Ergonomics Workload Analysis For The Prevention of Musculoskeletal Disorders in Food Services in The Health Sector

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ABSTRACT

The Design 4 Health National Manual Handling Campaign was conducted across Australia in 2004. The report highlighted the need to improve the management of manual handling risks in non-clinical areas such as food services in the health sector. This study aimed to identify risk factors for musculoskeletal disorders in Kitchen Hands and provide strategies to eliminate or minimize the risks.

The study was conducted in a major South Australian hospital. The physical demands, physiological responses and perceived workload were analysed to identify the risk factors arising from six manual tasks performed by Kitchen Hands. The assessment showed that physical demands during trayline serving – loader, collecting trays and trolleys and delivering lunch trolleys contributed to a higher risk of musculoskeletal disorders. Across the six manual tasks, the participants displayed the highest average blood pressure changes of 12.53% while dishwashing and 11.50% while collecting trays and trolleys. Delivering lunch trolleys displayed the lowest average blood pressure change of 1.65%. The perceived effort measured by Borg's RPE scale showed that the perception of exertion for four out of six tasks was rated as "somewhat hard". Recommendations focused on implementation of an effective hazard management program and maintenance and design of equipment and trolleys.

Further study of work design and pace of trayline tasks and dishwashing is recommended to identify opportunities to reduce risk and improve productivity. Assessment of the psychosocial factors and potential for occupational stress associated with workloads can provide added value by preventing musculoskeletal disorders in food service workers in the health sector.

1. INTRODUCTION

Workload is defined as the total amount of work that a person is expected to do in a specified time. Time pressure may contribute to high workloads or to tight deadlines. The major factors contributing to musculoskeletal disorders (MSDs) from the physical workload are repetition, force exertion, frequent or heavy lifting, pushing, pulling, or carrying of heavy objects, prolonged awkward postures and vibration. The speed of movement, the duration of the task and the cycle time should also be considered while assessing the risk of MSDs for manual handling tasks. Mental workload is defined primarily as the relationship between the worker's perceptions of the demands of the task and their perceived coping capacity (MacDonald 2004, p.40). When reviewing the workload of a job, both physical and mental workload should be considered.

The Design 4 Health National Manual Handling Campaign 2004 was conducted in Australia. The campaign industry summary report showed that manual handling risk management has significantly improved in the past five years. Particularly, with the increased promotion of safe patient handling in the workplace, the audit results show that the risks of patient handling were well managed. However, improvements are required in non-clinical areas such as kitchens and food services. Risk assessments in these areas were not undertaken in a systematic manner and were arranged on an ad-hoc basis. In some cases no assessment had been done. This audit result reflects the opportunity

to improve the management of risks in manual handling tasks in non-clinical areas (Australian Occupational Health and Safety Agencies 2005).

2. OBJECTIVES AND SCOPE OF STUDY

The major purpose of this study is to identify the potential risk factors of MSDs for Kitchen Hands and to provide preventive strategies to eliminate or minimize the associated risk of MSDs. The study was conducted in a major South Australian hospital. The afternoon duties of lunch meal services were selected for detailed analysis. This report details the evaluation of physical demands, the measurement of physiological responses to job demands and the collection of the subjective ratings of staff on perception of exertion among six major tasks of four Kitchen Hands. The job design, equipment use and other work organization factors of six manual tasks were reviewed.

The serving trayline involves ten sub-tasks and in this study, two sub-tasks, namely trays; and loader, were selected for thorough analysis. In addition, the analysis of the workload of four other manual tasks, namely collecting trays and trolleys; delivering and serving afternoon tea trolleys; delivering lunch trolleys; and dishwashing, were covered in this study. The findings and recommendations as well as further study suggestions were given for the reduction and prevention of MSDs.

3. METHODOLOGY

Four Kitchen Hands volunteered to participate in this study. The data collection was conducted in four lunch service periods and comprised of four Kitchen Hands in two teams for two-two day blocks. On the assessment of physical demands, videotaping and photo taking were used to assist in the postural analysis and assessment in this study. The Manual Tasks Risk Assessment Tool (ManTRA version 2.0) was used to assess the exposure to musculoskeletal risk factors associated with six manual tasks. The ManTRA included the assessment of the cycle time, repetition, force, awkwardness and vibration risks for four body parts of staff for a given task. The body regions of lower limbs, back, neck/shoulder and arm/wrist/hand were assessed individually.

Secondly, an automatic wrist blood pressure monitor was used to measure the blood pressure of the test subjects. The measurements included the blood pressure of test subjects at rest condition and also at 20 minute intervals after performance of a given task. The resting blood pressure readings of the test subjects were obtained after a 30 minute lunch break and before the start of the afternoon lunch service duties.

Thirdly, the Borg Rating of Perceived Exertion Scale (Borg's RPE Scale) was used to obtain the subjective rating of the four subjects' perception of exertion for each completed task activity. This rating was obtained at the same time interval as the blood pressure measurement of the test subjects. The Borg's RPE scale is based on the subjective feelings of the test subjects on how heavy and strenuous they felt the given task was, the perception of the strain and fatigue in the test subjects' muscles and on their feelings of breathlessness or aches in the chest. Scale 6 represents "no exertion at all", Scale 13 represents "somewhat hard, but it still feels OK to continue" and Scale 20 represents "maximal exertion" (Borg 1998).

4. FINDINGS AND DISCUSSIONS

4.1 Descriptions of Six Manual Tasks

The Food and Nutrition Service Department provides food and beverage services to approximate 600 patients daily. Kitchen Hands are mainly responsible for five major manual tasks, namely (1) serving trayline; (2) collecting trays and trolleys; (3) delivering and serving morning/afternoon tea trolleys; (4) delivering lunch trolleys and (5) dishwashing. Kitchen Hands are grouped to serve breakfast, lunch and dinner meals. For the breakfast and lunch meal services, two supervisory staff and 22 Kitchen Hands are rostered for work between 6:00am to 3:30pm and one team leader and two part-time staff work in the late morning and afternoon between 11:00am to 4:00pm.

Kitchen Hands for the morning and afternoon shift are assigned to team A or team B. The tasks

assigned to team A in the morning are rotated to team B in the afternoon shift and vice versa. By following this rotation arrangement, no staff are required to perform the same manual task twice for both breakfast and lunch services in a work-shift.

The task descriptions of six manual tasks are summarized as follows:

A) Task Group A

Serving Trayline

In serving trayline task for lunch meals, there are ten stations: trays, sandwiches, sweets, salads, entrée, modified consistency, soups, assist/soups, runner and loader. With the exception of the sandwiches and loader positions who swap halfway through the serving trayline task, all staff remain in the same position from 11:30am to 1:00pm for a total of one and a half hours.

Task 1: Serving Trayline – Trays

- Gets tray from stack on automatic raising table and slides onto platform at the start of conveyor.
- Gets menu slip and required serviettes and cutlery from trolley and places on tray.
- Informs staff of special menu required, then places menu slip on tray and slides tray forward in sideway posture onto conveyor.
- ➢ Force required to slide tray is less than 0.5kg; tray with loads less than 1kg.
- ➢ Serves approximately 10 trays per minute; up to 600 meals per lunch service.
- ➢ Serving preparation for 20 minutes and serving trayline for 1 hour 10 minutes.

Task 2: Serving Trayline – Loader

- As trays present along conveyor, lifts and carries tray and locates it in trolley shelves (Lifts up to or carry 3kg per tray).
- Upon finishing the loading for a trolley, pushes or pulls trolley to side for deliveries (pushes or pulls up to 5kg force).
- Pushes or pulls empty trolley from side to loading area.
- ➢ Loads approximate 10 trays per minute and involves pushing or pulling trolley.
- ➢ Loads up to 300 meals per 45 minutes lunch service time.
- ➢ Total task duration is 45 minutes.

Task 3: Collecting Trays and Trolleys

- Checks ward collections list for collecting.
- Removes patient's personal items on tray.
- Checks trolley at the beverage area (kept at the ward) for soiled items on trays and shifts all items to the collecting trolley.
- Pushes trolley from wards to kitchen and back (pushes up to 5kg force).
- ➢ Two Kitchen Hands work in a team. May need to handle double trolley with 16 shelves.
- ➢ Total task duration is 1 hour.

Task 4: Delivering and Serving Afternoon Tea Trolley

- Pushes tea trolley from kitchen to wards.
- Asks patients for drink and/or fruit/biscuits preferences.
- Makes a cup of drink according to patient order and obtains patient signage of diet notice.
- Places the drink on patient's side bed.
- ➢ Serves around 60 drinks per afternoon tea time.
- ➢ Total task duration is 1 hour.

B) Task Group B

Task 5: Delivering Lunch Trolleys

- Checks ward delivery order on ward delivery sheet.
- Pushes trolley from kitchen to wards (pushes up to 5kg force).
- Delivers meals according to bed order and slides the tray from trolley and places the tray on the side bed of the patient.
- ➢ Carries up to 3kg tray from trolley to bed side (carry for less than 10 seconds/serve).
- ➢ Total task duration is 1 hour and 30 minutes.

Task 6: Dishwashing

- Nine activities are: (1) Unload trays & remove rubbish; (2) Removal of tray & sweet bowls; (3) Cutlery & B&B plates; (4) Lids & tumblers; (5) Plates/bases/scraping plates; (6) Loader; (7) Unloader; (8) Sorter and (9) Runner.
- ➢ Staff rotate to different stations every 15 minutes.
- ➢ Approximately rotate to seven task activities in a meal section. No rest break is arranged.
- ➢ Total task duration is 1 hour and 45 minutes.

4.2 Risk Assessment of Physical Demands

The manual task risk assessment was conducted during the afternoon lunch meal service to assess the physical demands of six tasks. Task Group A included (Task 1) serving trayline – trays; (Task 2) serving trayline – loader; (Task 3) collecting trays and trolleys and (Task 4) delivering and serving afternoon tea trolley. Task Group B included (Task 5) delivering lunch trolleys and (Task 6) dishwashing.

Based on the action levels recommended by ManTRA (Burgess-Limerick, Straker, Pollock and Egeskov, 2004), further control actions may be necessary for any body region if 1) the combined risk factor for exertion is 5; 2) the sum of exertion and awkwardness is 8 or greater, or 3) the combined cumulative risk scores is 15 or greater. The risk assessment results, table 1, show that among six manual tasks, the cumulative risk score of serving trayline – loader, collecting trays and trolleys and delivering lunch trolleys are at 14 or 15 for all body regions except lower limbs.

Table 1. Cumulative Risk Score of Six Manual Tasks of Four Body Region

Body Region	**Cumulative Risk Score**					
	Serving Trayline -Trays	Serving Trayline - Loader	Collecting Trays and Trolleys	Delivering & Serving Afternoon Tea Trolley	Delivering Lunch Trolleys	Dishwashing
Lower Limbs	8	10	12	9	12	9
Back	11	**14**	**15**	9	**14**	12
Neck/Shoulder	13	**14**	**15**	11	**15**	13
Arm/Wrist/Hand	13	**14**	**14**	10	**14**	13

The assessment results also highlighted that all tasks were rated the highest score of “5” for repetitive risk for the body regions of neck/shoulder and arm/wrist/hand. All the tasks were performed for a long duration of approximately one and a half hours but with a short cycle time in the range of 10 to 20 seconds. Taking the serving trayline – loader task as an example, Kitchen Hands were required to load approximately 10 trays per minute which involved pushing/pulling trolleys and loading up to 300 meals in 45 minutes.

On the other hand, Kitchen Hands were responsible for two to three manual tasks in a lunch meal service and each task was performed for less than two hours per day. As a result, the risk assessment on the total time component is fairly low with scores at “1” for all tasks. However, since similar muscle groups were required to perform the tasks, the cumulative risk of suffering from MSDs is noted.

The tasks serving trayline – loader, collecting trays and trolleys, delivering lunch trolleys were rated the highest score of “5” of the risk of awkward postures for back and neck/shoulder body regions. Kitchen Hands were required to lift and carry fully loaded trays weighing up to 3kg while loading or unloading the trays from the trolley. The lowest shelves of the trolley were 50cm above ground level and the top shelves were 183cm above ground level. Therefore loading and unloading trays from the top shelves required reaching above shoulder height and bending down to reach the lower shelves. This demonstrates that the design of the equipment increased the risk of awkward postures.

Kitchen Hands also reported that the tea trolleys swung while pushing which made it especially hard to control when moving in or out of the lift. Kitchen Hands may try to exert more force to push or pull the trolley when it gets stuck in the middle of the lift’s gap.

Furthermore, when Kitchen Hands performed the collecting trays and trolleys task, they were required to adopt a fast and smooth movement which demanded moderate force. The Kitchen Hands explained that they were required to work as fast as they could because the dishwashing task was reliant on the trays being returned to the kitchen for dishwashing. If the collection was running late, the dishwashing task could not be finished on time as well. This situation resulted in time pressure to Kitchen Hands. The workload of the Kitchen Hands was increased when the number of patients required to serve increased or if trays were left over at the ward trolley after breakfast collection time.

The Food and Services Department placed a safety notice on the top trolley shelf with the message “Safety Notice: Avoid injury, store goods below shoulder height. Nothing is to be placed on the top

shelf." However, it was found that Kitchen Hands and/or nurses at the ward normally placed the cordial jars or sometimes trays or other items on the top shelf of the trolley. This is due to the cordial jars being too tall to fit in the lower shelves of the trolley. This reflects the inadequacy of the trolley design to fulfil its purpose.

The job rotation of the dishwashing task every 15 minutes is noted. This is one of the more effective characteristics of the task design to minimize the overall manual handling risk of the dishwashing task. However, there is no rest break for the Kitchen Hands during the one hour and 45 minutes task duration and all the task activities were highly repetitive and required exertion of similar muscle groups. Kitchen Hands were required to load and unload kitchenware to and from the dishwasher, which was a highly repetitive task.

The risk assessment results showed that the overall manual handling risk level of serving trayline – loader, collecting and delivering trays and trolleys tasks was high. However, it is important to note that when developing control measures, all the identified manual handling hazards should be addressed and the identified hazards should be eliminated or if that is not possible, minimized.

4.3 Physiological Responses to Task Workload

All four test subjects have worked in the Kitchen Hands position for over 15 years and were acclimatised to working conditions and well experienced to handle all tasks. The blood pressure of four Kitchen Hands was measured at rest and also at 20 minute time intervals while performing the task. The analysed data shows the physiological response of test subjects while performing different tasks.

When the body is in resting condition, 15 to 20% of blood flow is distributed to muscles and 20 to 25% to digestive system whereas when a person is doing heavy work, 70 to 75% blood flow is distributed to muscles. When a person performs physical work, additional oxygen uptake is consumed by working muscles. At the same time, the rate of breathing and the volume of air inspired with each breath increases. The oxygen and glucose are transported in the blood through the cardiovascular system. The heart must pump more blood per unit time to provide more oxygen and glucose. The increased cardiac output to the muscles results in an increase in blood pressure as well as heart rate when physical work is performed. The higher blood pressure changes compared with resting blood pressure level represents the test subjects' responses to higher physical demands (Sanders and McCormick 1993).

The following table, table 2, shows the maximum blood pressure (systolic readings) changes of four Kitchen Hands while performing six manual tasks. It also shows the mean blood pressure percentage of four Kitchen Hands in a given task as well as an individual subject's mean maximum blood pressure (systolic) percentage changes.

Table 2. The Maximum Percentage Blood Pressure (Systolic) Changes of Four Kitchen Hands While Performing Six Manual Tasks

Task Name	**Max B/P (Systolic) changes (%)***				**Mean B/P Changes (%)**
Task Group A	**Test Subject**				
	A	**B**	**C**	**D**	
Serving Trayline –Trays	9.9	--	**9.4**	--	9.65
Serving Tralyine – Loader	--	10.8	--	-4.5	3.15
Collecting Trays and Trolleys	**14.0**	14.6	6.3	**11.2**	**11.50**
Delivering and Serving Afternoon Tea Trolley	5.0	**15.4**	7.8	3.0	7.80
Individual Subject's Mean Max B/P (Systolic) Change (%)	***9.6***	***13.6***	***7.8***	***3.2***	***8.02***
Task Group B					
Delivering Lunch Trolleys	0.0	3.1	7.3	-3.8	1.65
Dishwashing	**4.9**	**23.1**	**13.8**	**8.3**	**12.53**
Individual Subject's Mean Max B/P (Systolic) Change (%)	***2.5***	***13.1***	***10.6***	***2.3***	***7.13***

Remark: * The maximum percentage blood pressure change is calculated by [(maximum blood pressure readings in a given task - blood pressure at rest)/blood pressure at rest] x100%.

Table 2 shows that in Task Group A, there is no consistent maximum percentage blood pressure change for the four test subjects. The maximum blood pressure change was 15.4% for a test subject while performing delivering and serving afternoon tea trolley. Two out of four participants displayed the highest maximum blood pressure change while collecting trays and trolleys. For Task Group B, the data consistently shows that all four subjects displayed higher maximum percentage blood pressure change in the dishwashing task than the delivering lunch trolleys task. Across six manual tasks, the test subjects displayed the average highest blood pressure changes of 12.53% while dishwashing and 11.50% while collecting trays and trolleys. Delivering lunch trolleys displayed the lowest average blood pressure change of only 1.65%.

Of the findings in this study, the individual test subjects' mean blood pressure percentage changes ranged from 2.3% to 13.6%. Test subject B displayed the highest mean blood pressure change for both Task Group A and B whereas test subject D displayed the lowest mean blood pressure change for both tasks. This shows the physiological responses may varies on individual basis and it may correlated to individual physical condition, age and sex.

4.4 Rating of Perceived Exertion

The perceived effort of Kitchen Hands was measured using Borg's RPE Scale. The means scale of four test subjects across six manual tasks, table 3 below, ranged from 11 (light task) while delivery lunch trolleys to 15.8 (heavy task) while serving trayline trays.

Table 3. The Means Reported Borg's RPE Scale of Four Kitchen Hands of Performing Six Manual Tasks

Task Name	**Means Reported Borg's RPE Scale**				**Means Scale**
Task Group A	**Test Subject**				
	A	**B**	**C**	**D**	
Serving Trayline -Trays	12.0	0	**15.8**	0	**13.88**
Serving Tralyine - Loader	0	13.7	0	**14.0**	**13.84**
Collecting Trays and Trolleys	**13.0**	13.3	13.7	13.3	13.31
Delivering and Serving Afternoon Tea Trolley	12.0	**15.0**	12.0	12.0	12.75
Individual Subject's Means Reported Borg's RPE Scale	***12.3***	***14.0***	***13.8***	***13.1***	***13.45***
Task Group B					
Delivering Lunch Trolleys	11.8	11.2	11.0	12.0	11.50
Dishwashing	**13.1**	**13.9**	**12.9**	**13.7**	**13.40**
Individual Subject's Means Reported Borg's RPE Scale	***12.5***	***12.6***	***12.0***	***12.9***	***12.45***

The means reported Borg's RPE scale of four Kitchen Hands across a given task shows that in Task Group A, the means scales for the four test subjects rated between 12.75 and 13.88. This shows the task being perceived as "Is somewhat hard, but it still feels OK to continue" at the scale of 13. In addition, four test subjects reported different means highest rates of perception of exertion, however, three test subjects reported the lowest means Borg's RPE scale was delivering and serving afternoon tea trolley task. Subject B reported the means Borg's Scale at 15 (heavy task) of the delivering and serving afternoon tea trolley but the task was rated the lowest scale at 12 by all other three test subjects.

For Task Group B, all four test subjects rated dishwashing task as harder than delivering lunch trolleys. All four test subjects consistently rated the dishwashing task as somewhat hard in the range of scale 13. Only the delivering lunch trolleys task was perceived as a light task (scale at 11.5). The overall perception of exertion on the strain and fatigue in muscle while performing the tasks were medium to high.

The reported perceived workload rating is influenced by the overall perception of exertion by the test subject. In addition, the previous experience and job motivation of the test subjects also affects the perceived workload. A highly motivated worker tends to underestimate his/her perceived exertion (Wilson and Corlett 1995).

5. CONCLUSION

This report summarises the evaluation results of the physical demands, physiological responses to job demands and four Kitchen Hands' subjective rating on perception of exertion among six major manual tasks in a major South Australian hospital. In Task Group A, the study result shows that collecting trays and trolleys task were rated as high in manual handling risk and the two Kitchen Hands also displayed highest mean blood pressure changes and one Kitchen Hands rated as the highest perceived workload. The result also shows that the tasks with the highest ratings of perceived workload were the same as those with the highest blood pressure changes except for participant D for the task in Task Group A

However, in Task Group B, the manual task risk assessment scores of four body regions are relatively high on the delivering lunch trolleys task when compared with the dishwashing task. Interestingly, the results of physiological measurement and subjective rating indicate higher demands within the dishwashing task ahead of delivering lunch trolleys task. None of the Kitchen Hands displayed higher maximum blood pressure percentage change and higher means reported Borg's RPE Scale of performing delivering lunch trolleys task. This shows that the risk assessment on the physical demands of a given task may not result in the same conclusion as the physiological response and subjective feeling of the test subjects.

This study concludes that a single measurement may not effectively identify the level of risks of the manual handling so the multi-modal assessment is useful to identify the complete manual handling risk.

6. RECOMMENDATIONS

A number of recommendations are given regarding the interaction between Kitchen Hands, the tasks performed, the workstation and tools used, work environment and organizational factors.

The serving trayline and dishwashing tasks are characterised as being highly repetitive and the tasks are performed for more than one hour. The job design and work pace should be reviewed. A short break in the middle of the task is suggested. The rest break can be arranged as a group stretching exercise break or a tea break. Job rotation should also be considered especially during peak periods for high intensity tasks.

The design of the meal delivering and collecting trolley task should be reviewed. The trolley's shelves should be located at an appropriate level so as to reduce over reaching and back bending while loading and unloading trays. In the meantime, the top and lowest shelves of trolleys can be blocked to reduce the risk of developing MSDs.

In addition, Kitchen Hands should be encouraged to report any malfunction of equipment. Maintenance of equipment should be arranged immediately after being reported by staff and regular inspection of equipment should be scheduled. Otherwise, Kitchen Hands may require extra force to use the damaged equipment which will increase the risk of suffering from MSDs.

Regular consultative meetings involving the sharing of information and exchange of views between management staff, Kitchen Hands and/or their representatives on job design, workload, organizational issues is advised. It should include the opportunity for all staff to contribute to decision-making in a timely fashion and resolve any job issues existing in the workplace.

Recommendations are summarized to identify risk factors for MSDs in Kitchen Hands and the strategies to eliminate or minimize the manual handling risks.

1. Develop a systematic approach to hazard management
2. Identify associated risk factors for MSDs by trained personnel, i.e. physical, mental, psychosocial, environmental and organizational elements
3. Undertake multi-modal risk assessment
4. Evaluate equipment design and develop maintenance program
5. Follow hierarchy of controls to eliminate or minimize the manual handling risk in reasonably practicable manner

6. Review the effectiveness of control measures and audit compliances
7. Establish participatory ergonomics

7. AREAS OF FURTHER STUDY

The findings of this study illustrated that the high physical demands of serving trayline – loader and collecting and delivering trays and trolleys. In addition, the collecting trays and trolleys as well as the dishwashing task lead to highest blood pressure and perceived high work demands to Kitchen Hands. Further study is advised by undertaking a multi-modal risk assessment of the workload for these few tasks. Consideration should be given to further review of work design and pace of trayline tasks and dishwashing to identify opportunities for further productivity improvement and reduce the risk level of MSDs.

In addition, it is also advised that manual handling risk assessments should be completed for all sub-tasks in the dishwashing task and ensure all hazards are identified and eliminated or minimized if reasonably practicable. The possibility of job rotation for serving trayline task is suggested for review. All sub-tasks in the serving trayline tasks are highly repetitive and some of the sub-tasks have relatively higher workload than others. Further evaluation of the level of the workload for all serving trayline tasks is recommended.

Evaluation and assessment of the psychosocial factors and potential for occupational stress associated with workload can provide added value of preventing MSDs in food services workers in the health sectors.

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