Relative benefit of a stage of change approach for the prevention of musculoskeletal pain and discomfort: a cluster randomised trial

by Diana Doda 3

ORIGINAL ARTICLE

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ABSTRACT

Objectives To examine the benefit of a psychological Stage of Change (SOC) approach, relative to standard ergonomics advice, for the prevention of work-related musculoskeletal pain and discomfort (MSPD).

Methods A cluster randomised trial was conducted in South Australia across a broad range of workplaces. Repeated face-to-face interviews were conducted onsite to assess MSPD, safety climate, job satisfaction and other factors. Changes in MSPD across intervention groups and time were investigated using Generalised Estimating Equation (GEE) methods.

Results 25 workgroups (involving 242 workers) were randomly allocated to either a standard intervention or an intervention tailored according to SOC. The prevalence of MSPD increased for both groups, but was only significant for the standard group, in respect of lower back MSPD. Workers receiving tailored interventions were 60% less likely to experience lower back MSPD. After adjusting for age, gender and job satisfaction, it was found that company safety climate and length of employment were significantly correlated to the time-intervention effect. There was no correlation with workload.

Conclusions Compared with standard ergonomics advice to management, there was evidence of a benefit of stage-matched intervention for MSPD prevention, particularly for low back pain. Organisational safety climate should be taken into account when planning prevention programmes.

What this paper adds

- The application of the Stage of Change approach has been proposed as a means of improving the effectiveness of injury prevention advice to organisations. However, there have been no randomised trials conducted to evaluate its effectiveness.
- This study, conducted in a range of workplaces known to be at high risk of musculoskeletal injury, has demonstrated the relative benefit of adopting the Stage of Change approach in the development of injury prevention advice.
- Safety climate was shown to be correlated with the prevalence of work-related musculoskeletal pain and discomfort and should be surveyed as part of any comprehensive prevention strategy.

INTRODUCTION

Work-related musculoskeletal disorders (MSDs) have a significant impact on workers' health and well-being, causing economic burden, not only to workers and the community but also organisations and governments, from compensation costs, lost wages and reduced productivity.[1] The prevalence and/or incidence of MSDs have been studied in many countries. The Fifth European Survey on Working Conditions in 2012 reported that from the seven most common health problems reported in the previous 12 months, the prevalence of musculoskeletal pain was the most frequent. The most prevalent locations of pain were the back (47%) and shoulder, neck or upper limb (45%).[2] The UK Health and Safety Executive (HSE), in their 2011/2012 Labour Force Survey reported that MSDs accounted for 439 000 out of 1 073 000 work-related illnesses.[3]

In Australia in 2010/2011, 41.9% of all serious compensation claims (those requiring more than 5 days absence from work) were attributed to sprains and strains with 39.9% of all work-related injuries caused by body stressing.[4] In the National Hazard Exposure Workers Surveillance survey (2010) only 27.8% of workers reported having no musculoskeletal pain in any body part in the past 7 days.[5] Multiple risk factors, both physical and psychosocial, have been found to be associated with work-related MSDs and various approaches to prevention used.

The Stage of Change (SOC) approach, originally developed to influence individual health-related behaviour change, has more recently been applied in workplace settings.[6–8] In the SOC approach injury prevention advice is tailored according to the workers' readiness to change. This is determined using a series of short, closed questions after which the participant is assigned to one of several stages:

1. Precontemplation (unaware or unconcerned with workplace hazards)
2. Contemplation (considering change but not yet ready to do so)
3. Preparation (intending to change in the near future)
4. Action (changes made in the previous 6 months)
5. Maintenance (changes made and are working to consolidate these and avoid relapse)

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Longitudinal research using the SOC approach in workplaces has been carried out in the UK[9] and Australia.[10] The UK study compared tailored (stage-matched) interventions versus standard (unmatched) interventions. At 6 months follow-up, the workgroups with tailored interventions showed a slight reduction in the reported 7-day prevalence of musculoskeletal pain and discomfort (MSPD 80–73%). However, there were significant reductions in several specific body areas including the upper arm, elbow, forearm, wrist, hand, lower back and leg. A similar result was found at 15 months and 20 months postintervention.[11] There were also significant changes in SOC, including fewer workers in the precontemplation and preparation stages, and more workers in action and maintenance, compared to preintervention.[11]

The authors concluded that the tailored interventions were able to reduce MSPD, encouraged advancement through the SOC and helped change behaviour.[8 9]

Utilising an Australian study population and the same UK survey tool, Stewart *et al*[12] reported baseline MSPD in a broad range of industries. Subsequently Rothmore *et al*[10] described the implementation of interventions applied to 25 workgroups which were randomly assigned to receive either standard ergonomics advice or advice tailored according to the SOC profile of the workers. At 12 months follow-up, companies in receipt of tailored ergonomics advice had implemented recommended changes at a significantly higher rate than those in receipt of standard ergonomics advice.

Rothmore *et al* did not include health outcomes and thus the purpose of this paper is to report on the differences between the interventions in respect of MSPD, using a cluster randomised analysis.

METHODS

Recruitment

A purposive sampling method was carried out to recruit companies. The choice reflected MSD claims experience from the State workers compensation authority—WorkCover South Australia.[13] Medium-size (20–200 employees) and large-size (more than 200 employees) companies[14] were invited to participate in this study by sending letters or making phone calls. The inclusion criteria for a company were (1) having definable workgroups with at least 10 workers in each workgroup,[15] and (2) planning to introduce interventions to reduce MSDs. The inclusion criteria for individual workers at each company were (1) being employed on an ongoing basis, (2) having similar roles to others within the workgroup, enabling comparison of similar risk of MSPD and (3) having sufficient English language skills. Participation of the workers was voluntary and based on their availability. Sample size was based on a similar study by Whysall *et al*[8] and on pragmatic participation. Ethics approval for the research was granted by the University of Adelaide.

Study design and instrument

The research design was a cluster randomised trial nested within two repeated cross-sectional studies.[16] The instrument for both surveys comprised a series of questionnaires which incorporated demographic information, MSPD (via a body chart), safety climate, SOC and job satisfaction (see online supplementary appendix).[12 17 18] MSPD was measured by asking participants to rate their pain/discomfort severity for 10 different body areas on a scale of 1–7 (ranging from minimal to extreme) over the previous 7 days.[12] Safety climate was measured using a version of a Safety Climate questionnaire originally developed by Cox and Cheyne[17] which had been modified to increase its applicability in the workplace by Whysall *et al*.[8] The original questionnaire has been extensively tested and was selected due to its reliability and sensitivity to detect differences between occupational groups.[12] SOC was assessed using a short series of closed questions which have been previously applied in workplace settings. Job satisfaction was measured using a scale developed by Warr *et al*.[18] This has been used widely and has shown good internal reliability. Workload was determined following direct observation by an ergonomist (at baseline and follow-up) and based on the definition used in the Dictionary of Occupational Titles (DOT).[19]

The questionnaire package was piloted with three companies (50 workers) which did not participate in the main study. Based on the results of the pilot study and suggestions from the previous UK study,[9] the contemplation and preparation stages in the SOC were merged.

Randomisation and blinding

Cluster randomisation was used with a workgroup within a company as a cluster. To allow for the intervention to be implemented continuously, block randomisation was used. Following recruitment of each consecutive block of 5–10 clusters (workgroups), an equal number of workgroups were assigned to either the standard or tailored group. Randomisation in each block was carried out by an independent researcher using a randomising function in Microsoft Excel.

Both the ergonomist delivering the intervention and company managers were blind to the allocation of each workgroup at the stage when the ergonomist undertook the initial worksite observations and developed recommendations for the workgroups. However, during implementation of the intervention blinding (of group allocation) of the ergonomist and the managers was not possible.

Research procedure (preintervention and postintervention study)

The overall research procedure is illustrated in figure 1.

Interventions

As part of the protocol, companies had agreed to implement interventions regardless of allocation to tailored or standard arms. The interventions were to be developed with advice from a single ergonomist. This advice was provided following direct observation of work activities and informal discussions with workers and managers. As a minimum, each workgroup manager was provided with a written report detailing the observations undertaken, the recommended changes as well as (publicly available) supplementary guidance for MSD prevention, such as brochures.

Implementation of interventions whether tailored or standard was undertaken as soon as practicable following receipt of the advice—that is, after the collection of baseline data—but at the company's discretion. The managers to whom the recommendations were provided were responsible for occupational health and safety within their organisations.

Intervention procedure in the standard group

The standard intervention workgroup managers received ergonomics recommendations based on the worksite observations that were not tailored on SOC.

Intervention procedure in the tailored group

Managers of workgroups allocated to a tailored intervention also received ergonomics recommendations based on the

worksite observations. In addition they received information on the SOC of the workers in the workgroup and its relevance to the choice of possible interventions. In this process, de-identified aggregated information was provided to the manager.

For example in a hypothetical workgroup 'X', the distribution of SOC of the workers was as follows: two workers in precontemplation stage, six in contemplation/preparation, zero in action and four in maintenance. The written recommendations took account of all three stages present in that workgroup (precontemplation, contemplation/preparation and maintenance). The manager then made a decision based on the practicability and affordability of the proposed interventions for the company and its employees. The managers to whom the reports were provided were responsible for the implementation of the chosen changes.

It should be noted that the recommendations for stage-matched interventions in this research were different from the previous UK study[9] where the recommended SOC approach was based on the most common stage. In this research the intervention was based on the workgroup SOC profile. Hence, for example, awareness-raising was included as part of the advice so long as there was at least one member of the workgroup in precontemplation. Interventions addressed various kinds of recommendations to control MSD, including redesign of tools, workstations, work processes, purchase of new equipment, job rotation, worksite inspection programmes, manual handling training and exercises. In total, 25 interventions (13 standard and 12 tailored) were monitored within a range of 21 companies and 8 industrial sectors. Interventions were implemented via the manager to the workers. The ergonomist followed up the interventions every 3 months by asking the manager through a phone call, about the progress of the implementation.

The follow-up survey was undertaken 12 months after the ergonomics recommendations were provided to the companies.

Statistical analysis

There was no difference in the number of recommended changes provided to companies in the standard or tailored arms of the study.

Only participants who were involved in the baseline (n=404) and follow-up surveys (n=242) were included in the analysis. The aim of this study was to assess the effect of a tailored intervention on risk of MSPD within this population of workers. While the data are repeated within individual and are therefore correlated, the main focus of the research question was not on the individual-level effect of the intervention. Therefore, Generalised Estimating Equations (GEE) with log link and binomial distribution were used to examine the population-averaged intervention effect. However, there were a number of additional variables which were thought to be important to the experience and reporting of MSPD. The variables also examined were SOC, job satisfaction, safety climate of the workplace, number of years employed, age and gender. These variables were included as main effects only in all models. Planned comparisons were conducted to examine the overall effect of intervention and the change over time within each group separately.

RESULTS

Industry participation

Twenty-five workgroups were allocated to two intervention groups, the tailored group (n=12) and standard group (n=13). The sample comprised a wide range of industry sectors including manufacturing, food industries, healthcare services, mining, professional services and other services In standard workgroups the majority of workers were from large companies (84%), similar to the proportion in the tailored group (65%).

Recommended interventions

There were no differences in the total number of recommended changes, their type or the timing of their implementation between companies in receipt of standard or tailored ergonomics advice. Managers in receipt of tailored advice did, however, introduce significantly more recommended changes. Details on the proposed interventions for companies in the standard and tailored groups are provided in table 1.

Participant characteristics

A total of 24[45] workers within 21 companies participated in both surveys. The characteristics of the participants are presented in table 2.

Prevalence of MSPD preintervention and postintervention

Table 3 shows the reported prevalences of MSPD, and the changes following interventions. At baseline (T1) the prevalence of MSPD in both groups were comparable: for example, standard group 41% versus tailored group 38%. However, at follow-up (T2) there was a significant increase in *any* MSPD and lower back pain in the standard group but not in the tailored group.

Occupational/organisational characteristics preintervention and postintervention

Data on workers' perceptions of safety climate, job satisfaction and stage of change, before and after the intervention, within standard and tailored groups were dichotomised and are presented in table 4. McNemar's test showed that there were no significant changes in safety climate, job satisfaction and stage of change, before and after the intervention in both groups. There were no significant differences in workload before and after the intervention.

GEE analysis

Table 5 presents the overall effect of the intervention and the change over time of MSPD relative risk (95% CI) after adjusting for age, gender, SOC, safety climate, years employed and job satisfaction. Overall, the main intervention was significant for lower back MSPD (RR=0.62, CI 0.39 to 0.94), with the tailored group showing a 40% lower risk of reported lower back pain than the standard group. The category of *any* MSPD also showed lowered risk, however the effect was not significant. Comparisons of change over time within each group separately showed a general increase over time in the risk of reported pain for both groups for *any* MSPD and lower back. However, the only significant difference over time was reported lower back pain within the standard group (RR=1.80, CI 1.21 to 2.69).

Safety climate, years of employment and SOC were found to be associated with increased[40] MSPD after the intervention. A higher safety climate score was associated with a lower risk of reported MSPD. Workers with more than 10 years and 5–9 years of work experience were more likely to report MSPD compared with those with less than 5 years' work experience in their current company. With regards to SOC, workers within maintenance, action and contemplation/preparation stages showed a higher risk of reported MSPD than those in the precontemplation stage.

Table 1 Details of interventions

	Standard/ tailored	Nature of work	Intervention detail
1	Standard	Nursing	Electric beds; powered bed movers; patient locker transport; equipment maintenance schedules; pause exercises; lighting audit; worksite Inspection Programme; audit bariatric equipment; safe weight limits
2	Standard	Technical services	Redesign corner desks; seating review; microdesks; office ergonomics training; pause exercises; prepurchase equipment programme; worksite inspection programme; audit of space allocation
3	Standard	Outdoor maintenance	Replace seat in a line-marking machine; lower plant stake heights; fit appropriate baffle systems in water trucks, pause exercises; job rotation; develop prepurchase assessment policy
4	Standard	Sheet steel	Adjustable height work stations; lift-assist mechanisms; powered assistance for moving large 'trolleys'; antifatigue matting; pause exercises; job rotation; safe operating procedures; trial of full-gloves
5	Standard	Charity collection	Modification conveyor platform; spring-loaded storage; lower sorting bins; weight limits for packed bags; floor zone marking; pause exercises; job rotation; trolley maintenance programme; audit of antifatigue matting
6	Standard	Foundry	Trial of sit–stand stools; conveyor height variation; pause exercises, job rotation; (PPE) audits; antifatigue mats; antivibration gloves
7	Standard	Call centre	Telephone headsets; task lighting; pause exercises; audit of space allocation
8	Standard	Warehouse	Redesign workflow; pallet lifters; review archive storage; sit–stand stools; microdesks; fit locking castors to chairs; audit of antifatigue matting; weight marking of goods on delivery; pause exercises
9	Standard	Disability services	Modified vehicle ramp; review storage areas; provide compressor/pump; powered wheelchair transport; slide sheets; manual handling equipment audit; worksite inspection programme; pause exercises; job rotation
10	Standard	Air-cond. maker	Height adjustable or spring-loaded storage; lift-assist mechanisms; alteration to conveyor height; non-slip paint surface; audits of machine guarding and trip hazards; pause exercises; job rotation
11	Standard	Snackfoods	Reduce pallet height; powered pallet jacks; pause exercises; job rotation
12	Standard	Snackfoods	Modification to storage area; pause exercises; job rotation; antifatigue matting
13	Standard	Retail	Sit–stand stools; review trolley size; review castor diameter/design; trolley register; weight marking of all stock boxes; pause exercises
14	Tailored	Laundry	Limit bag weights; washroom redesign; review floor surface; eliminate water overflow; adjustable workbenches; spring-loaded storage; pause exercises; job rotation; trolley maintenance; PPE/mat audit
15	Tailored	Food manufacturer	Powered trolley movers; adjustable workstations/platforms; modify trolley handles; limit bag weights; pause exercises; job rotation; trolley maintenance; antifatigue mat audit; training needs analysis; noise survey
16	Tailored	Hospital orderlies	Modify trolley height/handles; review linen storage; powered bed movers; redesign of bariatric wheelchair; pause exercises; job rotation; trolley maintenance programme; safe weight limit marking on wheelchairs
17	Tailored	Hospital services	Review kitchen trays storage, modify trolley design; raise sink base height; review linen skips; review tray and wash-up areas; pause exercises, job rotation; assess push forces and tray weights; audit of antifatigue matting
18	Tailored	Outdoor maintenance	Elevated work platforms; pause exercises; job rotation; PPE audits; safe operating procedure audits
19	Tailored	Library	Wireless headsets; modify shelving, sit–stand stools; corner desk workstations; microdesks; pause exercises; job rotation
20	Tailored	Optical lenses	Redesign tool racks to limit storage height; trial of sit–stand stools; pause exercises; job rotation
21	Tailored	Transport	Redesign shelf height; reduce size and weight of stock; label stock weight; pause exercises, immediate cleaning of spills
22	Tailored	Packaging	Review floor surface; height adjustable workbenches; powered pallet movers; audit of machine guarding; pause exercises; job rotation; audit antifatigue matting; training needs analysis; PPE audits
23	Tailored	Retail	Modify scanner height and security tag bins; review ladder use; weight marking of received goods; pause exercises; training needs analysis; worksite inspections
24	Tailored	Foundry	Automated lid-lifters; pause exercises; job rotation; PPE audits; antivibration gloves
25	Tailored	Technical services	Review seating; trial of microdesks; provide equipment for relocating or moving heavy items on each floor; office ergonomics training; pause exercises; worksite inspections

PPE, personal protective equipment.

Changes in safety climate

Changes in the overall safety climate score were not statistically significant in either group across time. However, significant changes were found in several dimensions of safety climate.

The Wilcoxon Test revealed a significant decrease in the standard group for *communication* (z=−2.39; p=0.017; r=0.23). In the tailored group a significant decrease was found in *communication* (z=−3.53; p=0.00; r=0.3) and *company prioritisation of safety* (z=−2.02; p=0.043; r=0.18). However, the effect sizes were small to medium.

DISCUSSION

The results of the McNemar analysis demonstrated a significant increase, postintervention, for *any* MSPD (p=0.016) and lower back pain (p=0.001) in the standard group compared with the tailored group. The GEE analysis confirmed an increase in relative risk for reporting lower back MSPD for those in the standard group of 1.80 (95% CI 1.21 to 2.69) demonstrating a relative benefit for stage-matched interventions when compared with stage-unmatched interventions in the workplace. However, a consistent, but non-significant increase in MSPD was observed in both groups. This is in contrast to other similar studies[8 11] where MSPD prevalence rates have declined over similar time periods. This paradoxical finding may be related to the timing of this study. While initial interviews, data collection and workplace observations were undertaken in 2008 and early 2009, the follow-up interviews occurred in late 2009 and early 2010. The initial interviews were therefore conducted prior to the Global Financial Crisis (GFC) while the follow-up interviews were conducted during, and at the height of the GFC. The principal reason for the withdrawal of a total of four companies at the 12 months follow-up was company economic rationalisation, with their participating workgroups either being redeployed or made redundant. Lower levels of job security have been

Table 2 Demographics characteristics of the participants

Demography data	Standard (n=109) n (%)	Tailored (n=133) n (%)
Age (years)*		
>50	29 (26.6)	31 (23.5)
31–50	57 (52.3)	73 (55.3)
<30	23 (21.1)	28 (21.2)
Gender		
Female	48 (44.0)	65 (48.9)
Male	61 (56.0)	68 (51.1)
Length of employment (years)		
<5	56 (51.4)	63 (47.4)
5–9	32 (29.4)	28 (21.1)
≥10	21 (19.3)	42 (31.6)
Hours worked per week*		
<35	22 (20.6)	19 (15.8)
35–44	71 (66.4)	88 (73.3)
≥45	14 (13.1)	13 (10.8)
Workload†		
Sedentary	11 (10.1)	19 (14.3)
Light	38 (34.9)	22 (16.5)
Medium	58 (53.2)	84 (63.2)
Heavy	2 (1.8)	8 (6.0)
Stage of change		
Precontemplation	30 (27.5)	29 (22.0)
Contemplation/preparation	45 (41.3)	68 (51.5)
Action	15 (13.8)	12 (9.1)
Maintenance	19 (17.4)	23 (17.4)

*Where totals do not total 242 (standard (n=109), The tailored group (n=133), data are missing for those variables.
†Workload was classified according to the criteria outlined in the Dictionary of occupational titles into Sedentary, Light, Medium or Heavy.

previously associated with occupational lower back MSPD.[20] The GFC may also partly explain the small (non-significant), postintervention decline in job satisfaction observed in both groups. Despite this uncontrolled confounder the results of our study provides evidence to support the relative effectiveness of the SOC approach to work-related MSPD prevention in organisations previously reported in a UK study.[21]

While the UK study[8] also reported reductions in worker lower back MSPD in those companies which had received stage-matched advice there are some important differences between the studies. These relate to questionnaire administration methods and to the design of the SOC based interventions. In the UK study baseline 7-day prevalence rates for *any* MSPD were 77% and 80% for the control and intervention groups, respectively. In our study the prevalence rates were 41% and 38%, respectively. Similarly the UK study reported 7-day lower back prevalence rates of more than 50% for both groups at baseline compared with 17% and 12% for the control and intervention groups in this study. The much lower 7-day prevalence rates reported in our study population rendered further significant reductions more difficult. While these differences may be related to differences in the study populations the method of questionnaire administration may also have an influence. In the UK study workers were provided with questionnaires for completion. In our study workers were interviewed individually, in a private room at the workplace. This method was selected in order so that ambiguous questions could be clarified and therefore improve the reliability of the responses. It is possible that the self-administration method used in the UK study resulted in over-reporting.[12]

The stage-matched implementation method also varied. In our study the implementation of stage-matched advice was based on the workgroup SOC profile, whereas in the UK study it was based only on the most common stage in the workgroup. The advice provided in the UK study was therefore limited to the nature of workplace changes which would be appropriate for the most common SOC identified. However, details on the implementation methods were not available from the UK study's published work. In our study specific ergonomics advice, based on direct observation of the workplace, was provided and prioritised to the workgroup SOC profile.

Safety climate, as a measure of the psychosocial conditions within an organisation, has been previously reported as being associated with MSPD.[12 22] In our study lower levels of safety climate were significantly associated with increased MSPD over time. In particular, where communication and company prioritisation of safety (as subscales of safety climate) declined, MSPD was seen to increase. This finding is supported by a previous study in the chemical industry[23] which found that poor organisational safety climate was related to increased accident rates. Similarly a cross-sectional study also found that lower safety climate was associated with increased MSPD.[12] Conversely, other studies have reported that a good psychosocial climate may have a protective effect in the development of MSPD, even when poor physical workload factors are present.[22 24]

In our study workers with longer periods of employment were more likely to report MSPD. The reasons why those with shorter periods of employment were less likely to report MSPD may be due to an insufficient length of exposure to workplace hazards but also to feelings of job insecurity, particularly during the GFC. This finding supports a previous study in Iranian automobile manufacturing that revealed that neck and shoulder pain was associated with longer duration of employment.[25] On the other hand other authors have reported that those with greater work experience were less likely to report MSPD due to work hardening.[26] Thus, there is an ambiguity in terms of the association between length of employment and MSPD. Consequently,

Table 3 MSPD within the standard and tailored groups, before and after the intervention (McNemar's test)

	Standard (n=109)					Tailored (n=133)				
	T1		T2			T1		T2		
Pain and discomfort	n	Per cent	n	Per cent	p Value	n	Per cent	n	Per cent	p Value
Any MSPD*	109	41.3	109	54.1	0.016†	128	38.3	128	46.1	0.184
Lower back	109	16.5	109	32.1	0.001†	128	11.7	128	16.4	0.286

*MSPD in any body part; T1=preintervention, T2=postintervention.
†Statistically significant result, McNemar test for change in *any* MSPD and lower back pain. Where totals do not total 242 data are missing for those variables.
MSPD, musculoskeletal pain and discomfort.

Table 4 Job satisfaction, safety climate and stage of change in tailored and standard groups (pre and postintervention)

	Standard (n=109)					Tailored (n=133)				
	T1		T2			T1		T2		
Variables	n	Per cent	n	Per cent	p Value	n	Per cent	n	Per cent	p Value
Safety climate total score	106				0.678	123				1.00
Higher score	60	56.6	57	53.8		69	56.1	68	55.3	
Lower score	46	43.4	49	46.2		54	43.9	55	44.7	
Job satisfaction	109				0.064	129				0.096
Satisfied	96	88.1	87	79.8		117	90.7	109	84.5	
Dissatisfied/not sure	13	11.9	22	20.2		12	9.3	20	15.5	
SOC	108				0.608	130				0.890
Advanced stage	35	32.4	31	28.7		34	26.2	36	27.7	
Early stage	73	67.6	77	71.3		96	73.8	94	72.3	

T1=preintervention, T2=postintervention, eq=equal since paired individuals were used; Where totals do not total 242 (Standard (N=109), The tailored group (N=133)), data are missing those variables. Safety climate scores were dichotomised (median split). Job satisfaction was rated on a 7-point Likert scale (1–4=dissatisfied/not sure; 5–7=satisfied). For SOC Advanced stage=Action and Maintenance stages; Early stage=Precontemplation and Contemplation/Preparation Stages.
SOC, Stage of Change.

a more objective assessment of MSPD such as physical examination should be undertaken in order to provide a more precise result.

Factors influencing the effectiveness of the intervention

Regarding the worker's stage of change, it could be argued that workers in the advanced stages may be more aware of the importance of reporting hazards, thereby reporting MSPD more frequently. This result supports a Canadian study, where the authors argued that pain might be a precursor to being in an advanced stage of change, thereby prompting MSPD prevention.[7] However, if pain is a precursor, studies that have high pain prevalence should have a high percentage of workers in the more advanced stages (action and maintenance). In fact, a UK study with approximately 80% MSD prevalence only had a small number of employees in the advanced stages, which was similar to the Canadian study where were only a few participants, were in advanced stages.[7 9] So, in this case the first alternative was found to be more likely—that workers in advanced stage were more aware of risk and more compliant in reporting MSPD and workplace hazards, in compliance with organisational Occupational Health and Safety requirements.

Another potential reason for the ineffectiveness of the intervention is the economic down turn at the time of implementation of the ergonomics intervention. The major problem of a comprehensive prevention method is that the more approaches are involved in the prevention programme, the more costly and time consuming it is. Thus, economic issues should also be considered when planning for MSD intervention.[27] Supporting research from Macdonald and Evans[28] point out that "…the tendency is for organisations to implement changes themselves and to select from the recommendations which are the least expensive or easiest changes". This is further supported by Rothmore *et al*[10] who reported that while companies in receipt

Table 5 Relative risks for reported MSPD and lower back pain[†,‡]

	Effect		Any MSPD	Lower back
Planned comparisons	Intervention	Standard	ref	ref
		Tailored intervention	0.91 (0.73 to 1.13)	0.62 (0.39 to 0.94)*
	Standard group	Change from T1 to T2	1.22 (0.98 to 1.51)	1.80 (1.21 to 2.69)*
	Tailored group	Change from T1 to T2	1.13 (0.88 to 1.47)	1.46 (0.85 to 2.48)
Model	Safety climate	Low score	ref	ref
		High score	0.67 (0.53 to 0.83)*	0.36 (0.22 to 0.57)*
	Length of employment	<5 years	ref	ref
		10+ Years	1.42 (1.05 to 1.93)*	1.30 (0.74 to 2.28)
		5–9 Years	1.48 (1.15 to 1.90)*	1.14 (0.72 to 1.80)
	Stage of Change	Precontemplation	ref	ref
		Contemplation /preparation	1.70 (1.13 to 2.56)*	1.85 (0.87 to 3.93)
		Action	2.09 (1.31 to 3.33)*	1.75 (0.71 to 4.27)
		Maintenance	2.35 (1.52 to 3.61)*	2.82 (1.27 to 6.27)*
	Job satisfaction		0.89 (0.78 to 1.017)	0.93 (0.71 to 1.21)
	Age		1.00 (0.98 to 1.01)	1.00 (0.98 to 1.02)
	Gender	Male	ref	ref
		Female	0.96 (0.78 to 1.18)	1.10 (0.731.66)

*p<0.05.
†A RR>1 indicates greater risk of reported pain relative to the reference category for categorical variables or for a 1 year increase in age.
‡Adjusted for age, sex, Stage of Change, safety climate, years employed and job satisfaction.
MSPD, musculoskeletal pain and discomfort.

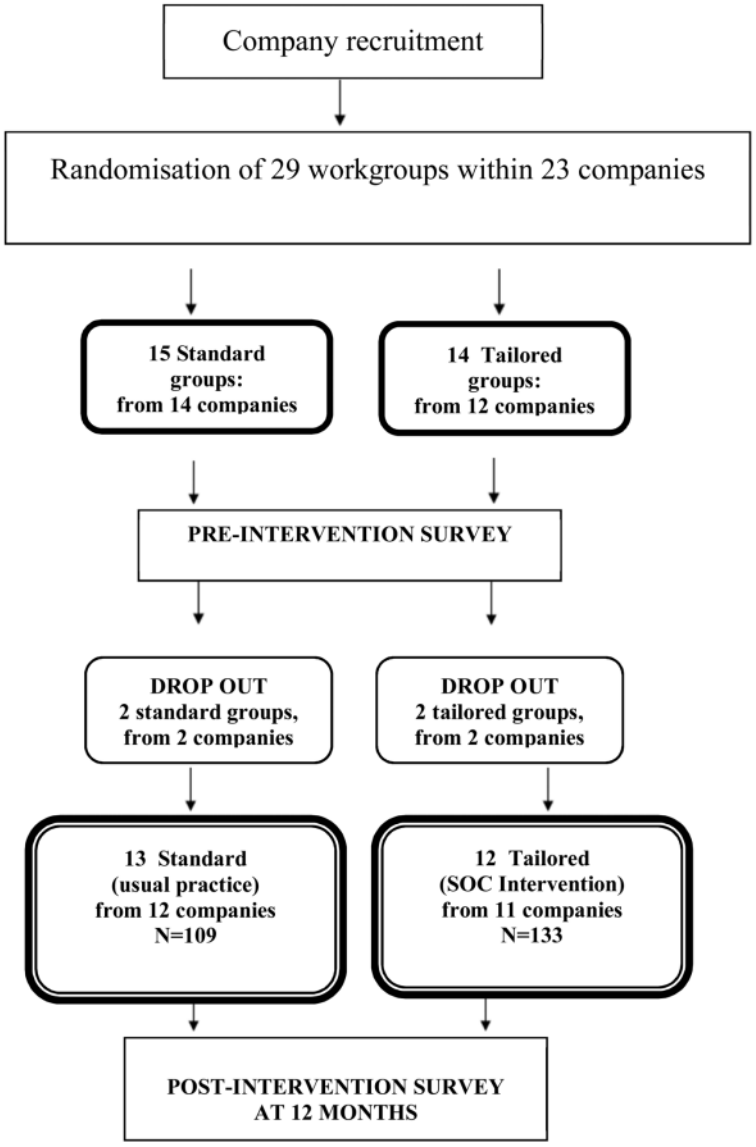

Figure 1 Overall research procedure. SOC, Stage of Change.

of advice tailored according to the SOC approach introduced significantly more changes this was primarily driven by the implementation of the easiest and less expensive options.

Strengths and weaknesses of the research

Participants' demographic characteristics, such as age and gender, were similar to those in the Australian and South Australian population.[12] Moreover, a wide range of industry types participated in this study including manufacturing, food industries, healthcare services, mining, professional sectors and other services. The definition of MSPD as occurring within the past 7 days was used to reduce recall bias.

The survey questionnaires were administered individually. This interview method was considered to be appropriate in order to reduce over and/or under-reporting of MSPD and for confidentiality issues, particularly as we were seeking information on job satisfaction and safety climate. Additionally, the face-to-face method allowed the interviewer to give an explanation of the meaning of questions or terms. Closed room interviews enabled participants to report MSPD and other sensitive issues with a degree of assurance that the confidentiality of their responses would be maintained.[29]

Only paired participants, that is, those who had participated in both surveys were included. Another strength in this study is that the workers' characteristics in the tailored and standard groups at the baseline were very similar. The block randomisation[30] also allowed very similar number of workgroups in each of tailored (n=12) and standard group (n=13). Generalised estimating equations (GEE) analysis was used as the interest was in a marginal model rather than modelling individual variation. That is, the overall population effect of the treatment intervention was the focus of the study, rather than an examination of the individual variation in change in MSPD over time.

While Rothmore *et al*[10] previously reported on the differences in implementation rates between organisations in receipt of tailored versus standard ergonomics advice they did not report on the associated health benefits. This is an important consideration in organisations where workplace changes require budgetary justification. This study provides further evidence for the potential economic benefits associated with SOC-based interventions.

The weakness of this study was the participants' attrition rate from the baseline to follow-up surveys (40.1%) which was larger than the UK study (20%).[8] However, the final number of participants in each group (tailored 133 and standard 109) was comparable.

The GEE addresses the population mean effect of the predictors on the outcome. Therefore, statements about the variability of individual change are not available. However, since the focus of this research was the effect of the intervention on the likelihood of reporting MSPD, individual variability was not of interest.

CONCLUSIONS

This is the first formal randomised trial of the SOC approach to the prevention of work-related MSPD. Compared with standard ergonomics advice to management, interventions tailored according to SOC showed a relative benefit, particularly for low back pain and discomfort. However, the timing of our study—during the GFC—means that unexpected economic circumstances may have influenced our findings. Organisational safety climate was found to be a significant correlate, which is consistent with other research demonstrating the importance of psychosocial factors in the development of MSD. It is recommended that safety climate be surveyed as part of any comprehensive strategy for the control of work-related MSD.

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