

ERGOKITA: AN EXAMPLE OF AN ERGONOMIC INTERVENTION IN THE EDUCATION SECTOR

Introduction

Musculoskeletal disorders (MSDs) affecting the lower back, neck, and upper and lower limbs are among the leading causes of occupational injuries and have a considerable socio-economic impact. Risk factors for the onset of MSDs include rapid work pace, repetitive motion patterns, insufficient recovery time, heavy lifting and awkward body postures. A combination of these physical work features and unfavourable features of the psychosocial work environment such as a lack of control over one's work and high demands are also considered risk factors [1]. A combination of manual lifting of loads, awkward body postures and psychosocial stressors is prevalent in the preschool environment.

In general, the type of physical activity that childcare professionals experience might be classified as not very high in metabolic cost. However, the tasks of nursery-school teachers involve elevated physical and mental stresses. These result from, among other causes, the low working heights of facilities geared to the body dimensions of small children, the lifting and carrying of children, and the performance of several tasks simultaneously (multitasking). Because facilities are designed to be appropriate for the heights of the children, nursery-school teachers have to adopt awkward body postures such as keeping the head down while standing, bending at the waist, and stooping, squatting and kneeling for sustained periods while conducting tasks such as teaching, supervising, feeding and providing hygiene care. All of these non-neutral postures are considered risk factors for developing MSDs. In addition, there is considerable political effort to include children under the age of 3 in day-care facilities. Healthy personnel are needed to be able to comply with this imperative. Health-preserving and health-promoting programmes for nursery-school teachers play their part.

The Ergokita project

The ErgoKita project pursued several purposes: one of them was to establish the current state of knowledge on musculoskeletal workloads in nursery-school teachers. Furthermore, the situational workload should be assessed objectively and subjectively in different types of work. By determining the effects of influencing factors and structural parameters (such as the teacher-to-child ratio and the available facilities), suitable prevention measures were to be identified and evaluated [2, 3]. The project duration was 4 years (2011-2014), with a follow-up evaluation 2 years later in 2016.

The project was launched by the German social accident insurance institutions for the public sector in Rhineland-Palatinate, North Rhine-Westphalia and Hessen, and the German Social Accident Insurance institution for the health and welfare services (Berufsgenossenschaft für Gesundheitsdienst und Wohlfahrtspflege — BGW). The scientific studies were headed by the Institute of Occupational Safety and Health of the German Social Accident Insurance (Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung — IFA), the Institute of Ergonomics of Darmstadt University of Technology and the Institute of Occupational, Social and Environmental Medicine of the Goethe University in Frankfurt.

In the ErgoKita project a sequential mixed-method approach was adopted (Figure 1).

Figure 1: Study design used in the ErgoKita project

Pre-intervention phase			Intervention phase	Post-intervention phase
Determining current work-structure parameters in preschools in Germany: <ul style="list-style-type: none"> questionnaires (n = 262 preschools)	Assessing work-specific risk factors: <ul style="list-style-type: none"> site inspections surveys/questionnaires (n = 24 preschools) <ul style="list-style-type: none"> surveys workshops technical measurements (CUELA) task analyses (n = 9 preschools)	Intervention development: based on <ul style="list-style-type: none"> surveys workshops technical measurements (CUELA) task analyses participatory ergonomics (n = 6 preschools)	Intervention: <ul style="list-style-type: none"> situation-orientated measures (ergonomically designed furniture) behaviour-oriented measures (awareness sessions) (n = 6 preschools)	Assessing intervention effects and acceptance: <ul style="list-style-type: none"> surveys workshops technical measurements (CUELA) task analyses (n = 6 preschools)

Source: based on figure 1 in Burford, E.-M., Ellegast, R., Weber, B., Brehmen, M., Groneberg, D., Sinn-Behrendt, A., Bruder, R. 'The comparative analysis of postural and biomechanical parameters of preschool teachers pre- and post-intervention within the ErgoKITA study', *Ergonomics*, 2017, Vol. 60, No 12, pp. 1718-1729 [4]

▪ Data collection and pre-measurement phase

As a first step, the managers of 262 children's day-care facilities in North Rhine-Westphalia, Rhineland-Palatinate and Hessen responded to a questionnaire that gathered information on the current structural work conditions of the facilities, advanced and further training of the personnel, and the facilities' equipment.

Out of these 262 preschools, 24 representative children's day-care facilities (7 each in North Rhine-Westphalia and Hessen, 10 in Rhineland-Palatinate) were selected and studied more closely by means of detailed site inspections and surveys assessing physical and mental stressors as well as the health status and working ability of the nursery-school teachers. Questionnaires used were a modified version of the Copenhagen Psychosocial Questionnaire (COPSOQ), the Nordic Questionnaire and a short version of the Work Ability Index (WAI).

Following up on the information received, the children's day-care facilities were classified into three grades: no intervention need, intermediate intervention need and high intervention need. From the 24 preschools, 9 representative day-care facilities were selected for further assessment: for each federal state 1 children's day-care facility per grade of intervention need was included. In these nine facilities the results of the surveys were deepened and supplemented in workshops with the entire staff. The work-specific risk factors and particularly straining tasks for the musculoskeletal system were identified and specific problems of the day-care facility in question were discussed, recorded and documented.

Furthermore, in these nine children's day-care facilities the analyses of the status quo were intensified by comprehensive computer-aided recording of physical workloads in various types of tasks (such as playing, eating, sleeping and bodily care). The measurements were taken over 36 working shifts (pre-measurements) by means of the ambulatory computer-assisted recording and long-term analysis of musculoskeletal loads (Computer-Unterstützte Erfassung und Langzeit-Analyse: CUELA) system [5]. Therefore, two nursery-school teachers from each facility were followed over two entire working shifts. Moreover, a task analysis was conducted, meaning the nursery-school teachers had to manually choose the kind of task they were currently doing from a list on a small portable device every time they changed their kind of task throughout the work shift. The CUELA system consists of inertial sensors, goniometers, and pressure-sensitive insoles, which allow body postures, movements and ground reaction forces to be measured continuously and instantaneously. From the measurements taken, the trunk inclination, trunk flexion and torsion of the upper body were calculated. A biomechanical model was used to assess the lifting of loads and to determine the weights of the

loads handled. The external load moments of the lumbar spine could thus be estimated as biomechanical evaluation variables. In addition, a heart rate monitor and a noise dosimeter were applied. The whole data-capturing session was videotaped to assign specific tasks executed during the work of the nursery-school teachers to the measurements recorded.

Two types of preventive measures to target the physical and mental strains experienced by nursery-school teachers were derived from all the data gathered that far and were applied as intervention in the six day-care facilities with intermediate and high intervention needs.

Intervention measures

▪ Situation-orientated measures

Using the results from the CUELA analysis, the questionnaires and the workshops conducted during the data collection phase, a basic furniture package was compiled that should help to change the working environment. This furniture package was put together by the project team and consisted of different ergonomically designed pieces of furniture, including seating options for the teachers (chairs, stools, cushions) and the children (child's beds and high chairs), table options, standing desks, benches and platforms for the children to stand on while being dressed by the nursery-school teachers, children's beds and nappy-changing tables with extending stairs (Figure 2). The aim was to provide furniture that not only fits the children's needs but also avoids awkward body postures for the nursery-school teachers. The basic furniture package was presented in workshops with each of the educational staff of the six intervention facilities. For each of the four task areas (playing, eating, sleeping and bodily care) the team of nursery-school teachers from each facility discussed which furniture they could best use in their institution and which changes in their own behaviours they could apply to work in a more ergonomic way. In consultation with the study team, the furniture most appropriate to the specific needs of each facility was chosen and placed at the facilities' disposal.

Figure 2: Ergonomically designed furniture included in the basic furniture package

Seating furniture for nursery-school teachers



Elements for table/chair combinations



Nappy-changing table



Seating options on the floor



Source: Institute for Occupational Safety and Health of the German Social Accident Insurance

▪ Behaviour-orientated measures

The ErgoKita project aimed to change the nursery-school teachers' behaviour as well. To change behaviour towards a more ergonomic way of working, individualised awareness sessions were conducted with the two nursery-school teachers who participated in the CUELA measurements in each of the six intervention facilities. In preparing the awareness sessions, biomechanical, postural and video data were scanned for working situations where awkward postures occurred. Videos of these working situations were shown to the nursery-school teachers. For these situations, ways were developed to improve the body posture and the performance of the task, including by using the newly adopted furniture. This process included the use of biofeedback measurement systems that allow direct feedback of musculoskeletal workloads to the nursery-school teachers. By following this problem-solving approach, participants are enabled to draw on this previous experience and to think of how to conduct a task in a more ergonomic way in the future [6, 7].

▪ Post-measurement phase

Post-measurements were conducted 2 months after implementing the different preventive measures and 1 year after the pre-measurement phase. CUELA measurements were repeated to assess possible intervention effects on the musculoskeletal system. The workload of the two nursery-school teachers from each of the facilities with medium and high intervention needs who had already participated in the pre-measurement phase ($n = 12$) was once more assessed during two work shifts. Again, the CUELA measurements were supplemented by task analyses.

To assess further intervention effects, the staff of the six intervention facilities were to answer the same questionnaires again that had already been completed in all 24 children's day-care facilities. Moreover, acceptance workshops were conducted in all six intervention facilities with all employees. The workshops were intended to assess the acceptance of the ErgoKita project, the compatibility of project-related changes at work with the pedagogical programme of the facility, the project's effects on the nursery-school teachers' health awareness and behaviour at work, and children's and parents' acceptance of project-related changes.

Results achieved in ErgoKita

Thanks to the package of preparatory and intervention measures taken, in most of which the entire staff of the different children's day-care facilities were involved, reductions in musculoskeletal workloads could be achieved. On the one hand this is because of nursery-school teachers' increased awareness of their own health and positive changes in their attitudes towards ergonomic behaviour, and on the other hand it is because of the implementation and use of the newly deployed ergonomic furniture.

Reduction in musculoskeletal workloads

The questionnaires filled in after the intervention showed that the nursery-school teachers subjectively rated the awkward postures as reduced. These subjective data were confirmed by the objective assessment of body postures (trunk inclination, trunk side inclination, back torsion) and musculoskeletal workload captured and analysed by the CUELA system.

As a first result, the duration of potentially harmful postures such as standing or knee-straining postures was reduced (Table 1). The duration of seated postures following the intervention increased. This indicates a positive change, as sitting may have replaced prolonged standing and kneeling positions.

As a second result, the time spent in awkward movements of the torso such as inclination, lateral bending and torsion decreased, as did the adverse bending of the knee by more than 130 degrees. In addition, loads of 10-15 kg were handled less often in four of the six day-care facilities. Furthermore, lumbar moments of 40-135 Nm, indicating a possible to probable spinal overload, were reduced in the post-measurements. The heart rate assessment showed a reduction in high values as well.

Table 1. Postural differences between pre-interventional and post-interventional phase

Parameter: CUELA postural code	p-value	Pre-intervention		Post-intervention	
		Mean (%)	SD (%)	Mean (%)	SD (%)
Standing postures	0.084	44.3	8.0	37.9	6.7
Knee-straining postures	0.023*	8.4	9.0	3.1	4.5
Seated postures	0.008*	28.5	8.2	40.7	8.9
Walking/active postures	0.530	18.5	4.1	17.8	4.2
Other postures	0.893	0.4	1.2	0.4	1.5

Source: Burford, E.-M., Ellegast, R., Weber, B., Brehmen, M., Groneberg, D., Sinn-Behrendt, A., Bruder, R. 'The comparative analysis of postural and biomechanical parameters of preschool teachers pre- and post-intervention within the ErgoKiTa study', *Ergonomics*, 2017, Vol. 60, No 12, pp. 1718-1729 [4]

Note: p-value (* = significant), mean and standard deviation (SD) of the percentage of the calculated shift for standing, knee-straining, seated, walking/active and other postures as classified by the CUELA postural code for the main postures adopted.

Reported behaviour changes

After the intervention measures, many nursery-school teachers paid attention more consciously to healthier behaviour in the workplace. The workshops helped them better link their behaviour at work and the workplace design to health and illness. Their partly newly acquired and partly refreshed knowledge led to their using the new work equipment (for instance the adult chairs and tables now in place instead of a children's chair and a table at children's height). However, the acceptance of the newly introduced furniture was related to the particular habits of work in and the needs of the specific day-care facility. For instance, employees found a cushion for sitting on helpful if they worked in a day-care facility whose pedagogical programme included a lot of time sitting on the floor, for example while supervising children, whereas others did not use a cushion much. Because they had had only 2 months to get used to the furniture, the answers of the nursery-school teachers on whether or not the use of the furniture reduced their health complaints were of only very limited use. However, the results indicate that they considered the furniture helpful in reducing health complaints.

Moreover, the arrangement of the work equipment changed and more attention was paid to avoiding heavy lifting during work. For instance, instead of a circle of chairs, which requires moving many chairs, children sat in a circle on the floor, or frequently required objects were placed within reach or were stored in easily accessible places in order to avoid handling loads in unfavourable positions. In addition, the organisation of work was modified in a way that encouraged the children to act more independently. As a result, the nursery-school teachers experienced a high level of acceptance of the measures by the children. This was reflected not only in the frequent use of the new children's furniture (high chairs for children, extensible stairs for the nappy-changing tables), but also in their active participation if work was assigned to them (setting up tables, moving tables with castors). The teachers also received positive feedback from the parents, who were informed about the project and its progress at every stage.

Consequences and acceptance of intervention (follow-up evaluation)

The evaluation was conducted in the six intervention facilities 2 years after the ErgoKiTa project's implementation. The evaluation comprised site inspections by the responsible labour inspector in the ErgoKiTa project team and the evaluator (an employee of IFA) as well as structured interviews with all nursery-school teachers who were part of the evaluation sample. The questions asked in the interviews were based on the evaluation model of Kirkpatrick and Kirkpatrick [8] and referred to four levels: reaction/acceptance, learning, behaviour and results. The evaluation was intended to reveal whether or not the ergonomic furniture was still in regular use at the time of the follow-up and which pieces of furniture were particularly helpful to prevent

musculoskeletal strain. In addition, it was to assess if ErgoKita could lead to sustained positive changes in personal attitudes to ergonomic behaviour, and sustained behavioural changes towards ergonomic behaviour at work.

The evaluation sample consisted exclusively of nursery-school teachers who were already working in the same facility before the ErgoKita project started and were thus able to compare the working situation before and after the project conduction. All in all, 38 nursery-school teachers (all female and with 6 years or more of professional experience in children's day-care facilities) participated in the evaluation. Out of the 38, 7 were managers of the facility, 4 were deputy managers and 10 were those who had participated in the pre- and post-intervention CUELA measurements.

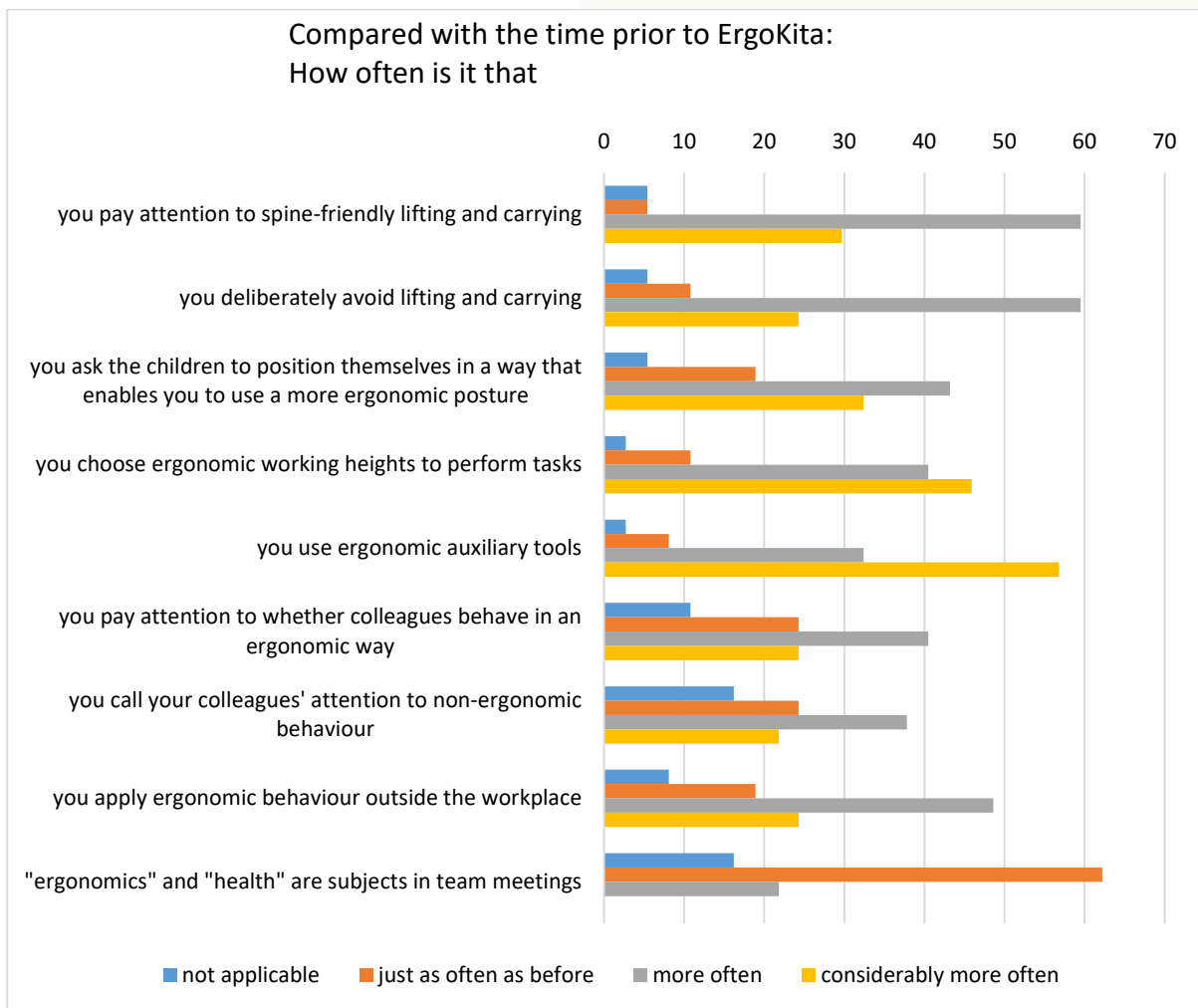
The evaluation showed that 97.3 % of the nursery-school teachers were very satisfied or satisfied with the totality of measures taken in ErgoKita, and 89.1 % were very satisfied or satisfied with the support that was provided by the ergonomic specialists in handling and using the ergonomic furniture during the implementation and adaptation phase. All of the 10 who participated in the awareness sessions were very satisfied or satisfied with their content.

A total of 73.7 % of the nursery-school teachers agreed and 15.8 % somewhat agreed that their knowledge of the health-protective effect of ergonomic behaviour at the workplace was deepened by the ErgoKita project; 2.6 % somewhat disagreed. Similarly, 76.3 % agreed and 18.4 % somewhat agreed that the measures taken in the ErgoKita project raised their awareness of musculoskeletal strain in their daily work-life.

The feedback of the nursery-school teachers regarding the ergonomic furniture was very positive. Only cushions were rated as not helpful and were regularly used by few nursery-school teachers. Other furniture, such as chairs and stools designed for adults, nappy-changing tables with extensible stairs, high chairs for children, tables at adult height and tables on wheels, were still in regular use and were generally rated as (highly) helpful.

Some 64.9 % of the nursery-school teachers agreed that they behaved in a more ergonomic way at work than before the project, 24.3 % somewhat agreed, 8.1 % neither agreed nor disagreed and 2.7 % somewhat disagreed. More specifically, 89.2 % of the nursery-school teachers stated that they more often or considerably more often paid attention to spine-friendly lifting and carrying, and 83.8 % deliberately avoided lifting and carrying (considerably) more often than before. 75.6 % of the nursery-school teachers said that they (considerably) more often asked the children to position themselves in a way that enabled the teachers to use a more ergonomic posture for the required task. A total of 86.4 % (considerably) more often chose ergonomic working heights to perform tasks and 89.2 % used ergonomic auxiliary tools (considerably) more often. Some 64.8 % paid attention (considerably) more often to whether or not colleagues behaved in an ergonomic way and 59.6 % stated that they (considerably) more often called their colleagues' attention to non-ergonomic behaviour. A total of 72.9 % applied ergonomic behaviour (considerably) more often even outside the workplace (for example by applying lifting techniques suitable for the back). Nevertheless, 62.2 % of the nursery-school teachers specified that ergonomics and health were not discussed more often in team meetings (Figure 3).

Figure 3: Results regarding behaviour changes assessed in the evaluation (2 years later) (%)



All in all, the nursery-school teachers perceived a shift in their perspective on health issues from only focusing on the children's health to paying increased attention to preserving their own health. They felt surprised and were thankful to know now with what little changes in their own behaviour and by using the ergonomic furniture they were able to feel better and protect their health from damage. In total, 16.2 % of the nursery-school teachers noticed a very considerable reduction of the physical strain at work, 43.2 % a considerable reduction and 37.8 % a slight reduction; 2.7 % chose 'not applicable'. They perceived the ergonomic furniture as particularly easing their work, as it provided working heights that fitted the nursery-school teachers' physiques. Moreover, they strongly favoured the integration of the subjects of ergonomics and health in their vocational education and training (as seen in [9]).

Participatory approach in ergonomic interventions

The concept of participatory ergonomics (PE) has been shown to be effective in reducing exposure to biomechanical and psychosocial risk factors [10-12]. Given the increasingly 'participatory nature of approaches to industrial health and safety generally, and the related processes of the total quality movement' (p. 309) [13], the implementation of initiatives following the PE approach is growing.

PE is seen as an umbrella term for various terms and concepts, but all include the active involvement of employees, end users or necessary actors in decision-making processes leading to problem-solving ideas and solutions [14-16]. The actual process of participatory work is further described as 'the combination of increases in social interaction and support with greater opportunities for decision making and control over one's work activities' (p. 6) [7]. Following Wilson, we define PE as 'the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both

processes and outcomes to achieve desirable goals' p. 1071 [17]. In general, PE includes participation in intervention planning and implementation as well as in a collaborative problem-solving dialogue.

Added value of the participatory approach

Internally managed programmes are more cost effective, but often more efficient than employing a consultant ergonomist, who might be too isolated from the organisation and lack the necessary insight [18]. Employees know their everyday work content exactly and are experts regarding the conditions they need to be able to work efficiently and healthy. Therefore, engaging them in the analysis, diagnosis and redesign of working processes naturally results in improved design ideas and information [18]. The acceptance of and commitment to health and safety initiatives at the workplace increase, as participation generates greater feelings of ownership of solutions [17, 19].

Participation might also be a learning experience in itself for the workers: on the one hand, their knowledge of their own work and especially of the organisation may be increased [20]; on the other hand, the process of learning a new system might be faster and deeper. This leads to a decrease in training costs and improved performance [21, 22]. Haims and Caravon [23] state that an increase in the employees' understanding results from being provided with feedback in practical ergonomic training and will lead to a changed perception of the work environment. This in turn might also lead to greater opportunities for processes of learning, action and control in the future. Solutions found in and the results of previous interventions might be transferred to other projects and places throughout an organisation [24, 25].

In general, PE is helpful to open up means of communication between the workers and the management. Especially in large-scale initiatives or highly complex projects, a mixture of top-down and bottom-up approaches is more effective to successfully plan and implement them [26]. Participation can also play an important role in reducing stress at the workplace, because 'allowing workers to be involved in decisions about their work can balance the negative influences of low job content' [27]. Wilson and Haines refer to the development of self-confidence, competence and independence in employees who are directly involved [18]. Moreover, it seems to have a positive impact on psychosocial factors at work, which might also retard the onset of work-related diseases [28].

Success factors and participatory ergonomics approach in the ErgoKita project

Specific conditions, including the use of participatory methods, support the effectiveness of interventions. These success factors are presented below and are linked to different participatory methods that were used in the data collection phase and the intervention phase of the ErgoKita project.

- **Steering group**

To thoroughly plan the aims of and processes in the ErgoKita project, a steering group was set up. It consisted of specialists in ergonomics and occupational medicine, labour inspectors from the social accident insurance institutions of the states involved and an evaluator. Therefore, the interests and perspectives of different stakeholders and disciplines could be taken into account in the conceptualisation, execution and evaluation of the intervention. Through the interdisciplinary cooperation of different research institutions, a biopsychosocial approach was pursued to achieve the most comprehensive effects possible. However, successfully implementing and conducting interventions is possible only if decision-makers within the target organisation are convinced by the intervention concept and pave the way for it. Therefore, while analysing the data collected in the pre-measurement phase of the ErgoKita project, the steering group was in close contact with the managers of the nine day-care facilities. It communicated the aims of the project to the managers and convinced them that they should participate in and engage with the project.

Establishing a steering group also ensures that all stakeholders have the same information and communicate consistent messages to participants in the project.

▪ Communication and involvement

Communication should provide adequate information on the intervention's aims, and should be realistic about expected intervention outcomes and the employees' role in the change process. If unrealistically high expectations on the intervention are raised and then only little change is implemented or employees do not get the chance to participate in initiatives, they might be disappointed and report worsened working conditions. In the course of ErgoKita, different participatory workshops were conducted with the managers and all nursery-school teachers in the nine facilities selected for assessment and the six intervention facilities (see section on study design above), by means of which the nursery-school teachers were involved in problem solving and intervention planning. This oriented the content of the intervention towards the actual needs of the nursery-school teachers, and the experiences, wishes and suggestions of the staff were particularly considered and included.

Regarding the intervention implementation, the managers and nursery-school teachers of the six intervention facilities were asked to choose jointly from the basic furniture package those pieces of ergonomic furniture most suitable for their institutions, taking into account their pedagogical programmes.

Participation in the intervention was partly open to all employees of the six intervention facilities and partly limited: whereas the awareness sessions were offered to only two nursery-school teachers per facility, all employees in the six intervention facilities were provided with ergonomic furniture.

▪ Readiness for change

Readiness for change is an important precursor of actual change. Employees are ready for change if they are not satisfied with their current work situation (for example because they are exposed to safety and health risks), consider change necessary and beneficial, and are motivated to take actions for change [29]. An organisation's readiness for change is highest if the organisation's members value the intended change, commit to it, and feel able to collectively implement and execute the actions necessary to attain change. Therefore, employees have to be 'both psychologically and behaviourally prepared to take action'. They have to be 'willing and able' to implement change [30].

ErgoKita collected data on physical and mental stressors at work and the health status of the nursery-school teachers in 24 children's day-care facilities. In nine facilities workshops were also conducted to collaboratively identify the most straining work situations, and specific solutions for each institution could be discussed. Thus, awareness was raised of working conditions that might be unfavourable to the nursery-school teachers' health. By means of this sensitisation, their readiness for change was positively affected.

▪ Leadership support

Commitment of the board and leadership support is essential in successful implementation of interventions. Change will happen more easily if managers provide a compelling vision of the post-intervention situation and how to achieve it in cooperation, show a positive attitude towards the intervention, act as role models and encourage the employees to participate. However, to ensure a continuous and effective change process, more than simply initial support is necessary. Managers must get involved in the change process and prioritise it, should provide specific feedback to the employees on how to make progress and should evaluate the change process [31]. Whenever employees perceive that their line manager shares their values and norms, they are more likely to follow their line manager in engaging in or holding back from the intervention [32]. However, if managers consider the intervention a disruption to the work to be done or do not have decision-making power, employees will rather be reluctant to act [29, 32].

Other barriers to employees' commitment to change processes are, for example, inconsistent messages coming from the board and line managers, or managers acting inconsistently or not supporting the change process at all. Sometimes there might be no management support for change processes in general; they might be resistant or might not enforce or encourage employees' intervention in job design or training. Sometimes managers might see the participation of employees as a threat instead of something worth supporting [33]. This suppresses the interest and participation of employees in interventions, particularly in strictly hierarchical structures. There might also be structural explanations for a lack of commitment or willingness to participate. These could include the fact that important decisions about change processes are taken elsewhere and not by the groups involved in the intervention.

In the ErgoKita project, two conditions were given that helped persuade the facilities to participate. First, the hierarchical structures of the children's day-care facilities involved in ErgoKita were all very lean and the sizes of the pedagogical teams rather small. Once the manager was convinced about the project, the team was very

likely to get involved as well. Second, the ergonomic furniture was provided by the social accident insurance institutions involved and was not to be financed by the organisation that ran the facility.

▪ **Good working climate**

In a trusting work environment with good cooperation, openness for learning and lean hierarchical structures, employees and managers can be co-learners in a change process and thus benefit from the positive collaborative climate. In cases where difficulties in working together exist, team-building activities should precede participatory activities [7]. If external consultants or experts are involved in the participatory interventions, a history of good labour relations with well-established communication channels is an advantage [7].

The ErgoKita project partly benefited from well-established working relations between the labour inspectors of the social accident insurance institutions and the managers of the facilities, as they already knew each other from regular inspections over the years. The social accident insurance institutions enjoy a good reputation in this sector, which helped to pave the way for the ErgoKita project even when the labour inspectors and the manager of the facility were not already acquainted.

Barriers to successful interventions are work settings with poor interpersonal relations or conflicts and low levels of teamwork. Employees might not be motivated or feel encouraged to actively support or promote change processes if they do not feel valued at work [34]. Low levels of social support and of role clarity are associated with less active involvement of middle managers in implementing interventions [35]. Moreover, normally even potentially successful interventions do not lead to change in organisations that are facing big challenges such as mergers or downsizing [32].

▪ **Resources**

The appropriateness of resources provided in a change process determines in part how the employees perceive their own ability to effect change. If there are enough and appropriate resources in terms of time, money, structural and cultural conditions, staff, material and information, employees are more likely to believe that they can effectively implement change processes [30].

However, often financial and time resources are limited and sometimes impede the implementation of all possible or the most suitable intervention measures. Moreover, not all participating groups might be able to benefit in the same way because they have different budgets and time restrictions, which might obstruct change. This is also true of ErgoKita: participation of the entire staff of each facility in the awareness sessions would probably have further increased the effect of the intervention. It was, however, not realisable, as the awareness sessions had to be conducted while the facility was open and the children had to be looked after by the remaining staff.

▪ **Training and information**

Employees might resist change, and their readiness for change might be low, if they fear that they lack specific competencies needed to work effectively once the changes are implemented [34]. Thus, employees should be prepared sufficiently for change processes by receiving training. It helps them to learn how to incorporate the desired behaviour into their daily working life and thus might increase their commitment. Training can also be used to explain the expected chain of effects of the intervention, that is, the separate steps that are supposed to be reached before finally reaching the intended improvements of the working conditions. Such training might be helpful to convince line managers, in particular, about the intervention, so that they buy in.

Valuing change can be enhanced by providing information and raising awareness of safety and health risks related to the work design or the way work tasks are executed [29].

In the ErgoKita project, putting the selected ergonomic furniture into use was accompanied by workshops. During these workshops, training in ergonomic behaviour was provided. It used video recordings and biofeedback measurement technologies showing the nursery-school teachers in unfavourable postures while carrying out their work. This 'auto-confrontation' method is agreed to lead to better sensitisation and memorability [14]. In joint discussions with the nursery-school teachers, suitable solutions were developed for a positive long-term change in behaviour. In line with the 'teach the teacher' principle, the two nursery-school teachers at each intervention facility were asked to pass on what they had learned to their colleagues.

▪ Long-term sustainability

It is a great challenge for all types of interventions to achieve a long-term and sustained impact. It requires a considerable effort to turn short-term interventions into continuous improvement programmes. One important factor is to find an effective way to awaken the interest of the participants and maintain their motivation. Another is to find the right way to embrace the non-participatory stakeholders, which in ErgoKita were the organisations that ran the facilities. In ErgoKita, this task was taken over by some of the facilities' managers, who informed their supervisors in the organisation about the positive effects of the ergonomic furniture. They asked them to invest in this kind of furniture and thus make it available to all groups within the facility. Some of the facilities' managers also asked their supervisors to take part in informative meetings on ergonomics in children's day-care facilities, provided by the social accident insurance institutions, so that they learned to focus not only on the children's health but also on that of the nursery-school teachers.

Furthermore, long-term support can counteract relapsing into old behaviour [4]. Throughout the implementation phase of the ErgoKita project, the participants were supported by ergonomic specialists, who initiated and guided the whole process, acted as project team members and trained the nursery-school teachers. The ergonomic specialists offered continuing support during the implementation and adaptation phase, which was rated as having a very favourable effect on long-term behaviour change. It was perceived as especially helpful in periods of high time pressure or particularly large workload, when the nursery-school teachers tended to relapse into old behaviour. As the furniture was planned to remain in the facilities right from the start, the long-term effect of the intervention was reinforced. In addition, the evaluation 2 years later brought the topic back onto the participants' agenda.

Transferability of this intervention to other countries/sectors/education levels

The PE approach, adopted by the ErgoKita project, is generally used to design interventions that aim to assess and reduce heavy muscular (over)load and/or awkward body postures and in the long run occupational MSDs. The PE approach can be applied at a vast variety of workplaces from the education sector to industry. Examples of applications include mining [36], domestic and civil construction [37], office environments [38], small businesses [39], newspapers [40], healthcare institutions [41] and manufacturing sites [42]. Although PE programmes originally focused on reducing physical loads, they are also used to create human-centred work [43] and improve organisational climate [44]. Moreover, PE is used as a framework for health promotion [45] and can thus be applied to all sectors.

The ErgoKita intervention, with its underlying reflections on height adaptations to the physiques of adults and the emphasis on preserving the nursery-school teachers' health, can be transferred to other children's day-care facilities in Germany and to other countries with similar working conditions for nursery-school teachers.

Based on the project's findings, a checklist was developed that addresses different types of work tasks of nursery-school teachers (such as playing, eating, sleeping, providing hygiene care, dressing children, and documentation) [46]. For each type of work task, questions are asked regarding the availability of ergonomic furniture and/or the application of ergonomic behaviour. The answer options are 'yes' and 'no'. This checklist comprises questions regarding not only ergonomics but also lighting conditions, indoor climate and ventilation, and acoustics, and can therefore also be used for the health-conscious design of children's day-care facilities or to redesign and transform individual facilities into model ones. All the ergonomic recommendations, along with strategies for the implementation of suitable acoustics, ventilation and lighting in nursery schools, were implemented in practice in another project, the MusterKita (model nursery) project (for more information see [47, 48]). This model nursery was built and can be used for advisory purposes whenever organisations that run children's day-care facilities intend to build a new facility or want to remodel facilities and seek advice from the relevant German social accident insurance institution. Thus, this model nursery can be used for demonstration purposes and could also be visited by nursery-school teachers in training.

The checklist mentioned above is part of an action guideline for the ergonomic design of day-care centres for children [46], which will be used uniformly by all accident insurance institutions in Germany. This will ensure that labour inspectors in day-care centres provide systematic ergonomic advice based on the latest findings of the ErgoKita project.

The findings and insights gained in ErgoKita could more easily be spread to other children's day-care facilities and put into practice if they were included in the vocational education and training of nursery-school teachers.

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