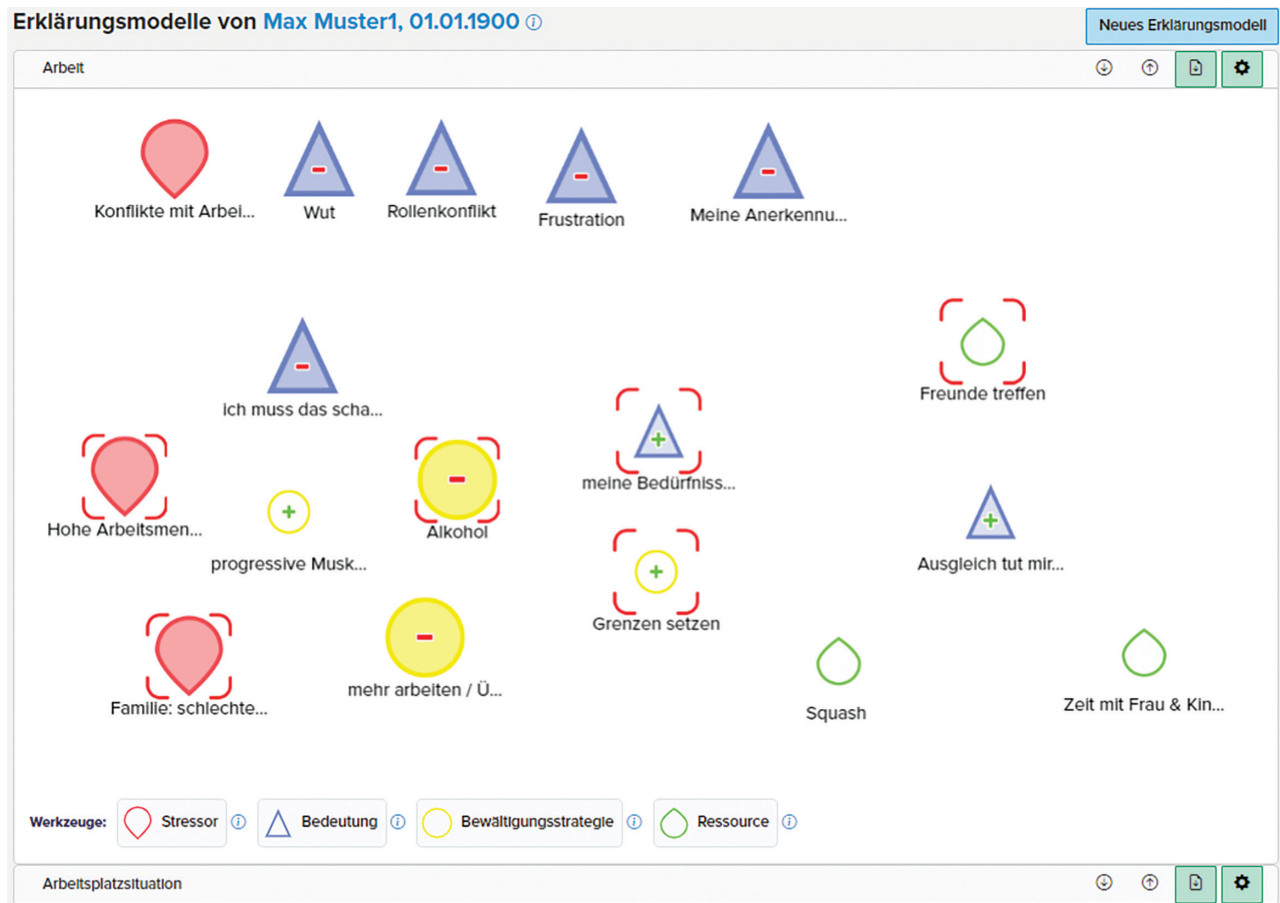


Figure 1. Exemplary explanatory model. (In this explanatory model, entries from different real test persons are newly combined, so that no conclusions can be drawn about the identity of the test persons. Source: Screenshot Software SELBA).

the explicit modelling of risk constellations. They can provide assistance to patients by citing examples, asking questions, and showing correlations. Patients are also supported by inspirational state-of-the-art lists on psychosocial risks in the software (see info button ⓘ in Figure 1).

Policy design

The temporal and content-related design of the therapeutic process as well as self-exploration is defined within the framework of the policy design. Here, psychotherapeutic support also determines which strategies are initiated with the change of risk constellations. Patients receive questions on the selected elements of the explanatory models at regular intervals (Figure 1 indicates the selected elements with a red frame). This means that, based on the knowledge gained, alternative strategies are derived from explicit modelling in order to improve the patients' individual life and work situations. Furthermore, individual longer-term therapy goals are defined, which patients should gradually approach. In addition, the regularity of the reflection of these goals is determined and the time intervals in which therapy sessions will take place in the aftercare process are determined.

(Self)-exploration and updating the risk constellation

Between therapy sessions, patients can track workloads, work-related stress, coping strategies, resources, individual life goals, personalised risk constellations, early warning indicators, and health-preserving/health-promoting factors using the SELBA software based on their cause-effect narratives and self-recorded time series data. Based on the questions on personal early warning signs and elements of the individual explanatory models, the subjective working conditions, work-related stress and resources or individual risk constellations must be reflected upon on a regular basis. These appear as process diagrams on the basis of a visualised traffic light system on the patients' personalised dashboard.

Figure 2 shows the recorded time series to the fictitious test person. Through (self)-exploration of the temporal dynamics, it becomes possible in the formative process of the patient to create hypotheses about possible interrelationships between elements of the explanatory models and between elements of the explanatory models and early warning signs. In the example shown here, the early warning sign "Sleep" as well as the elements of the explanatory models "Alcohol," "High workload" as well as "Meet friends" are correlated. In the example,

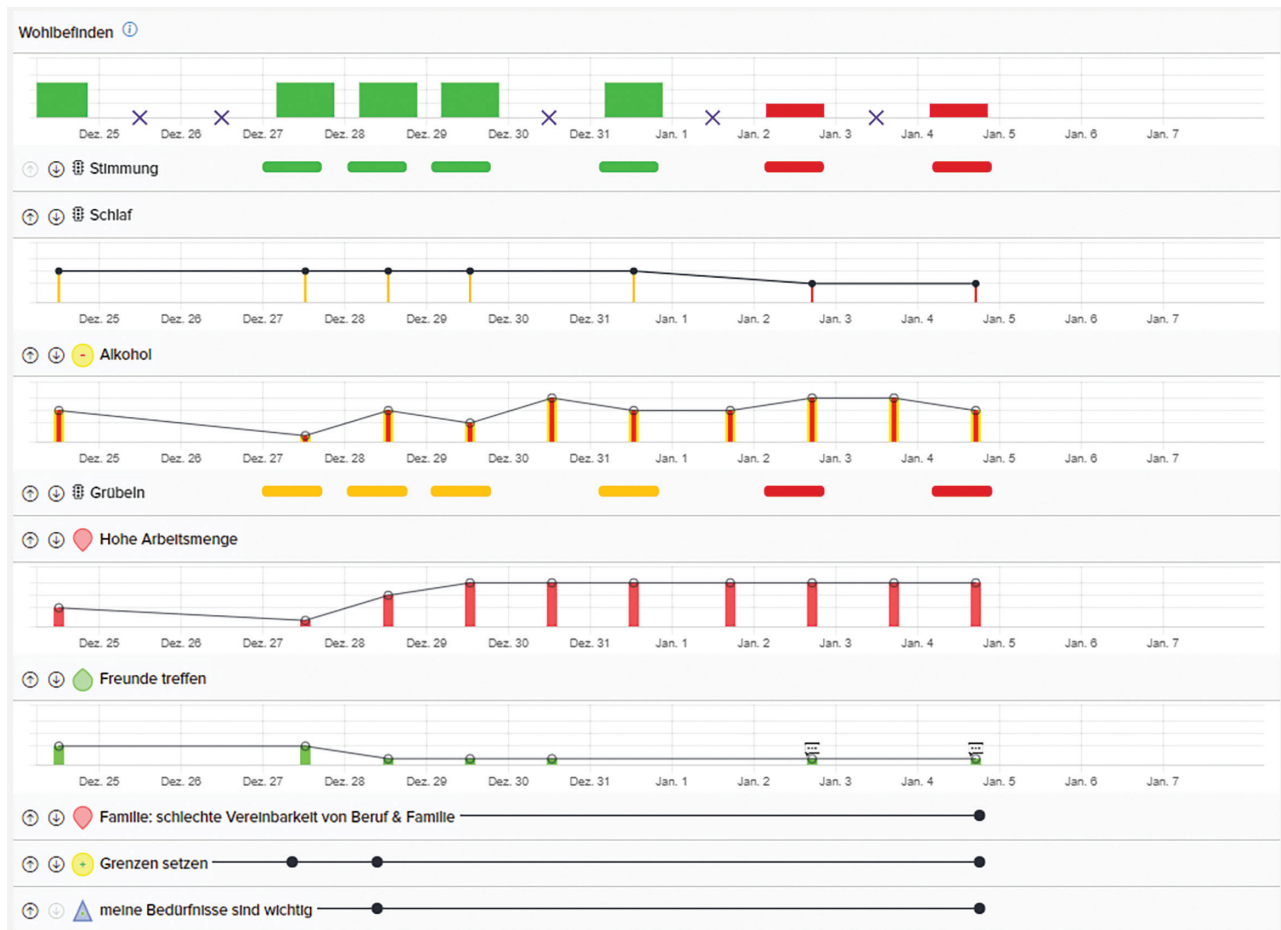


Figure 2. Time series (observations on current personal early warning signs and the current risk constellation).

an increase in the observed stressor (“High workload”), the dysfunctional coping strategy (“Alcohol”) and a decrease in the resource (“Meet friends”) coincide. With a time delay, the early warning sign (“Sleep”) changes colour from yellow to red, indicating a higher risk. In the context of self-exploration, the patient arranges the time series in such a way that they can recognise correlations. Thus, hypotheses on self-reinforcing (health-promoting or health-damaging) and self-regulating dynamics can be developed, rejected or hardened; tipping points and patterns associated with this can be identified.

Updating the problem can be operationalised within the framework of therapy (or by the patient) itself (themselves) in the software by adapting explanatory models, creating new explanatory models or adapting the observed elements.

In an individually defined interval (adherence), patients make actual-target comparisons. The SELBA software has an automatic SMS and email notification feature that can be configured individually. Depending on the location of the patients in the recovery process, the technical assistance system can be used more intensively or less intensively. Based on the reminders of outstanding early warning sign questions and upcoming activities, the aim is to facilitate access

to the software and thus also to the therapeutic content and to improve adherence. Patients can undertake activities, set goals and set resources in the software to help them achieve a salutogenic scenario. The planning and reflection of activities and therapy goals can be carried out with the help of the software modules **Activities** and **Goals**. Reflection of the activities takes place through a colour scale, on which the intensity of joy perceived can be visualised during or shortly after the performance of the activity on the basis of a correspondingly chosen colour. This should open up the possibility of building up an archive of activities that are useful for subjective well-being and self-efficacy and that patients can fall back on in moments of deteriorated mental health.

An automated risk assessment of the personally determined risk limit warns patients if their mental state is deteriorating and they have approached their personal risk limits. The risk limit is operationalised as a statistical estimate of the total value of Beck Depression Inventory II based on the inputs to the personal early warning signs, with users being advised that it is not a medical diagnosis. They are reminded to immediately activate their resources and to contact the responsible assigning person at Klinik Gais in case of questions or needs.

The prospective or dynamic or time-sensitive orientation of the individual risk scenario allows patients to look beyond immediately coping with everyday life and to observe themselves in their everyday life with a view to a longer time horizon (several weeks, months to years) and to anticipate risks at an early stage by identifying patterns or early warning indicators and to proceed accordingly in a behaviourally or proportionally preventive way. With automated risk assessment for the risk limit, a distinction is made between two risk levels: approaching the individual risk limit and exceeding the individual risk limit (configuration in the context of psychotherapy). If the personal risk limit has been exceeded, Klinik Gais will contact the patients, provided they have consented to receiving written enquiries or enquiries by phone. The purpose of the outreach phone or mail service is to contact patients as early as possible with observed downward dynamics and thus prevent relapses. The findings obtained through self-observation and self-exploration can be recorded in the graphical trends using a commentary feature integrated into the questions asked and serve as a diary for the patients. This allows for the health status of patients in the past days to be reconstructed at any time and incidents discussed in therapy and fluctuations or dynamics observed.

EVALUATION CASE STUDY AND TRANSFERABILITY TO OTHER AREAS OF OCCUPATIONAL HEALTH AND SAFETY

The contents of the SELBA software and the SELBA process were continuously reviewed with the patients and therapists at Klinik Gais in improvement-oriented evaluations (see above). The following initial positive findings were obtained:

- The software module **Explanatory models** developed across disciplines is suitable to clarify problems at the beginning of psychiatric or psychotherapeutic treatment, to visualise the risk constellations and to understand them. The explanatory models can thus be integrated into the therapeutic process. It appeared that the possibility of clustering risk constellation elements is necessary in order to recognise the effects of structural workloads and subjective work-related stress.
- The individually configurable **hazard indicators**, which are oriented towards the effects of structural workloads and subjective work-related stress, can reflect the psychological and physical symptoms of the patients. Deterioration of mental health can be identified and correctly assessed by monitoring and automated risk assessment. The individual configurability of the SELBA software has proven itself for both monitoring structural workloads and subjective work-related stress.
- The SMS or email notifications as well as the low-threshold software modules **Early warning signs** and **Activities** with an integrated weekly calendar facilitate access to the web application and thus to the content of stress prevention. The design of the software by using recognisable icons,

traffic light system colours, warning symbols and quick access buttons also allows for intuitive use of the software and improves low threshold.

- The outreach telephone contact at Klinik Gais, when **exceeding** the personal risk limit was found to be helpful.
- Patients in aftercare or **work integration** describe a high level of adherence and a high level of benefit assessment for detecting risk constellations.

To date, nothing can be said about the long-term effect of self-monitoring. The test period is still too short and there were no control groups. With the inpatient setting, obstacles in implementing the technical assistance system have emerged in the test phases. Since the weekly therapy time is only one hour on average, it is unrealistic that the web application can be configured individually within the therapy session. A solution was sought for this time conflict. Therefore, the future involvement of nursing staff in the SELBA process is considered useful, as the relationship between the nursing staff and the patient is more time-consuming. In addition, nursing staff is closer to what patients experience every day. Thus, nurses see great potential in supporting patients in using the SELBA web application and updating risk constellations together with them. This offers the opportunity to outsource therapeutic content between therapy sessions.

In summary, the elements of formative risk assessment can largely be operationalised in a blended therapy process. This means that interactions between structural workloads and subjective work-related stress can be made explicit and can be discussed through mental models. Visual boundary objects, policy design and a continuous update of problems are used to process the interactions. Community-based modelling allows problems to be communitised and problem owners empowered. Community development has so far been the least developed of all the elements. On the one hand, this is related to the clinical setting, on the other hand, to the fact that the occupational problem owners or those who organise and manage conditions of employment or care work are not present.

With regard to transferability to other areas of occupational health and safety, the constitutive elements of formative risk assessment can be used to address and edit central challenges and strategies in the area of safety and health at work.

OSH policies and measures

The process and the elements of formative risk assessment are developed in such a way that they cannot be used exclusively in blended therapy, but that the role of psychotherapists can be replaced by occupational scientists (and the disciplines they are involved in, such as occupational medicine, psychology, occupational social work, occupational health management) in order to obtain an assessment of temporally dynamic risk constellations together with people affected by stress. In particular, the participation procedure of formative risk assessment oriented towards science and thus the contextualisation of the subjective perception of workloads offer a framework for

evaluating risks and opening up a creative scope for (innovative) measures and concepts for prevention (in future) in connection with physical and psychological risks. The dialogical process implemented in the context of psychotherapy as part of the case study can be interpreted as a prototype of formative risk assessment within a protected therapeutic framework. As part of further transdisciplinary research projects, the process of formative risk assessment in other settings with other groups involved will be researched further. In doing so, instruments and processes must be adapted to the specific setting, and the resources and interests of the stakeholder group involved must be taken into account. One must emphasise that the elements of the explanatory models and updating problems can minimise the pitfalls (dynamic interactions between workloads [gainful employment and care work] and work-related stress over time) in the practical implementation and use of risk assessments, through the feedback or effective evaluation of persons suffering from stress.

Stakeholders and institutions involved in OSH

Since formative risk assessment for recognising, understanding, changing and monitoring risk constellations is designed as research from the subject's point of view [10,14] or as an "assessment for learning", persons suffering from stress are at the centre of risk assessment accompanied by their supporters (work scientists, psychotherapists, coaches, etc.). This has the advantage of preventive measures being focussed on individuals, that persons affected by stress *and* their supporters will be able to develop learning processes in order to make salutogenic coping strategies applicable due to certain risk constellations. If a formative risk assessment is applied periodically and the results thereof are continuously reflected on, then there will be a learning loop in which all participants recognise which measures work.

The combination of face-to-face risk assessment (person-to-OSH) and app-based self-monitoring (blended OSH) strengthens the effectiveness of secondary preventive measures as well as the roles of the various stakeholders (e.g., employees, health and safety officers), as assessments are borne jointly. This also allows employers to implement targeted measures and allows for an effective and efficient use of human resources in occupational secondary prevention, as stress-related diseases can be effectively prevented. Especially smaller companies that do not have sufficient know-how in the area of occupational health management and/or time resources can benefit from the provision of formative risk assessment. For participating companies, there is a benefit that goes beyond the circle of employees directly taking part in self-monitoring: within the framework of company health management, processes can be designed that allow the participating employees, for example in the form of working groups, to contribute their skills acquired within the context of self-monitoring to occupational primary prevention and thus make a significant contribution to the company's own health culture.

Inequalities in occupational safety and health

Inequalities between different groups of workers in terms of exposure to potential (physical and mental) risks as well as strategies and measures for occupational safety and health can also be addressed. Formative risk assessment strengthens the ability of employees to act directly and on a low threshold level in order to promote their own mental health. Personalised measures are proposed, which are based specifically on the life situation, work situation and preferences of the users. This procedure can also be found, for example, in the health circle's Düsseldorf model. Since occupational health circles are often not anonymous or do not include long-term studies, a long-term assessment can take place in combination with the innovation "SELBA", which in turn allows for continuous analysis of the effects of corresponding OSH measures.

To sum up, it can be concluded that formative risk assessment can contribute to the following:

- To increase improving the implementation records of risk assessments, since the assessment takes place on a low threshold level and from the individual interest of those affected by stress.
- To address the improvement of preventing work-related diseases by combating existing, new and emerging risks, as persons suffering from stress are themselves empowered to identify, change and monitor existing, new and emerging risks.
- To improve statistical data collection and increase the information base on challenges in identifying and assessing risks and/or interactions between structural workloads and subjective work-related stress, as well as the impact of coping strategies, when individuals suffering from stress are willing to share their information and experience with stakeholders of occupational safety and health.

OUTLOOK AND FUTURE RESEARCH ASPECTS

Since stress develops dynamically and is experienced and processed transactionally, future research challenges lie in identifying changes in individual/specific cases of burnout over time. This means causal structures of psychosocial risks can be based on individual transactions reconstructed in system dynamics models, but only if they include circular, time-lagged, and accumulating causalities. In capturing stress, a theoretical or generic model of stress can help identify stress, but only a "subjective dynamic problem" can be identified if, distress is assessed by the individual. We believe that participatory case reconstructions of stress in particular have great potential to address such research challenges. To do so, future research projects would need to develop subject-oriented theoretical frameworks and methods. According to current research, frameworks in OSH are not yet aligned with these challenges [40–41] and therefore, does not fully develop its potential with regard to work integration measures for persons with stress-related work strain and life situation-specific stresses.

For this purpose, the following points must be addressed:

- a) Because stress is processed transactionally, i.e., work stress is subjectively perceived and managed differently, it is necessary to process corresponding OSH measures from the subject perspective or along the respective life management system of clients (work environment, work-life balance, recreational time, individual coping skills and resources).
- b) Because stress and stress management are dynamic, i.e., workloads can reinforce or compensate for themselves over time through dysfunctional or functional coping strategies, OSH measures must be applied in a time-sensitive manner in order to achieve the best possible effect.

This not only complicates a proper analysis of the effects of OSH, but it raises the question of how interventions work when a subject orientated potential is realized in practice. To this end, the following research questions could be investigated in future research projects:

- How can a formative risk assessment for stress-related psychosocial health risks be operationally transferred to different settings of OSH or specific organizations and work environments?
- How effective is formative risk assessment for psychosocial health risks when used to its full potential compared to an intervention as usual?

ETHICAL GUIDELINES

The research project was ethically and legally advised by the responsible Ethics Committee of Eastern Switzerland (EKOS). The EKOS has declared its non-responsibility.

FUNDING

The results of this study refer to the externally funded projects: Swiss National Science Foundation (SNSF) Project [10001A_178934]: Psychosocial Risks in the Work Environment. Evidence-based risk assessments of interdependencies between structural workloads and subjectively perceived work stresses. Swiss Innovation Agency - Innosuisse Project [53268.1 IP-LS]: "SELBA" (Recognize, understand, change and monitor self-perceived work stresses and work demands).

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