

Evaluating and managing MSDs in domestic tasks through ergonomics

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ABSTRACT

An increasing number of elderly people in recent years have raised the issue of disability/dependency. The common cause of disability/dependency in elderly people is musculoskeletal pain and related indications (Urwin, Symmons et al. 1998). Therefore, Musculoskeletal disorders (MSDs) have become worldwide dilemma (Sanders 1997). The risk of MSDs occurs both within and outside the work environment where it is being performed (Hedge, Rudakewych et al. 2002). If MSDs risk is identified at an early stage of life, then it might help people manage the MSDs risks in performing daily tasks before they can interfere in their life and make them dependent on others. Also, early management of person's own risk can help the healthcare professionals help people in the society in maintaining their independence in later life and reducing the social care cost burden on community. The main objective of this study is to address the known statement that there is an increased risk in later life of injury, which is associated with loss of independence. Therefore, this study evaluates a person's risk of having MSDs through performing domestic tasks. And thus, with a greater understanding of that risk, put in place an assessment methodology with the aim of increasing independence by decreasing or managing risks related to bad postures associated with the performance of domestic tasks. A survey was conducted to identify the hardest tasks, to be performed in a home environment. A newly developed tool called "task assessment tool for ease and risk (TAER)"(Zaheer, Yoxall et al. 2018) is used to identify associated risk involved. The survey results showed that the top three main tasks numerous people struggle with are general housekeeping (mopping), laundry, and food cooking. It was found that TEAR analysed results were in accordance with the survey results. It is concluded from the study that TEAR analysed results were in accordance with the survey results, and people were struggling with three main tasks, that is, general housekeeping (mopping), laundry, and food cooking. Also, TAER can easily distinguish between those tasks, which help the individual take heed of the way in which he or she is performing the tasks. We conclude that if this tool (TAER) is provided to general people in the community through healthcare services, it will enable people to know their risks in performing domestic tasks and maintain their independence by acting upon the recommendation provided, which results in a decrease in the likelihood of disability/dependency and stay in their own home as long as possible.

KEYWORDS: Musculoskeletal disorders (MSDs), dependency, task assessment tool for ease and risk (TAER) and ergonomics.

INTRODUCTION

Aging is a natural process for every individual. It is a process (Benjamin and Wilson 2005) that represents the changes in an individual's physical and psychological behaviour over a period of time (Bowen and Atwood 2004; Hilger 2009). However, one aspect about ageing, which is clearly prominent, is that ageing comes with a variety of problems, for instance, losing independence, which is generally due to MSDs and related issues (Zaheer, Carre et al. 2015). With ageing, the person's physical ability to perform daily chores is shortened due to diminishing of muscles strength. This may result in dependency (loss of independence) in advanced stages of life (Lankveld, Bosch et al. 1998). Within the home environment, there are numerous essential tasks (e.g., ironing, mopping, laundry, etc.) that are the essential for requirement of day-to-day life. However, people adopt awkward postures, which surge the discomfort at intermediate stage and a disability or dependability in later stages of life. This study assesses and quantifies the risk level associated with the performance of daily domestic tasks that contribute to developing disabilities/dependency in a later stage of life. In order to recognize the definition of domestic tasks in an ordinary mind, a survey was conducted. This survey helped identify the perceptions about domestic tasks and identify/classify the hardest task within the long list. The survey result shows that, customarily, the public are

struggling in performing three tasks: general housekeeping (mopping), food cooking, and laundry. Therefore, the aim of the study was made to analyse the above mentioned daily domestic tasks. A newly developed tool called “Task Assessment Tool for Ease and Risk (TAER)” (Zaheer, Yoxall et al. 2018) was used in order to examine the opinions of people regarding hardest domestic tasks (tasks that are believed to likely develop MSDs in the future). Awareness to the public regarding the performance of domestic tasks has also been made so that the associated risks in developing MSD could be reduced. The significance of this research is to develop the knowledge of ergonomic risks that are present in daily tasks, such as awkward postures.

LITERATURE REVIEW

Musculoskeletal disorders (MSDs) are a worldwide dilemma (Sanders 1997) because musculoskeletal pain is unescapable in a later stage of life. It creates a wide impact on one’s quality of life (Banerjee, Jadhav et al. 2012), particularly in old age (Suzanne, Yuqing et al. 2005). The common risk factors associated with musculoskeletal pain, which lead to MSDs, are as follows: excessive force, awkward postures, and excessive bending, reaching, or twisting. A research by Helen et al. (Helen L, Elaine et al. 2011) revealed that human hands perform several daily activities and are the most common body parts that are affected by musculoskeletal pain (Chaparro-Rico, Cafolla et al. 2020). However, another research (Vishwas and Amit 2012) identified that other body parts such as shoulders, neck, back, knees, hips, and feet are also affected. Moreover, OSHA conferred that musculoskeletal pain, which leads to MSDs, has a potential to interfere with the person’s ability to perform work as well as non-work activities (OSHA 2000 (Revised)). Therefore, MSDs are largely considered as persistent (Michelle, Deborah et al. 1998), and their occurrence, resulting in physical disability, increases with age. Likewise, the research conducted by Stephen et al. and Elizabeth et al. (Elizabeth M and Alan 1992; Stephen M., Paula et al. 2012) confirmed that musculoskeletal pain slowly and steadily progresses with age.

The term “musculoskeletal condition” is normally used by the medical practitioners and professionals to cover all conditions related to arthritis, back pain, tissues disease, and widespread pain (Arthritis Research Campaign 2002). The musculoskeletal condition can affect the muscles, bones, and the soft tissues around joints (Attwood, Deeb et al. 2004; Arthritis Care 2011). Often it attacks the arm or the back (Cohen, Gjessing et al. March 1997). Among the risk factors associated with MSDs, physical, psychological, and psychosocial are the main contributors that develop and augment MSDs (Van der Beek and Frings-Dresen 1998). Further, OSHA 2000 (Revised) has explained that physical elements like force, repetitive motion, mechanical compression, awkward body postures, etc. can further aggravate the disorders. Further, OSHA has described that the symptoms associated with MSDs include stiff joints, continuous pain, tingling, numbness, muscles loss, paralysis, herniated disks, back pain, tendinitis, sciatica, and disorders like Carpel Syndrome (CTS Tunnel). Table 1 shows the risk factors associated with work and non-work related tasks.

Ergonomics is the discipline responsible for safe and comfortable surroundings of work, either at home or in the office. Ergonomics works around the key risk factors such as repetition, force, and awkward positions.

Table 1: The risk factors associated with work and non-work related tasks.

Work related	Non-work related
<input type="checkbox"/> Manual handling	<input type="checkbox"/> Physical condition of a person
<input type="checkbox"/> Heavy lifting	<input type="checkbox"/> Medical conditions such as,
<input type="checkbox"/> Working in awkward position	<input type="checkbox"/> Diabetes
<input type="checkbox"/> Twisting movements	<input type="checkbox"/> Obesity
<input type="checkbox"/> Manufacturing and production	<input type="checkbox"/> Pregnancy
<input type="checkbox"/> Prolonged working	<input type="checkbox"/> Arthritis
<input type="checkbox"/> Excessive bending/bending	<input type="checkbox"/> Basic activities of daily living (BADLs) task or hobbies
<input type="checkbox"/> Environmental conditions	<input type="checkbox"/> Social or psychological stress

Source: (OSHA 2000 (Revised)).

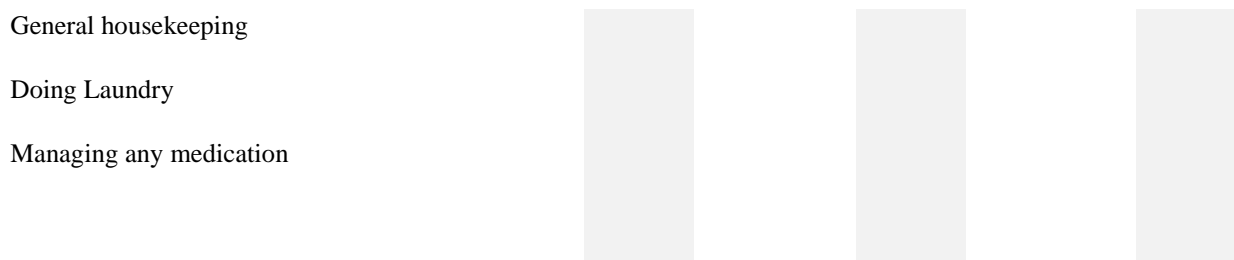
Up till now, the principles of ergonomics were mainly applied on industrial activities. But numerous researches on ergonomics risk factors have shown that ergonomics risks also exist in a home environment (William E. Garrett and Kirkendall). Therefore, it is correct to approximate that domestic activities may also contribute to musculoskeletal disorders. However, there is no single study that effectively and quantitatively evaluates risks and recommends corrective actions to perform a domestic task. To scrutinize the difficulty in the domain of ergonomics, researchers have developed several methods to assess the exposure level of risks that have a potential to develop MSDs (David 2005). The commonly used ergonomics methods are the Strain Index (SI) (Moore and Garg 01 May 1995), Rapid Upper Limb Assessment (RULA) (McAtamney and Corlett 1993), and Rapid Entire Body Assessment (REBA) (Hignett and McAtamney 2000). The potential use of these methods to a domestic setting may give substantial understanding into similar risks within the home. However, the nature of tasks in industrial and domestic environment is different. Therefore, care and thought are required to apply existing ergonomic methods. For instance, many tasks performed in a domestic environment are not repeated frequently; instead, people may be involved in activities that require them to adopt different postures while manually handling the objects. This may lead to exposed risk factors, that is, physical and psychological. Hence, using existing ergonomics tools directly into the domestic environment may be misleading and/or overestimating/underestimating the risk. Recently, Zaheer, Yoxall et al. (2018) have developed a self-assessment tool, using ergonomics principles, named as Task Assessment Tool for Ease and Risk (TAER). Its purpose is to assess the domestic tasks and evaluate the risk associated with the performance of daily tasks. TEAR is based on three risk parameters: (1) psychological perception of the tasks, (2) adopted postures, and (3) manual handling.

METHOD

The methodology for this study is based on two steps. First, a survey (Table 2) is used to gather the opinions, attitudes, and factual information regarding the hardest task with the domestic environment. A census study was performed with 95% of confidence level. 255 people were contacted through the university email list, while after carefully analysing the responses, only 181 people responses were found satisfactory. This makes a response rate of 71%. The result of survey is presented in Table 3.

Table 2: The survey.

Q 1. Please rate the following tasks in terms of difficulty to perform.					
Domestic Tasks	Easy	Moderate	High	Extremely Hard	Don't do
Using the telephone					
Use computer/ access internet					
Grocery Shopping					
Preparing meals					
General housekeeping					
Doing Laundry					
Managing any medication					
Q 2. Please rate the following tasks with respect to the amount of physical effort required:					
Domestic Tasks	Low effort	Moderate effort	High effort	Extremely high effort	Don't do
Using the telephone					
Use computer/ access internet					
Grocery Shopping					
Preparing meals	188				



Q3 Please state three task that cause discomfort, when performed.

Table 3: Survey result

SR. No.	Question	Rank 1	Rank 2	Rank 3
1	Domestic tasks people find difficult to perform	General housekeeping (mopping) 69%	cooking 66%	laundry 57%
2	Highest physical effort required in domestic tasks	General housekeeping (mopping) 84%	Laundry 67%	Cooking 60%
3	The first four tasks which cause physical discomfort to people when performed	General housekeeping (mopping) 34%	Laundry 12%	Cooking 14%

Second, an inferential study was conducted using a newly developed self-assessment tool for domestic tasks, named as “task assessment tool for ease and risk (TAER).” Figure 1 shows the TEAR record sheet. The TAER assessment considered five body parts, that is, neck, arm, wrist, back, and leg, for the assessment of physical risk (adopted postures). TAER evaluation consists of a risk rating score (1, 2, and 3) and is represented by respective colours (green, yellow, and red). It also consists of a field for evaluating the final exposure score that revealed the implication about the task performed. The task frequency and duration were used to obtain an exposure score by simply multiplying their related multipliers. Then, the exposure score was used to select the appropriate risk and action to be taken. Assessment provides a total score based on three variables: psychological perception, adopted postures, and manual handling of objects. Each subject and each task are analysed separately by using the TEAR record sheet.

Subjects

A sample size of seven subjects was used (3 males and 4 females), and a confidence level of 95% was used. The choice of the sample size utilized in this study was based on an approach presented by Glaser and Anselm (Glaser and Anselm L 1995). According to this approach, participants are included in the study until saturation in result is obtained. All subjects were aware of the top voted tasks (mopping, laundry, and cooking food) that were to be observed in the study. Prior to the trial, they were informed to perform the task in a usual manner/routine. Table 4 shows the characteristics of the subjects.

Table 4: Characteristics of subjects.

Variables to measures	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7
Age (years)	35	28	35	35	28	29	35
Gender	Male	Female	Male	Female	Male	Female	Female
Height (cm)	172	163	178	164	174	166	162
Weight (kg)	74	55	69	59	70	62	61
Lifestyle	Active	Active	¹⁸⁹ Active	Active	Active	Active	Active

Before recitalling a task, each subject was provided with a TAER record sheet and a step-by-step guide. The purpose of step-by-step guide is to make sure that all subjects clearly understand the contents and purpose of a record sheet. Moreover, a separate sheet was prepared for each individual task. Figure 2 shows the snapshot of subjects observed during mopping, laundry, and food cooking in their home comforts.

RESULT AND DISCUSSION

For the period of the trial sessions, subjects performed the mentioned activities, and each subject was individually analysed. Table 5 shows the result of the detailed analysis of TEAR record sheet for the subjects performing mopping, laundry, and food cooking. From the questionnaire survey, it was found that domestic mopping is an extremely important chore, yet difficult day-to-day task that requires physical skills. This may result in an increased likelihood of injuries when performed frequently.

Floor mopping at home environment is a strenuous task because we need to clean under narrow places such as the tables and back of sofas, which forced the person to adopt awkward postures.

Similarly, many people feel exertion when using wet mop because it is a very physically demanding and time-consuming activity (Kumar, Chaikumarn et al. 2005). TAER results suggest (Table 5) that, within the studied subjects, the risk level associated with the domestic mopping varies from moderate to high, having TAER score from 1.95 to 6.12. Although the average risk level for the entire subjects is moderate, having 3.9 TAER score, however, the average is insignificant and misleading in the identification of overall risk for domestic mopping because the average is the value that can replace all other existing values and have the same effects, while, on the other hand, the mode is a way of taking a vote. Therefore, the mode is calculated, which shows the overall risk that the people who are involved in domestic mopping are exposed to high risk.

We all do laundry, and it is the essential part of the domestic chore and required physical effort to complete it. Normally, the laundry task is divided into five subtasks: gathering, sorting and pretreatment, washing machine preparation, drying, and folding clothes (Zaheer, Carre et al. 2015). There are five risk factors associated with doing laundry, which are forceful exertion, repetitive motion, awkward postures, static posture, and contact stress (Occupational Health and Safety Agency for Health care in BC 1999).

Task Assessment Tool for Ease and Risk (TAER) Record Sheet

(Version 1)

Task name:

	Rating			Score
	1	2	3	
Psychological Perceptions				
Perceived physical demand required	None OR Minor	Moderate	Too much	<input type="text"/>
Perceived complexity	Not at all OR Slight	Moderate	Extreme	
Postures adopted				
Neck	0-10°	10-20°	Extension >10° Flexion >20°	<input type="text"/>
Arm	0-20°	20-45°	>45°	
Wrist	Nearly straight or in neutral position	Flexion/extension 0-15°	Flexion/extension >15°	
Back	0-20°	20-60°	>60°	
Leg	Both legs are straight and level or in a sitting position	One or both legs are bent from knees	Legs are not supported and bent from knees (flexion) more than 30°	
Manual handling				
Lifting/lowering, pushing/pulling and carrying	Light (e.g. <1 kg)	Moderate (e.g. 1 to 5 kg)	Heavy (e.g. > 5 kg)	<input type="text"/>

Frequency per week:

Total of all of the above X

Duration per day	Duration of task	Frequency per week				Selected Multiplier	IADL Exposure Score
		Once	Twice	3 times	4-7 times		
<input type="text"/>	Less than 5 mins	0.006	0.01	0.02	0.04	<input type="text"/>	<input type="text"/>
	5 - 15 mins	0.02	0.05	0.07	0.17		
	16 - 25 mins	0.05	0.1	0.15	0.34		
	26 - 35 mins	0.07	0.15	0.22	0.51		
	36 - 45 mins	0.1	0.2	0.29	0.68		
	46 - 60 mins	0.12	0.26	0.38	0.88		
More than 1 hr	0.18	0.38	0.54	1.25			

IADL Exposure Score	Risk Rating	TAER implications about the task
< 1.6	Low	Task is easy to perform; but required caution
1.6 to 5	Moderate	Task is not easy to perform; required more consideration
> 5	High	Task is hard to perform; further investigation required urgently

Task Risk Level L M H
(Please circle)

Figure 1: Task assessment tool for ease and risk (TAER) record sheet (Zaheer, Yoxall et al. 2018).



a)



b)

Figure 2: Subjects performing domestic tasks in their home in the way they normally do; a) mopping, b) laundering and c) cooking.

It is observed from Table 5 that, within the studied subjects, the risk level associated with doing laundry varies from low to moderate, having TAER score from 0.75 to 2.55. The mode (selected for the same reason as mentioned above) value for overall risk in doing laundry is moderate, which revealed that most of the people who are involved in doing laundry are exposed to moderate risk. Therefore, it is necessary to manage or maintain good body mechanics, which help reduce the forces necessary to perform the task that might help in reducing the risk of injury.

Table 5: Detailed results analysis of subjects performing mopping, laundry and food cooking by using the TAER record sheet.

Tasks	Subject	Age (year)	Gender	Height (cm)	Number of adults	Number of children	Style of home	Life style	Average Duration in a day (min)	Frequency (week)	TAER score	Risk Level	Mode
Mopping	S1	35	M	172	2	1	Flat	Active	20	thrice a day	1.95	Moderate	High
	S2	28	F	163	2	2	Flat	Active	30	everyday	6.12	High	
	S3	35	M	178	2	1	House	Active	10	everyday	6.63	High	
	S4	35	F	164	2	2	House	Active	35	everyday	2.04	Moderate	
	S5	28	M	174	2	1	Flat	Active	15	thrice a day	0.98	Low	
	S6	29	F	166	2	1	Flat	Active	25	everyday	3.74	High	
	S7	35	F	162	2	2	House	Active	35	everyday	6.12	High	
										Avg. Score	3.9	Moderate	
Laundry	S1	35	M	172	2	1	Flat	Active	30	once	0.98	Low	Moderate
	S2	28	F	166	2	2	Flat	Active	12	twice	1.3	Moderate	
	S3	35	M	175	2	1	House	Active	10	everyday	2.55	Moderate	
	S4	35	F	165	2	2	House	Active	25	twice	1.3	Moderate	
	S5	28	M	163	2	1	Flat	Active	12	twice	0.75	Low	
	S6	29	F	165	2	1	Flat	Active	15	Everyday	2.21	Moderate	
	S7	35	F	173	2	2	House	Active	40	twice	1.4	Moderate	

											Avg. Score	1.50	Moderate	
Cooking Food	S1	35	M	176	2	1	Flat	Active	26	thrice a week	3.3	Moderate	High	
	S2	28	F	175	2	2	Flat	Active	20	Everyday	4.42	High		
	S3	35	M	168	2	1	House	Active	28	Everyday	7.14	High		
	S4	35	F	164	2	2	House	Active	19	Everyday	4.42	High		
	S5	28	M	171	2	1	Flat	Active	24	Thrice	3.3	Moderate		
	S6	29	F	162	2	1	Flat	Active	28	Everyday	6.63	High		
	S7	35	F	161	2	2	House	Active	20	Everyday	4.42	High		
												Avg. Score		4.80

Generally, the kitchen is considered as the most commonly used room in the home (Biller 2014). In everyday kitchen activities, everybody is engaged in walking, bending, or kneeling to reach what they need, as well as searching through the cupboards for the utensils and pans needed, while adopting awkward postures. Generally, people are adopting a standing posture while working in their kitchen as it entails physical mobility between the oven/stove, refrigerator, and sink (work triangle (Kitchens.com 2014)). For young people, working in a domestic kitchen is not a problem, but it could be a problem for older people because their standing strength ability and endurance decrease with advancement of age (Sulaiman, Taha et al. 2013). It is perceived from table 5 that, within the studied subjects, the risk level associated with cooking food varies from moderate to high, having TAER sore from 3.3 to 6.63. The mode value (selected for the same reason as mentioned above) for overall risk in cooking food is high, which revealed that most of the people who are involved in cooking food are exposed to high risk. Based on the TEAR results, it is, therefore, necessary to manage or maintain good body postures by knowing our own risk in daily activities, which might help in maintaining the independence in later stage of life. From the above analysis, it is revealed that the hardest tasks perceived by people educated by the survey are indeed the hardest because the TAER based analysis also revealed the same.

RECOMMENDATIONS

In domestic environment, everyone is involved in performing many tasks simultaneously and adopted nonneutral or awkward postures that might trigger cause of concern in relation to affecting our quality of life. Therefore, if people are able to know the risk level associated with the performance of particular daily tasks earlier, then it will enable them to be more guarded in their next stage of life. It is recommended that the tool TAER should be used for the self-assessment of risks in daily tasks. It will aid individuals to know their own risk level and help them to maintain the neutral postures. It also benefits in prioritizing tasks within the known risk level, according to individual ability. This will diminish the stress on their body and can help them improve their level of independence in next stage of life. Table 6 presents the preventive control measures that can be inhabited to successfully reduce the associated risks in mopping, laundry, and cooking. It provides the detailed instructional information, which, if adopted in continuity, can significantly reduce risk levels and, hence, the vulnerability in later stage of life. Moreover, we recommend (see table 6) authorities to make general public awareness plan incorporating TEAR and preventive control measures for day-to-day tasks. If implemented successfully, it will not only bring prosperous future life to the individual and create a healthy world, but also minimise the cost put towards the health care and social care for the elderly.

CONCLUSION AND FUTURE RECOMMENDATIONS

The following conclusion and future recommendations, are drawn from the study:

1. A survey-based study concluded that people are struggling with three main tasks, that is, general housekeeping (mopping), laundry, and food cooking, and it was found that TEAR analysed results were in accordance with the survey results. It was also found that the hardest tasks perceived by people in the survey are indeed the hardest, as the TEAR tool also evaluates the same. Task Assessment Tool for Ease and Risk (TAER) can easily distinguish between those tasks, which help the individual take heed of the way in which he or she is performing the tasks. Performing them in nonneutral postures leads the individual to vulnerable conditions in the later stages of life, whereas having knowledge, through TAER, of the risk level when performing a task will help understand the right way to perform such tasks. Furthermore, the knowledge of the risk level revealed by the TAER tool will provide the necessary information for a person to lead or adopt an efficient and independent lifestyle for as long as possible.

2. The TAER will prove to be an efficient tool for the healthcare professional services. Providing this tool to the entire community will enable people to maintain their independence and stay in their own home (not in social care) as long as possible. This tool, as well as recommendations, could be used remotely on websites such as Mayo clinic, age-well, WebMD, or NHS direct. This will enable people to understand their tasks and perform their tasks in an efficient way. It would help people prove their ageing journey from ailment.

Furthermore, it is hoped that the early detection of risks in our daily tasks might help identify those risk factors that are responsible for musculoskeletal disorders, and this identification will in turn decrease the likelihood of dependency.

Table 6: Preventive control measures.

Tasks	Recommendations
Cleaning activities	<ul style="list-style-type: none"> Mopping pace should be minimized (e.g. one room/day). While mopping, user use his leg power to walk along and move his entire body back and forth with a sweeping action. Avoid excess twisting, bending and reaching during mopping task. Also, reduce polishing/dusting duration (e.g. one room/day). Dusting aids such as a feather duster should be used which help to diminish excessive reaching Polishing/dusting should be done below the shoulder height (do not over-extend) and use each hand alternatively. Ladder or telescopic handles should be used for reaching high dusting areas. During high dusting hold handle with both hands, keep your elbows closer to the body and minimize excessive reaching During mopping tasks don't band your back and bend your knees. When emptying the garbage bend your knees not back.
Laundry	<ul style="list-style-type: none"> Keep your back straight and bend the knees during the laundry. Try to use kneeling pads or cushion during putting the clothes and taking out the wet clothes in to the laundry machine. Low chair or stool should be used for when transfer the clothes from the machine. Try to avoid repetitive movements when drying and folding clothes. Try to avoid lifting of laundry basket full of clothes Anti-fatigue mat should be used to reduce standing fatigue. Ironing pace should be minimized (10 minutes or less/day). Avoid excessive bending or stooping by adjusting ironing surface height. Make sure that the ironing surface height is not too high, otherwise it will incessantly raise the arm and shoulder which put a strain on shoulder, neck and upper back. Try to keep the iron stand as close as possible. Prolonged standing should be avoided or use a stand up chair. Light weight iron should be used because it requires a lesser amount of effort for ironing the clothes. Throughout the ironing task try to evade repetitive bending and twisting. During bed making task don't bend or stretch over the bed. If possible use fitted bed sheets, instead. Get a help from an assistive device such as Bed-MadeEZ in making your bed.
Food cooking	<ul style="list-style-type: none"> Prolonged standing should be avoided during food cooking task. Avoid use of those sinks which are too deep. One can use high chair or stool to sit when involved in food cooking activities such as chopping/slicing vegetables, and washing dishes etc. Don't bend or stoop over the kitchen sink. Try to stand as close to the sink as possible. Avoid manual lifting of kitchen utensils such as heavy dishes, pots, trays, kettles etc. Prolonged/sustained postures should be avoided which result in postural strain Evade those tasks which entail excessive bending or reaching too low or too high.

- Items such as trays, pots and pans, within power zone (shoulder to knee height), so that excessive bending or reaching should be minimized.
- Counter top and kitchen work surface should be design at proper dimensions, so that excessive bending or stooping should be minimized.
- If your stove/cooker height is too low then bend knees not your back.
- You must keep your back straight and bend your knees when working with refrigerator /freezer and oven, also don't bend and twist simultaneously.

Source: (Addenbrooke's Hospital NHS Cambridge University Hospitals NHS Foundation Trust).

REFERENCES

Addenbrooke's Hospital NHS Cambridge University Hospitals NHS Foundation Trust. "Posture!".

Arthritis Care (2011). Get a grip: Making the Case for a National Strategy for Musculoskeletal Diseases. London.

Arthritis Research Campaign. (2002). "Arthritis the Big Picture." from www.arc.org.uk.

Attwood, D. A., J. M. Deeb, et al. (2004). Ergonomics Solution for the Process Industries. Burlington, MA, USA, Elsevier Inc.

Banerjee, A., S. Jadhav, et al. (2012). "Limitation of Activities in Patients With Musculoskeletal Disorders." Annals of Medical and Health Sciences Research 2(1): 5-9.

Benjamin, K. and S. Wilson (2005). Facts and Misconceptions about Age, Health Status and Employability. Buxton, Health and Safety laboratory.

Billr, A. (2014). "Kitchen ergonomics is all about making your work effortless." from <http://www.snaidero-usa.com/designliving-blog/2014/02/07/kitchen-ergonomics-making-work-effortless>.

Bowen, R. L. and C. S. Atwood (2004). "Living and Dying for Sex -A Theory of Aging Based on the Modulation of Cell Cycle Signaling by Reproductive Hormones " Gerontology 50(5): 265-290.

Chaparro-Rico, B. D. M., D. Cafolla, et al. (2020). "Design of arm exercises for rehabilitation assistance." Journal of Engg. Research 8(3 September 2020): 203-218.

Cohen, A. L., C. C. Gjessing, et al. (March 1997). Elements Of Ergonomics Programs:(A Primer based on Workplace Evaluations of Musculoskeletal Disorders). Cincinnati, OH, U.S Department Of Health and Human Services National Institute for Occupational Safety and Health (NIOSH).

David, G. C. (2005). "Ergonomic Methods for Assessing Exposure to Risk Factors for Work-related Musculoskeletal Disorders." Occupational Medicine 55: 190-199.

Elizabeth M, B. and T. Alan (1992). "Changing Profile of Joint Disorders with age: Finding from a Postal Survey of the Population of Calderdale." Annals of Rheumatic Diseases 51(3): 366-371.

Glaser, B. G. and S. Anselm L. (1995). "The Discovery of Grounded Theory Strategies for Qualitative Research ", from http://www.sxf.uevora.pt/wp-content/uploads/2013/03/Glaser_1967.pdf.

Hedge, A., M. Rudakewych, et al. (2002). Investigating Total Exposure to MSD Risks: The Roles of Occupational and Nonoccupational Factors. Human Factors and Ergonomics Society 46th Annual Meeting

Helen L, M., T. Elaine, et al. (2011). "Hand Assessment in Older Adults with Musculoskeletal Hand Problems: A Reliability Study." BMC Musculoskeletal Disorders 12: 2-9.

Hignett, S. and L. McAtamney (2000). "Rapid Entire Body Assessment (REBA)." Applied Ergonomics 31(2): 201-205.

Hilger, Z. (2009). "Family Caregiver Education, Area Agency on Aging, Revised 2009. Includes materials adapted from As People Grow Older, Jane Oderberg and Sue Smith, 1995 and as cited in the materials.".

Kitchens.com. (2014). "The Work Triangle (Breaking Down A Standard Kitchen Design Rule)." from <http://www.kitchens.com/design/layouts/the-work-triangle/the-work-triangle>.

Kumar, R., M. Chaikumarn, et al. (2005). "Physiological, Subjective and postural loads in passenger train wagon cleaning." Industrial Ergonomics 35: 931-938.

Lankveld, W. G. J. M. V., P. V. T. P. Bosch, et al. (1998). "Predictors of Changes in Observed Dexterity During One Year in Patients with Rheumatoid Arthritis " British Journal of Rheumatology **37**: 733-739.

McAtamney, L. and E. N. Corlett (1993). "RULA: A Survey Method for the Investigation of Work-Related Upper Limb Disorders." Applied Ergonomics **24**(2): 91-99.

Michelle, U., S. Deborah, et al. (1998). "Estimating the Burden of Musculoskeletal Disorders in the Community: The Comparative Prevalance of Symptoms at different Anatomical Sites, and the Relation to Social Deprivation." Annals of the Rheumatic Disease **57**(11): 649-655.

Moore, J. S. and A. Garg (01 May 1995). "The Strain Index: A Proposed Method to Analyze Jobs For Risk of Distal Upper Extremity Disorders." American Industrial Hygiene Association Journal **56**(5): 443-458.
Occupational Health and Safety Agency for Health care in BC (1999). An ergonomics Guide for Hospital Laundries. Vancouver, BC, Occupational Health and Safety Agency for Health care in BC (OHSAH).
OSHA (2000 (Revised)). Ergonomics : The Study Of Work. Bostan, MA.

Sanders, M. J. (1997). Musculoskeletal Disorders: A Worldwide Dilemma. Ergonomics and the Management of Musculoskeletal Disorders, Elsevier.

Stephen M., T., D. Paula, et al. (2012). "Persistence and Remission of Musculoskeletal Pain in Community-Dwelling Older Adults." Journal of the American Geriatrics Society **60**(8): 1393-1400.

Sulaiman, R., Z. Taha, et al. (2013). "Application of Anthropometric Dimension for Estimating Stove Height, Stove Depth and Cooking Task Envelop for Malaysian Elderly population." Pertanika Journal of Science & Technology (JST) **21**(1): 15-28.

Suzanne, G. L., Z. Yuqing, et al. (2005). "Sex Differences in Musculoskeletal Pain in Older Adults." National Institute of Health (Pain.Author manuscript) **116**(3): 332-338.

Urwin, M., D. Symmons, et al. (1998). "Estimating the Burden of Musculoskeletal Disorders in the Community: The Comparative Prevalance of Symptoms at Different Anatomical Sites, and the Relation to Social Deprivation." Annals of the Rheumatic Disease **57**(11): 649-655.

Van der Beek, A. J. and M. H. W. Frings-Dresen (1998). "Assessment of Mechanical Exposure in Ergonomic Epidemiology." Occupational and Environmental Health **55**: 291-299.

Vishwas, M. and C. Amit (2012). "Prevalance and Risk Factor associated with Musculoskeletal pain among Students of MGM Dental College: A Cross-Sectional Survey." Journal of Contemporary Dentistry **2**(2): 22-27.
William E. Garrett, J. and D. T. Kirkendall Excercis and Sport Science 2000. Philadelphia, USA Lippincott Williams & Wilkins.

Zaheer, A., M. Carre, et al. (2015). Evaluation of adopted postures and the hardest part of the domestic laundry task. Proceedings of the Third European Conference on Design4Health 2015. K. Christer. Sheffield, UK.

Zaheer, A., A. Yoxall, et al. (2018). "Ergonomics Approach to Assess The Risk Associated with the Performance of Domestic Tasks–Part “A”." International Journal of Public Health and Clinical Sciences (IJPHCS) **5**(4): 228-245.