

Acceptability of a Multicomponent Intervention for Musculoskeletal Disorders among Blue-Collar Workers in Denmark – a Mixed-methods Feasibility Study

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Abstract

Background

Work-related musculoskeletal disorders (MSD) are highly prevalent, and workers with physically demanding work are at increased risk. Evidence-based standardised workplace interventions for MSD remain limited. PATH@work comprises 15 half-hour modules delivered by an occupational safety and health professional over an 8-week period, and includes three components: musculoskeletal health literacy education, physical exercises, and participatory ergonomics. This study aimed to evaluate the acceptability of and worker perceptions of the PATH@work intervention before preceding to a full-scale implementation trial.

Methods

A mixed-methods convergent feasibility study was conducted across four work teams at four workplaces, including 61 workers (team size 10–19). The primary outcome was acceptability, evaluated at follow-up using the Theoretical Framework of Acceptability questionnaire. Secondary, explorative outcomes included self-reported pain intensity (0–10 numeric rating scale) and sickness absence (days during the past month). Six semi-structured interviews using the Theoretical Framework of Acceptability explored the workers' perceptions and experiences of the intervention. Quantitative data were analysed descriptively, and qualitative data using the Framework Method. Mixed-method data analysis developed meta-inferences and potential intervention modifications in a joint display.

Results

Acceptability was high with 98% of the workers replying that they liked the intervention, 95% found it fair to include at the workplace and 95% rated it acceptable overall. However, 41% perceived the intervention burdensome, although qualitative data indicated that participation did not interfere with normal work tasks. The median pain scores were generally low (medians = 0–4) at both baseline and follow-up, and sickness absence was similarly low (median = 0). Qualitative findings indicated a preference for the physical exercise component, while participatory ergonomics was less well received. The workers described a workplace culture with limited openness regarding MSD and highlighted managerial engagement as important for sustained implementation.

Conclusion

The PATH@work intervention demonstrated high acceptability and was perceived as relevant among blue-collar workers, supporting its feasibility in workplace settings. Participation in participatory ergonomics was influenced by the workplace sociocultural norm as talking openly about MSD was

unfamiliar among the workers. Future intervention implementation should strengthen organisational support to enhance participation and intervention sustainability.

Trial registration

ClinicalTrials.gov NCT07466680. Registered 03/03/2026. This study is retrospectively registered.

Key messages regarding feasibility

1. Uncertainties regarding the feasibility

It was uncertain if a newly developed multicomponent workplace intervention based on a contemporary bio-psycho-social understanding of musculoskeletal disorders was acceptable among blue-collar workers.

2. Key feasibility findings

The intervention was acceptable among the workers. The workers were particularly positive about the physical exercise component, whereas engaging in dialogues on MSD during the participatory ergonomics component was challenging.

3. Implications of the findings

Strengthening the participatory ergonomics component through improved organisational implementation may facilitate workplace dialogue on MSD and enhance worker participation engagement.

Background

Work-related musculoskeletal disorders (MSD) are among the most prevalent global health challenges, affecting individuals and contributing substantially to the economic burden on society (1, 2). In Denmark, national surveys indicate that 29% of workers report regular pain, with the highest prevalence (approximately 50%) observed in occupational groups with physically demanding work tasks such as repetitive movements, sustained or awkward postures or heavy lifting (3).

MSD is associated with substantial individual consequences including pain, stiffness, impaired functional capacity and reduced work capacity (4). At the societal level, MSD impose considerable economic costs through increased health care use, sickness absence and premature exit from the labour market (1, 2, 5).

The World Health Organization defines work-related disorders as multifactorial conditions (6), and there is a broad consensus that MSD should be understood and prevented within the bio-psycho-social model (7, 8). However, existing workplace interventions, such as physical exercises (9, 10) and ergonomic

modifications to the work environment (11, 12), primarily target physical or ergonomic risk factors (13). Furthermore, studies suggest that manual handling advice and assistive devices alone are insufficient for preventing low back pain (14, 15). Participatory ergonomics interventions, involving the active engagement of workers in planning and organising their work tasks to reduce perceived workplace risk factors, may contribute to positive psycho-social working conditions (16). Educational components to enhance the understanding of MSD as a multifactorial condition provides a rationale for targeting pain drivers beyond physical exposures and aligns workplace interventions with contemporary clinical management of MSD (17). However, while single workplace interventions show promise, they are often fragmented and lack an integrated bio-psycho-social approach (8).

In response, we developed the multicomponent PATH@work intervention aiming to prevent MSD among blue-collar workers. However, ensuring the acceptability of the intervention among its intended recipients is necessary to support its potential effectiveness (18). Within implementation research, acceptability is the perception that a given intervention, service or practice is agreeable or satisfactory (Proctor, 2011) and is a critical determinant of intervention, uptake, adherence, and ultimately effectiveness (19).

The Theoretical Framework of Acceptability (TFA) provides a structured approach to conceptualising and assessing intervention acceptability (18). Within the TFA, acceptability is defined as a multifaceted construct that reflects the extent to which individuals delivering or receiving an intervention consider it appropriate based on anticipated or experienced cognitive and emotional responses (18). For feasibility studies, the TFA can help to operationalise acceptability and guide the methods used (18). Since its development, the TFA has been widely applied across qualitative, quantitative, and mixed-methods research, demonstrating its utility in evaluating interventions in a range of contexts, including home- and clinical-based care, digital health, and global health interventions (20–25). Acceptability is thus considered a prerequisite for intervention uptake, adoption and implementation (26).

Pain and sickness absence are common outcome measures for evaluating workplace interventions for MSD (27, 28). While acceptability or feasibility studies are not designed to determine intervention effectiveness (29), collecting potential outcome data alongside acceptability may provide a more comprehensive understanding of the intervention's potential impact.

Accordingly, the overall aim of this study was to evaluate the acceptability and the potential for individual-level effects of the PATH@work intervention among blue-collar workers prior to a full-scale implementation trial. The specific objectives were:

1. To evaluate the acceptability of the PATH@work intervention among blue-collar workers
2. To gain insights into the workers' perception and experiences with the PATH@work intervention
3. To explore pre- and post-intervention levels of pain and sickness absence
4. To compare and contrast quantitative and qualitative data to gain a comprehensive understanding of intervention acceptability and identify potential modifications for the future intervention

Methods

This study was conducted from April to June 2025. The reporting of this study follows the Consolidated Standards of Reporting Trials (CONSORT) statement for pilot and feasibility trials (30). A completed checklist is provided as Supplementary file 1.

Design, setting and participants

We carried out a mixed-methods convergent feasibility study, in which quantitative and qualitative data were collected in parallel (31). Companies with work teams with physically demanding job tasks (e.g. heavy lifting, awkward postures, repetitive and prolonged exertions) were eligible to participate. The companies were recruited via an invitation from a health insurance company acting as a gatekeeper and through social media (LinkedIn). All companies that responded to the invitations ($n = 4$) were included in the study. Three of the workplaces were large industrial production companies, and one workplace was a contracting company undertaking infrastructure development projects. At each workplace, a manager appointed a work team to participate in the intervention; no specific eligibility criteria were applied at the individual level. As a single-arm feasibility study in which all participants participated in the intervention, we did not include a formal power calculation to determine a sample size. Instead, the sample size was guided by the need to evaluate the predefined progression criteria related to the primary feasibility outcome of acceptability (see Data Analysis). For pragmatic reasons, all eligible workers at the participating companies were invited to participate (32). Further, due to the influx of new employees and the exit of others from the participating companies, this was an open cohort.

The PATH@work intervention

The multicomponent PATH@work intervention consisted of three overall components: musculoskeletal health literacy education, physical exercises and participatory ergonomics (Table 1). The intervention comprises 15 half-hour modules delivered during working hours over an 8-week intervention period, by a trained, in-house occupational safety and health (OSH) professional. The development of the PATH@work intervention and implementation strategy is described in detail elsewhere (33).

Table 1
The aim and content of the PATH@work intervention components.

Intervention component	Aim	Content
Musculoskeletal health literacy education	To increase workers' musculoskeletal health literacy	Short educational sessions on the bio-psycho-social model and dialogue about workplace prevention of MSD
Physical exercises	To increase workplace musculoskeletal health and workers' confidence in physical exercises	Whole-body physical exercises focusing on general body movements
Participatory ergonomics	To promote worker collaboration on managing MSD	Tools for structured dialogues to identify workplace challenges and develop action plans

MSD = musculoskeletal disorders

Data collection and analysis

Quantitative data collection

At baseline, worker characteristics (gender, age, level of education, job title, years of work experience) were collected. At follow-up, we collected data on acceptability using the translated TFA questionnaire, which operationalises acceptability through seven constructs (affective attitude, burden, perceived effectiveness, ethicality, intervention coherence, opportunity costs and self-efficacy). The questionnaire has one item per construct and a final item addressing overall acceptability, totalling eight items (18). Workers were asked to indicate their level of agreement with a statement for each construct in the questionnaire on a 5-point Likert scale (from *Completely agree* to *Completely disagree*). We translated the original TFA questionnaire into Danish and adapted it to PATH@work and the workplace setting. Each item was discussed and agreed through consensus within the research team to ensure relevance, meaning and accurate translation. Subsequently, the questionnaire was piloted on a sample of three workers from one of the participating workplaces, before the final version of the questionnaire was agreed (Supplementary file 2).

At both baseline and follow-up, we collected data on pain intensity using an 11 point (0–10) Numeric pain Rating Scale (NRS) (34). The workers were asked to score their average pain intensity within the last week from eight body areas (head, neck/shoulders, elbow, wrist/hands, lower back, hips, knees and ankles/feet). Sickness absence was also measured as the self-reported number of days of absence due to pain within the last four weeks at both timepoints. Data were collected through electronic questionnaires via SurveyXact for two workplaces, and in print for the other two workplaces.

Quantitative data analysis

To analyse acceptability, we used descriptive statistics reported as numbers and proportions. We dichotomised the Likert scale responses by combining *completely agree* with *agree* and *disagree* with *completely disagree*. The continuous outcomes were summarised using medians and interquartile ranges (IQR). All statistical analyses were performed using SAS software.

Qualitative data collection

At the end of the intervention period, two workers from each workplace (n = 8 in total) were invited to participate in the interviews. We used the TFA to structure the interview guide with at least one question per construct (Supplementary file 3). The interview guide was reviewed by the research group, and amendments were discussed and modified through consensus. Six interviews were completed face-to-face, and two interviews were completed online. All interviews were carried out by MS and audio recorded. MS has a professional background as a physiotherapist, with extensive clinical experience as well as practical experience as a work environment consultant.

Qualitative data analysis

The audio files were transcribed verbatim and pseudonymised. Transcripts were imported into NVivo 15 (version 3) software. Firstly, transcripts were coded deductively using the TFA. Secondly, codes within each construct were analysed inductively using the Framework Method to identify relevant themes (35, 36). The data analysis steps were: 1) Familiarisation, where the transcripts were read through several times and initial codes were made, 2) Construction of analytical framework using the TFA, 3) Applying the framework by indexing and sorting the data into the categories, 4) Charting and summarising the data by category, 5) Abstraction and interpretation of the data detecting elements and dimensions, and 6) Developing themes and subthemes. MS carried out the initial data analysis and discussed the findings iteratively with members of the research team to reach consensus.

Mixed-methods analysis and progression criteria

We used the integration of the quantitative and qualitative data to evaluate the overall acceptability of the intervention and propose potential modifications of the intervention content. To inform a decision on advancing from a feasibility study to the next step in evaluating an intervention, Eldridge et al. (2016) recommend developing progression criteria (30). Using the traffic light system proposed by Mellor et al. (2023), we created a set of progression criteria (37) based on TFA (Table 2). Across the eight constructs, criteria consisting of both a quantitative and a qualitative component were formulated to indicate one of three options: *go ahead as planned* (green), *amend and proceed with minor changes* (yellow), and *stop and proceed with major changes* (red). The criteria were developed through iterative discussions within the research group and previous workplace intervention research (25), and ultimately displayed as a joint display (38, 39).

Table 2
Progression criteria for interpretation of acceptability

TFA construct	Go and proceed as planned	Amend and proceed with minor changes	Stop or proceed with major changes
Affective attitude	≥ 75% completely agree or agree	60–74% completely agree or agree	< 60% completely agree or agree
Burden	The intervention is described as possible during work hours The intervention is described as positive, and the workers are willing to continue with the intervention beyond the study	The intervention or components are described as challenging at times Some of the intervention components are described less positively or modifications are suggested	The intervention is described as too excessive or disruptive to work tasks The intervention conflicts with values or causes stigma
Ethicality			
Perceived effectiveness			
Intervention coherence			
Self-efficacy			
Opportunity costs			
General acceptability			
Unintended consequences	No harm or negative consequences	Negative consequences, which are manageable or can be addressed through modifications	Severe, widespread or non-modifiable consequences

TFA = the Theoretical Framework of Acceptability

Results

Quantitative results

Worker characteristics

A total of 61 workers from four workplaces (10-19 workers per workplace), responded to the questionnaire at baseline. At follow-up, 59 workers responded (Figure 1).

Worker characteristics are presented in Table 3. The age ranged from 20 to 64 years. The majority were male (65%), and had completed primary, secondary or vocational training (65%). The most commonly reported job title was manual or warehouse worker (58%), and with just over half reporting more than ten years of work experience (54%).

Table 3. Worker characteristics

Gender (n=57), n (%)	
Male	37 (65%)
Female	20 (35%)
Age (n =58), median (IQR)	
51 (41-58)	
Level of education (n=56), n (%)	
Completed primary and secondary	11 (20%)
Completed college/vocational training	25 (45%)
Completed higher education	20 (35%)
No formal education	0
Job title (n=31), n (%)	
Manual worker	10 (32%)
Warehouse worker	8 (26%)
Technical support	5 (16%)
Project manager/team coordinator	6 (19%)
Other	2 (7%)
Years of work experience (n=24), n (%)	
≤10	11 (46%)
>10	13 (54%)

Acceptability

Overall, the acceptability of the intervention was high. Almost all of the workers (98%) liked the intervention (affective attitude), 95% thought the intervention was fair to include at the workplace (ethicality), 80% thought the intervention had given them competencies to manage MSD at the workplace (perceived effectiveness), 91% felt confident in participating in the intervention (self-efficacy), and 95% found the intervention acceptable (general acceptability). Lower agreement was reported for the two items, burden (59%) and intervention coherence (70%) (Table 4).

Table 4. Descriptive statistics for the questionnaire data on acceptability at follow-up (n=56)

TFA constructs	n (%)
<i>Affective attitude: I liked the intervention</i>	
Completely agree	35 (62.5)
Agree	20 (35.7)
No opinion	1 (1.8)
Disagree	0
Completely disagree	0
<i>Burden: It required little of me to participate in the intervention</i>	
Completely agree	7 (12.7)
Agree	26 (46.4)
No opinion	11 (19.6)
Disagree	9 (16.1)
Completely disagree	3 (5.4)
<i>Ethicality: The intervention is fair to include at the workplace</i>	
Completely agree	37 (66.1)
Agree	16 (28.6)
No opinion	2 (3.6)
Disagree	0
Completely disagree	1 (1.8)
<i>*Perceived effectiveness: The intervention has given me competencies to manage MSD at the workplace</i>	
Completely agree	16 (29.1)
Agree	28 (50.9)
No opinion	9 (16.4)
Disagree	2 (3.6)
Completely disagree	

	0
Intervention coherence: <i>It is clear to me how the intervention can help me manage MSD</i>	
Completely agree	
Agree	22 (29.3)
No opinion	23 (41.1)
Disagree	9 (16.1)
Completely disagree	2 (3.6)
	0
Self-efficacy: <i>I feel confident in participating in the intervention</i>	
Completely agree	34 (60.7)
Agree	17 (30.4)
No opinion	2 (3.6)
Disagree	0
Completely disagree	3 (5.4)
Opportunity costs: <i>The intervention did not interfere with my other work tasks</i>	
Completely agree	21 (37.5)
Agree	21 (37.5)
No opinion	8 (14.3)
Disagree	5 (8.9)
Completely disagree	1 (1.8)
General acceptability: <i>I find the intervention acceptable</i>	
Completely agree	34 (60.7)
Agree	19 (33.9)
No opinion	2 (3.6)
Disagree	0
Completely disagree	1 (1.8)

*n=55

TFA=the Theoretical Framework of Acceptability; MSD=musculoskeletal disorders

Pain and sickness absence

The median pain scores were generally low (medians=0-4) at both baseline and follow-up, with only marginal differences observed and no clear pattern. Across pain sites, the lower back (median=3) and neck/shoulders scored highest (median=4). Days of sickness absence due to pain remained low (median=0) at both baseline and follow-up (Table 5).

Table 5. Pain score and sickness absence at baseline and follow-up.

	Baseline Median (IQR), n=56*	Follow-up Median (IQR), n=56*
NRS score		
Head	1 (0-3), 56	1 (0-3), 55
Neck/shoulders	4 (2-6), 55	4 (2-5), 56
Elbow	0 (0-1), 53	0 (0-2), 55
Wrists/hands	1 (0-3), 55	1 (0-4), 56
Lower back	3 (1-6), 56	3 (1-5), 55
Hips	0 (0-3), 53	0 (0-2), 55
Knees	2 (0-4), 55	2 (0-4), 56
Ankles/feet	2 (0-3), 54	1 (0-4), 51
Days of sickness leave due to pain in the last 4 weeks	0 (0-0), 49	0 (0-0), 48

**Due to missing data, n varied from 48-56*

IQR=Interquartile range; NRS=Numeric pain Rating Score

Qualitative data results

Three themes emerged relating to the effect of the intervention, the relevance of the intervention and the workplace culture.

Theme 1. Psychosocial effects of physical exercises

All interviewed workers expressed positive experiences with the intervention, particularly related to the physical exercise component. The physical exercises were consistently described as beneficial and as improving well-being. As described by one worker: *"I can definitely feel it, that you're kind of put through your paces in the morning. You're less stiff in your joints when you get cracking and all that, you know"* (Worker 5).

The exercises also appeared to facilitate positive social interactions among co-workers, including informal conversations, improved mood and strengthened social relations. One worker stated: *"It's a nice break, but you also get to see your colleagues in a different way, and that actually means something too; something you can't really measure. I mean, just being able to have a laugh together. I suppose it's been OK to know some of the theory behind it, too. The physical stuff is better because then people can feel in their body the effect it's having"* (Worker 2).

This was supported by another worker: *"It's also helped me focus on myself and the mental work environment. The physical exercises have a positive effect on the rest of the working day. Everyone can join in. It's been really great"* (Worker 1).

Theme 2. The intervention is relevant

The workers described that maintaining a safe and healthy work environment was an integral part of their daily work routines. They suggested that, over time, the intervention could similarly become integrated into their work practice: *"[the work environment] is not something people really talk about that much on a daily basis...we're so invested in the working environment, it's sort of become part of everyday life, remembering to use the technical aids and all that, you know? Maybe [the intervention] will be the same in time and inspire people to do a bit more"* (Worker 7).

The workers believed the intervention could help create more openness regarding musculoskeletal challenges and their management. Two workers expressed:

"It's not a crime to be in pain, you know, and, when you're helping each other, it's useful for [my co-worker] to know that I've got some limitations that day, or maybe even permanently" (Worker 7).

"But I think that for people who maybe aren't as close-knit as we are in my department, it might actually help them to put some things into words, instead of allowing it... to lurk in the background all the time, you know" (Worker 5).

Theme 3. Workplace culture as a barrier for participatory action

The participatory ergonomic component was perceived less positively. Several workers indicated that they were not accustomed to openly talking about MSD with peers, which made engagement in participatory discussions challenging.

“Men will be men, so if our finger hurts or stuff like that, we keep it to ourselves... I think it's a male pride thing” (Worker 5).

“But I feel, if my back hurts, I will tell, as I am not able to carry stuff that day. But it is still a bit of a taboo, you don’t want to come across as weak or something” (Worker 1).

One worker noted that dialogues about MSD were often selective: *“In those cases, I think you’re selective in terms of who you talk to. You don’t tell everyone” (worker 2).*

Integration of data and progression criteria

The quantitative and qualitative data synthesis, interpretation and implications are presented in Table 6. Seven of the eight items met our progression criteria for acceptability, while one item, *burden*, fell in the *amend category*. No unintended consequences were identified. The integration of findings led to several suggestions for modifications of the intervention content and design (Table 6).

Table 6. Joint display synthesising, comparing and interpreting quantitative and qualitative data

TFA construct	QUANTITATIVE	QUALITATIVE	Interpretation	Meta-inferences and potential modifications of the intervention
Affective attitude	98% agreed that they liked the intervention	<i>"It's been great, both the teaching and the physical exercises. A breath of fresh air and a good laugh" (Worker 7)</i> <i>"The only time it was boring is where we've stood around and talked a lot...I get the sense that people are thinking, 'Just get on with it' Can't we just do something?" (Worker 1)</i>	Expand. The quantitative data indicated that the workers liked the intervention. The qualitative data expanded this as the workers described the intervention enjoyable and refreshing. However, some qualitative nuance indicated that the participatory ergonomics component was less engaging.	We found that the positive attitude towards the intervention was primarily driven by the physical exercise component. Potential intervention modifications may include: • To retain the core structure of the intervention, but refine participatory ergonomics to enhance engagement

Burden	59 % agreed that it required little of them to participate in the intervention	<i>"So, I don't think it's got in the way of anything. I think, the days and production, they'll be taken care of anyway, and we're allowed to set aside time for it, right? There's been no pressure afterwards..." (Worker 6)</i> <i>"It was no problem; we can do each other's' tasks afterwards if needed" (Worker 1)</i>	Diverge. The quantitative data suggested a relatively high burden, however the qualitative findings indicated that despite time away from normal work tasks, it was manageable due to task-sharing and workplace flexibility.	The findings indicated that the worker participation time was manageable in practice. Potential intervention modifications may include: • Integrating the intervention into existing work tasks or routines
Ethicality	95% agreed that the intervention was fair to include at the workplace	<i>"Not to generalise, but some people may not eat healthy or exercise according to the recommendations. I think this intervention can motivate people to do more" (Worker 1)</i>	Converge. The quantitative and qualitative data indicated that the intervention was perceived as fair.	We found that the intervention fitted individual values. Potential intervention modifications may include: • Communication across organisational levels to promote collaboration and shared responsibility rather than individual responsibility alone
Perceived effectiveness	80% agreed that the intervention had given them competencies to manage MSD at the workplace	<i>"Difficult to define pain. Can be caused by a physical ailment or if you're depressed; pain can also affect you mentally and drain your energy" (Worker 3)</i>	Expand. Both the quantitative and qualitative data suggested that workers had	We identified a potential disconnect between perceived benefits (competencies and knowledge) and objectively measured outcomes

	Median pain scores were similar at the baseline and follow-up time. No change was observed in days of sickness absence.	<i>"I get to talk to other colleagues. It creates a positive atmosphere and new relations. New relations are good for the workplace"</i> (Worker 2)	gained competencies to manage MSD at the workplace and a bio-psycho-social understanding of MSD. However, this was not transformed into changes in pain or sickness absence.	(pain and sickness absence). Potential modifications related to measuring the intervention effect may include: • Proximal outcomes focusing on knowledge and competencies at individual and group levels, as well as psycho-social benefits • Measuring pain and pain-related sickness absence as distal outcomes, expected to change only at long-term and follow-up and only in those experiencing pain at baseline
Intervention coherence	70% agreed that the intervention can help them to manage MSD	<i>"[the intervention] just highlights that it's a good idea to look after each other and your self"</i> (Worker 5) <i>"I think it's a combination. You may have lots of ideas about exercises but it doesn't work if you do not have the theory to back it up. You need both for it to work"</i> (Worker 3)	Convergence. The quantitative data suggested that the workers believed the intervention could help them to manage MSD and the qualitative data suggested that both theory and exercises are needed.	The findings indicate that the intervention "made sense" and reinforced existing beliefs. Potential intervention modifications may include: • Integration of educational components, physical exercises, and

				practice as this appears central to engagement and understanding
Self-efficacy	91% agreed that they felt confident in participating in the intervention	<i>"And it would also help if the whole organisation prioritised this"</i> (Worker 6)	Expand. The quantitative data suggested high confidence in participating in the intervention. Further, the qualitative data suggested the importance of organisational support for this.	The findings indicated that high worker confidence in intervention participation appeared contingent on organisational support and priorities. Potential intervention modifications may include: • Strengthening the organisational endorsement and include managers in the planning and execution of the intervention
Opportunity cost	75% agreed that the intervention did not interfere with their other work tasks	<i>"Maybe things take an extra half hour of you day, but its not like several days delay"</i> (Worker 2) <i>"...because, had [the management] said it was after work, then maybe only 50% of us would participate"</i> (Worker 6)	Convergence. The quantitative data suggested that the workers did not perceive major interference with work tasks. The qualitative data confirmed that although sessions take time, they do not significantly cause delay.	We found that the intervention is manageable within the workday without causing significant delays.

General acceptability	95% agree that the intervention is acceptable	<i>"I think, we should have ambassadors in each unit. I would really like to continue, I really would"</i> (Worker 2)	Expand. The quantitative and qualitative data suggest high acceptability. More ambassadors may be a way to promote intervention continuation.	We found that the workers' motivation and uptake may be increased by more ambassadors to facilitate empowerment and collaboration. Potential intervention modifications may include: • Include worker ambassadors or peer-learning to strengthen intervention implementation and sustainment
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Abbreviations: TFA=the Theoretical Framework of Acceptability; MSD=musculoskeletal disorders

Discussion

We conducted a mixed-methods feasibility study to evaluate the acceptability of the PATH@work intervention among blue-collar workers. Both quantitative and qualitative findings demonstrated high acceptability among the workers. Most of the workers expressed a positive attitude towards the intervention and perceived it as relevant to their workplace. In particular, the physical exercise component was well received and was reported to provide mental and social benefits. In contrast, the workers reported that they were not used to talking openly about MSD which made engagement with the participatory ergonomics component challenging. This finding suggests the presence of a social and cultural barriers that influence intervention participation. No meaningful changes were observed in pain after the intervention period. Sickness absence was too infrequent for the median number of absence days to be a meaningful outcome measure. The mixed-methods analysis identified several areas for refinement of the intervention, including greater integration into existing work tasks to reduce the perceived burden of participation, stronger alignment between the three intervention components, and increased organisational engagement to support implementation and intervention sustainability.

The workers expressed a clear preference for the physical exercise component. One explanation was that they experienced a positive effect on physical and general well-being. In addition, the exercises were viewed as an opportunity for informal interactions with their colleagues. These findings align with

previous workplace studies showing that physical exercise interventions reduce MSD and produce beneficial psychosocial effects (12, 40). The well-established literature on workplace physical exercises (12, 41) and the increasing number of workplaces introducing physical exercises during work hours may also reflect a shift in Danish workplace culture, where physical exercises and active breaks are becoming more commonly implemented and accepted (42).

In contrast, the participatory ergonomics component was challenging for the workers to engage with. As participatory ergonomics is a flexible process rather than a standardised intervention, worker participation and engagement are essential (43). The findings may therefore indicate challenges in establishing a collaboration around participatory ergonomics, which should be addressed before progressing to a larger implementation study. Another possible explanation is that the workplace culture was characterised by limited openness and familiarity with discussing MSD-related issues among workers. This finding is consistent with previous research showing that participatory ergonomics are dependent on the implementation conditions such as worker needs, clear distribution of roles and responsibilities, allocation of sufficient resources and managerial commitment (44). Effective prevention of MSD requires integration of physical, organisational and psychosocial aspects of work (7, 45). Consequently, strengthening the participatory ergonomics component through improved organisational implementation may facilitate dialogue about MSD, enhance worker engagement, and better counter any negative or unproductive workplace cultures.

Despite overall high acceptability, and green light progression criteria in seven out of eight TFA constructs, the construct *burden* was characterised by divergent quantitative and qualitative findings and was judged to need “amendment”. The question used to inquire about the burden (*it required little of me to participate in the intervention*) may have been interpreted in various ways. Burden may signify measurable factors such as time or task completion, but may also extend beyond to include cognitive and emotional demands related to behavioural change and skills acquisition (20). In future, a comprehensive understanding of burden as multidimensional (temporal, cognitive and emotional) should be explored to ensure accurate interpretation of study results and intervention feasibility. To reduce the perceived burden, interventions may be closer aligned with the workplace core tasks. Such alignment has been identified as an important facilitator among childcare workers and machine operators at manufacturing settings, where embedding interventions for MSD with the core work tasks and with the workers’ needs facilitated intervention participation (46).

To further enhance acceptability of and engagement with participatory ergonomics, future studies could incorporate a formal needs assessment to identify workplace factors that may influence intervention uptake such as an assessment of organisational readiness for change (45, 47). Such an assessment may examine managerial commitment, existing organisational practices and procedures, and previous successful collaborative initiatives that could facilitate intervention acceptability and uptake (48, 49). Furthermore, Andersen et al. (2021) emphasise the importance of assessing the relational fit between the intervention facilitator (the OSH professional) and the workers, as relationship may account for up to 40% of the observed intervention effect (50).

We did not observe any changes in pain intensity or sickness absence. This finding was not unexpected, as the study was designed as a feasibility study with a small sample size and was therefore not powered to detect intervention effects on these outcomes (30, 51). Furthermore, baseline levels of pain and sickness absence were low, limiting the potential for detecting meaningful improvements over the relatively short intervention period. A notable finding was that 35% of the workers had completed higher education, raising questions about the extent to which the sample was representative of blue-collar workers. This characteristic may also have contributed to the low baseline levels of pain observed in the study.

Methodological strengths and limitations

A strength of this study was the use of mixed-methods in the design, methods and analysis steps (38). We integrated the two data sources and obtained a more comprehensive understanding of the workers' acceptability. As mixed-methods analysis offers a powerful approach for addressing limitations inherent to single-method approaches (52), we were able to provide a more nuanced and rigorous assessment of intervention feasibility.

Several limitations should be considered when interpreting the findings. Firstly, the study included a relatively small sample and no control group. However, both are characteristics of feasibility studies, where the primary objective is to assess whether an intervention *can work* (53). Secondly, the workers were selected by the workplace manager, which may have influenced workers' engagement and motivation for the intervention. Thirdly, we translated the TFA questionnaire without doing back-translation or cultural adaptations (54). Since the completion of our data collection, a Danish version of the TFA questionnaire following a more rigorous translation process has become available (55). Overall, our translation closely resembles the final Danish version across most constructs. Lastly, the number of missing data points is relatively high, limiting the generalisability of the findings.

Conclusions

The PATH@work intervention demonstrated high acceptability and was perceived relevant among blue-collar workers, supporting its feasibility in workplace settings. The findings suggest that while workers readily engaged with the physical exercise component, participation in the participatory ergonomics component was influenced by sociocultural norms, where open dialogue of MSD was unfamiliar. Future refinement of the PATH@work intervention should therefore strengthen organisational engagement, integrate intervention components more closely into routine work practices, and incorporate strategies to facilitate cultural change, thereby enhancing implementation, participation, and intervention sustainability.

Abbreviations

MSD
Musculoskeletal Disorders

Declarations

Ethics approval and consent to participate

The Committees on Health Research Ethics for the Capital Region of Denmark assessed the study (Ref number: F-24011807) and concluded that ethical approval was not required as the planned evaluation of the study did not fall under the definition of the laws defined in Committee Act § 2 and § 1 (56). Participation in the study was voluntary, and written informed consent was obtained from all participants before the study began.

Consent for publication

Not applicable.

Competing interests

AK is a co-developer of GLA:D®. A non-for-profit initiative hosted at University of Southern Denmark aimed at implementing evidence-based patient education and exercise therapy for osteoarthritis and back pain in clinical practice.

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Author Contribution

MS designed and developed the intervention, recruited the workplaces, carried out the interviews, analysed the data and wrote the first manuscript draft. AK developed the intervention and contributed to overall study design and evaluation. RSL, SBTJ and SVS developed the intervention and contributed to data analysis and evaluation. MJS developed the intervention, contributed to data analysis and evaluation, and supervised the study. All authors read and approve the final manuscript.

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Not applicable

Data Availability

The interview datasets analysed during the current study are not publicly available due to concerns regarding participant anonymity. Other datasets generated and/or analysed during the study are available from the corresponding author on reasonable request.

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Figures

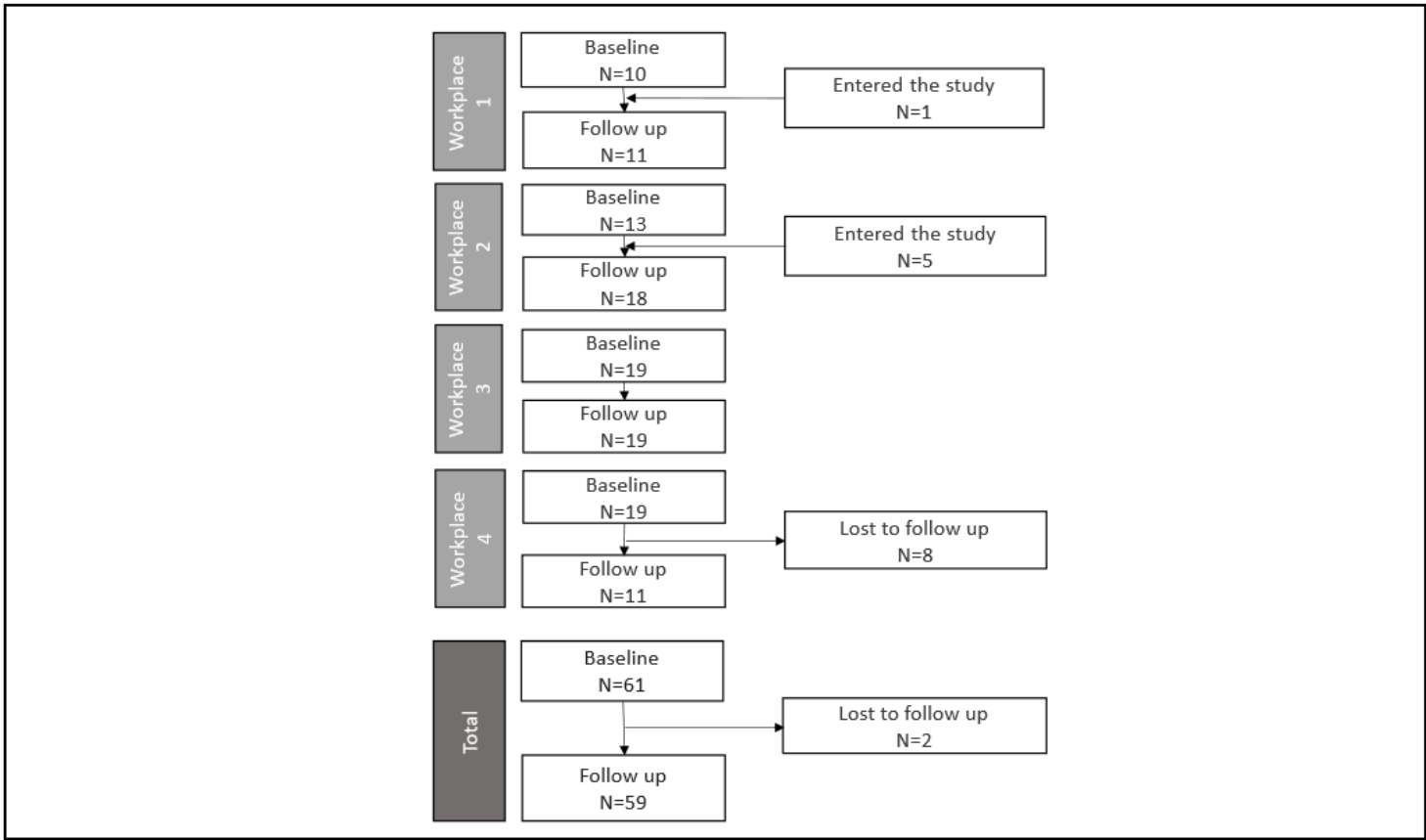


Figure 1

Worker flow chart.

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