10 Longitudinal study

10.1 Workplace questionnaire

At the beginning of the study each participant completed a workplace questionnaire. This was repeated up to six months after the second set of trials.

The questionnaire results before and after training for groups 1 and 2 were compared to establish whether training had resulted in increased confidence, changes in attitudes towards health and safety, or the involvement of staff in identifying and reporting problems and proposing solutions.

The results are presented separately for each of the four participating companies. For each company the results are split into uniform categories so that inter-company data can be directly compared. The results presented here are descriptive only; for a detailed breakdown of participants' responses, please contact the authors of this report.

10.2 Company 1 – Flowers

10.2.1 Results

In total 15 participants from Company 1 completed the workplace questionnaire at the start of the study (before) and 17 at the end of the study (after six months).

10.2.2 Respondents' awareness and understanding of MSDs

Results from the questionnaire showed that over 75 per cent of respondents from both sites had heard of RSI or musculoskeletal disorders. Curiously, the participants who had not heard of RSI or MSDs appeared in the post training group, but this is most likely to be accounted for by substitute workers replacing those who had left before the training session.

10.2.3 Origin of MSD knowledge

The participants were asked where they had heard of the terms RSI or MSD. Television, magazines and work were the predominant sources of this knowledge for the pre-training participants from both groups. When asked after training, the balance shifted such that work accounted for 80 and 71 per cent respectively for the two groups. This may well be explained by the attendance at the training course.

10.2.4 Knowledge and understanding of MSD risk factors

Question 11 of the workplace questionnaire investigated people's understanding and knowledge of musculoskeletal problems, and asked respondents to list up to six risks or causes which may lead to musculoskeletal problems or RSI. It is notable that the number of correct risk factors or causes reported by respondents was not raised by the training process, with the mean dropping for group 1 and remaining similar for group 2.

10.2.5 Reported pains, aches and discomfort relating to MSDs

Question 5 of the questionnaire described musculoskeletal problems as 'affecting the muscles, tendons, ligaments of the neck, shoulders, back, arms, wrist, hands or legs. Symptoms can be feelings of pain, aches, numbness and/or discomfort in any of these body areas.' Respondents were asked whether they had experienced any such pain, aches or discomfort in any body area in the last six months or last seven days.

The participants' answers revealed that over half had experienced pain or discomfort in the last six months, with nearly a fifth experiencing these symptoms in the last seven days. Both groups reported a rise in the percentage of reported pain after training. This might be due to increased awareness, or may be due to more direct work-related factors.

For those individuals who reported pain or discomfort, a further question explored the location of the symptoms. The results of this question are presented by group in Tables 10.1 and 10.2. These data were further investigated to establish what action, if any, had been taken regarding this discomfort and what the participant considered to be the cause.

At the start of the study over half of both groups had consulted a doctor about the discomfort experienced. This fell for both groups after training. Absence due to discomfort fell significantly for group 1 after training but remained roughly constant, albeit at a lower level, for Group 2.

Table 10.1 Percentage of group 1 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (>25%) are in bold

Group 1 start: *n* = 4; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	50	0	**25**	**25**	0	0	0	0
	After 6 months	67	0	0	17	0	0	17	0
Shoulders	Start	25	0	**25**	**25**	0	0	0	0
	After 6 months	67	0	0	17	0	17	0	0
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	50	0	17	17	0	0	0	17
Elbows	Start	100	0	0	0	0	0	0	0
	After 6 months	50	0	17	0	0	17	0	17
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	67	0	17	0	0	0	0	17
Wrist	Start	100	0	0	0	0	0	0	0
	After 6 months	33	17	0	17	17	17	0	0
Hands	Start	75	0	0	0	**25**	0	0	0
	After 6 months	67	17	0	0	17	0	0	0
Upper back	Start	75	0	0	0	0	**25**	0	0
	After 6 months	67	17	0	0	0	17	0	0
Lower back	Start	25	0	0	**25**	0	**25**	0	**25**
	After 6 months	67	17	0	0	0	17	0	0
Legs	Start	50	0	0	0	0	**25**	0	**25**
	After 6 months	67	0	17	0	17	0	0	0

The participants were also asked to identify the cause of their discomfort, with the choices being hobbies, sport, work tasks and housework. Virtually all respondents identified work as the origin of their pain both before and after training.

10.2.6 Future health concerns

A further question enquired whether the participants were concerned that they may develop MSD problems in the future. Both before and after training, more group 1 respondents (57 per cent before training, 40 per cent after) reported that they were concerned that they would develop a musculoskeletal problem from their work than group 2 respondents (13 per cent before, 14 per cent after).

10.2.7 Desired changes to the workplace

Respondents were asked if they would like the layout of their workplace to be changed so that it was easier or more comfortable to do their job. Less than a third of respondents from both groups said yes, despite the apparently high rate of discomfort. This suggests that they may view the activities as more problematic than the immediate location.

All of those respondents who said they would like to see changes said they would like them to be made in the next 6 months.

Table 10.2 Percentage of group 2 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (> 25%) are in bold

Group 2 start: *n* = 5; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	100	0	0	0	0	0	0	0
	After 6 months	75	0	**25**	0	0	0	0	0
Shoulders	Start	60	0	0	20	0	0	20	0
	After 6 months	75	0	0	**25**	0	0	0	0
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	75	0	0	**25**	0	0	0	0
Elbows	Start	80	0	0	0	0	0	0	20
	After 6 months	100	0	0	0	0	0	0	0
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Wrist	Start	60	0	20	20	0	0	0	0
	After 6 months	0	**25**	0	**50**	0	**25**	0	0
Hands	Start	60	0	20	0	0	20	0	0
	After 6 months	50	0	**25**	**25**	0	0	0	0
Upper back	Start	100	0	0	0	0	0	0	0
	After 6 months	75	0	0	0	0	**25**	0	0
Lower back	Start	80	0	0	0	0	20	0	0
	After 6 months	50	0	0	0	0	**25**	**25**	0
Legs	Start	100	0	0	0	0	0	0	0
	After 6 months	75	0	0	**25**	0	0	0	0

Table 10.3 shows the types of change respondents reported they would like to see.

10.2.8 Changes already made to the workplace

Respondents were asked if they were aware whether their employer had made any changes to reduce MSD risks. Less than half of both Groups 1 and 2 responded that this was the case. A similar percentage of participants had undertaken changes to the workplace themselves.

Those respondents who indicated that they had undertaken changes themselves were asked to provide further information on the nature of those changes. Details of the responses are given in Table 10.4.

10.2.9 Communication and attitudes relating to health and safety

The participant survey attempted to explore attitudes to health and safety in the workplace and how communication took place in the workplace. In particular, they were asked for their views on communication between the operations or production department and company management.

The majority of both groups reported that they felt these communication links were satisfactory. This is encouraging since it suggests that this traditional barrier to improving health and safety is not realised in practice.

Table 10.3
Description of changes that respondents said they wanted to make to their workplace

Group 1	Start	• Make tables higher when wrapping • Make wrap boxes lighter • Reducing packaging in boxes • Higher tables for tall people
	After 6 months with training	• Move people on line, line speed • Change break times • Heating when cold • Body warmers for staff
Group 2	Start	• Very cold temperature, change would make the work area more comfortable and happier place to be.
	After 6 months without training	• Times of break (too cold in pack house) • Body warmers for staff

Table 10.4
Description of changes that respondents had made themselves to their workplace

Group 1	Start	• Get packaging on a trolley and not carrying it • Change jobs throughout the day • Thought about how I stand and actually do the job
	After 6 months with training	• I have changed what I used to do so it is easier on my wrists • Health and safety, cleaning floor, carrying carefully • Make sure I do job in the right way, stand and twist correctly • Moved staff so they aren't doing the same job all the time
Group 2	Start	• Got fingerless gloves and liners to put under working gloves. • Stopped working on the line. • Rotation of staff • Rotating jobs within packhouse
	After 6 months without training	• Health and safety • Rotating staff • Rotate operatives, don't let them do the same job for more than a certain time

The final section of the questionnaire probed the attitudes of the workers with a series of statements against which the participants could record a level of agreement on a five-point scale between 'strongly disagree' to 'strongly agree'.

Below the statements are listed, along with details of any apparent conflict (ie where responses indicate a potential health and safety risk).

- In my workplace management acts quickly to correct health and safety problems. Conflicts in group 1 before and after training; group 2 at start.
- Health and safety information is always brought to my attention by my line manger/supervisor. No conflicts.
- In my workplace the chances of developing a work-related health problem are quite high. Conflicts in group 1 before and after training; group 2 after six months.
- There is good communication here about health and safety issues which affect me. Conflicts in group 1 before training; group 2 after six months.
- Management here considers health and safety to be equally as important as production. Conflicts in group 1 before and after training; group 2 after six months.
- I believe health and safety issues are given a high priority. No conflicts.

- Some health and safety rules and procedures don't need to be followed to get the job done safely. Conflicts in both groups at both time points.
- Some health and safety rules are not really practical. Conflicts in both groups at both time points.
- I am strongly encouraged to report unsafe conditions. Conflict in group 1 before training.
- I can influence health and safety performance here. Conflict in group 1 before training.
- I am involved in informing management of important health and safety issues. Conflict in group 1 before training.
- Health and safety is the number one priority in my mind when completing a job. No conflicts.
- It is important to me that there is a continuing emphasis on health and safety. Conflict in group 1 before training.
- I'm sure it's only a matter of time before I develop a work-related health problem. Conflicts in group 1 at both time points and in group 2 after six months.
- Production targets rarely conflict with health and safety measures. Conflict in group 2 at start.
- I am always given enough time to get the job done safely. Conflicts in both groups at start.

10.3 Company 2 – Labs

10.3.1 Results

In total 18 participants from Company 2 completed the workplace questionnaire at the start of the study (before) and 12 at the end of the study (after six months).

10.3.2 Respondents' awareness and understanding of MSDs

Results from the questionnaire showed that over 75 per cent of respondents from both sites had heard of RSI or musculoskeletal disorders. The participants who had not heard of RSI or MSDs appeared in both groups before training.

10.3.3 Origin of MSD knowledge

The participants were asked where they had heard of the terms RSI or MSD. Television and the media, work and training were the predominant sources of this knowledge for the pre-training participants from both groups.

When asked after training the balance shifted such that work accounted for 60 and 57 per cent respectively for the two groups, with virtually all the other sources playing a large part in this message as well.

10.3.4 Knowledge and understanding of MSD risk factors

Question 11 of the workplace questionnaire investigated peoples' understanding and knowledge of musculoskeletal problems, and asked respondents to list up to six risks or causes which may lead to musculoskeletal problems or RSI. Training only slightly raised the number of correct risks identified by both groups.

10.3.5 Reported pains, aches, discomfort relating to MSDs

Question 5 of the questionnaire described musculoskeletal problems as 'affecting the muscles, tendons, ligaments of the neck, shoulders, back, arms, wrist, hands or legs. Symptoms can be feelings of pain, aches, numbness and/or discomfort in any of these body areas.' Respondents were asked whether they had experienced any such pain, aches or discomfort in any body area in the last six months or last seven days.

The participants' answers revealed that over three quarters of those in group 1 had experienced pain or discomfort in the last six months, with over half experiencing these symptoms in the last seven days. Group 2 had a much lower incidence of reported discomfort which increased slightly six months later.

For those individuals who reported pain or discomfort, a further question explored the location of the symptoms. The results of this question are presented by group in Tables 10.5 and 10.6.

These data were further investigated to establish what action, if any, had been taken regarding this discomfort and what the participant considered to be the cause. At the start of the study nearly half of group 1 and all of group 2 had consulted a doctor about the discomfort experienced. This fell for both groups after training. Absence due to discomfort fell significantly for group 1 after training and remained constant at zero for group 2.

Table 10.5
Percentage of group 1 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (>25%) are in bold

Group 1 start: *n* = 4; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	30	0	10	20	10	10	10	10
	After 6 months	25	0	**25**	0	**25**	0	**25**	0
Shoulders	Start	80	0	0	10	0	0	0	10
	After 6 months	50	0	0	0	0	**50**	0	0
Upper arms	Start	90	0	0	0	0	0	0	10
	After 6 months	75	0	0	0	0	0	0	**25**
Elbows	Start	80	0	0	10	0	0	0	10
	After 6 months	75	0	0	0	0	0	0	**25**
Forearms	Start	90	0	0	0	0	0	0	10
	After 6 months	75	0	0	0	0	0	0	**25**
Wrist	Start	80	0	0	0	0	10	0	10
	After 6 months	25	0	0	0	**25**	**25**	0	**25**
Hands	Start	90	0	0	0	0	0	0	10
	After 6 months	50	0	0	0	0	**25**	0	**25**
Upper back	Start	70	0	0	0	10	10	10	0
	After 6 months	100	0	0	0	0	0	0	0
Lower back	Start	30	0	20	0	10	0	40	0
	After 6 months	25	0	**25**	0	0	0	**25**	**25**
Legs	Start	70	0	10	0	10	10	0	0
	After 6 months	25	0	0	0	**50**	**25**	0	0

The participants were also asked to identify the cause of their discomfort, with the choices being hobbies, sport, work tasks and housework. Virtually all respondents identified work as the origin of their pain both before and after training.

10.3.6 Future health concerns

A further question in the survey enquired whether the participants were concerned that they may develop MSD problems in the future. Both before and after training, more group 1 respondents (60 per cent before training, 80 per cent after) reported that they were concerned that they would develop a musculoskeletal problem from their work than group 2 respondents (38 per cent before, 29 per cent after).

10.3.7 Desired changes to the workplace

Respondents were asked if they would like the layout of their workplace to be changed so that it was easier or more comfortable to do their job. Less than a third of respondents from both groups said yes, despite the apparently high rate of discomfort. This suggests that they may view the activities as more problematic than the immediate location. Nearly all of those respondents who said they would like to see changes said they would like them to be made in the next six months. Table 10.7 shows the types of change respondents reported they would like to see.

Table 10.6 Percentage of group 2 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (> 25%) are in bold

Group 2 start: *n* = 5; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Shoulders	Start	100	0	0	0	0	0	0	0
	After 6 months	50	0	0	0	**50**	0	0	0
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Elbows	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Wrist	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Hands	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Upper back	Start	0	0	0	0	0	**100**	0	0
	After 6 months	100	0	0	0	0	0	0	0
Lower back	Start	0	0	0	0	0	**100**	0	0
	After 6 months	50	0	**50**	0	0	0	0	0
Legs	Start	100	0	0	0	0	0	0	0
	After 6 months	50	0	0	0	0	**50**	0	0

10.3.8 Changes already made to the workplace

Respondents were asked if they were aware whether their employer had made any changes to reduce MSD risks. There was a wide range of responses; all participants in group 1 said that they were aware of such changes after training, and 43 per cent of those in group 2 were aware after six months. A similar spread of participants had undertaken changes to the workplace themselves.

Those respondents who indicated that they had undertaken changes themselves were asked to provide further information on the nature of those changes. Details of the responses are given in Table 10.8.

10.3.9 Communication and attitudes relating to health and safety

The participant survey attempted to explore attitudes to health and safety in the workplace and how communication took place in the workplace. In particular, they were asked for their views on communication between the operations or production department and company management.

The majority of both groups reported that they felt these communication links were satisfactory. This is encouraging since it suggests that this traditional barrier to improving health and safety is not realised in practice.

Table 10.7
Description of changes that respondents said they wanted to make to their workplace

Group 1	Start	• More space in critical areas • Higher benches • Move around more • Change jobs often
	After 6 months with training	• Higher work benches
Group 2	Start	• More mechanisation (being tested at the moment) • A ramp in fridge on the lift
	After 6 months without training	• More comfortable fume cupboard • Proper seating

Table 10.8
Description of changes that respondents had made themselves to their workplace

Group 1	Start	• Job rotation • More self awareness • Used my problem to advise others • Taken a more stern approach to those who are failing in this area and should know better • Identifying less obvious risk factors • Stretching my back/legs • Keep moving • Swimming • Sitting the right way in chairs • Increased job rotation • Lifting in the correct manner • Exercise and yoga
	After 6 months with training	• Acquired sit/stand workstation. It slows down work but eases back pain • Made sure workstation is set up correctly for me • Vary work during the day • Liaised with HSO, company nurse, HSE and access to work to address my particular needs (Keinbachs) but changes should help other staff
Group 2	Start	• Job rotation
	After 6 months without training	• Vary work to stop repetitiveness • Manual handling course • Changed chair height to suit desk • Ensure lifted objects correctly • Used trolleys to move heavy items

The final section of the questionnaire probed the attitudes of the workers with a series of statements against which the participants could record a level of agreement on a five-point scale between 'strongly disagree' to 'strongly agree'.

Below the statements are listed, along with details of any apparent conflict (ie where responses indicate a potential health and safety risk).

- In my workplace management acts quickly to correct health and safety problems. Conflicts in group 1 before and after training.
- Health and safety information is always brought to my attention by my line manger/supervisor. Conflicts in group 1 after training and in group 2 at start.
- In my workplace the chances of developing a work-related health problem are quite high. Conflicts in group 1 before and after training.
- There is good communication here about health and safety issues which affect me. Conflicts in group 1 before training; group 2 at start.
- Management here considers health and safety to be equally as important as production. Conflicts in group 1 before and after training.

- I believe health and safety issues are given a high priority. Conflicts in group 1 before and after training; group 2 at start.
- Some health and safety rules and procedures don't need to be followed to get the job done safely. Conflicts in both groups at both time points.
- Some health and safety rules are not really practical. Conflicts in both groups at both time points.
- I am strongly encouraged to report unsafe conditions. Conflicts in group 1 before and after training; group 2 at start.
- I can influence health and safety performance here. Conflict in group 1 after training and group 2 at start.
- I am involved in informing management of important health and safety issues. Conflict in group 1 before training; group 2 at both time points.
- Health and safety is the number one priority in my mind when completing a job. Conflicts in both groups at both time points.
- It is important to me that there is a continuing emphasis on health and safety. Conflict in group 1 after training.
- I'm sure it's only a matter of time before I develop a work-related health problem. Conflicts in both groups at both time points.
- Production targets rarely conflict with health and safety measures. Conflicts in group 1 before and after training; group 2 at start.
- I am always given enough time to get the job done safely. Conflicts in group 1 before and after training; group 2 after six months.

10.4 Company 3 – Salads

10.4.1 Results

The data from Company 3 are incomplete because the participants before training were unable to complete the post-training questionnaire. This is primarily due to reductions in the level of staffing due to economic pressure and seasonal demand.

In total six participants from Company 3 completed the workplace questionnaire at the start of the study and none at the end.

10.4.2 Respondents' awareness and understanding of MSDs

Results from the questionnaire showed that over 65 per cent of respondents from group 1 had not heard of RSI or musculoskeletal disorders. The remainder reported only hearing of RSI and not MSDs. In comparison, in group 2, over 65 per cent of participants had heard of MSDs and a further 33 per cent had heard of RSI. There were no post-training data.

10.4.3 Origin of MSD knowledge

The participants were asked where they had heard of the terms RSI or MSD. Television and work were the predominant sources of this knowledge in group 1, while group 2 demonstrated a much wider range of influences.

10.4.4 Knowledge and understanding of MSD risk factors

Question 11 of the workplace questionnaire investigated people's understanding and knowledge of musculoskeletal problems, and asked respondents to list up to six risks or causes which may lead to musculoskeletal problems or RSI. The mean number of correct risks listed by group 1 participants was 2.33 and by group 2 participants 1.33.

10.4.5 Reported pains, aches and discomfort relating to MSDs

Question 5 of the questionnaire described musculoskeletal problems as 'affecting the muscles, tendons, ligaments of the neck, shoulders, back, arms, wrist, hands or legs. Symptoms can be feelings of pain, aches, numbness and/or discomfort in any of these body areas.' Respondents were asked whether they had experienced any such pain, aches or discomfort in any body area in the last six months or last seven days.

Over half of the Group 1 respondents had experienced pain or discomfort in the last six months, with nearly a third experiencing these symptoms in Group 2.

For those individuals who reported pain or discomfort, a further question explored the location of the symptoms. This is presented by Group in Tables 10.9 and 10.10. These data were further investigated to establish what action, if any, had been taken regarding this discomfort and what the

Table 10.9
Percentage of group 1 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (>25%) are in bold

Group 1 start: *n* = 4; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	50	0	0	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Shoulders	Start	25	**50**	0	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Elbows	Start	100	0	0	0	0	0	0	0
	After 6 months	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wrist	Start	100	0	**50**	0	0	0	0	0
	After 6 months	33	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hands	Start	75	0	0	**50**	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Upper back	Start	75	0	**50**	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lower back	Start	25	0	**50**	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Legs	Start	50	0	0	0	0	0	0	0
	After 6 months	67	n/a	n/a	n/a	n/a	n/a	n/a	n/a

participant considered to be the cause. None of the participants had consulted a doctor about their symptoms and none of them reported having been absent due to their discomfort. All respondents cited work tasks as being the cause of their discomfort.

10.4.6 Future health concerns

A further question enquired whether the participants were concerned that they may develop MSD problems in the future. An equal percentage (33 per cent) of respondents in both groups said that they were concerned that they would develop a musculoskeletal problem from their work.

10.4.7 Desired changes to the workplace

Respondents were asked if they would like the layout of their workplace to be changed so that it was easier or more comfortable to do their job. A third of respondents from group 2 stated that they would like the layout of their workplace changed, while none of group 1 asked for this.

All those asking for changes wanted them to be made within the next six months. The change they requested was for more working space in the working environment and less overcrowding.

Table 10.10 Percentage of group 2 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (> 25%) are in bold

Group 2 start: *n* = 5; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	100	0	0	0	0	0	0	0
	After 6 months	75	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Shoulders	Start	60	0	0	0	0	0	0	0
	After 6 months	75	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	75	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Elbows	Start	80	0	0	0	0	0	0	0
	After 6 months	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Wrist	Start	60	0	**100**	0	0	0	0	0
	After 6 months	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hands	Start	60	0	0	0	0	0	0	0
	After 6 months	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Upper back	Start	100	0	0	0	0	0	0	0
	After 6 months	75	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lower back	Start	80	0	0	0	0	0	0	0
	After 6 months	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Legs	Start	100	0	**100**	0	0	0	0	0
	After 6 months	75	n/a	n/a	n/a	n/a	n/a	n/a	n/a

10.4.8 Changes already made to the workplace

Respondents were asked if they were aware whether their employer had made any changes to reduce MSD risks. No-one in either group responded that this was the case. On the other hand, a third of respondents in group 1 and all those in group 2 had undertaken changes to the workplace themselves. Those respondents who indicated that they had undertaken changes themselves were asked to provide further information on the nature of those changes. Details of the responses are given in Table 10.11.

10.4.9 Communication and attitudes relating to health and safety

The participant survey attempted to explore attitudes to health and safety in the workplace and how communication took place in the workplace. In particular, they were asked for their views on communication between the operations or production department and company management. The majority of both groups reported that they felt these communication links were satisfactory. This is encouraging since it suggests that this traditional barrier to improving health and safety is not realised in practice.

The final section of the questionnaire probed the attitudes of the workers with a series of statements against which the participants could record a level of agreement on a five-point scale between 'strongly disagree' to 'strongly agree'.

Table 10.11 Description of changes that respondents had made themselves to their workplace

Group 1	Start	• Varied work pattern to regulate time spent on specific jobs
	After 6 months with training	n/a
Group 2	Start	• Limited the number of utensils needed to produce the product • Kept the floor dry where possible and worked in a safe environment
	After 6 months without training	n/a

Below the statements are listed, along with details of any apparent conflict (ie where responses indicate a potential health and safety risk).

- In my workplace management acts quickly to correct health and safety problems. Conflict in group 1.
- Health and safety information is always brought to my attention by my line manger/supervisor. Conflict in group 2.
- In my workplace the chances of developing a work-related health problem are quite high. Conflicts in both groups.
- There is good communication here about health and safety issues which affect me. Conflicts in both groups.
- Management here considers health and safety to be equally as important as production. Conflict in group 2.
- I believe health and safety issues are given a high priority. No conflicts.
- Some health and safety rules and procedures don't need to be followed to get the job done safely. Conflicts in both groups.
- Some health and safety rules are not really practical. No conflicts.
- I am strongly encouraged to report unsafe conditions. Conflict in group 1.
- I can influence health and safety performance here. Conflicts in both groups.
- I am involved in informing management of important health and safety issues. Conflict in group 1.
- Health and safety is the number one priority in my mind when completing a job. Conflict in group 1.
- It is important to me that there is a continuing emphasis on health and safety. No conflicts.
- I'm sure it's only a matter of time before I develop a work-related health problem. Conflicts in both groups.
- Production targets rarely conflict with health and safety measures. Conflict in group 2.
- I am always given enough time to get the job done safely. Conflict in group 2.

10.5 Company 4 – Cakes

10.5.1 Results

In total 8 participants from Company 4 completed the workplace questionnaire at the start of the study (before) and 18 at the end of the study (after six months).

10.5.2 Respondent's awareness and understanding of MSDs

Results from the questionnaire showed that 100% of respondents from both groups had heard of RSI or musculoskeletal disorders.

10.5.3 Origin of MSD knowledge

The participants were asked where they had heard of the terms RSI or MSD. There was an even spread of sources for both groups before training. When asked after training the percentages increased for the majority of possible sources, suggesting that overall awareness had been raised by the training process.

10.5.4 Knowledge and understanding of MSD risk factors

Question 11 of the workplace questionnaire investigated people's understanding and knowledge of musculoskeletal problems, and asked respondents to list up to six risks or causes which may lead to musculoskeletal problems or RSI. It is notable that this value was only raised for group 1 by the training process.

10.5.5 Reported pains, aches and discomfort relating to MSDs

Question 5 of the questionnaire described musculoskeletal problems as 'affecting the muscles, tendons, ligaments of the neck, shoulders, back, arms, wrist, hands or legs. Symptoms can be feelings of pain, aches, numbness and/or discomfort in any of these body areas.' Respondents were asked whether they had experienced any such pain, aches or discomfort in any body area in the last six months or last seven days.

The participants' answers revealed that nearly two thirds of the respondents in group 1 had experienced pain or discomfort in the last six months, with nearly half experiencing these symptoms in the last seven days. Group 2 had a much lower incidence of reported discomfort, which decreased by half by the second time point.

For those individuals who reported pain or discomfort, a further question explored the location of the symptoms. This is presented by group in Tables 10.12 and 10.13.

Table 10.12 Percentage of group 1 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (>25%) are in bold

Group 1 start: *n* = 4; after six months: *n* =									
		No prob-lems	Minimal		Discomfort				Extreme
			1	2	3	4	5	6	7
Neck	Start	75	0	0	**25**	0	0	0	0
	After 6 months	0	0	0	**100**	0	0	0	0
Shoulders	Start	25	0	0	0	**50**	0	0	**25**
	After 6 months	0	0	**100**	0	0	0	0	0
Upper arms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Elbows	Start	75	0	0	0	0	**25**	0	0
	After 6 months	0	0	0	0	**100**	0	0	0
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Wrist	Start	50	0	0	**25**	**25**	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Hands	Start	75	0	0	0	**25**	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Upper back	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Lower back	Start	0	0	**25**	0	**25**	0	**25**	**25**
	After 6 months	0	0	0	0	**100**	0	0	0
Legs	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0

Table 10.13 Percentage of group 2 respondents who reported pain, aches or discomfort, with the body part affected and the level of discomfort experienced. High scores (> 25%) are in bold

Group 2 start: *n* = 5; after six months: *n* =									
		No problems	Minimal			Discomfort			Extreme
			1	2	3	4	5	6	7
Neck	Start	50	0	0	**50**	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Shoulders	Start	50	0	0	**50**	0	0	0	0
	After 6 months	0	0	0	**100**	0	0	0	0
Upper arms	Start	50	0	0	0	**50**	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Elbows	Start	50	**50**	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Forearms	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Wrist	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Hands	Start	50	0	**50**	0	0	0	0	0
	After 6 months	0	0	0	**100**	0	0	0	0
Upper back	Start	100	0	0	0	0	0	0	0
	After 6 months	100	0	0	0	0	0	0	0
Lower back	Start	50	0	0	0	0	**50**	0	0
	After 6 months	0	0	**100**	0	0	0	0	0
Legs	Start	0	0	0	**50**	0	0	**50**	0
	After 6 months	0	0	0	**100**	0	0	0	0

These data were further investigated to establish what action, if any, had been taken regarding this discomfort and what the participant considered to be the cause.

At the start of the study nearly half of group 1 had consulted a doctor about the discomfort experienced. This fell after training. Absence due to discomfort fell significantly for group 1 after training but remained constant at zero for group 2.

The participants were also asked to identify the cause of their discomfort, with the choices being hobbies, sport, work tasks and housework. Virtually all respondents identified work as the origin of their pain both before and after training.

10.5.6 Future health concerns

A further question enquired whether the participants were concerned that they may develop MSD problems in the future. Both before and after training, more group 1 respondents (80 per cent before training, 75 per cent after) reported that they were concerned that they would develop a musculoskeletal problem from their work than group 2 respondents (25 per cent before, 25 per cent after).

10.5.7 Desired changes to the workplace

Respondents were asked if they would like the layout of their workplace to be changed so that it was easier or more comfortable to do their job. Less than half of respondents from both groups said yes, despite the apparently high rate of discomfort. This suggests that they may view the activities as more problematic than the immediate location.

Nearly all of those respondents who said they would like to see changes said they would like them to be made in the next six months.

Table 10.14 shows the types of change respondents reported they would like to see.

Group 1	Start	• Change rota duties daily • Place pallets of butter, flour and sugar in the work zone
	After 6 months with training	n/a
Group 2	Start	• Make tables higher so you don't have to bend over, and make chairs higher • Clear gangways and make more machinery available in stand and ride mode
	After 6 months without training	n/a

Table 10.14 Description of changes that respondents said they wanted to make to their workplace

10.5.8 Changes already made to the workplace

Respondents were asked if they were aware whether their employer had made any changes to reduce MSD risks. No participants believed this to be the case after training, but 25 per cent in both groups changed this view at the second time point. A wider spread of participants had undertaken changes to the workplace themselves.

Those respondents who indicated that they had undertaken changes themselves were asked to provide further information on the nature of those changes. Details of the responses are given in Table 10.15.

Group 1	Start	• Swap duties every other day • Use baths, deep heat and exercise • Change staff around to different jobs
	After 6 months with training	• Take breaks • Shake arms and hands
Group 2	Start	n/a
	After 6 months without training	• Rotation of staff

Table 10.15 Description of changes that respondents had made themselves to their workplace

10.5.9 Communication and attitudes relating to health and safety

The participant survey attempted to explore attitudes to health and safety in the workplace and how communication took place in the workplace. In particular, they were asked for their views on communication between the operations or production department and company management.

The majority of both groups reported that they felt these communication links were satisfactory. This is encouraging since it suggests that this traditional barrier to improving health and safety is not realised in practice.

The final section of the questionnaire probed the attitudes of the workers with a series of statements against which the participants could record a level of agreement on a five-point scale between 'strongly disagree' to 'strongly agree'.

Below the statements are listed, along with details of any apparent conflict (ie where responses indicate a potential health and safety risk).

- In my workplace management acts quickly to correct health and safety problems. Conflicts in group 1 before and after training; group 2 at start.
- Health and safety information is always brought to my attention by my line manger/supervisor. Conflicts in group 1 before and after training; group 2 at start.
- In my workplace the chances of developing a work-related health problem are quite high. Conflicts in both groups at start.
- There is good communication here about health and safety issues which affect me. Conflicts in group 1 before and after training; group 2 at start.
- Management here considers health and safety to be equally as important as production. Conflicts in group 1 before and after training; group 2 at start.
- I believe health and safety issues are given a high priority. Conflicts in group 1 before and after training; group 2 at start.
- Some health and safety rules and procedures don't need to be followed to get the job done safely. Conflicts in both groups at both time points.
- Some health and safety rules are not really practical. Conflicts in both groups at both time points.
- I am strongly encouraged to report unsafe conditions. Conflict in group 2 at start.
- I can influence health and safety performance here. Conflicts in group 1 before and after training; group 2 at start.
- I am involved in informing management of important health and safety issues. Conflict in both groups at start.
- Health and safety is the number one priority in my mind when completing a job. Conflict in group 1 before training.
- It is important to me that there is a continuing emphasis on health and safety. No conflicts.
- I'm sure it's only a matter of time before I develop a work-related health problem. Conflict in group 2 at start.
- Production targets rarely conflict with health and safety measures. Conflicts in group 1 at both time points.
- I am always given enough time to get the job done safely. Conflicts in group 1 before training and group 2 at both time points.

10.6 Interview and walk-through with health and safety manager

The final component of the study was to revisit the participating companies to undertake a further walk-through with the health and safety manager and to interview them to assess any changes planned or made during the study process. In particular, this activity was intended to establish:

- where the request for change had originated from (eg in response to reports made by workers, engineers, production staff, client demands)
- why they had been made (eg to improve health and safety, to improve production rates, in response to product changes, demands from external clients)
- what the changes were
- whether the changes had been effective in achieving the goals
- whether health and safety in relation to MSDs had been improved or worsened by the changes.

In practice, this component of the study was less productive than had been hoped. It had been hoped that any health and safety changes would have been integrated into the normal working practices of the participating companies and that the cultural backdrop would remain constant so as to allow those changes to be appraised. In reality, the rapid changes to the economic climate during the second half of the study had a significant impact on all of the organisations.

For some companies this had resulted in reduced production, a corresponding shrinking of the workforce and a restriction on investment in changes to working practices. This extended to restricting any additional training or the introduction of new innovations due to the need to control budgets.

Additionally there was not only a reduction in the overall staff complement but a rapid change in staff. This was partly due to seasonal factors (an annual and relatively predictable event) but also an increase in the flow of foreign workers, as an increased number decided to leave the UK because of the deteriorating economy.

This meant that the individuals who had made up much of the early participant set were no longer employed in the participating companies, so changes in their skills, experience, expectations and knowledge were lost to the study. Additionally, for those organisations that had retained a significant

proportion of their original staff, few changes (if any) had moved beyond the concept stage since the health and safety budgets had been capped, frozen or reduced.

This perspective was a common thread among all the managers who were interviewed, and seemed to be a genuine reason for little change in the status quo, as opposed to an excuse.

A summary of the information gained from the interviews and walk-through activities is presented below.

10.6.1 Company 1 – Flowers

Company 1 had suffered considerably from economic changes, which resulted in the closure of the site where the study had been undertaken. This was imminent at the time of the interview and walk-through. Some of the staff were to be transferred to other sites, but others faced losing their jobs.

The health and safety manager role was filled by an external consultant, who also had to restructure their working practices, with less time spent on site.

Because of these limitations no changes had been undertaken in the organisation during or after the study at the site where the participants had been located. However, it was stated that some changes were being carried forward into other sites in order to improve workers' health. The proposed changes are summarised in Table 10.16.

In other respects there had been no changes within the production lines and the working culture. The same infrastructure had been maintained, there had been no noticeable rise or fall in accident rates and there had been no new cases of reported MSDs.

Table 10.16 Company 1 health and safety changes during and after the study

Change	Who requested	Why requested	Change effective?	MSD H&S improved?
Reduction in weight of bulk containers for flowers to 25 kg	H&S manager	H&S – reduce risk of manual handling injury	Yes	Yes
Further reduction in weight of bulk containers for flowers (proposed)	H%S manager	H&S – further reduce risk of manual handling injury	Yes	Yes
Evaluation of potential means of mechanising some of the more repetitive tasks (proposed)	H&S manager, staff	H&S and productivity – Reduce risks of repetitive actions	Yes	Yes
Introduction of more carousels which would hold flower bunches whilst they were assembled	H&S manager, staff	H&S – Reduce amount of static grip tasks	Yes	Unknown
Ongoing evaluation of working practices (proposed)	Staff	H&S – Seek out potential improvements	Unknown	Unknown

10.6.2 Company 2 – Laboratories

Company 2 had managed to resist recession-related workplace changes to the greatest extent. The majority of the staff had been continuously employed throughout the duration of the study. The health and safety manager was also highly motivated to improve the safety culture, and was supported by the employer.

This organisation also employed individuals with a higher level of academic achievement that the other participating companies. This had been apparent during the earlier activities, where there was a high level of interaction between the workers and the research study representatives. This increased academic experience is likely to have accounted for this company identifying and implementing more interventions.

Table 10.17 shows the changes that had been implemented or planned during the study. The main changes, namely the provision of sit/stand work stations and stools with a greater range of adjustability, were influenced by discomfort affecting a single member of staff. This individual was unusually tall and stooping to reach the workbench had caused discomfort. While a height adjustable workstation would be a more appropriate solution, the ability to sit at a more comfortable height had relieved the pain that this individual suffered.

A further intervention of evaluating the feasibility of multiple nozzle pipettes would significantly reduce the number of repetitive actions. This had cost and work rate implications so had not yet been implemented, so different patterns of work rotation were being explored to generate a more immediate improvement

These actions had also prompted the introduction of a wider-ranging review of health and safety practice, as a result of which a more co-ordinated approach to health and safety was planned.

In other respects there had been little change during and after the study. Accident rates and complaints of discomfort did not appear to have changed and remained at a low level. No additional cases of MSDs had been reported.

Table 10.17
Company 2 health and safety changes during and after the study

Change	Who requested	Why requested	Change effective?	MSD H&S improved?
Introduction of sit/stand workstation	Line worker	Improve H&S – Discomfort from stooping	Yes	Yes
Provision of adjustable stools	Line worker	Improve H&S – Discomfort from stooping and when seated	Yes	Yes
Increase staff rotation	H&S manager, staff	Improve H&S – Reduce risks of repetitive actions	Yes	Yes
Evaluating multiple output pipettes (proposed)	Staff	Improve H&S – Reduce number of repetitions	Yes	Unknown
Ongoing evaluation of working practices (proposed)	Staff	Improve H&S – Seek out potential improvements	Unknown	Unknown

10.6.3 Company 3 – Salad preparation

Company 3 had also suffered significantly from the economic downturn that had occurred during the latter part of the study. This coincided with the normal slump in sales that occurs during the winter period. The result was a significant reduction in staff, many of whom had been involved in the early stages of the study. This had resulted in knowledge loss, a lack of continuity and interruption to planned improvements to systems and equipment.

The problems identified by Company 3 in implementing and monitoring changes were echoed by the fact that they were unable to secure any individuals who could complete the post-training questionnaire. This in itself led to difficulties in appraising the effectiveness of the study and the training in particular, but also demonstrated the magnitude of the problems facing the organisation.

In discussion it was noted that no new initiatives had been implemented, although the health and safety manager was confident that more improvements could be contemplated when the seasonal trade picked up. Additionally, the health and safety manager was keen to develop new training packages and was looking to involve elements of the study in this. It is not known whether this initiative resulted in positive changes to MSD health and safety.

Company 3 noted that there had been no apparent rise in accident rates (allowing for reduced staff numbers) and no additional MSD related incidents had been noted.

10.6.4 Company 4 – Cakes

Company 4 had also moved through normal seasonal changes during the latter part of the study, with two peaks in production separated by a lull. This had resulted in variation in staff numbers, including the loss of some individuals who had contributed to the early stages of the study. This had in turn affected the continuity of knowledge and ideas that might have been developed from the study.

Company 4 had very robust training programmes and these had continued without change. The organisation also continued to be receptive to suggestions for change from any quarter. However, no specific new policies or interventions had been taken up during the study duration, partly due to the financial caution that reflected the general economic climate.

It was noted that the health and safety manager took an active interest in the study and was keen to retain some of the material (checklists, teaching material), which would hopefully be included in future safety initiatives.

No specific changes in health and safety practice were noted from Company 4, but they had not recorded any increase in accident or incident rates over the study period. No additional MSD issues had been raised during the study.

11 Phase 4 and 5: Statistical analysis

A thorough statistical analysis of the results derived from phases 4 and 5 of the research was undertaken by an expert statistician. The results of this analysis are presented in summary form in this section.

11.1 General notes

Some key principles were applied to the data analysis. These include the following:

- The significance criterion has been set at 0.05. At this level, it was noted that none of the Task 2 tests gave any significance.
- The data relating to the detection of errors is essentially ordinal. Because of this, low scores are required since they imply a low difference from the expert recorded score.
- The data relating to with and without training was row-ranked, because samples were related, and tested using repeated measures analysis of variance (ANOVA). The outcome was that too many ANOVA assumptions were violated so non-parametric inferential testing was used instead. However, ANOVA graphs (which continue to be valid for showing any experimental effect) have been retained, but the ordinate values of these graphs do not correspond directly to values shown in the non-parametric test output.
- Graphs have been provided only for significant or near-significant results. The bar heights for tests for main effects should be equal to the mean ranks of test outputs.
- The ordinal non-parametric tests regarding the detection of errors rank raw error detection data and then do calculations using those ranks. Accordingly, the corresponding bar charts must use the appropriate ranked variable.

11.2 Results for data relating to Task 1

For each of the analyses the results are presented by the variable under scrutiny and paraphrased as the meaningful research question.

11.2.1 Task 1 - Main effect of company on risk factor detection ability.

Proposition: 'On average, does the type of work make any significant difference to the risk factor detection difference-to-expert scores?'

Result: Significant correlation

A Kruskal-Wallis test revealed that it seems highly likely that the significance was being produced by a difference in detection ability between those who worked in laboratories and those who did not. The results are presented below in Table 11.1.

Table 11.1
Effect of company on risk factor detection ability (task 1)

Ranks			Test statistics (a, b)	
DiffToExp_DV Company	*n*	Mean rank		DiffToExp_DV
Flowers	5	14.10	Chi-square	10.336
Labs	7	5.50	df	3
Salads	5	11.90	Asymp. sig.	0.016
Cakes	5	16.90	a. Kruskal Wallis test b. Grouping variable: company	
Total	22			

This was checked by conducting a Kruskal-Wallis test with lab workers excluded, and this produced a non-significant result. Accordingly, a new variable was constructed which differentiated workers as being either non-lab or lab and the Kruskal-Wallis test was rerun. This showed a significant difference in risk factor detection ability between lab workers and non-lab workers. It can be seen, therefore, that a significant main effect is the company when it is defined in this way, with lab workers being significantly better than non-lab workers. The results are given in Table 11.2.

Ranks			Test statistics (a, b)	
DiffToExp_DV Comp_NL_L	*n*	Mean rank		DiffToExp_DV
Non-lab	15	14.30	Chi-square	8.835
Lab	7	5.50	df	1
Total	22		Asymp. sig.	0.003
			a. Kruskal Wallis test b. Grouping variable: Comp_NL_L	

Table 11.2
Effect of company on risk factor detection ability – revised (task 1)

11.2.2 Task 1 – main effect of position on risk factor detection ability

Proposition: 'On average, does the worker status (worker, leader) make any significant difference to the risk factor detection difference-to-expert scores?'

Result: No significant correlation

A Kruskal-Wallis test using position as the independent variable was conducted and found to be non-significant. Thus the data do not give acceptable evidence of a main effect of status on the ability to detect risk factors. The results are given in Table 11.3.

Ranks			Test statistics (a, b)	
DiffToExp_DV Position	*n*	Mean rank		DiffToExp_DV
Team leader etc	9	13.44	Chi-square	1.377
Line worker	13	10.15	df	1
Total	22		Asymp. sig.	0.241
			a. Kruskal Wallis test b. Grouping variable: Position	

Table 11.3
Effect of position on risk factor detection ability (task 1)

11.2.3 Task 1 – main effect of training on risk factor detection ability

Proposition: 'On average, does the worker training (untrained, trained) make any significant difference to the risk factor detection difference-to-expert scores?'

Result: No significant correlation.

A Friedman test was conducted using both trained and untrained risk factor detection as independent variables. Friedman testing was used since the dependent variable samples are related and the data is essentially ordinal. The output was found to be non-significant; therefore, the data do not give acceptable evidence of a main effect of training on risk factor detection ability. The results are shown in Table 11.4.

11.2.4 Task 1 – main effect of checklist on risk factor detection ability

Proposition: 'On average, does the checklist (A, B) used make any significant difference to the risk factor detection difference-to-expert scores?'

Result: Significant correlation

A Kruskal-Wallis test was conducted and found to be marginally non-significant. Thus, strictly, the data do not give acceptable evidence of a main effect of checklist on the ability to detect risk factors.

Table 11.4
Effect of training on risk factor detection ability (task 1)

Ranks		Test statistics (a)	
	Mean rank	*n*	22
ABS_UT_DV	1.39	Chi-square	1.471
ABS_T_DV	1.61	df	1
		Asymp. sig.	0.225
		a. Friedman test	

However, it is clear that the results would have been significant had there been a few more participants, and those results would have shown that checklist A had an effect which is better than that of checklist B for risk factor detection. This is shown in Table 11.5.

Table 11.5
Effect of checklist on risk factor detection ability (task 1)

Ranks			Test statistics (a, b)	
DiffToExp_DV Checklist	*n*	Mean rank		DiffToExp_DV
A	12	9.08	Chi-square	3.686
B	10	14.40	df	1
Total	22		Asymp. sig.	0.055
			a. Kruskal Wallis test b. Grouping variable: Checklist	

11.2.5 Task 1 – interaction of company and position on risk factor detection ability

Proposition: 'On average, is the effect of company (non-lab and lab) on risk factor detection ability significantly modified by worker status?'

Result: No significant correlation.

The ranked dependent variable data violates ANOVA assumptions, so a Kruskal-Wallis test was used with position as the independent variable. This proved to be non-significant, indicating that these data are not acceptable as evidence of interaction between company and position on risk detection ability. The results are shown in Table 11.6.

Table 11.6
Interaction of company and position on risk factor detection ability (task 1)

Ranks			Test statistics (a, b)	
DiffToExp_DV Co_Pos_Int	*n*	Mean rank		DiffToExp_DV
1	8	10.19	Chi-square	0.518
2	14	12.25	df	1
Total	22		Asymp. sig.	0.472
			a. Kruskal Wallis test b. Grouping variable: Co_Pos_Int	

11.2.6 Task 1 – interaction of company and training on risk factor detection ability

Proposition: 'On average, is the effect of Company (Non-Lab and Lab) on risk factor detection ability significantly modified by training?'

Result: Significant correlation.

Absolute trained–untrained row differences were calculated and column-ranked before being tested for with company (lab and non-lab) in univariate ANOVA. This was found to violate too many assumptions. However, unranked absolute differences when used with Kruskal-Wallis testing were found to be significant, so these data are acceptable as evidence that effect of (non-lab, lab) work type on risk factor detection ability is modified by training. Alternatively, the effect of training on risk factor detection ability is modified by (non-lab, lab) work-type. The results are given in Table 11.7.

Although the inferential analysis of a repeated measures ANOVA is not valid, the graphical output supports a significant interaction (Figure 11.1 below, noting that the graphs give the same information).

Ranks			Test statistics (a, b)	
TrainAbsDiff_DiffsToE_DV Comp_NL_L	*n*	Mean rank		TrainAbsDiff_ DiffsToE_DV
Non-lab	15	13.87	Chi-square	6.520
Lab	7	6.43	df	1
Total	22		Asymp. sig.	0.011
			a. Kruskal Wallis test b. Grouping variable: Comp_NL_L	

Table 11.7 Interaction of company and training on risk factor detection ability (task 1)

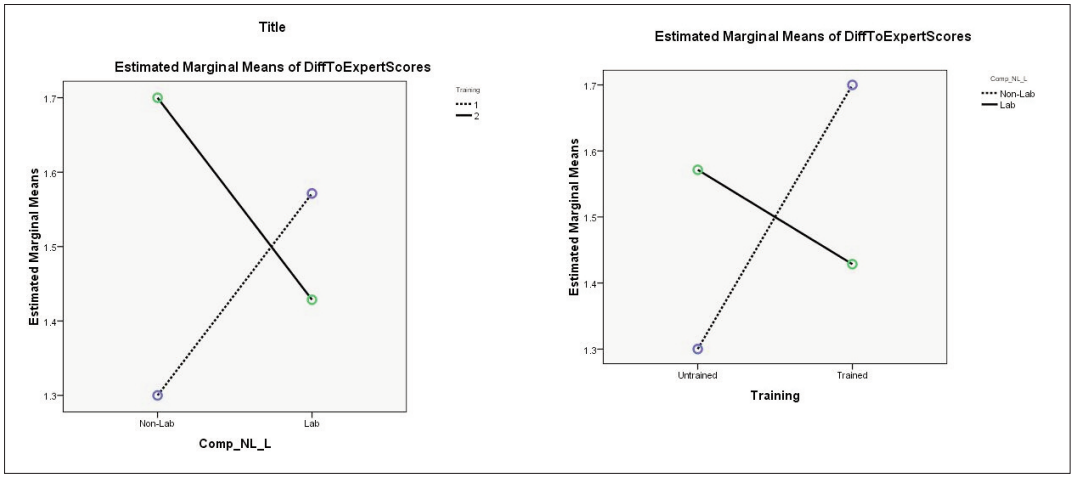


Figure 11.1 Interaction of company and training on risk factor detection ability (1 = untrained, 2 = trained) (task 1)

11.2.7 Task1 – interaction of company and checklist on risk detection ability

Proposition: 'On average, is the effect of company (non-Lab and lab) on risk factor detection ability significantly modified by the checklist used?

Result: These data were unsuitable for any test since there was a missing category: no lab worker has used checklist B.

11.2.8 Task 1 – interaction of position and training on risk detection ability

Proposition: 'On average, is the effect of worker status (worker, leader) on risk factor detection ability significantly modified by training?'

Result: No significant correlation.

These data were not suitable for ANOVA testing. A Kruskal-Wallis test using position as the independent variable and absolute trained–untrained row differences gives non-significance. However, the obtained significance is fairly low, suggesting that a doubling or tripling of participant numbers would show an effect. Although the data are unsuitable for the inferential part of ANOVA testing, the ANOVA graphs suggest that significance would be obtained with a slight increase in slope. However, the current data are not acceptable as evidence of an interaction between position and training on risk detection ability. The results are given in Table 11.8 and Figure 11.2.

Table 11.8 Interaction of position and training on risk factor detection ability (task 1)

Ranks			Test statistics (a, b)	
TrainAbsDiff_DiffsToE_DV Position	*n*	Mean rank		TrainAbsDiff_ DiffsToE_DV
Team leader etc	9	13.94	Chi-square	2.247
Line worker	13	9.81	df	1
Total	22		Asymp. sig.	0.134
			a. Kruskal Wallis test b. Grouping variable: Position	

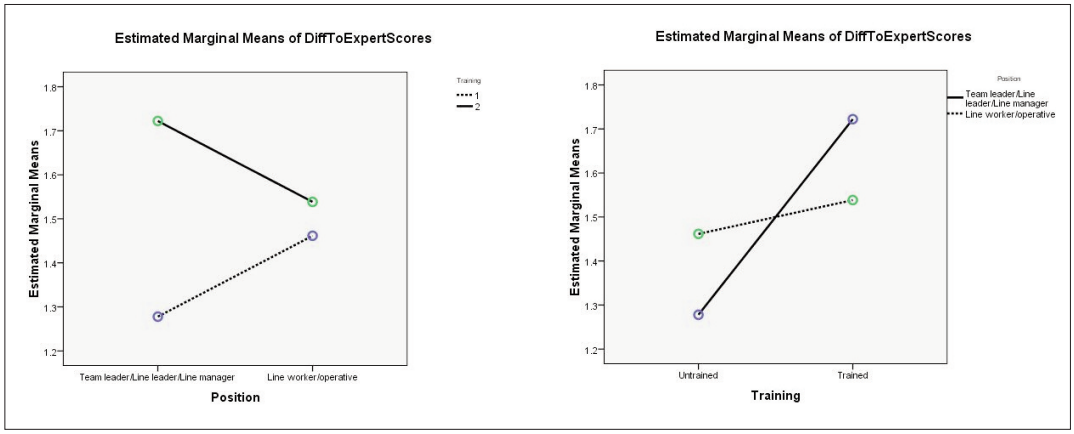


Figure 11.2 Interaction of position and training on risk factor detection ability (1 = untrained, 2 = trained) (task 1)

11.2.9 Task1 – interaction of position and checklist on risk detection ability

Proposition: 'On average, is the effect of worker status (worker, leader) on risk factor detection ability significantly modified by the checklist used?'

Result: No significant correlation.

The data were unsuitable for ANOVA tests. Interaction analysis is very non-significant, indicating that the data are not acceptable as evidence of an interaction between position and checklist on risk detection ability. The results are given in Table 11.9.

11.2.10 Task 1 – interaction of training and checklist on risk detection ability

Proposition: 'On average, is the effect of training (untrained, trained) on risk factor detection ability significantly modified by the checklist used?'

Ranks			Test statistics (a, b)	
DiffToExp_DV Pos_Checkl_Int	*n*	Mean rank		DiffToExp_DV
1	10	11.75	Chi-square	0.027
2	12	11.29	df	1
Total	22		Asymp. sig.	0.869
			a. Kruskal Wallis test b. Grouping variable: Pos_Checkl_Int	

Table 11.9 Interaction of position and checklist on risk factor detection ability (task 1)

Result: Significant correlation.

These data are unsuitable for the inferential part of ANOVA testing, so Kruskal-Wallis was used with checklist as the independent variable. Here the data show significance, indicating that they are acceptable as evidence that the effect of training on risk detection ability is modified by the checklist used or, alternatively, that the effect of the checklist used on risk detection ability is modified by whether or not training has been received. The results are shown in Table 11.10, with ANOVA graph output in Figure 11.3.

Ranks			Test statistics (a, b)	
TrainAbsDiff_DiffsToE_DV Checklist	*n*	Mean rank		TrainAbsDiff_ DiffsToE_DV
A	12	8.04	Chi-square	7.796
B	10	15.65	df	1
Total	22		Asymp. sig.	0.005
			a. Kruskal Wallis test b. Grouping variable: Checklist	

Table 11.10 Interaction of training and checklist on risk factor detection ability (task 1)

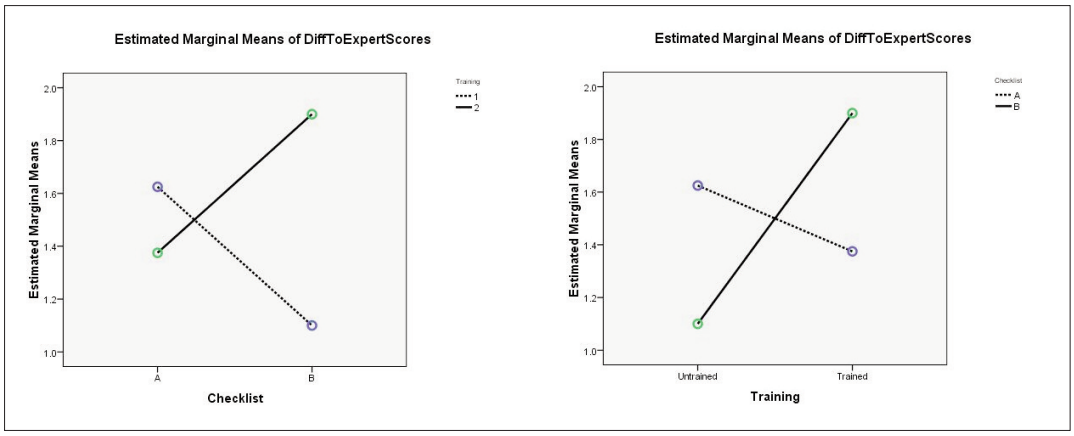


Figure 11.3 Interaction of training and checklist on risk factor detection ability (1 = untrained, 2 = trained) (task 1)

11.3 Results for data relating to Task 2

These results are presented in a similar fashion, with the variable under scrutiny stated and paraphrased as the meaningful research question.

11.3.1 Task 2 – main effect of company on risk factor detection ability

Proposition: 'On average, does the type of work (as defined by the four types in the variable company) make any significant difference to the risk factor detection difference-to-expert scores?'

Result: No significant correlation.

The data were found to violate too many ANOVA assumptions, so a Kruskal-Wallis test was used with company as the independent variable. These results were also non-significant, so the data are not acceptable as evidence of a main effect of work-type on risk factor detection ability. The results are shown in Table 11.11.

Table 11.11
Effect of company on risk factor detection ability (task 2)

Ranks			Test statistics (a, b)	
ABS_DV Company	*n*	Mean rank		ABS_DV
Flowers	12	18.50	Chi-square	3.187
Labs	16	26.56	df	3
Salads	8	20.25	Asymp. sig.	0.364
Cakes	8	22.62	a. Kruskal Wallis test b. Grouping variable: company	
Total	44			

11.3.2 Task 2 – main effect of position on risk factor detection ability

Proposition: 'On average, does the worker status (worker, leader) make any significant difference to the risk factor detection difference-to-expert scores?'

Result: No significant correlation.

The data were column-ranked and used with a univariate ANOVA analysis, with position as the independent variable. Cases with a data value of 0 were filtered out. The data were found to violate too many ANOVA assumptions, so a Kruskal-Wallis test was used with position as the independent variable. The results (Table 11.12) were non-significant, so these data are not acceptable as evidence of a main effect of work type on risk factor detection ability.

Table 11.12
Effect of position on risk factor detection ability (task 2)

Ranks			Test statistics (a, b)	
ABS_DV Position	*n*	Mean rank		ABS_DV
Team leader etc	14	17.96	Chi-square	1.453
Line worker	27	22.57	df	1
Total	41		Asymp. sig.	0.228
			a. Kruskal Wallis test b. Grouping variable: position	

11.3.3 Task 2 – main effect of training on risk detection ability

Proposition: On average, does the worker training (untrained, trained) make any significant difference to the risk factor detection difference-to-expert scores?

Result: No significant correlation.

The data were column-ranked and used with a univariate ANOVA analysis, with training as the independent variable. The data were found to be consistent with ANOVA assumptions. Also, a Kruskal-Wallis test was used with training as the independent variable. Results were very close but non-significant, so these data are not acceptable as evidence of a main effect of training on risk factor detection ability. Results from the Kruskal-Wallis test are shown in Table 11.13.

Ranks			Test statistics (a, b)	
ABS_DV Any_Training	*n*	Mean rank		ABS_DV
With training	24	21.50	Chi-square	0.339
Without training	20	23.70	df	1
Total	44		Asymp. sig.	0.561
			a. Kruskal Wallis test b. Grouping variable: Any_Training	

Table 11.13 Effect of training on risk factor detection ability (task 2)

11.3.4 Task 2 – main effect of checklist on risk factor detection ability

Proposition: 'On average, does the checklist (A, B) used make any significant difference to the risk factor detection difference-to-expert scores?'

Result: No significant correlation.

The data were column-ranked and used with a univariate ANOVA analysis, with checklist as the independent variable. The data were found to violate too many ANOVA assumptions, so a Kruskal-Wallis test was used with checklist as the independent variable. The results (Table 11.14) were non-significant, so these data are not acceptable as evidence of a main effect of checklist on risk factor detection ability.

Ranks			Test statistics (a, b)	
ABS_DV Checklist	*n*	Mean rank		ABS_DV
A	27	22.72	Chi-square	0.254
B	16	20.78	df	1
Total	43		Asymp. sig.	0.615
			a. Kruskal Wallis test b. Grouping variable: Checklist	

Table 11.14 Effect of checklist on risk factor detection ability (task 2)

11.3.5 Task 2 – interaction of company and position on risk factor detection ability

Proposition: 'On average, is the effect of company (ie the four types of work) on risk factor detection ability significantly modified by worker status?'

Result: No significant correlation.

These data were column-ranked and used with a univariate ANOVA analysis, with company and position as independent variables and with rows with Position = 0 filtered out. The data were found to violate too many ANOVA assumptions, so adapted Kruskal-Wallis tests were used to get a conservative estimate.

The output of all tests was non-significant (0.737 for the ANOVA and 0.455–0.904 for the Kruskal-Wallis tests) so the data are not acceptable as evidence of an interactive effect of work type (company) and position (worker, leader) on risk factor detection ability. The results for the best Kruskal-Wallis tests are shown in Table 11.15.

Table 11.15 Interaction of company and position on risk factor detection ability (task 2)

Ranks			Test statistics (a, b)	
CoPosDV4 CoPosIV4	*n*	Mean rank		CoPosDV4
1	27	21.98	Chi-square	0.558
2	14	19.11	df	1
Total	41		Asymp. sig.	0.455
			a. Kruskal Wallis test b. Grouping variable: CoPosIV4	

11.3.6 Task 2 – interaction of company and training on risk factor detection

Proposition: 'On average, is the effect of company (non-lab and lab) on risk factor detection ability significantly modified by training?'

Result: No significant correlation.

The data were column-ranked and used with a univariate ANOVA analysis, with company and training as independent variables. The data were found to violate too many ANOVA assumptions, so adapted Kruskal-Wallis tests were used to get a conservative estimate.

The output of all tests was non-significant (0.093 for the ANOVA and 0.161–0.377 for the Kruskal-Wallis tests) so these data are not acceptable as evidence of an interactive effect of work type (company) and training (untrained, trained) on risk factor detection ability. Results for the best Kruskal-Wallis test are shown in Table 11.16 and Figure 11.4.

Table 11.16 Interaction of company and training on risk factor detection ability (task 2)

Ranks			Test statistics (a, b)	
CoTrain_DV1 CoTrain_IV1	*n*	Mean rank		CoTrain_DV1
1	26	24.73	Chi-square	1.961
2	18	19.28	df	1
Total	44		Asymp. sig.	0.161
			a. Kruskal Wallis test b. Grouping variable: CoTrain_IV1	

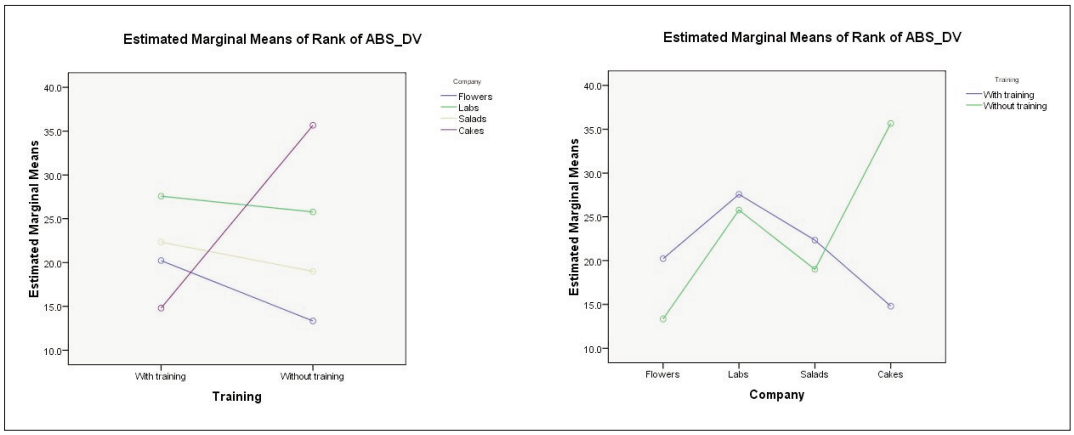


Figure 11.4 Interaction of company and training on risk factor detection ability (task 2)

11.3.7 Task 2 – interaction of company and checklist on risk detection ability

Proposition: 'On average, is the effect of work-type (company) on risk factor detection ability significantly modified by the checklist used?'

Result: The interaction could not be assessed because the data were unsuitable – checklists A and B were not used by each company (Flowers and Labs used only checklist A, Salads and Cakes used only checklist B).

11.3.8 Task 2 – interaction of position and training on risk detection ability

Proposition: 'On average, is the effect of worker status (worker, leader) on risk factor detection ability significantly modified by training?'

Result: No significant correlation.

The cases for which Position = 0 were filtered out. The dependent variable data were column-ranked and used with a univariate ANOVA analysis, with position and training as independent variables. The data were found to violate too many ANOVA assumptions, so adapted Kruskal-Wallis tests were used to get a conservative estimate.

The output of all tests was non-significant (0.255 for the ANOVA and 0.257 for the Kruskal-Wallis) so these data are not acceptable as evidence of an interactive effect of position (worker, leader) and training (untrained, trained) on risk factor detection ability. The results for the Kruskal-Wallis test are shown in Table 11.17 and Figure 11.5.

Table 11.17 Interaction of position and training on risk factor detection ability (task 2)

Ranks		
ABS_DV PosTrain_IV	*n*	Mean rank
1	24	19.27
2	17	23.44
Total	41	

Test statistics (a, b)	
	ABS_DV
Chi-square	1.283
df	1
Asymp. sig.	0.257
a. Kruskal Wallis test b. Grouping variable: PosTrain_IV	

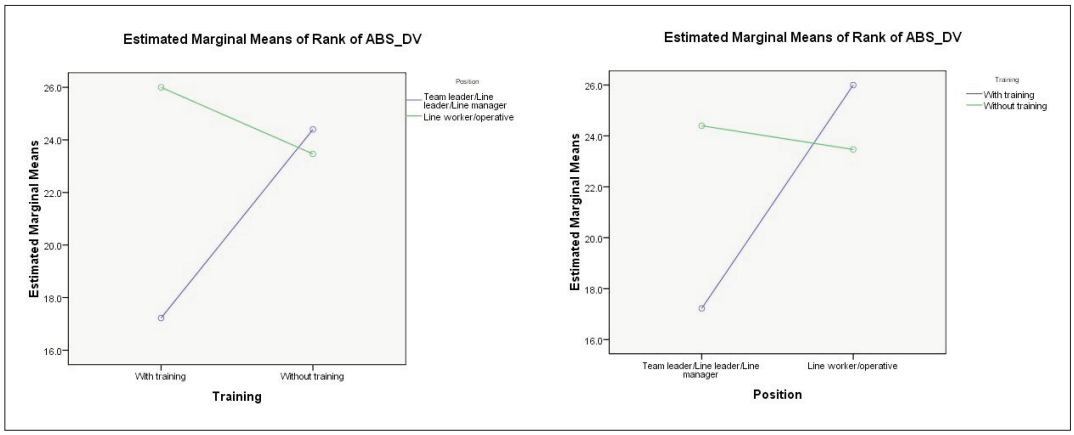


Figure 11.5 Interaction of position and training on risk factor detection ability (task 2)

11.3.9 Task 2 – interaction of position and checklist on risk detection ability

Proposition: 'On average, is the effect of worker status (worker, leader) on risk factor detection ability significantly modified by the checklist used?'

Result: No significant correlation.

Initially, cases for which Position = 0 were filtered out. The data were then column-ranked and used with a univariate ANOVA analysis, with position and checklist as ndependent variables. The data were found to violate too many ANOVA assumptions, so adapted Kruskal-Wallis tests were used to get a conservative estimate.

The output of all tests was non-significant (0.538 for the ANOVA and 0.751 for the Kruskal-Wallis test) so these data are not acceptable as evidence of an interactive effect of position (worker, leader) and checklist (A, B) on risk factor detection ability. The results for the Kruskal-Wallis test are shown in Table 11.18.

Table 11.18 Interaction of position and checklist on risk factor detection ability (task 2)

Ranks			Test statistics (a, b)	
ABS_DV PosCheck_IV	*n*	Mean rank		ABS_DV
1	15	21.23	Chi-square	0.100
2	25	20.06	df	1
Total	40		Asymp. sig.	0.751
			a. Kruskal Wallis test b. Grouping variable: PosCheck_IV	

11.3.10 Task 2 – interaction of training and checklist on risk detection ability

Proposition: 'On average, is the effect of training (untrained, trained) on risk factor detection ability significantly modified by the checklist used?'

Result: No significant correlation.

The dependent variable data were column-ranked and used with a univariate ANOVA analysis, with training and checklist as independent variables. The data were found to violate too many ANOVA assumptions (although for this test, the decision was marginal), so an adapted Kruskal-Wallis test was used to get a conservative estimate.

The output of the tests was non-significant (0.261 for the ANOVA and 0.317 for the Kruskal-Wallis test) so these data are not acceptable as evidence of an interactive effect of training (untrained,

trained) and checklist (A, B) on risk factor detection ability. Results for the Kruskal-Wallis test are shown in Table 11.19 and Figure 11.6.

Ranks			Test statistics (a, b)	
ABS_DV TrainCheck_IV	*n*	Mean rank		ABS_DV
1	23	23.74	Chi-square	1.002
2	20	20.00	df	1
Total	43		Asymp. sig.	0.317
			a. Kruskal Wallis test b. Grouping variable: TrainCheck_IV	

Table 11.19 Interaction of training and checklist on risk factor detection ability (task 2)

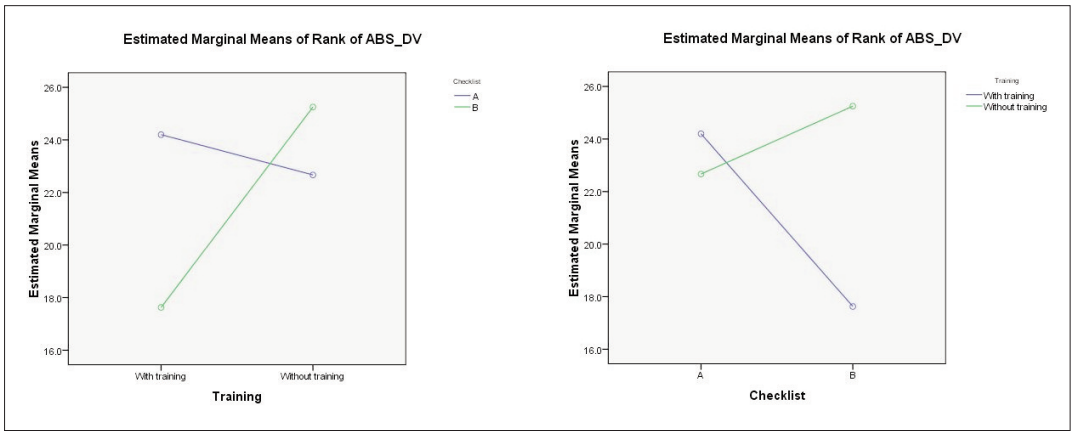


Figure 11.6 Interaction of training and checklist on risk factor detection ability (task 2)

11.4 Summary of statistical findings

The findings of the statistical testing are summarised below, giving the relevance of the outcomes to the research programme.

11.4.1 Risk factor detection ability for task 1 (for tests showing significance)

- Overall, laboratory workers were better than others.
- Overall, checklist A was better than checklist B
- When training is not given, non-laboratory workers are much better than laboratory workers.
- When training is given, laboratory workers become better than non-laboratory workers.
- When training is not given, checklist B is better than checklist A
- When training is given, checklist A is better than checklist B

11.4.2 Risk factor detection ability for task 2 (all tests show non-significance)

No conclusions could be drawn because all tests gave non-significant results. As a rough intuitive estimate, about four times the number of participants would have been needed to give significance.

11.4.3 Effects suggested by tests showing non-significance

Comment is made only for those tests giving p-values where $p < 0.4$ because above this level, the numbers of participants required would be very large and the experimental effects are likely to be very small.

Risk factor detection ability for task 1

- Overall, workers are better than leaders/managers.
- Overall, untrained people are better than trained people.
- When training is not given, leaders and managers are better than workers
- When training is given, workers are better than leaders and managers.

Risk factor detection ability for task 2

- Overall, people working with flowers were much better than those working with salads, cakes or in laboratories. People working in laboratories were much worse than those working with flowers, salads or cakes.
- Overall, leaders and managers were better than workers.
- People working with flowers, salads and in laboratories are better without training, but people working with cakes are better with training.
- Untrained workers were better than untrained leaders and managers but trained leaders and managers were better than trained workers.
- For untrained people, checklist A is better than checklist B but for trained people, checklist B is better than checklist A.

11.5 Additional testing

Further checks were undertaken to determine whether there were any transformations which could be used to make the data usable with ANOVA tests. Unfortunately, conventional transformations revealed no greater possibility for the use of ANOVA tests and consequently the findings reported above remain the best available.

Additional testing was undertaken to include multistage Bonferroni correction. In total 18 tests were conducted: nine for the Task 1 participants and nine for the Task 2 participants. It should be noted that there was no significance for a 5 per cent criterion for the Task 2 tests, so there was no value in applying the criterion to those tests. However, there was significance for a 5 per cent criterion for some of the Task 1 tests when the correction was applied. The results are shown in Table 11.20.

Table 11.20 Multistage Bonferroni correction for task 1

p-value	Significance criterion	Significant?
0.003	0.05/9 = 0.0056	Yes
0.005	0.05/8 = 0.0062	Yes
0.011	0.05/7 = 0.0071	No
0.055	0.05/6 = 0.0083	No
0.134	0.05/5 = 0.0100	No
0.225	0.05/4 = 0.0125	No
0.241	0.05/3 = 0.0167	No
0.472	0.05/2 = 0.0250	No
0.869	0.05/1 = 0.0500	No

This correction leaves only the tests giving *p*-values of 0.003 and 0.005 as being truly significant, so, strictly, conclusions should be drawn only in respect of those results. However, for the remaining tests, there is no harm in indicating the effects that they suggest.

Accordingly, the tests and corresponding conclusions divide themselves into three classes:

A those which are non-significant when run
B those which are significant when run
C those which are significant with Bonferroni correction.

The main body of the statistical findings deals only with A and B. Following the Bonferroni correction a few of the conclusions relating to A should be moved to C.

One way for reducing the negative impact of the Bonferroni correction would be to rule out a set of tests as a complete class – eg all interactions, or all tests involving a specific variable – because they do not relate to the experimental hypotheses that were specified a priori (given that it would be

incorrect to specify them *post hoc*). This may change the status of some of the tests and conclusions from B to C but it would have no effect on A.

Another approach could be to treat the overall findings as an exploratory study which paves the way to a later more targeted study which could recruit much larger participant samples and offer a higher degree of consistency within specific organisations.

It is possible to argue that these findings are specific to the study that has been undertaken and that conclusions are not necessarily to be generalised to the overall population. In this case, the significance criterion could be set at a level that was felt appropriate. A value of 0.4 has been suggested to rule out very small experimental effect sizes. This would increase the number and scope of the investigation variables which were observed to be significant within the context of this research rather than reflecting the whole working population.

12 Discussion and conclusions

12.1 Discussion

The motivation behind this research project was to establish the key variables in the nature of checklists intended for aiding risk assessment and to scrutinise the role of training in the effectiveness of checklist application. Effectiveness was determined as the ability to correctly identify risk factors when they were present and to select appropriate interventions to help reduce the effects of those risk factors. These are the prime elements which make up the practical value of the risk assessment process.

The problem that industry faces is that of competition for resources. While it is entirely reasonable to presume that no company intentionally wishes harm on its workforce, there are clearly tensions between profitability, efficiency and safe working practices. The balance struck between these variables will differ between companies and even between departments in the same company. How that balance is decided upon may be through design or chance, but once chosen there will clearly be a motivation to substantiate the correctness of that stance. This is one of the inherent problems with risk assessment – because it contains subjective elements, the results can be engineered if so desired.

It may be argued that the 'safety first' mantra is somewhat distorted. Current practice is evidently to manufacture safely rather than to safely manufacture – the emphasis being on the paramount need to produce viable product but to try and do so safely, rather than to ensure safe practices are laid down and then evaluate whether the product can be manufactured for reasonable cost. It would not necessarily be unfair to say that the interests of the shareholders still dominate over the interests of the workforce – as can be substantiated by the working practices employed on the grounds of economy. Automation, slower production rates, higher staffing levels and numerous other investment-heavy variables could be employed to provide a safer working environment but are not because of the costs involved.

While this may be the reality it does not necessarily have to be acceptable. This is particularly true when site visits reveal both chronic and acute occupational problems for which the company cannot apparently find resources, yet they still return share dividends and bonuses. This is, to some degree, understandable given the immediacy of profit statement versus the longer term costs of occupational welfare. However, once this situation becomes apparent then the 'safety first' culture can be revealed to be a misguided presumption.

Legal obligations on employers should ensure that safe working practices are financed and employed, but poor intervention knowledge and enforcement, alongside a lack of financial resources, result in inferior levels of safety on a day-to-day level for many workers.

It is important to establish the current cultural climate before attempting to evaluate the effectiveness of procedures such that erroneous assumptions are avoided. In evidence, despite assurances from all the companies that participated in the study that safety was their highest priority, all had factors present in their working practices (some of which were quite hazardous) which could readily be made safer if more money was spent on the design of the work system. In some instances this was not readily apparent, and assistance may have been required to help the company identify the areas for improvement. However, in other instances the activities being undertaken were bordering on completely unacceptable. In these cases is it likely that the health and safety practitioner responsible was working without the full support of their board, but also may have lost sight of some of the problems due to routine exposure.

On other occasions it could be seen that safety benefits had been consumed as performance benefits, rendering the levels of safety lower again. Alternatively, safe practice was observed to have been overruled by more subtle influences such as the brand image or personal preference of senior employees.

The message here is strong. There is an awareness of safety at all levels within the manufacturing sector, but it is not clearly seen as an obligation, more as an interpretative option. Accordingly, scientific evaluation of modifications to safety practice is unlikely to be easy.

In addition there is a problem in getting people to recognise that there is a problem to solve. Safety practitioners may be unaware that the activities in their company present an unacceptable level of risk

due to poor education, poor evaluation or misleading behaviour (whereby the workers change behaviour when they are being assessed). These circumstances may be easier to address through the provision of better quality risk assessment tools. However, unless there is an awareness raising exercise and a political will to change, there is unlikely to be an improvement in individuals recognising their own limitations. In this fashion it is likely that defective systems will be considered adequate, that problems will be considered conventions and that injuries are considered inevitable not due to deliberate action but by default – those with responsibility simply are not aware that an issue exists.

Risk assessment is intended to alleviate this situation and consequently forms a main component of both legislation and guidance. The wording of the legislation and guidance is clear and the expectation of the actions which should result apparent. However, the assumption that all stakeholders will willingly 'buy into' the philosophy is perhaps optimistic. Unfortunately, this assumption leads to the provision of numerous risk assessment tools, many of them checklist-based, intended to be used by enthusiastic safety practitioners, for the benefit of a responsible and motivated workforce and with the support of an empathetic board. It is almost inevitable that this will fail.

The result is that risk assessment becomes a formality, undertaken by under-resourced and under-supported practitioners, seen by the workforce as ineffective and devious and viewed by the board as leverage for unnecessary expenditure.

In this light it is no surprise that the simplest risk assessment tools are often considered the best and those tools which fail to interrogate the processes particularly effectively will also be preferred, since they are unlikely to illuminate problems which need to then be resolved. This may explain the popularity of proprietary of free risk assessment tools over bespoke versions. It may also be the case that practitioners wish to use the tools that are likely to be used by an enforcement agency such that they can avoid later confrontation. This might be despite the tools being inappropriate for the circumstances or compromised in their effectiveness.

It can be seen, therefore, that the presumption that risk assessment is a good thing relies on a number of flawed assumptions, largely related to the perversity of human nature and the primary focus of manufacturing industry to be commercially viable.

Despite this, risk assessment is arguably the only thing that can be legally required and consistently applied. However, by acknowledging the limitations and conflicting motives in safety practice then better assessment tools can be generated. This project set out to evaluate the performance of such tools and to identify the critical elements in them when they are applied in the manner in which current legislation and guidelines envisage – namely across a diversity of staff, all of whom are motivated to use them effectively.

The findings should inform the development of better risk assessment tools, at least in theory, for this application. However, it is probable that the effectiveness of the tools through their design is dwarfed by the compromises made by other factors. Chief among these are financial restrictions and motivation of participating staff. It is clear that the assumption that all staff collaborate in a harmonious fashion towards the highest levels of safety is not supported and some workers clearly either do not want to contribute or are unable to contribute. This has a significant impact on the nature of effective risk assessment design: if it is intended to be used by a more select group of individuals, it can be tailored more effectively.

In order to be able to apply the findings of this work, it is important for that distinction to be made. A recognition that workers might be involved in the process, for instance by discussion or observation rather than by actually using the assessment tools, means that the content and structure of the tools can be better suited to the practitioners. Similarly, if the tools are better designed for those practitioners then the results will be more accurate (and therefore more trusted by the other stakeholders) and be of more value in attempting to get boardroom engagement for funds. Ideally it could lead to a situation as is currently found in road safety where safety interventions could be justified by more accurate financial modelling of health costs.

The alternative is that the current situation is retained, albeit with the design of the tools improved for general comprehension. This inclusive approach will mean that the tools lose effectiveness in their drive to be comprehended by the educated and uneducated, English speaking and other native tongues, the safety aware and the safety resistant.

A prime tenet of ergonomics is that in order to produce optimised systems one must first be able to precisely define the population who will interact with it. It is clear that in the current scenario the mismatch between the task the tools and the user is leading to not only an ineffective system whereby poor results are achieved, but to a potentially harmful one where the presumption is that the process has been followed so inevitable the system must be right.

12.2 General study conduct

Several key observations where made early in the study when the site visits were being undertaken. These went on to inform and influence the nature of the later investigations.

Principal among these were that the industrial partners who volunteered to take part fell into two distinct groups.

One group was made up of organisations who felt they had some serious occupational problems but were unable to identify solutions or interventions which would work within the constraints they had acting upon them. For this group it was often the case that the constraints were the issue rather than finding solutions to the occupational problems – for instance, by trying to resolve complex manual handling problems where automation was the only viable solution. The constraint was an unwillingness to invest the necessary capital expenditure.

The second group contained those organisations who felt they already had robust systems in place and that they worked effectively. In these cases this confidence was almost universally misplaced. This usually resulted from a poor assessment of the occupational risks or a heavy reliance on processes rather than practice. In both scenarios there was support from poor tools. The poor assessment largely stemmed from inappropriate tool choice or from poor completion of an appropriate tool. The process reliance occurred where individuals slavishly followed a protocol which required the use of specific assessment. There were few controls to ensure that the assessment actually achieved the desired effect, but this was overlooked since the system was prescriptive. Better risk assessment tools would serve both of these groups well.

An additional problem was observed whereby most companies believed that their workforce was doing something that professional observes considered they were not. In most cases this was revealed as a corporate view that there were few manual handling activities involving repetitive actions, but many erroneously viewed tasks as not manually intensive when they actually were. Both these situations led to poor risk evaluation – either by failure to undertake risk assessment or by the use of inappropriate risk assessment tools (manual handling tools for repetitive activities, for example). Training and improved tools could assist both groups.

Finally, and arguably of most importance, most companies believe they do not have a problem where expert assessors believe they do. This leads to a failure to take any steps, good or bad, due to an assumption that there is no issue to address. This may be due to a limited outlook or a misguided confidence, but both possible causes could be mitigated by better training and through more intelligent tool design, particularly for scoping or initial assessment tools.

12.3 Limitations and future study recommendations

While the study was intended to be as robust as possible, several limitations were observed which served to compromise accuracy and effectiveness. Most of these affected the later stages of the work, which caused the greatest impact, and they all resulted from the dependent relationship with the industrial partners.

Paramount among the issues was the commitment of the industry partners. The study's authors are indebted to the partners for the investment they have made, but there is a significant gap between the demands of a scientifically rigorous study and the day-to-day demands of a responsive commercial concern.

This gap was evidenced by the conflict between the needs of the study to gain consistency in participants and to undertake certain components of the study at specific times. These were compromised by largely unavoidable factors such as staff turnover, seasonal changes and pressures of work, but also by potentially avoidable ones had the partners bought into the scientific protocol more actively. This is a valuable lesson for future studies: no matter how big the sample size intended to minimise population errors, there is significant value in 'selling' the scientific requirements thoroughly and effectively. This will undoubtedly put off some potential partners, but

will ensure that those who do take part are able to make the commitments necessary to realise a meaningful outcome.

In practice, an entire study such as this could be rendered meaningless by one or two organisations suffering commitment fatigue or being unaware of the importance of their contribution, so efforts made early on to secure robust engagement will be well rewarded. In the case of this study, the fact that Company 3 was unable to provide post-training questionnaire responses compromised the validity of the findings – removing 25 per cent of the data – and potentially meant that the efforts of the other three companies were wasted.

In this instance this was partly due to staff turnover, but also to the motivation of the remaining staff to take part. Commitment is needed at all levels for such a study to work. It is clear that a better communication at the outset of the implicit value of each participant would have greatly aided the quality of the final data.

The selection of industry partners meant that they had similar working practices. Unfortunately this also meant they were influenced by seasonal variations as well as a number of more covert factors such as a high percentage of migrant workers, high percentage of workers for whom English was a second language, workers that were mobile within the organisation so unavailable for long term commitment and workers who did not value the opportunity to participate.

Many of these factors are a normal part of a naturalistic study and are attenuated through the recruitment of sufficient numbers of participants. However, due to the 'long, thin' nature of this evaluation, small drop-out numbers had significant effects. This is indicative of the cost of trying to undertake such comprehensive research. While the research question is vital and far reaching, the requirement for independent bodies to finance it (as opposed to state agencies) means that financial resources will be restricted and stretched. In practice this means that participant numbers are pared back and consequently abandonment has significant impact. Future work might require larger collaborations of funding agencies in order to generate larger participant numbers which could ameliorate this effect.

It is noted that a between subject experimental design appears to be much less sensitive than a within subject design. This is primarily attributable to the factors noted above – staff retention and commitment of partners. It is recommended that future studies focus on this study methodology to improve the quality of the statistics that are collected.

Manufacturing industry was chosen as the target group for this study since it is the industry segment identified by the HSE as that with the highest incidence of RSI. (Although there are specific activities in other domains with high industry rates, such as aviation and construction, these often involve manual handling problems rather than upper limb RSI.) It has not been assumed that industry is solely manufacturing, but this one category of the industry directory which offered a high level of appropriate industrial injury and which covered a broad range of activities was regarded as most appropriate. While a relatively narrow part of the UK manufacturing base has been scrutinised in this study, due to the natural filtering by volunteering organisations, that part contributes the most significant number of upper limb RSIs which were the main focus. The focus on upper limb RSI allowed the use of specific prescriptive checklists which were representative of tools being used in industry to address these issues. Widening the approach to all manual handling would have required a wider diversity of tools to be considered as well as a much larger sample population.

In principle, the members of the community sampled are representative of the UK manufacturing base in terms of their capabilities and since the study was evaluating the nature of checklists and their training, the usability of the checklists was more important than the specific nature of the work as long as that work was a controlled variable. In addition, there is much more precise guidance on upper limb activity than on manual handling in general and by concentrating on this area it was possible to review specific training, interventions and evaluations rather than the more contextualised approach which is associated with general manual handling appraisal.

12.4 Conclusions

It is clear from each phase of this research project that the elements which affect the effectiveness of risk identification and the selection of interventions are high variable and liable to change over time. This variability makes studying the critical elements difficult but also suggests that the conflicting elements within the choice, design and application of checklists are unlikely to result in simple

solutions being effective. Despite the complexity, a number of consistent messages emerged from the activities undertaken in this study, and they are indicated below.

- It is not necessarily possible to include all worker types in the risk assessment intellectual process despite this being popular and widely promulgated as good practice.
- Different worker types have different preferences for assessment tools, suggesting that assessors might wish to choose the type of tool they use from a range rather than have a single corporate form.
- Different worker types have different risk detection performance with different assessment tools. This suggests that there might be the possibility of optimising worker type and tool combinations. However, the complexity for this relationship within and between companies and over time makes it difficult to be prescriptive about good performance.
- Preference and performance may not be synonymous and may change over time with training and experience. This is problematic since workers are less receptive to assessment types that do not appeal to them, which may lead to self selection of inferior assessment tools. Similarly, implementation of effective assessment aids may be hampered by resentment or abandonment by worker groups.
- Different training approaches are likely to be required by different worker groups. While unsurprising given the different roles and probable differences in educational backgrounds, this would be costly and is unlikely to be accommodated by companies.
- This suggests that training will either be inferior in efficacy or that some worker groups may be eliminated from the assessment activities due to non-availability of, or limited interest in, the training given.
- Motivation is more of a problem than the tools or training. Workers need to actively wish to participate and see a reason for doing so in order to embrace the challenges presented by risk assessment. Involvement and contribution in order to avoid other duties, or solely for reasons such as status will be counterproductive. The prevalence of such practices reflects the worker view of health and safety activities in general. Finding the correct triggers to promote health and safety as a desirable activity in which to be involved will require an investment of time for individual companies.
- Safety needs to be seen as an end in itself rather than a reason not to do something else. Current scepticism and cynicism over the role and practice of health and safety is hugely counterproductive and stands as a major obstacle to both effectively studying these activities and implementing new strategies.
- Multinational or multilingual workforces present numerous challenges which cannot be effectively addressed by conventional means. This was the most consistent problem facing the companies taking part in the study and even those with robust strategies faced logistical problems that were almost insurmountable. Issues such as translation of important information, trustworthiness of translations, composition of workforce, and effective communication left the majority of companies feeling that they were unable to demonstrate compliance with their legal obligations. Most felt that legal requirements that could not be reasonably met were counterproductive and led to more significant failures in safety practice.
- Identifying appropriate training is a challenge in and of itself. Standard packages may well be ineffective or unpopular and consequently bespoke resources might be needed for individual companies. This may challenge the established view of the provision of nationally approved packages, but offers great opportunity for training professionals.
- Similarly, the identification and provision of appropriate checklists may be an activity that needs to be undertaken by third parties with suitably qualified professionals developing appropriate checklist resources for specific companies. This conflicts with the current appeal of checklists as readily available and generically approved.
- A further problem exists in ensuring that checklists are correctly interpreted. While changes in risk factor detection can be brought about by the implementation of appropriate checklists for workers and companies, there is a significant hurdle between this achievement and correctly identifying appropriate interventions. Not only are there difficulties in matching interventions to risk factors in practice, but the conflict with other commercial factors such as cost and productivity may not be comprehended or accommodated. Failure to adopt recommendations by risk assessors will also ultimately lead to disenfranchisement with the safety system and probable abandonment.
- An important activity is ensuring that messages from checklists are properly disseminated to all appropriate staff. This communication faces numerous difficulties, ranging from the obvious ones such as language barriers, demands of shift working and handover and staff churn, through to more complex and pervasive issues such as encouraging senor management participation and

endorsement. Rather than adopting a ground-up approach, most participating companies felt that a top-down strategy, reflecting true boardroom commitment to safety, would be more effective.

- In the modern multicultural and multinational workforce, cultural differences and rivalries may override good practice. While it is easy to dismiss these issues as trivial, the extensive use of these labour resources makes such problems very real and challenging in the workplace.
- Companies trying to discharge their legal responsibilities with regard to risk management are largely unable to identify a means of dealing with such issues without other forms of discrimination being cited.
- Honesty still appears to have a perceived price – whistleblowers and other people who share information covertly are seen as champions by the workforce but traitors by the management. This makes reporting of poor practices and standards a perilous activity and conflicts with most companies stated safety first policy. It is observed that rather than to 'safely make things', the priority is to 'make things safely' and this change in emphasis places production values over safety ones.
- It is apparent that companies should be more ready to employ professional assistance in the area of risk management since they often 'don't know what they don't know'. Because of this, the provision of easily accessible, 'endorsed' risk assessment resources can lead to poor judgements and bad practice. A shift is needed from the closed shop approach where safety is kept in-house and somewhat secret to a more open approach welcoming external involvement, which should be seen as part of a constructive safety policy by enforcement agencies. Extensive in-house safety strategies are meaningless unless they are effective but currently detail seems to prevail over efficiency. It is also the case that most companies are very defensive – usually declaring their systems fully robust despite injury statistics indicating otherwise. Removing the stigma associated with safety issues would lead to outside consultation being more welcome.
- Risk assessment is only the starting point not the finishing point, and may work against improving the safety culture if allowed to be undertaken badly.
- The universal reliance on risk assessment as a means of despatching legal obligations has led to a formulaic set of solutions (such as accessible checklists) which clearly cannot meet the needs of all.
- Litigation culture might be a greater motivator for change. If the resistance to good safety practice is the cost, then the cost of poor safety practice needs to be more clearly spelt out in financial terms such that the benefits can be more readily used to motivate change. Including financial costs in risk assessment checklists may be an effective means of helping to prioritise interventions, select the right intervention for an activity and engage the enthusiasm of the boardroom.

13 Guidelines

Section 13.1 identifies the key areas of the two checklists used in this evaluation and highlights those areas where one checklist was more effective than the other. Section 13.2 goes on to consider the critical elements of the checklist design and makes recommendations for changes and improvements which would improve the effectiveness of each checklist style.

13.1 Assessment of the checklist facets offering greatest potential

Table 13.1 presents the facets of checklists A and B that the findings of trial 1 suggest work the best. It will be noted that checklist A has a higher percentage of such features.

13.2 Review of design and layout assessment tools

An expert appraisal was undertaken of the two checklists devised for, and used in, this study. Where possible this was in comparison to published best practice guidelines.

The two checklists used in the study embodied a significant number of features that are found in leading checklist-based risk assessment tools, such as 'traffic light' colour coding, text or image-based advisory panels, prompts for interventions, task-specific as well as overall scoring protocols and generic risk categorisation (high, medium, low). It is unlikely that future checklist-based resources will deviate greatly from these types of features, so the relative benefits of each were assessed as an indication of improvements to these skeletal forms.

13.2.1 Introduction

The two assessment tools were reviewed in terms of organisation and layout, typography, colour, contrast, language, sentence construction and readability statistics. A summary of the main principles is given below:

Organisation and layout: The information should have a clear structure with items presented in a logical order. This makes it easy for the reader to see where to start and how to proceed through the document with key items such as tick boxes or sections to complete clearly visible.

Typography: This is the art and technique of arranging characters on a page. A clear font style and size should be selected so that the text can be read comfortably, thus assisting people with poorer eyesight. For passages of text, lower case text is easier to read than upper case because lower case letters have a greater variety of shapes. Lines should also not be so long that readers have to move their heads slightly or strain their eye muscles to track the whole line. Similarly, reading columns of text with very short lines is tiring.

Text is normally displayed left justified to enable comfortable reading, but it is recommended that the right margin is ragged rather than right justified to avoid unequal spacing between letters and words which causes reading discomfort.

Colour and contrast: Colour should be used effectively whether for coding information (eg red text for critical information) or to reinforce information grouping and structure. The use of bright saturated colours can cause visual discomfort while the use of too many colours (more than four) adds complexity to information. The contrast between the text and the background should also be sufficiently high to aid readability.

Language and sentence construction: Textual information can be complex if sentences are long, if they contain technical jargon or less common words and if their logical meaning is difficult to understand. However, the wording of instructions needs to be precise. Repeated sentences giving sequential related information should be presented in a consistent way to maintain ease of reading and avoid errors. Sentences should also be unbiased and, where the user community is varied, consideration should be given to multilingual versions.

Readability indices: Readability indices or scores have been designed to show how easy text is to read. They are based upon factors such as the number of words in each sentence and the number of syllables in each word. However, the tests do not indicate whether the correct words have been used, so they can only give an indication of the ease of reading of a passage of text.

Table 13.1 Characteristics of the two checklists that trial 1 suggests work best

		Checklist A	Checklist B
Format			
Flow chart		N	N
List format		Y	Y
Multiple choice		Y	N
Dichotomous		N	Y
Phrasing definitions			
Uses numerical figures to define joint angles		Y	N
Uses only words to describe joint angles		N	Y
Uses numerical figures to define frequency rates		Y	N
Uses only words to describe frequency rates		N	Y
Uses numerical figures to define duration		N	Y
Uses only words to describe duration		Y	N
Uses numerical figures to describe weight/force		Y	N
Uses words to describe weights/force		N	Y
Visual aids			
Illustrations of postures		N	Y
Word descriptor of postures		Y	N
Recording risk details			
Space for notes on reported problems		N	Y
Space and notes on risk /probable cause		N	Y
Ratings			
Means of rating individual items	Colour coding	Y	N
	Symbol coding	N	N
	Numerical	Y	N
	Words, eg high, medium and low, good, satisfactory	Y	N
Means of prioritising specific aspects of concern within a single task		Y	N
Means of calculating an overall scores		Y	Y
Means of prioritising tasks for action		Y	Y
Controls and interventions			
Asks whether action is required		N	Y
Space for notes on potential actions		N	Y
Provides hints or suggestions for control actions	In checklist	N	Y
	In accompanying guidance	N	N
	Provides reference to other sources of information.	Y	Y

13.2.2 Review of assessment tools against principles

Based on the above principles, 23 guidelines were specified and applied to the two assessment tools, A and B. These are based on established recommendations for the creation of user instructions for consumer products.[73]

Table 13.2 shows an evaluation of the assessment tools against each of the guidelines. Where a tool meets one of the guidelines, this is indicated by the word 'Yes' in the 'Met?' column. If the guideline is not met or only partially met, this is shown by the word 'No'. For the guidelines not met, recommendations are made for the modification of the assessment tool in order to meet them. Occasionally, although a guideline is met, a suggestion is made to enhance the tool further.

At the end of the table some additional minor recommendations are also made for each tool that cannot be categorised under the guidelines.

Table 13.2 Comparison of the assessment tools against document design and layout guidelines

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
Organisation and layout				
1. Page number present	No	**Recommendation 1A:** Add at the bottom of each page (if possible when printed in 2 pages per page format).	No	**Recommendation 1B:** Add at the bottom of each page (if possible when printed in 2 pages per page format).
2. Margins wide enough to frame each page	Yes		Yes	A blue frame around each section helps group questions together.
3. Grouping and spacing show structure clearly	Yes	The yellow frames help to group questions together well. **Recommendation 3A:** Consider whether, for consistency, similar frames should be placed around the score sheet table and overall risk section at the end of the tool.	Yes	The questions, problems and improvements are structured in a clear and consistent way. The white background for the questions and the No/Yes checkboxes gives them less prominence than the 'potential improvement' list on the yellow background. **Recommendation 3B:** For consistency, consider putting a similar yellow background behind the questions and the No/Yes tick boxes (but not the diagrams).
4. Text appears spacious	No	Lack of additional spacing between some red, amber, green options creates the effect of dense blocks of text. **Recommendation 4A:** Insert a little more line or paragraph spacing between options for questions 4, 5, 7, 9, 10 and 13. Also put the explanatory notes shown in brackets into italics to break it up.	Yes	The text is spacious enough given the length of the list of improvement options that needs to be displayed for some questions.
5. Sections in a logical order	?	**Issue 5A:** Should 'postural' factors be considered before 'repetition' and 'force'?	?	**Issue 5B:** Should 'postural' factors be considered before 'repetition' and 'force'?
Typography				
6. Text characters have a height of at least 1.5 mm (10–11 point)	Yes	14-point text is used for most of the assessment tool which, when printed as two pages per page, appears in 11 point.	Yes	14-point text is used for most of the assessment tool which, when printed as' two pages per page', appears in 11 point.
7. Few different typefaces and sizes are used.	Yes	A single font style is used (Arial).	Yes	A single font style is used (Arial). gs and text are shown in sentence case.

Table 13.2
continued

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
8. Sentence case is used	Yes	All headings and text are shown in sentence case.	Yes	All headings and text are shown in sentence case.
9. Use of block capitals, italics, bold or underlining over several lines of text is avoided	Yes		Yes	
10. Line lengths are all between 35 and 65 characters	Yes	Line lengths are between 50 and 60 characters.	Yes	Line lengths are between 45 and 60 characters.
11. A ragged right-hand margin is used	Yes		Yes	
Colour and contrast				
12. Colour is used sparingly	Yes	Although the tool contains brightly coloured sections, this is for coding purposes. **Recommendation 12A:** Put the traffic light colours behind the tick boxes rather than the whole statement. However the result may reduce the visual impact of the three options.	Yes	Only three colours in addition to white are used for titles and highlighting. (Since colour is not used for coding, the tool can be printed and used in black and white.)
13. Colour is used consistently	Yes	Colour is used for coding the three risk options for each question and as a background for groups of questions in a consistent way. **Recommendation 13A:** For consistency, consider putting a yellow background box around the score sheet table and overall risk section.	Yes	**Recommendation 13B:** For consistency, consider putting blue frames around the score sheet table and overall risk section.
14. There is good contrast between text and background	No	The contrast between black text and the coloured backgrounds is reasonable. However the black text on red or green may be hard to read in poor lighting. **Recommendation 14A:** Make all background colours slightly paler to increase contrast.	Yes	**Recommendation 14B:** Consider making the blue and yellow colours slightly paler to increase contrast.

Table 13.2
continued

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
Language and sentence construction				
15. All sentences have fewer than 30 words	No	In the assessment tool all sentences have less than 30 words. However, in the instructions, five sentences have more than 30 words (see Section 13.2.7).	No	In the assessment tool all sentences have less than 30 words. However, in the instructions, six sentences have more than 30 words (see Section 13.2.7).
16. Wording not overly technical	Yes	The assessment tool is technical in nature but presents the information in an accessible way.	Yes	The assessment tool is technical in nature but presents the information in an accessible way.
17. Wording is precise	Yes	The user may find it hard to judge the angles 15 degrees and 20 degrees without visual representation. **Recommendation 17A:** Consider whether a visual representation of angles can be provided alongside the statement options for Q4, 5, 8 or in the instructions.	Yes	In questions 3, 4, 5, 6, 8, and 9 the user may find it difficult to judge 15%. **Recommendation 17B:** Provide an example in the instructions or a question to help the user judge the 15% limit e.g.'15% = about 10 minutes in an hour'.
18. Wording is consistent	No	**Recommendation 18A(i):** In Q2, insert the word 'are' to make each statement a complete sentence to be consistent with the rest of the tool. **Recommendation 18A(ii):** In Q9, change the amber and red options to be statements rather than questions. **Recommendation 18A(iii):** In Q13, 'a. Gloves' should perhaps have more explanation, eg 'Gloves are worn and may hinder manipulation'.	No	**Recommendation 18B(i):** Questions 11, 12 and 13 should be formulated as questions to be consistent with the rest of the tool. (Note: item 13h is already phrased as a question). **Recommendation 18B(ii):** In Q13, 'a. Gloves' should perhaps have more explanation, eg 'Are gloves are worn which may hinder manipulation?' **Recommendation 18B(iii):** In Q3, 4, 5, 6, 8, change 'more' to 'for more', eg "for more than 15% of the time". **Recommendation 18B(iv):** In Q7, add 'held' before 'in a static position'.
19. Unbiased language is used, eg not gender specific	Yes	Neutral language used throughout the tool.	Yes	Neutral language used throughout the tool.

Table 13.2
continued

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
20. Sentences are simple to understand.	No	Generally the sentences are clear. However, in trying to be precise and consistent, some of the statements become slightly repetitive and complex. The similarity of groups of sentences adds to the complexity – for example see questions 4 to 11. **Recommendation 20A(i):** Review and try to simplify some of the wording, eg in Q1, "intermittent" to "occasional"; in Q2, "motion patterns" to "movements". **Recommendation 20A(ii):** Consider whether some of the repeated wording in each group of statements can be replaced by dots. For example Q2 could be reworded as: "Similar motion patterns are repeated 10 times per minute or less", "… more than 11-20 times per minute", "…more than 20 times per minute". **Recommendation 20A(iii):** Consider highlighting (emboldening or italicising) the words that are different in similar statements, eg in Q1 (green) "infrequently", (amber) "frequently", (red) "very frequently".	No	Generally the sentences are clear and their formulation as yes/no questions make them simple to comprehend. However in trying to describe the criteria, some of may appear hard to assimilate, eg Q7: "Is one or both shoulders in a static position (i.e. infrequently moved) for more than 1 hour?" **Recommendation 20B:** Review questions 1, 7, 10 and 13h and try to simplify some of the wording and logic.
21. Availability of multilingual versions	No	There may be a case for producing versions in different languages for people whose first language is not English	No	There may be a case for producing versions in different languages for people whose first language is not English
Readability statistics				
Assessment tool: 22. Flesch readability index is 80 or above.	No	70.4 Simplification and rewording following recommendations 20A(i) and (ii) will increase the score.	No	73.7 The relatively short sentences in the tool mean that the target is close to achievement. Simplification following recommendation 20B will increase the score.
Flesch-Kincaid grade level is no more than 5.0 (reading level for 10 to 11-year-old students).		7.0 Simplification and rewording would reduce the level. (An electronic copy of the text used for testing is available.)		6.2 Simplification and rewording would reduce the level. (An electronic copy of the text used for testing is available.)

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
Instructions: 23. Flesch readability index is 80 or above. Flesch-Kincaid grade level is no more than 5.0 (reading level for 10 to 11 year old students).	No	58.2 9.9 **Recommendation 23A:** Reduce the length of the longest sentences (over 30 words) and consider whether text can be simplified.	No	55.3 10.4 **Recommendation 23B:** Reduce the length of the longest sentences (over 30 words) and consider whether text can be simplified.
Other comments				
24. Full stops and question marks	n/a	**Recommendation 24A:** Full stops are needed after each sentence.	n/a	**Recommendation 24A:** Full stops or question marks are needed after each sentence.
25. Use of slashes	n/a	Use of slashes in some parts of the tool is ambiguous, eg "Awkward hand/finger grip". **Recommendation 25A:** Use of "and" and "or" is preferred to a slash for precision.	n/a	Use of slashes in some parts of the tool is ambiguous, eg "Awkward head/neck posture". **Recommendation 25B:** Use of "and" and "or" is preferred to a slash for precision.
26. Minor typos	n/a	**Recommendation 26A(i):** In Q4, the selection square for the red option should be lowered slightly to be in line with the text and the 'R' code should be added. In Q1, red option, move words in brackets upwards. **Recommendation 26A(ii):** In Q3 make statements for second and third options a single continuous sentence. **Recommendation 26A(iii):** In Q6, remove the stray character at the start of the red option.	n/a	**Recommendation 26B(i):** In the instructions, where examples of problems are written, change (1) "may" to "a", (2) "has" to "have", and (3) insert "to" before "flick". **Recommendation 26B(ii):** Missing bullet in Q5 improvements list.
27. No/Yes columns	n/a		n/a	For each question, having the No column before the Yes could lead to errors. **Recommendation 27B(i):** Swap the columns so that the Yes column comes first. **Recommendation 27B(ii):** Each time it says "If you have ticked any yes boxes...", put the word "yes" in quotes or capitals.

Table 13.2
continued

Table 13.2
continued

Guideline	Assessment tool A		Assessment tool B	
	Met?	Comments	Met?	Comments
28. Underlining	n/a		n/a	For questions 6–10, the request "Describe any problems" is underlined, but it is not elsewhere. **Recommendation 28B:** Remove underlining and add following dots to make consistent with other questions.
29. Summarising the assessment and completing the score sheet or table	n/a	There are limited prompts to complete the score sheet. **Recommendation 29A(i):** Add a general instruction as given in Assessment tool B: "In the table below…" **Recommendation 29A(ii):** In the score sheet table, add the prompt "(G, R, A)" under Colour Band, and "(0 to 6)" under Numerical Score. **Recommendation 29A(iii):** In the instructions for the tool, show an example of a completed score sheet and selected overall risk level.	n/a	**Recommendation 29B(i):** Where the user enters the total number of ticks, put "out of 21" to show the total number in relation to the maximum. **Recommendation 29B(ii):** A specific prompt would be useful for completing the table, eg after the heading "Priority action: High, Medium, Low" add "(Enter H, M or L)". **Recommendation 29B(iii):** Consider providing guidance for deciding the overall risk (L, M or H), such selecting the most common table entry. **Recommendation 29B(iv):** In the instructions for the tool, show examples of a completed summary table and overall score.

13.2.3 Readability indices

The readability of the assessment tool text is measured using the following two tests:

- The Flesch Reading Ease test[74] rates text on a scale of 0 to 100. The higher the score, the easier it is for the reader to understand the document. For most standard documents, a score of 70 to 80 should be achieved. Reader's Digest magazine has a readability index of about 65, Time magazine scores about 52, and the Harvard Law Review has a general readability score in the low 30s. The criterion for the assessment tools is set at 80 to cater for a wide range of literacy skills and English language knowledge among the user population.
- The Flesch–Kincaid Grade Level Formula relates text to United States grade-school level. For example, a score of 5.0 means that a fifth grader, ie a British year 6 child or an average 10 year old, can understand the document. For most standard documents, a score of 5.0 can be achieved by using short sentences. The reading level criteria is thus set at 5.0, the expected reading level for 10–11 year olds in the UK. This is to ensure readability for those adults with poor literacy skills.

Readability indices are normally applied to text composed of sentences. The tests were therefore applied only to full sentences in each tool and not the headings, lists, single words and so on. The instructions for each assessment tool were also tested but separately from the tool itself.

13.2.4 Summary of compliance to guidelines

Table 13.3 shows that both assessment tools comply with the majority of the 23 guidelines.

For those guidelines where recommendations are offered, it is proposed that they be considered for implementation. While the recommendations should help to improve the assessment tools, it may be decided some of the recommended changes are not effective or necessary.

	Assessment tool A (red, amber, green)	Assessment tool B (yes, no)
Number of guidelines met	13	15
Number of guidelines not met	9	7
Issues open to discussion	1	1
Other changes recommended?	Yes	Yes

Table 13.3 Number of guidelines met by each assessment tool

13.2.5 Discussion for assessment tool A (red, amber, green)

This section summarises the review for assessment tool A and presents the recommendations for change.

Organisation and layout: In general, assessment tool A offers a simple and straightforward process. It is only when the user reaches the summary scoring sheet that they may need additional guidance and prompts. This would be further assisted by providing an example of the table completed and the overall risk level circled in the instructions for the tool.

Typography: The text font and text size is clear and should not present any major problems in terms of reading comfort.

Colour and contrast: The use of colour coding for the different risk options is effective. However the use of saturated background colours gives the tool a slightly gaudy appearance, which reduces the contrast between text and background. Making the colours paler would enable more comfortable reading and improve the contrast between text and background. Alternatively the background for the each statement could be made white and the red, amber, green colour could just be retained behind the box containing the score. It should also be mentioned that the reliance upon colour coding would reduce the effectiveness of the tool if it were photocopied or printed in black and white. However the letters G, A and R next to each score do provide additional coding for greyscale versions.

Language and sentence construction: In general the statements describing each of the different options are clear and precise. The wording is not overly technical and is unbiased.

For each set of three options in the tool, much of the wording is repeated, which is necessary to make each statement self contained. However, this tends to add to the complexity of each question as a whole and makes it harder to distinguish each option. Simplifying the statements would be beneficial, for example by:

- using simpler wording where possible (see for example the Dale-Chall word list[75])
- reducing repetition in each set of three statements
- distinguishing between the statements by highlighting key words (eg 'infrequent', 'frequent', 'very frequent').

There is a minor degree of inconsistency in the wording of statements which could be removed.

Readability statistics: These show that the reading level for the assessment tool is satisfactory but for the instructions it is a little too high if text is to be easily understood by a large proportion of people. This could, however, be improved by simplifying some of the words and reducing the length of some of the longer sentences.

Other comments: Additional suggestions for change include providing more guidance on completing the summary score sheet at the end of the assessment. Experience during the trials showed a potential benefit in producing versions of the questionnaire in different languages.

13.2.6 Discussion for assessment tool B (yes, no)

This section summarises the review for assessment tool B and presents the recommendations for change.

Organisation and layout: Assessment tool B presents a simple and consistent structure based around answering yes or no questions. More guidance could be provided on completing the summary table and deciding on the overall risk level. It would also be useful to provide an example of the completed table and risk level in the instructions.

Typography: This selection of text font and text size is clear and meets the guideline requiring at least 10 or 11-point size.

Colour and contrast: The use of coloured title bars and background for the improvement lists is helpful. However, this perhaps reduces the prominence of the questions themselves. The designers could experiment with providing the same coloured background for the questions and tick box sections and in making both the blue title bar and yellow background colour paler. Interestingly printing the tool out in black and white provides an effective toned down appearance showing that the tool can still be read when printed in greyscale.

Language and sentence construction: In general the statements describing each of the different options are clear and precise. The wording is not overly technical and is unbiased.

However, as with assessment tool A, it would be worth reviewing the wording to see whether simpler words can be used.

Readability statistics: These show that the reading level for the tool is satisfactory but for the instructions it is too high. This could be reduced by simplifying some of the words and reducing the length of some of the longer sentences.

Other comments: Other suggestions for change include providing more guidance on completing the summary score sheet at the end of the assessment. As for tool A, there could be potential benefit in producing versions of the questionnaire in different languages.

13.2.7 Longer sentences in the instructions that could be split up or shortened

There are several long sentences (with more than 30 words) in the instructions for assessment tool A. The examples below could be considered for shortening or dividing up to increase the readability score to over 80 and reduce grade level to 5.0 or below:

- A repetitive task is made up of a sequence of actions of fairly short duration, which are repeated over and over again and almost always use the same or very similar actions (e.g. stitching a piece of cloth, manufacturing one part, packaging items). (43 words)

- For each risk factor there are at least three different choices of answer, and each possible response is categorised as either Green, Amber or Red and has a corresponding numerical score. (31 words)
- The tool can be used to highlight areas (i.e. individual risk factors) of concern and it can also be used to gain a single overall risk score for the whole task by adding the numerical scores for each risk factor together at the very end of the assessment. (48 words)
- For each risk factor there is a table with green, amber and red rows please circle one square (containing a letter and a number) for the statement that best describes the action involved in the task. (36 words)
- At the end you need to transfer each score onto to the score sheet on the last page and rate each risk factor in terms of Low, Medium and High priority for action. (33 words)

Here are some similar examples from the instructions to assessment tool B:

- A repetitive task is made up of a sequence of actions of fairly short duration, which are repeated over and over again and almost always use the same or very similar actions (e.g. stitching a piece of cloth, manufacturing one part, packaging similar items). (44 words)
- The tool can be used to highlight areas (i.e. individual risk factors) of concern and it can be used to gain a single overall risk score for the whole task by counting up the total number of YES ticks. (39 words)
- Look across to the end column ('Tick potential improvements which may be useful for this task and which should be investigated further') and tick improvements you think might be useful in reducing that particular risk factor in this task. (39 words)
- At the end of the assessment count up the total number of YES ticks to gain a single overall risk score for the whole task and write the score in the box provided at the end of the assessment. (39 words)
- At the very end please write (in the box provided) any ideas you have as to what changes could be made to reduce the risks of musculoskeletal disorders from this task. (31 words)
- To do this you might want to flick back through your assessment of the task and see which boxes you have ticked in "Tick potential improvements which may be useful for this task and which should be investigated further" this might give you more ideas on what sort of changes could be made. (53 words)

Note that to test the readability for any changes to the text, it would be necessary to change the electronic version of the instructions or assessment tool and to regenerate the Microsoft Word 'document statistics'. To display the readability statistics for a document in Word:

- in the Tools menu, click Options, and then click the Spelling and Grammar tab
- select the Check grammar with spelling check box
- select the Show readability statistics check box, and then click OK
- in the Tools menu, select Spelling and Grammar (first option)
- when Microsoft Word has finished checking spelling and grammar, it displays information about the reading level of the document.

References

1. Neathey F, Sinclair A, Rick J, Ballard J, Hunt W and Denvir A. *An evaluation of the five steps to risk assessment* (RR476). Institute for Employment Studies, 2006.
2. National Institute for Occupational Safety and Health. *Elements of ergonomics programs – a primer based on workplace evaluations of musculoskeletal disorders*. NIOSH, 1997. www.cdc.gov/niosh/docs/97-117/epstep1.html.
3. Urlings I J M, Nijboer I D and Dul J. A method for changing the attitudes and behaviour of management and employees to stimulate the implementation of ergonomic improvements. *Ergonomics* 1990; 33 (5).
4. Hendrick H W. Ergonomics in organisational design and management. *Ergonomics* 1991; 34: 743.
5. Lawton G C and Haslam R A. Organizational issues as obstacles to intervention for musculoskeletal complaints. *Contemporary Ergonomics* 2000.
6. Gadd S A, Keeley D M and Balmforth H F. Pitfalls in risk assessment: examples from the UK. *Safety Science* 2004; 42 (9): 841.
7. Health and Safety Commission. *Health and safety statistics 2005/06*. HSC, 2006.
8. Whysall Z, Haslam C and Haslam R. *A staged approach to reducing musculoskeletal disorders (MSDs) in the workplace*. Health and Safety Executive, 2005.
9. Health and Safety Executive. *Five steps to risk assessment* (INDG163). HSE, 2011. Available online at www.hse.gov.uk/pubns/indg163.pdf.
10. Health and Safety Executive. *Upper limb disorders in the workplace* (HSG60). HSE, 2002. Available online at www.hse.gov.uk/pubns/books/hsg60.htm.
11. Worksafe Code Australia. *National code of practice for the prevention of occupational overuse syndrome* (NOHSC:2013) Australian Government Publishing Service, 1994.
12. Liker J K, Joseph B S and Armstrong T J. *From the ergonomic theory to practice: Organisational factors affecting the utilisation of ergonomics knowledge. Human factors in organisational design and management*. Proceedings of First Symposium held in Honolulu, Hawaii, 1984.
13. Alexander D C and Orr G B. Development of ergonomics programs. In: Karwowski W and Marras W S (eds). *The occupational ergonomics handbook*. CRC Press, 1998.
14. McNelly K and Morgan D. *MSD: Safety reps survey 2006* (HSL/2006/20). Health and Safety Laboratory, 2006.
15. Imada A S. Ergonomics: influencing management behaviour. *Ergonomics* 1990; 33 (5): 621–628.
16. Prussia G E, Brown K A, Willis P G. Mental models of safety: do managers and employees see eye to eye? *Journal of Safety Research* 2003; 34: 143–156.
17. Hignett S. *Measuring the effectiveness of competency-based education and training programmes in changing the manual handling behaviour of healthcare staff* (RR315). Health and Safety Executive, 2005.
18. Catherine T, Marie F J, Zeng Q-X, Xie X, Wang L-Q and Qian X-M. Increasing prevention of health hazards in the firm by training people in ergonomic work analysis (EWA). *Safety Science and Technology* 1998; 792–799.
19. Vink P, Koningsveld E A P and Molenbroek J F. Positive outcomes of participatory ergonomics in terms of greater comfort and higher productivity. *Applied Ergonomics* 2006; 37: 537–546.
20. Brodie D and Wells R. *An evaluation of the utility of three ergonomics checklists for predicting health and safety outcomes in a car manufacturing environment. Ergonomics at Work III: A National Approach*. Proceedings of the 29th Annual Conference of the Human Factors Association of Canada, Winnipeg, Manitoba, September 13-17, 1997. Human Factors Association of Canada, 1997.
22. Graves R, Way K and Riley D. *The development of the risk filter and risk assessment worksheets for HSG60(rev)* (report HSL/2002/34). Health and Safety Laboratory, 2002.
23. Li G and Buckle P. Current techniques for assessing physical exposure to work-related musculoskeletal risks, with emphasis on posture-based methods. *Ergonomics* 1999; 42 (5): 674.
24. Accredited Standards Committee Z365. *Management of work-related musculoskeletal disorders*. Working draft August 2002.
26. Occupational Safety and Health Administration. *Ergonomics program 29* (CFR 1910.900). OSHA, 2000.
27. Quirk M, Best M and Darzins S. Expert and non-expert use of the Victorian Code of Practice (Manual Handling) Risk Assessment Worksheet. *Journal of Occupational Health and Safety – Australia and New Zealand* 2004; 20 (4): 359.

28. Burdorf A and Van Der Beek A. Exposure assessment strategies for work-related risk factors for musculoskeletal disorders. *Scandinavian Journal of Work, Environment and Health and Safety* 1999; 25: 25.
29. Keyserling W M, Brouwer M and Silverstein B A. A checklist for evaluating ergonomic risk factors resulting from awkward postures of the legs, trunk and neck. *International Journal of Industrial Ergonomics* 1992; 9: 283–302.
30. Neumann P, Wells R P and Norman R W. A participative field study of inter-rater reliability of a risk factor assessment checklist used by manufacturing plant personnel. In: Kumar S (ed.). *Advances in occupational ergonomics and safety 2*. IOS Press, 1998.
31. Chen Y, Meyer J D and Song J. Reliability assessment of a coding scheme for the physical risk factors of work-related musculoskeletal disorders. *Scandinavian Journal of Work, Environment and Health and Safety* 2002; 28 (4): 232–237.
32. Genaidy A M, Al-Shedi A A and Shell R L. Ergonomic risk assessment: preliminary guidelines for analysis of repetition, force and posture. *Journal of Human Ergology* 1993; 22 (1): 45.
33. Kenningham L. A scientifically based manual handling risk assessment checklist and guidelines and usability testing – one approach. In: Best M, Di Stefano M and Evans O (eds). *Proceedings of the 34th Annual Conference of the Ergonomics Society of Australia, Melbourne, Victoria, Australia, 5-7 October, 1998*. Ergonomics Society of Australia, 1998.
34. Lee D and Ferreira J J. *Reliability and usability evaluation of the manual handling assessment charts (MAC) for use by non-regulatory professionals* (HSL/2003/19). Health and Safety Laboratory, 2003.
35. Winnemuller L L, Spielholz P O, Daniell W E and Kaufman J D. Comparison of ergonomist, supervisor, and worker assessments of work-related musculoskeletal risk factors. *Journal of Occupational and Environmental Hygiene 2004*; 1: 414–422.
36. Kemmlert K. A method assigned for the identification of ergonomic hazards – PLIBEL. *Applied Ergonomics* 1995; 26: 199–211.
37. Burt S and Punnett L. Evaluation of inter rater reliability for posture observations in a field study. *Applied Ergonomics* 1999; 30: 121–135.
38. Park J, Boyer J, Tessler J, Perez G and Punnett L. *Exposure assessment of musculoskeletal disorder risk factors in hospital work: inter rater reliability of PATH observations*. Proceedings of the Human Factors and Ergonomics Society 49th Annual Meeting, Orlando, Florida, September 26-30, 2005. Human Factors and Ergonomics Society, 2005.
41. Gude D, Argyropoylos N, Konhoff M, Seidel-Fabian B and Laurig W. Checklists for the evaluation of computer workplaces – practical requirements and current design concepts. In: Vink P, Koningsveld E A P and Dhondt S (eds). *Human factors in organizational design and management*, volume VI. Elsevier, 1998.
42. Care B, Quarrie C and Monnington S C. *Testing and improving the usability of the Manual Handling Assessment Chart (MAC)*. Health and Safety Executive, 2002.
43. Graves R, Way K, Riley D B, Lawton C G and Morris L. Development of risk filter and risk assessment worksheets for HSE guidance – 'Upper limb disorders in the workplace', 2002. *Applied Ergonomics* 2004; 35 (5).
44. David G C. Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine* 2005; 55 (3): 190.
45. Spielholz P, Silverstein B and Stuart M. Reproducibility of a self-report questionnaire for upper extremity musculoskeletal disorder risk factors. *Applied Ergonomics* 1999; 30 (5): 429.
47. May A. Personal communication regarding ongoing project. Ergonomics and Safety Research Institute, Loughborough University, 2007.
48. Kimoto K, Endo K, Iwashita S and Fujiwara M. The application of PDA as mobile computing system on construction management. *Automation in Construction* 2005; 14: 500–511.
49. Abdullah O B and Thai O B. *Personal digital assistants as a mobile inspection system at construction site*. Proceedings of the 6th Asia-Pacific Structural engineering and construction conference (APSEC 2006), Kuala Lumpur, Malaysia.
50. Jones J A R, Cockcroft A and Richardson B. The ability of non-ergonomists in the health and safety care setting to make manual handling risk assessments and implement changes. *Applied Ergonomics* 1999; 30 (2): 159.
52. Greene B L, Dejoy D M and Olejnik S. Effects of an active ergonomics training program on risk exposure, worker beliefs, and symptoms in computer users. *Work* 2005; 24 (1): 41.
54. Saleem J J, Kleiner B M and Nussbaum M A. Empirical evaluation of training and a work analysis tool for participatory ergonomics. *International Journal of Industrial Ergonomics* 2003; (31): 387–396.
58. Haims M C and Carayon P. Theory and practice for the implementation on 'inhouse' continuous improvement participatory ergonomics programs. *Applied Ergonomics* 1998; 29 (6): 461–471.

59. Hignett S. Intervention strategies to reduce musculoskeletal injuries associated with handling patients: a systematic review. *Occupational and Environmental Medicine* 2003; 60.
62. Zalk D M. Grassroots ergonomics: initiating an ergonomics program utilizing participatory techniques. *Annals of Occupational Hygiene* 2001; 45 (4): 283.
63. Carrivick P J W, Lee A H, Yau K K W and Stevenson M R. Evaluating the effectiveness of a participatory ergonomics approach in reducing the risk and severity of injuries from manual handling. *Ergonomics* 2005; 48 (8): 907.
64. Cameron I, Hare B, Duff R and Maloney B. *An investigation of approaches to worker engagement* (RR516). HSE Books, 2006.
65. Morken T, Moen B, Riise T, Hauge S H V, Holien S, Langedrag A, Olson H, Pederson S, Saue I L L, Selijebo G M and Thoppil V. Effects of a training program to improve musculoskeletal health among industrial workers – effects of supervisors role in the intervention. *International Journal of Industrial Ergonomics* 2002; 30 (2): 115–127.
66. Straker L, Burgess-Limerick R, Pollock C and Egeskov R. A randomized and controlled trial of a participative ergonomics intervention to reduce injuries associated with manual tasks: physical risk and legislative compliance. *Ergonomics* 2004; 47 (2): 166.
67. Arezes P M and Miguel A S. Does risk recognition affect workers' hearing protection utilisation rate? *International Journal of Industrial Ergonomics* 2006; 36: 1037–1043.
68. Robson L S, Shannon H S, Goldenhar L M and Hale A R. *Guide to evaluating the effectiveness of strategies for preventing work injuries: how to show whether a safety intervention really works*. National Institute for Occupational Safety and Health, 2001.
69. Ghafarian V, Sayadli S and Kavian-Lanjani J. *Evaluation of correlation in two job analysis techniques of QEC and Ergo-Easer. Ergonomics in the Digital Age. Proceedings of the XVth Triennial Congress of the International Ergonomics Association and the 7th Joint Conference of the Ergonomics Society of Korea and the Japan Ergonomics Society, Seoul, Korea, 24–29 August 2003*.
70. O'Keeffe V and Burgess-Limerick R. *Risk assessment of repetitive work: a comparison of two tools. Ergonomics for a BIZ-e world. Proceedings of the 40th Annual Conference of the Human Factors and Ergonomics Society of Australia and the 7th Annual Conference of PanPacific Council on Occupational Ergonomics, Cairns, Australia, 22-25 August 2004*. The Human Factors and Ergonomics Society of Australia, 2004.
72. Tolmie S W and Potvin J. *An evaluation of the validity and reliability of an ergonomic risk factor checklist. Fit, Form & Function: Proceedings of the 34th Annual Conference of the Association of Canadian Ergonomists, London, Ontario, 15-18 October 2003*. Association of Canadian Ergonomists, 2003.
73. Galley M and Clift L. *Instructions for consumer products*. Department of Trade and Industry, 1988.
74. Flesch R. A new readability yardstick. *Journal of Applied Psychology* 1948; 32: 221–233. A summary is available at http://en.wikipedia.org/wiki/Flesch-Kincaid_Readability_Test.
75. Dale-Chall simple word list, 2008. www.rfp-templates.com/Dale-Chall-List-of-3000-Simple-Words.html. This list consists of 3,000 words which can be used to substitute words in the text to make it simpler.

Appendices

The appendices to this research report reproduce all of the questionnaires and surveys that were given to participants during the course of the project, whether health and safety professionals or ordinary members of the workforce. In addition, Appendix 2 presents some of the responses to the initial questionnaire.

Further more detailed material is available direct from the authors of this report and can be obtained by contacting them at the address on the cover or at **rdfunding@iosh.co.uk**. This additional material includes:

- detailed reports of the case studies carried out in 15 companies
- the presentation and spoken introduction used for trial 1
- detailed instructions on using the checklists
- original and modified versions of the training presentation used for those groups given training before trial 2
- detailed data on the ease of use and completion of the checklists
- further statistical analyses
- the total risk factors recorded in trial 1.

Appendix 1: Initial questionnaire

This appendix reproduces the letter and questionnaire sent to health and safety professionals in target organisations. It has been reset to fit the page layout of this report but is otherwise unchanged.

Dear Health and Safety professional,

The Ergonomics and Safety Research Institute (ESRI), which is part of Loughborough University, has been commissioned by the Institution of Occupational Safety and Health (IOSH) to investigate the effectiveness of risk assessment in the workplace.

This study, lasting over 16 months, is designed to explore the link between risk identification and risk control. The initial stages are to capture current practice in manufacturing industry, including who is undertaking risk assessments and what tools they use to do them.

This questionnaire is inviting you, as a health and safety professional, to contribute to the understanding of current practice and hence help to improve the effectiveness of health and safety practice in the British workforce. The questionnaire itself should only take a few minutes to fill in and will be invaluable in helping to clarify what is actually occurring in the workplace.

In the later stages of the project, partner organisations will be selected from those who have submitted questionnaires and they will be invited to take an active part in evaluating the tools used in undertaking risk assessments. These organisations will receive, as an incentive, free professional training from an IOSH accredited trainer. An invitation to be involved further in the project is provided at the end of this questionnaire.

Please be assured that any information you supply will be strictly confidential and that the project is being conducted under the ethical and confidentiality guidelines of Loughborough University. More information about the project and ESRI can be found at http://www.lboro.ac.uk/research/esri in the 'News' section article called 'Effect of training on the application and effectiveness of checklist-based risk assessments'.

We appreciate that you are busy and that providing this information will be another task to add to your 'to do' list, but by contributing you will be providing critical information which will help make risk assessment more effective and simpler in the future. So why not get a drink and take a few minutes to answer the questions – you can then cross another thing off your 'to do' list!

Thank you for reading this and we hope you will be able to find just a few minutes to provide answers to the following questions.

General information

1. Does your organisation have a standard Risk Assessment which is used for musculoskeletal risks?

Yes	
No	

If 'YES' please (if possible) send a copy of this Risk Assessment to us when you return this questionnaire

About your organisation

2. How many people are employed by your organisation?

Small – 1 - 49	
Medium – 50 to 299	
Large - 300 or more	

3. Is your organisation...

Based on a single site	
Part of a larger group	

4. Approximately, how many employees work on your site?

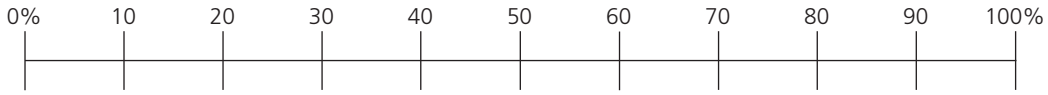
5. Please tick the industry sector that best applies to your organisation.

Chemical Manufacturing		Mining & Quarrying	
Consumer Goods		Optical & Precision Instruments	
Electrical & Electronics		Packaging	
Food & Drink Manufacturing		Paper Manufacturing	
Fuel		Refrigeration	
Glass, Ceramic & Brick		Rubber & Plastics	
Machinery Manufacturing		Textile Manufacturing	
Manufacturing Tools		Timber Manufacturing	
Metal & Metal Goods		Transport Manufacturing	
Other, please state:			

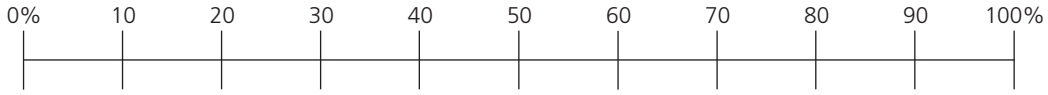
Type of work tasks conducted by employees

6. This is intended to show how much of your workforce is involved in various types of task. On the scales below, please circle the approximate percentage of the workforce that is engaged in each of the tasks as part of their work.

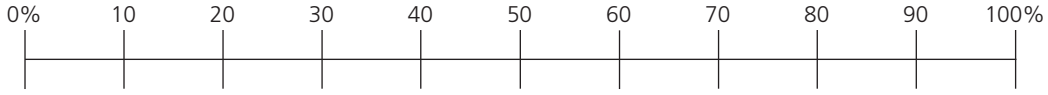
a) Manual handling



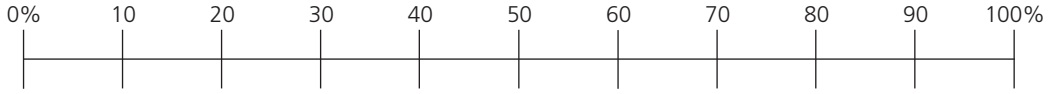
b) Repetitive tasks with short cycle times (1 second to 2 minutes)



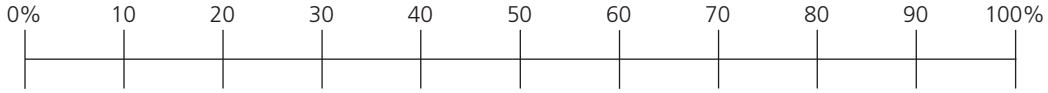
c) Repetitive tasks with long cycle times (greater than 2 minutes)



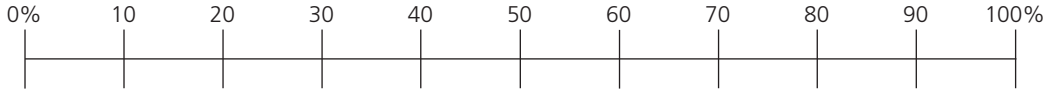
d) Seated (mainly tasks that don't require a lot of physical activity)



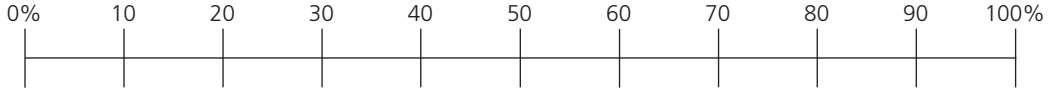
e) Standing (mainly tasks that don't require a lot of physical activity)



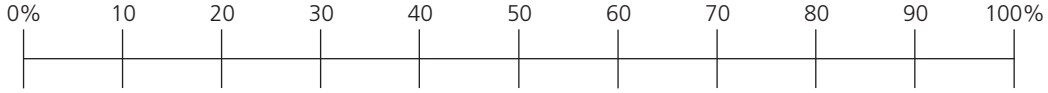
f) Machine-paced tasks (where the rate of work is dictated by a machine)



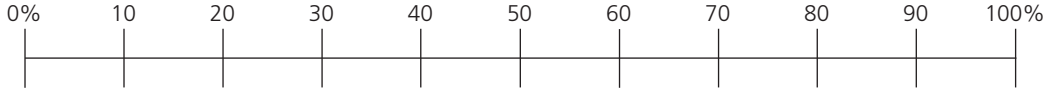
g) Using hand-held tools



h) Using a computer/computer screen (VDU)



i) Tasks which frequently require bending, twisting or reaching



About you

7. What is your job title?

8. How long have you been working in this position?

Less than 1 year	
1 to 3 years	
4 to 7 years	
8 to 12 years	
13 years +	

9. Have you previously worked in a position with a Health and Safety role?

Yes	
No	

10. On average, what percentage of your work time is spent conducting Health and Safety responsibilities (please circle)?

0% 10 20 30 40 50 60 70 80 90 100%

11. Have you received specific training in Risk Assessment?

Yes	
No	

If no, go to Question 16

12. How long ago did you receive this training?

13. What form did this training take?

Workplace "toolbox talk" of no more than 1 hour	
'Teach yourself' booklet	
Computer-based interactive course	
One/two day face-to-face training	
Other, please state:	

14. If the training was organised, who delivered the training you received?

Your organisation	
A consultant (training held in your workplace)	
A consultant (training held in another location)	
A training company	

15. Did this specifically cover risks for musculoskeletal problems?
Musculoskeletal problems refer to problems affecting workers' muscles, tendons, ligaments of either the neck, shoulders, back, arms, wrist, hands or legs also known as MSD, upper limb disorders (ULD), work-related upper limb disorders (WRULD) or repetitive strain injury (RSI).

Yes	
No	

Health and safety staff

16. How many health and safety officers are responsible for your site?

17. How many health and safety representatives are permanently located on your site?

18. Is there an external contractor (i.e. Health and Safety consultant / advisor/ Ergonomist) involved in the management of health and safety on site?

Yes	
No	

If no, go to Question 19

If 'YES', what role do they play in the management of Health and Safety on your site?

Musculoskeletal problems

19. To what extent do you agree with the following statement:
"Reducing the number of musculoskeletal risks is a priority for this company"

Strongly agree | Agree | Disagree | Strongly disagree

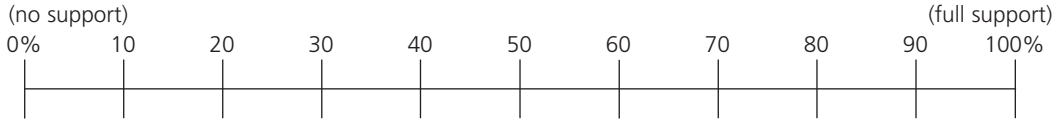
20. Do you have a clear idea of what you are going to do to reduce the risk of musculoskeletal problems in this company?

Yes	
No	

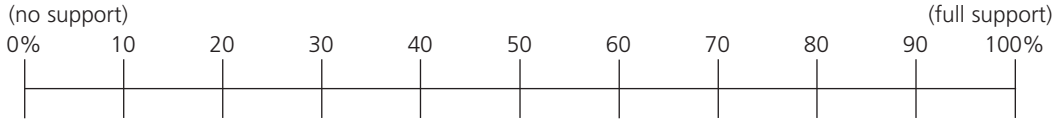
If 'YES', where did you get the information to enable you to formulate an action plan?

21. Please indicate on the scales below how supported you feel by the following personnel in tackling musculoskeletal problems in your company

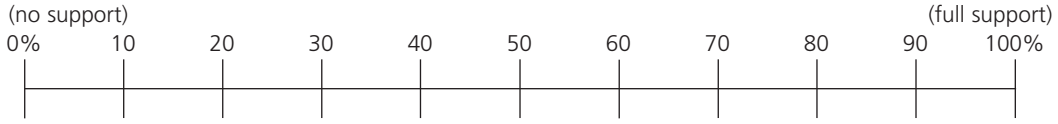
a) Workers



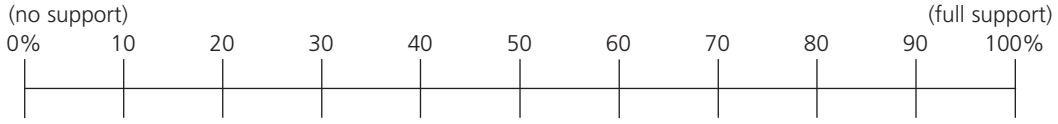
b) Supervisors



c) Management



d) Engineers/equipment designers



Risk assessment for musculoskeletal problems

22. Have risk assessments for musculoskeletal problems been conducted for any work tasks?

Yes	
No	

If no, go to Question 40

23. Do the risk assessments include completing a checklist to identify the risk factors?

Yes – all	
Yes – some	
No	

24. Who conducts the risk assessments for musculoskeletal risks? (tick more than one if required and their level of training)

	For each person who conducts risk assessment please tick if they have had ...		
	Training in general Health and Safety	Training in risk assessment	No training
You			
Health and Safety Officer			
Health and Safety representative			
External consultant			
Supervisor			
Manager			
Workers			
No one			

25. Have the people who conduct the risk assessment received specific training in completing the musculoskeletal risk assessment that is used by your company?

Yes – all	
Yes – some	
No	

26. Overall how satisfied are you with the training people have received to complete your company's risk assessment for musculoskeletal risks? (please circle)

Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied	Not applicable

27. Are supervisors involved in the risk assessment of musculoskeletal problems?

Yes	
No	
Not applicable	

If 'YES', please describe how they are involved

28. Are workers involved in the risk assessment of musculoskeletal problems?

Yes	
No	

If 'YES', please describe how they are involved

29. Do supervisors in your company receive training in risk assessment for musculoskeletal risks?

Yes	
No	
Not applicable	

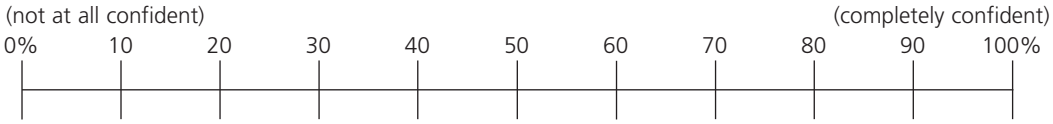
30. Were any of the following resources used to assess the musculoskeletal risks? (please tick more than one if necessary)

Resource	Tick
Checklist - developed in house	
Checklist - provided by external consultant / advisor	
HSE's 'Five Steps to risk assessment' Leaflet	
HSE's Health and Safety (Display Screen Equipment) Regulations 1992	
HSE Manual Handing Operations Regulations 1992	
HSE HSG60 – Work related upper limb disorders: a guide to prevention	
HSE Manual Handling Assessment Charts (MAC)	
NIOSH lifting equation	
Rapid upper limb assessment (RULA)	
Quick exposure check (QEC)	
Other (please describe):	
Don't know	

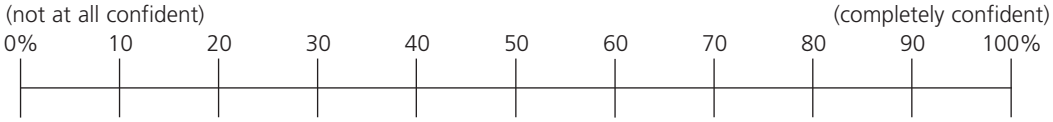
31. Who decides which method is used to assess musculoskeletal risks? (please tick more than one if necessary)

Decision maker	Tick
You	
Health and Safety Officer	
Health and Safety representative	
Boardroom level	
External consultant	
Supervisor	
Manager	
Workers	
Other (please specify):	

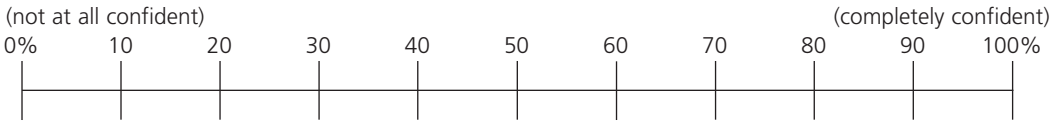
32. How confident do you feel that the risk assessment used to assess musculoskeletal risk factors in your company is capturing all the risks? (please circle)



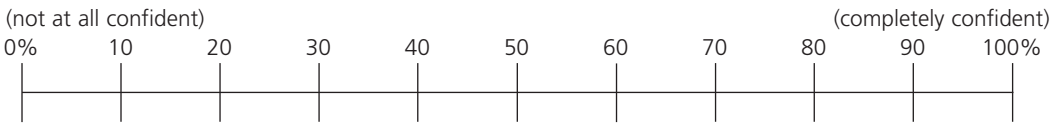
33. How confident do you feel that the risk assessment to assess musculoskeletal risk factors in your company is in prioritising areas for improvement/action?



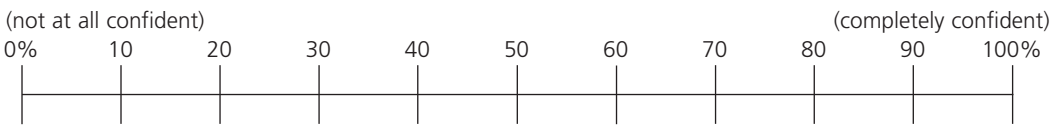
34. How confident do you feel that the risk assessment used to assess musculoskeletal risk factors in your company is accurate in differentiating between high / medium and low risk tasks?



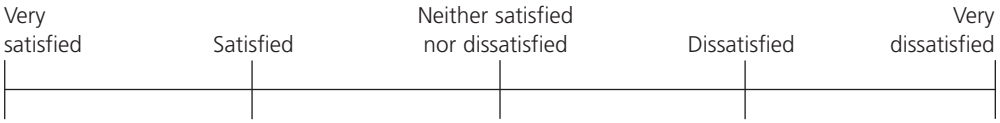
35. How confident do you feel that you (or whoever conducts the risk assessment) are using the musculoskeletal risk assessment correctly?



36. How confident do you feel that you (or whoever conducts the risk assessment) have sufficient time to conduct the risk assessment correctly?



37. Overall how satisfied are you with the current risk assessment your company uses for assessing musculoskeletal risks?



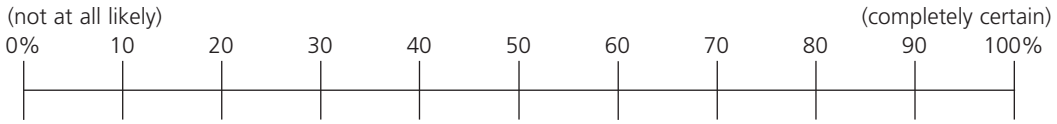
38. What do you <u>like</u> most about the risk assessment that your company uses to assess musculoskeletal risk factors?

39. What do you <u>dislike</u> most about the risk assessment that your company uses to assess musculoskeletal risk factors?

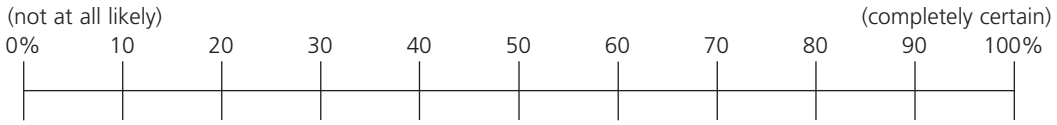
40. Do you feel that you need additional training in order to undertake musculoskeletal risk assessments effectively?

Yes	
No	

41. When musculoskeletal risks have been identified, how likely is it that changes to reduce the risk will be identified?



42. When musculoskeletal risks have been identified, how likely is it that changes to reduce the risk will be implemented?



43. What are the main obstacles to making changes?

Further information and participation

Your name:
Your phone number:
Your email address:
Your company's name:
Your company's address:
Thank you for your contribution to this valuable project. The next stage will be to select organisations to take part in testing different risk assessment models. Selected organisations will receive **free risk assessment training** as part of this process and in recognition of their support. We will include your organisation in this selection process unless you tick this box to indicate that you do not want to contribute further. ☐

Please return the completed questionnaire as soon as possible and no later than 31 October 2007.

Return to:
Clare Lawton
Ergonomics and Safety Research Institute (ESRI)
Holywell Building, Holywell Way
Loughborough, LE11 3UZ

THANK YOU

Any further questions please contact:

Clare Lawton Tel: 01509 226909 email: c.lawton@lboro.ac.uk

Appendix 2: Selected responses to the initial questionnaire

Resources used in assessing risks

The table below shows the spread of resources used in assessing musculoskeletal risks listed in question 30 of the initial questionnaire in relation to the size of the respondent's organisation.

	Question 2 Company size					
	Small (5 to 49)		Medium (50 to 299)		Large (300 or more)	
	No. respondents	%	No. respondents	%	No. respondents	%
Checklist developed in house	10	42	14	58	25	63
Checklist provided by external consultant/adviser	4	17	6	25	9	23
HSE *Five steps to risk assessment* leaflet	10	42	14	58	24	60
DSE Regulations 1992	7	29	16	67	25	63
MHO Regulations 1992	10	42	15	63	28	70
HSG60	3	13	8	33	12	30
HSE Manual Handling Assessment Charts (MAC)	3	13	11	46	23	58
NIOSH lifting equation	1	4	1	4	3	8
Rapid Upper Limb Assessment (RULA)	0	0	0	0	1	3
Quick Exposure Check (QEC)	0	0	0	0	6	15
Other	0	0	0	0	0	0
Don't know	0	0	1	4	1	3

Respondents' likes and dislikes

This is a summary of respondents' answers to questions 38 and 39, which asked which aspects of the risk assessment they use to assess musculoskeletal risks they most liked and disliked.

Most liked aspects of the risk assessment

- I developed it so am familiar with it.
- I like the methodology behind the MAC assessments. I like how the MAC assessments incorporate a numerical and colour coding score system to highlight high risk manual handling tasks.
- Pragmatic.
- It triggers areas to check.
- Straight forward and simple.
- It is simple and relatively easy to demonstrate results.
- Simple to fill in paperwork.
- The checklist based on either set of regulations and consultations it practices.
- It covers all areas as per the HSE guidance and it's unambiguous.
- It is easy to use and yet thorough.
- MAC tool developed by HSE: quick and easy and provides confirmation of risk.
- It is simple to understand and it is difficult to forget to perform any of the required steps.

- The documentation.
- To get the workers involved.
- The assessment is easy to use and required little training. It covers all areas specified in the manual handling guidance and assesses the task as a whole providing a clear numerical score for comparison.
- Easy to complete.
- You can work through the check list to ensure that each assessment is done in the same manner.
- We have developed a hazard identification check sheet and an *aide-mémoire* of control measures.
- I have a condition that affects my spine so I understand the importance of the risk assessment and how to deliver it.
- Simple to understand, involves everyone.
- Quick risk (level 1 in-house proforma). MAC charts (level 2). Checklists (level 1) is preferred by managers.
- Any changes made to existing work practices or the introduction of new processes, are assessed immediately and affected staff informed the same day.
- Assess factors on a task and location factor, not just generically.
- No real MSD assessment in place of general task assessments.

Most disliked aspects of the risk assessments

- Persons completing don't always put in accurate information, takes managers ages to follow up.
- There is nowhere on the form to document how you come to the numerical score. The form doesn't allow a description on how you come to the score.
- In our industry it is very difficult to eliminate manual handling due to the variety of materials and products we produce.
- The different levels of understanding of assessors; however, we do have occupational health or SHE managers for further advice if any problems highlighted.
- Not enough time spent on this particular risk.
- It takes up valuable time from my other work areas but it is necessary.
- Being able to access the results.
- Time taken to do a risk assessment if somebody does a risk assessment without asking the person who does the job.
- The assessment leaves the level of risk for each question completely up to subjective judgment. This can result in differences in rating between different assessors; however the training for using this assessment helps reduce this problem.
- Lacks formal training for assessors.
- Could be more comprehensive.
- There are no separate columns for the target dates and responsibilities for each individual action, which makes it difficult to ensure that all actions are carried out to target.
- Quite an involved document which needs trimming down.
- Nothing other than lack of time.
- Risk assessment may not exist in 90 per cent of cases.
- Too simple. No depth. Incorporated with general risk assessment.
- Lack of awareness of the problem.
- Not specific enough when applied to other risk assessments.
- Trying to identify the easiest but best method of assessment in the business.

Main obstacles to change

Question 43 asked respondents what the main obstacles were to devising and implementing changes to help reduce musculoskeletal risks. The following issues were raised:

- Obtaining more information and enforcing changes.
- Cost.
- Senior management budgetary constraints.
- Time/money.
- Budget.
- Time scale. Running a small business involves doing almost everything from office to shop floor.
- Cost and communication.
- Resistance to change
- Time, finance, other priorities and production demands.
- Space is a limiting factor in positioning pallets for stacking and lifting equipment. Also reluctance of the workforce to accept change.
- The difficulty to find machinery to be able to perform a varied amount of products and materials.

- Money, we have an ongoing programme to remove certain manual handling tasks in our operation, but can only progress one thing a year as the machinery required is expensive.
- Peoples' attitudes and behaviours. If the employee, supervisor and manager all 'buy in' to the control measures then they're usually successful.
- Time, competing pressures from other risks, eg COSHH, COMAH, noise, vibration, working at height and so on.
- Employees disliking the effects changes may have on their ability to do the work efficiently and without increasing demand on them.
- Being able to hold a meeting with management.
- Put workers first when making all risk assessments.
- Custom and practice. Macho attitude. Lack of suitable equipment.
- Lack of practical solutions, cost *versus* risk.
- Capital investment.
- People.
- Inertia and/or lack of communication or involvement.
- Sometimes customer requirements. Not technically possible.
- People and reluctance to change
- Cultural and budgetary.
- The attitude of the people – "I have been doing this for 30 years".
- Method options.
- Cost and practicality of retraining.
- Upfront costs.
- Meeting customers' demands for cloth of certain weight versus handling risk.
- Ensuring improvement actions are completed amongst all the other competing actions.
- Finding practical solutions.
- Management of the control measures, supervision.
- Most of our workforce does not speak English as a first language; it is difficult to get understanding especially through a translator.
- Financial restraints. Convincing employees to change long standing practices.
- Knowledge, we are very keen to progress.
- Training
- Getting all staff to follow the advice.
- Blinkered attitudes of workers. Will carry out procedures when watched but take short cuts that put them at risk when unsupervised.
- Lack of interest/motivation/time and specific guidance of most managers. No perceived problems for most. Lack of awareness in manual handling (not DSE) risk assessment needs. Other priorities such as falls, stress, transport, asbestos.
- Changes to production/performance.
- Custom and practice – we have always done it this way. Also cost.
- Identifying manageable and cost-effective solutions.
- Costs and operational restrictions.
- Convincing people we are making change for their benefit. Often staff believe we only do it to protect the company.
- Equipment changes, cost.
- Convincing general operatives that risk assessments are in place for their benefit as much as a legal requirement.
- More training and greater awareness.
- Lack of structure in company.
- Very little manual handling and mainly office-based tasks.
- Finance and lack of understanding, the methods employed – ie the manual handling has always been done this particular way.
- Space, time, cost.
- Flexible labour force which changes frequently.
- Lack of time to implement changes/paperwork.

Supervisors' involvement in risk assessment

Question 27 asked whether supervisors were involved in assessing musculoskeletal risks. Respondents identified the following ways in which they were involved:

- By identifying hazards and helping assess risk and input into controls.
- Consulted on specific jobs/equipment.
- Supervisors are consulted on the nature and the task.

- RAs are a team process.
- Problems/resolutions are discussed with them.
- Trained to conduct risk assessments.
- They get invited and help with the assessment in their area.
- We are a small company and everybody has a 'hands-on' approach although most tasks done on site do not involve manual handling.
- Part of the risk assessment team.
- Trained in risk assessment and monitor team.
- Being aware of results/possible results of activities.
- They advise as to the requirement for the type of handling.
- Consulted on problems/work practices discussed.
- Risk assessments are generic and are completed by a team which includes the departmental manager, supervisors and workers.
- They are advised of the controls required and then they review the controls to ensure they remain sufficient.
- Joint risk assessment – full consultation.
- They are supposed to be involved, but this varies.
- Informed of assessment and expected to act on any recommendations.
- Help with assessments and reviews.
- Assessing the tasks.
- As part of the assessment process the job is discussed with supervisors. Their contributions are considered whilst carrying out the assessment and reporting the associated risks.
- Part of the risk assessment teams.
- Trained assessors working with health and safety officer.
- Link between management and employees identifying risk.
- Conduct both individual and joint risk assessments with operators.
- They assist in looking at the activity to ensure the assessor sees what really happens.
- They are supposed to carry them out.
- Only trainers and managers at present can do assessments. Eventually when trained key safety reps from each department will be involved.
- Quality check of the assessments and sign off on actions.
- They conduct risk assessments and input a range of controls.
- The group management and onsite management work together as it is a training process and safety management is new to the group.
- Supervisors carry out assessments.
- As part of the task they are consulted along with the staff doing the job.
- Provide information on how tasks are carried out.
- They conduct some of the assessments.
- Risk assessor is works supervisor.
- Consulted and asked for their opinion on tasks and if any of their staff have complained about pain, discomfort.
- Asked about own experience and perceived risk factors.
- Consultant asks them to describe the processes.
- Consulted on task requirements and action plans.
- They have been trained to carry out the risk assessments.
- There is always a supervisor on the RA team.
- They are consulted and then are required to sign their agreement to the assessment content.
- They get involved in the corrective actions or control measures.

Workers' involvement in risk assessment

Question 28 asked whether workers were involved in assessing musculoskeletal risks. Respondents identified the following ways in which they were involved:

- Workers are directly involved and are asked to demonstrate the postures they adopt in undertaking a lifting task.
- RAs are a team process.
- Problems/resolutions are discussed with them.
- Trained in manual handling.
- They get invited and help.
- They put suggestions on how their jobs could be made easier.
- Risk assessments are generic and are completed by a team which includes the departmental manager, supervisors and workers.

- They're asked to input their views during the risk assessment process.
- Consultation during observation of work tasks.
- The worker is present during the assessment to answer questions regarding work methods and existing problems.
- Being involved in assessing the tasks.
- To show the assessor how tasks affect different movement in the body.
- As part of the assessment process the job is discussed with the workers that are observed. Their contributions are considered while carrying out the assessment and reporting the associated risks.
- Part of the risk assessment teams.
- Trained assessors working with health and safety officer.
- Risk assessed with all employees involved.
- Identifying problem jobs/areas.
- Conduct both individual and joint risk assessments with operators.
- They assist in looking at the activity to ensure the assessor sees what really happens.
- They do it with the supervisor.
- Often undertake them and are observed and questioned.
- Workers have manual handling training and good awareness of the risks involved in the tasks they are involved in and understand that it is part of their responsibility to risk assess continually.
- They are allowed to comment and involved in discussions as to what and how their activities can effect health.
- Via safety representatives and shop stewards.
- They participate fully in discussing the task under assessment.
- Provide information on how tasks are carried out.
- They conduct some of the assessments.
- Consultant asks them to describe the processes.
- Safety reps have been trained to carry out the risk assessments and work with the supervisors.
- There is always a worker on the RA team.
- Again, consultation is conducted initially.
- Carry out risk assessment as reps.
- Tasks are talked through when analysis is being done.
- Interviewed on the musculoskeletal aspects of their jobs.
- By asking for suggestions on how they can improve the tasks they must do. Offering information if they feel a cause for concern while performing tasks.
- By assisting in carrying out the assessment.
- Asked about the task in hand. Task based.
- Training on how to sit at a workstation, DSE.
- Workers from every area take part in risk assessment to ensure all activities covered.
- Asked questions at point of assessment.
- Persons doing the job are involved in the assessment.

Appendix 3: Workplace questionnaire

This appendix reproduces the questionnaire sent to workers in target organisations. It has been reset to fit the page layout of this report but is otherwise unchanged.

The Ergonomics and Safety Research Institute (ESRI), which is part of Loughborough University is investigating the effectiveness of risk assessment of musculoskeletal problems in the workplace. As part of this we are visiting a number of companies and observing the types of tasks workers carry out as part of their normal working day. We are also asking people to complete a short questionnaire.

We do not need your name so all the information you provide will be anonymous and will only be viewed by ESRI researchers. The questionnaire takes about 5 minutes to complete.

1. How long have you been working for the company?

Less than 6 months		4 to 6 years	
6 to 12 months		7 to 10 years	
1 – 3 years		Greater than 10 years	

2a. What is your employment type?

Full time	
Part time	
Agency / casual	

b. Which area do you work in?

c. What work tasks do you regularly do?

3. Have you heard of 'musculoskeletal disorders/problems' or 'repetitive strain injury' (RSI)?

Yes, I have heard of musculoskeletal disorders/problems	
Yes, I have heard of RSI	
No, I have not heard of either	

Go to Question 5

4. Where or how have you heard of musculoskeletal disorders or RSI? (Please tick more than one box if required)

Television		Work	
Radio		Training course	
Books		Doctor	
Magazines		Physiotherapist	
Websites		Other (please state):	

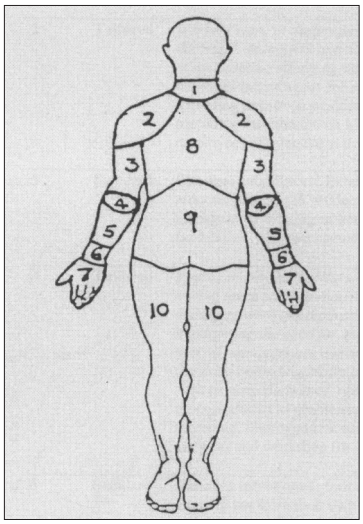
5. Musculoskeletal problems and RSI refer to problems affecting the muscles, tendons, ligaments of the neck, shoulders, back, arms, wrist, hands or legs. Symptoms can be feelings of pain, aches, numbness and/or discomfort in any of these body areas.

Have you experienced any pain, aches or discomfort in any body area... (tick more than one, if required)

No	
Yes, in the last 6 months	
Yes, in the last 7 days	

If no, please go to Question 11

6 Please mark with a cross on the diagram below where you have felt discomfort in the last 7 days or 6 months.



7. **For each of the body parts that you have marked with a cross, please circle a number on the scales below to show how much discomfort you have felt.**

	Minimal discomfort						Extreme discomfort
1. Neck	1	2	3	4	5	6	7
2. Shoulders	1	2	3	4	5	6	7
3. Upper arms	1	2	3	4	5	6	7
4. Elbows	1	2	3	4	5	6	7
5. Forearms	1	2	3	4	5	6	7
6. Wrists	1	2	3	4	5	6	7
7. Hand	1	2	3	4	5	6	7
8. Upper back	1	2	3	4	5	6	7
9. Lower back	1	2	3	4	5	6	7
10. Legs	1	2	3	4	5	6	7

8. **Have you seen a doctor or other qualified health professional (e.g. nurse, physiotherapist) about these pains, aches or discomfort?**

Yes	
No	

9. **Have you had to take time off work because of these areas of pain, ache or discomfort?**

Yes	
No	

If yes, approximately how long?

10. **What do you think may have been the cause(s) of your areas of pain, ache or discomfort (consider hobbies, sports, work tasks etc.)**

Hobbies		Work tasks	
Sport		Housework	
Other please state			

11. **Can you list up to six risks/causes which may lead to musculoskeletal problems or RSI?**

1.
2.
3.
4.
5.
6.

12. Are you concerned about developing musculoskeletal problems from your work?

Yes	
No	

13. Are there any ways in which the you would like the layout of your workplace changed so that it is easier or more comfortable to do your job?

Yes	
No	

If no, go to question 16

If **YES** please describe the changes you would like to be made

14. Do you think changes should be made to reduce the risk of musculoskeletal problems from your work in the next 6 months?

Yes	
No	

15. Do you think changes should be made in the next month or two?

Yes	
No	

16. Do you know if your employer has made any changes to reduce the risk of musculoskeletal problems from your work?

Yes	
No	

17. Are you doing or have you done anything to reduce the risks?

Yes	
No	

If yes, please describe what you have done:

18. Do you feel the communication links for information and suggestions between operations/ production and management are mostly...

Good and efficient		Unsatisfactory	
Satisfactory		Very poor and inefficient	

19. For each statement please tick a box which best describes your level of agreement

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
A In my workplace management acts quickly to correct health and safety problems					
B Health and safety information is always brought to my attention by my line manager/supervisor					
C In my workplace the chances of developing a work related heath problem are quite high					
D There is good communication here about health and safety issues which affect me					
E Management here considers health and safety to be equally as important as production					
F I believe health and safety issues are given high priority					
G Some health and safety rules and procedures don't need to be followed to get the job done safely					
H Some health and safety rules are not really practical					
I I am strongly encouraged to report unsafe conditions					
J I can influence health and safety performance here					
K I am involved in informing management of important health and safety issues					
L Health and safety is the number one priority in my mind when completing a job					
M It is important to me that there is a continuing emphasis on health and safety					
N I'm sure it's only a matter of time before I develop a work related health problem					
O Production targets rarely conflict with health and safety measures					
P I am always given enough time to get the job done safely					

THANK YOU for completing this questionnaire.

Appendix 4: Checklists

The two checklists used in the trials are reproduced here precisely as they were presented to the trial participants.

Checklist A

Frequency / Repetition

1. Shoulder / arm movements	
The shoulders / arms are moved infrequently (e.g. some intermittent movement)	[redacted]
The shoulders / arms are moved frequently (e.g. regular movement with some pauses)	[redacted]
The shoulders / arms are moved very frequently (almost continuous movement)	[redacted]

2. Repetition	
Similar motion patterns repeated 10 times per minute or less	G 0
Similar motion patterns repeated more than 11-20 times per minute	A 3
Similar motion patterns repeated more than 20 times per minute	[redacted]

Force

3. Force	
Light force (Less than 1kg) There is no indication of any particular effort	[redacted]
Moderate force (1-4kg) or Strong force (More than 4kg) Needs to be exerted a part of the time.	[redacted]
Moderate force (1-4kg) Needs to be exerted more than half of the time.	[redacted]
Strong force (More than 4kg) Force is obviously high, strong or heavy and needs to be exerted frequently.	[redacted]

Posture

The neck is held more or less straight (upright) or bent or twisted slightly (less than 15 degrees relative to the upright and forward facing position) most of the time	0
The neck is held bent or twisted (more than 15 degrees relative to the upright and forward facing position) a part of the time	A 1
The neck is held bent or twisted (more than 15 degrees relative to the upright and forward facing position) more than half of the time	

5. Awkward back posture	
The back is upright or is bent, twisted, or sideways less than 15 degrees from the upright forward facing position most of the time	
The back is bent forward, sideways or twisted (more than 20 degrees from upright forward facing position) part of the time	A 1
The back is bent forward, sideways or twisted (more than 20 degrees from the upright forward facing position) more than half of the time	

6. Awkward shoulders/arm posture	
Both of the elbows are close to the body or both arms are supported	
One or both of the elbows are raised away from the body part of the time	
One or both of the elbow are raised away from the body more than half the time	

Posture

Both of the shoulders and both elbows regularly change position to adopt relaxed/neutral postures during every hour of work	G 0
One or both of the shoulders and elbows are in a static position (i.e. infrequently moved) for between 1 and 2 consecutive hours	A 2
One or both of the shoulders and elbows are in a static position (i.e. infrequently moved) for more than 2 consecutive hours	

8. Awkward wrist posture	
Both wrists are straight or bent slightly (i.e. less than 15 degrees from the straight position) most of the time	0
One or both of the wrists are bent or deviated more than 15 degrees from the straight position a part of the time	
One or both of wrists are bent or deviated more than 15 degrees from the straight position for more than half of the time	

9. Awkward hand / finger grip	
Both hands are not used to grip anything or they are using a 'Power grip' (Power grip is where the fingers are wrapped around an object and the thumb placed against it; used, for example, in certain hammering operations)	
Is one of both hands using a 'Pinch' or 'Wide finger' grip for a part of the time ('Pinch' or 'Wide finger' grip is where the fingers are on one side of an object, and the thumb is on the other. Typically, an object lifted in a pinch or wide finger grip do not touch the palm)	
Is one of both hands using a 'Pinch' or 'Wide finger' grip for more than half of the time ('Pinch' or 'Wide finger' grip is where the fingers are on one side of an object, and the thumb is on the other. Typically, an object lifted in a pinch or wide finger grip does not touch the palm)	

Posture

Both hands and wrists regularly change position to adopt relaxed/neutral postures during every hour of work	G 0
One or both hands and wrists are in a static position (i.e. infrequently moved) for between 1 and 2 consecutive hours	A 1
One or both hands and wrists are in a static position (i.e. infrequently moved) for more than 2 consecutive hours	R 2

Additional Factors

11. Breaks	
The task is conducted by the worker continuously for less than 1 hour	
The task is conducted by the worker continuously for 1 to 2 hours	
The task is conducted by the worker continuously for more than 2 but less than 3 hours	
The task is conducted by the worker continuously for more than 3 but less than 4 hours	
The task is conducted by the worker continuously for more than 4 hours	

12. Work pace	
It is never difficult to keep up with the work	
It is sometimes difficult to keep up with the work	
It is often difficult to keep up with the work	2

Additional Factors

a. Gloves	☐
b. A tool is used to strike 2 times per minute or more	☐
c. The hand is used a tool and struck 10 times per hour or more	☐
d. The tools, work piece or workstation cause compression of the skin or body part	☐
e. The hand/arm is exposed to vibration	☐
f. The task requires fine precision movements of the hand and fingers	☐
g. A wide finger grip and or hand span is needed to grip, or manipulate items	☐
h. Are there any tools, hand held equipment or work pieces that are too large of small or be gripped easily.	☐
i. Operators are exposed to cold or draughts or grip cold tools	☐
No factors present	G 0
One factor is present	A 1
Two or more factors are present	R 2

Score sheet

Risk factor	Colour Band	Numerical score
1. Shoulder / arm movements		
2. Repetition		
3. Force		
4. Head / neck posture		
5. Back posture		
6. Shoulder / arm posture		
7. Static shoulder and elbows		
8. Wrist posture		
9. Hand and finger grip		
10. Static fingers, hand and wrist		
11. Breaks		
12. Work pace		
13. Other factors		
Overall task score		

To find out the overall risk level of the task match the overall task score with the proposed level of risk using the table below.

The overall risk level for the whole task is …… (please circle)

Low risk **Medium risk** **High risk**

Overall task score	Proposed overall risk level	
0-11	Low	Consider individual circumstances
12-25	Medium	Further investigation required

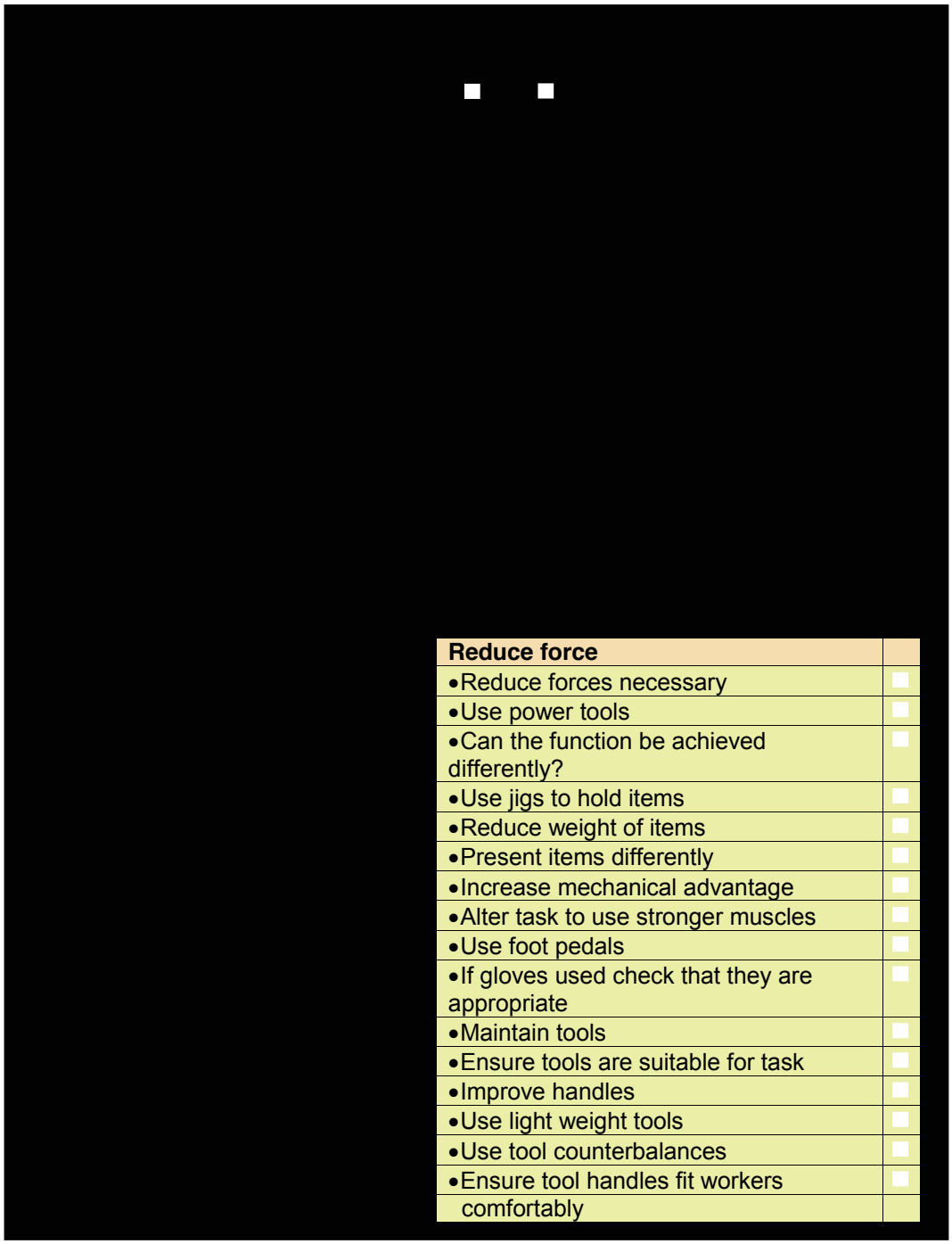
Checklist B

Frequency and repetition

Shoulder / arm movements

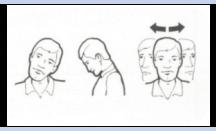
Repetition

Reduce repetition	
•Mechanise or automate repetitive functions	☐
•Use power/ratchet tools	☐
•Remove machine or other pacing	☐
•Restructure task (job design)	☐
•Remove or monitor piecework schemes	☐
Reduce duration	
•Implement job enlargement	☐
•Ensure adequate breaks	☐
•Implement job rotation	☐
•Limit / control overtime	☐



Reduce force	
•Reduce forces necessary	☐
•Use power tools	☐
•Can the function be achieved differently?	☐
•Use jigs to hold items	☐
•Reduce weight of items	☐
•Present items differently	☐
•Increase mechanical advantage	☐
•Alter task to use stronger muscles	☐
•Use foot pedals	☐
•If gloves used check that they are appropriate	☐
•Maintain tools	☐
•Ensure tools are suitable for task	☐
•Improve handles	☐
•Use light weight tools	☐
•Use tool counterbalances	☐
•Ensure tool handles fit workers comfortably	☐

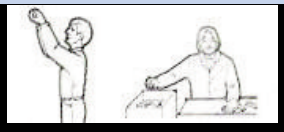
Awkward head/neck posture



Awkward back posture

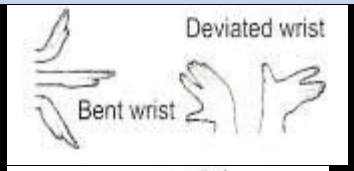
Optimise visual viewing	
•Ensure visual requirements are not too demanding	
•Provide visual aids	
•Ensure lighting is suitable	
•Reposition items that workers are required to look at	
Optimise working posture	
•Automate or mechanise	
•Modify operations or production method	
•Relocate equipment or items	
•Present work items differently	
•Reduce amount of manipulation required	
Ensure workplaces and equipment account for differences in worker size, shape and strength	
•Ensure working heights are appropriate	
•Ensure items are within reach distances	
•Provide suitable and adjustable seating	
•Use fixtures/jigs	
•Ensure tools are suitable for task	
•Ensure tools do not require awkward posture	
•Provide arm support for precision work	
•Introduce micro pauses or rest breaks which encourage adopting relaxing and significantly different postures to those adopted whilst working	

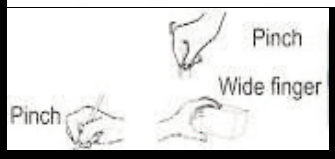
Awkward shoulders/arms posture



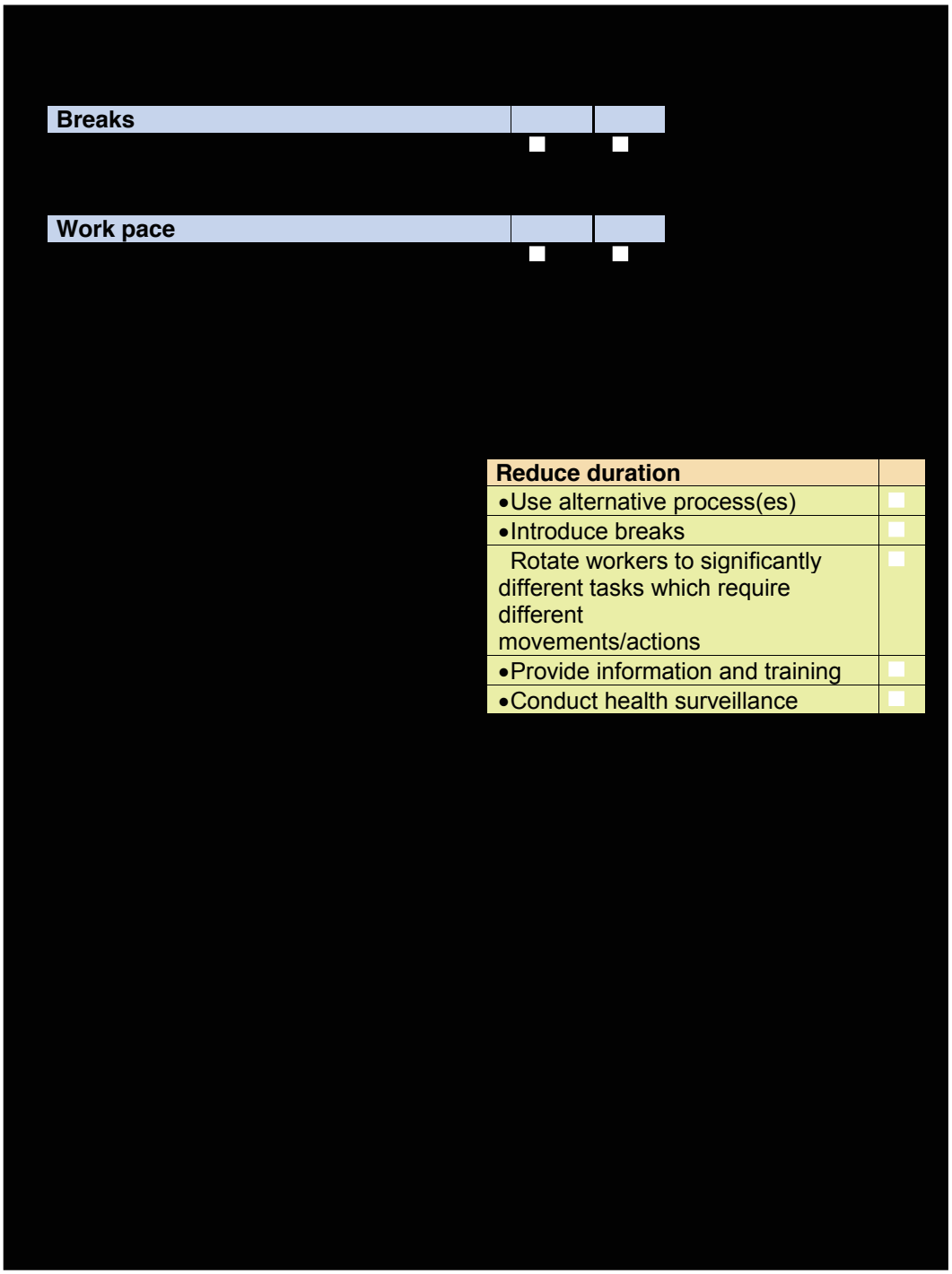
Optimise visual viewing	
•Ensure visual requirements are not too demanding	☐
•Provide visual aids	☐
•Ensure lighting is suitable	☐
•Reposition items that workers are required to look at	☐
Optimise working posture	
•Automate or mechanise	☐
•Modify operations or production method	☐
•Relocate equipment or items	☐
•Present work items differently	☐
•Reduce amount of manipulation required	☐
•Ensure workplaces and equipment account for differences in worker size, shape and strength	☐
•Ensure working heights are appropriate	☐
•Ensure items are within reach distances	☐
•Provide suitable and adjustable seating	☐
•Use fixtures/jigs	☐
•Ensure tools are suitable for task	☐
•Ensure tools do not require awkward posture	☐
•Provide arm support for precision work	☐
Introduce micro pauses or rest breaks which encourage adopting relaxing and significantly different postures to those adopted whilst working	☐

Awkward wrist posture





Optimise working posture	
•Automate or mechanise	☐
•Modify operations or production method	☐
•Reduce amount of manipulation required	☐
•Ensure workplaces and equipment account	☐
for differences in worker size, shape and strength	
•Use fixtures/jigs	☐
•Ensure tools are suitable for task	☐
•Ensure tools do not require awkward posture	☐
•Provide arm support for precision work	☐
Reduce repetition	
Introduce more rest breaks that encourage adopting relaxing and different postures to those adopted whilst working	☐



13. Other factors

Improve working environment	
•Use alternative process(es)	☐
•Select alternative lower vibration equipment	☐
•Use balance / tensioners	☐
•Maintain equipment	☐
•Reduce exposure time to vibration	☐
•Provide information and training	☐
•Conduct health surveillance	☐
•Avoid working in cold	☐
•Avoid handling or insulate cold items or tools	☐
•Redirect blowing air	☐
•Use warm clothing	☐
Ensure workplaces and equipment account for differences in worker size, shape and strength	☐

TOTAL number of 'Yes' ticks_____

In the table below please rate the level of action required for each risk factor for this task.

Risk factor - Worksheet reference number	Priority for action High, medium, low priority
1. Shoulder / arm movements	
2. Repetition	
3. Force	
4. Head / neck posture	
5. Back posture	
6. Shoulder / arm posture	
7. Static shoulder and elbows	
8. Wrist posture	
9. Hand and finger grip	
10. Static fingers, hand and wrist	
11. Breaks	
12. Work pace	
13. Other factors	

The overall risk level for the whole task is …… (please circle)

Low **Medium** **High**

Appendix 5: Comparison questionnaire

This appendix reproduces the questionnaire given to workers to compare the two checklists. It has been reset to fit the page layout of this report but is otherwise unchanged.

Name (please print your name):

1. **Overall which of these two assessment tools was the easiest to use?** (please tick)

Assessment A (red, amber, green)	
Assessment B	

2. **Which of these assessment tools would you prefer to use on your workplace?** (please tick)

Assessment A (red, amber, green)	
Assessment B	

3. **Which of these assessments do you think would be the best to help your company reduce the risks of musculoskeletal problems in your workplace?** (please tick)

Assessment A (red, amber, green)	
Assessment B	

4. **How effective was each assessment tool in identifying whether the whole task was either high, medium or low risk?** (please circle your rating score for A and B)

	Not at all effective				Very effective
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

5. **How effective was each assessment tool in identifying particular areas (risk factors) within a task as high, medium or low risk?** (please circle your rating score for A and B)

	Not at all effective				Very effective
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

6. **How effective was each assessment tool in identifying what the causes to the problems were?** (please circle your rating score for A and B)

	Not at all effective				Very effective
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

7. **How effective was each assessment tool in identifying what changes should/could be made to reduce the risks?** (please circle your rating score for A and B)

	Not at all effective				Very effective
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

8. **How easy was it for you to understand the instructions on how to use the assessment tool?** (please circle your rating score for A and B)

	Very difficult				Very easy
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

9. **How confident did you feel in using the assessment tool?**

	Not at all confident				Very confident
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

10. **How confident were you that you had assessed the tasks correctly?**

	Not at all confident				Very confident
Assessment A (red, amber, green)	1	2	3	4	5
Assessment B	1	2	3	4	5

11. **For each of the following statements please circle the response that best describes your level of agreement to that statement.**

a. **I would have liked more background information about the risk factors.**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

b. **I would have liked more information about how to complete the risk assessments.**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

c. **I would have liked more information about possible control actions/changes to make to reduce the risks.**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

d. I think face to face training in the use of the assessments would be more useful than following written instructions.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

e. I think following written instruction would be more useful than attending a face to face training session.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

f. I thought that the written instructions were sufficient to conduct the assessments.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

g. I would have liked to have gone through some example assessments with a trainer.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

12. Which of these terms (1 or 2) do you find most helpful in describing a risk? (please tick the statement you most prefer (1 or 2))

Term 1		Term 2	
Does the task involve similar motion patterns being repeated frequently		Similar motion patterns are repeated more than 11-20 times per minute	
Moderate force (1-4kg) or Strong force (More than 4kg) is exerted		Moderate or strong force is exerted	
Does the task involve holding the neck bent or twisted more than 15% of the time		Does the task involve holding the neck bent or twisted a part of the time	
Does the task involve holding the neck bent or twisted 		Does the task involve holding the neck bent or twisted (more than 15 degrees relative to the upright and forward facing position)	
The back is bent forward, sideways or twisted (more than 20 degrees from upright forward facing position)		The back is bent forward, sideways or twisted 	

13. What were the top things you liked most about...

a. Assessment A (red, amber, green)

1

2

b. Assessment B

1

2

14. What were the two things you most disliked about...

a. Assessment A (red, amber, green)

1

2

b. Assessment B

1

2

Appendix 6: Training evaluation questionnaire

This appendix reproduces the questionnaire given to workers after they received training. It has been reset to fit the page layout of this report but is otherwise unchanged.

Name (please print your name):

1. Can you please list up to six risks/causes which may lead to musculoskeletal problems or RSI?

1.
2.
3.
4.
5.
6.

2. How confident were you that you had assessed the last two tasks correctly?

	Not at all confident				Very confident
Task 1	1	2	3	4	5
Task 2	1	2	3	4	5

3. How confident did you feel in using the assessment tool before and after receiving training?

	Not at all confident				Very confident
Before training	1	2	3	4	5
After training	1	2	3	4	5

5. For each of the following statements please circle the response that best describes your level of agreement to that statement.

h. I would have liked more background information about the risk factors (please circle)

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

i. I would have liked more information about how to complete the risk assessments.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

j. I would have liked more information about possible control actions/changes to make to reduce the risks.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

k. I think face to face training in the use of the assessments was more useful than following just the written instructions.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

l. I think following written instruction was more useful than attending a face to face training session.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

m. It was good to go through an example assessment with the trainer.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

About the training course

Student assessment

	Yes	No	Please add comments:
Have you enjoyed the course?			
Has this course increased your knowledge about the risks for Musculoskeletal problems?			
Has this course been of practical benefit to you? i.e. will you use the knowledge you have gained back in the workplace?			
How would you improve this course?			

	Yes	No
Is there anything you feel the tutor did to hinder your learning? Please comment:		
Is there anything you feel the tutor did to help your learning? Please comment:		

Using the following ratings please tick the score in the boxes below:
(5 = Excellent) (4 = Very Good) (3 = Good) (2 = Satisfactory) (1 = Poor)

	1	2	3	4	5
Content of the course					
Course Material					
The pace of the course					
Overall Standard					

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