Effects of Exercise Intervention on Work-Related Musculoskeletal Discomforts among Computer Users

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Abstract

This article identifies the musculoskeletal discomforts experienced by using computers and evaluates the effectiveness of exercise and education on appropriate posture. This is a single group experimental study. The participants were 39 academic and non-academic staff at Divine Word University. The measurement tool of *Rapid Upper Limb Assessment* was administered to determine the action level of work related discomforts. Exercise intervention and posture education were taught and the effect of exercise was assessed using the *Exercise Benefit/Barrier Scale.* The results were 63.2% (n=24) reported to have pain or discomfort while using computers. *Rapid Upper Limb Assessment* revealed that none of the participants had an acceptable working posture (Level 1), whilst there was 51.3% (n=20) required further investigation and changes to alter posture (Level 2), 43.6% (n=17) required investigation and changes to posture as early as possible (Level 3) and 5.1% (n=2) required investigation and changes to posture immediately (Level 4). The exercise benefit scales showed a positive mean score of 33.8 where 80% of participants reported the highest score. There was a significance of $p < 0.001$ in *Wong-Baker Faces Pain Rating Scale,* which describes the level of discomfort. The study suggests that long-term use of computers is associated with various musculoskeletal discomforts and exercise and posture correction seem to alleviate or reduce the discomforts.

Key words: musculoskeletal discomfort, pain, computer, exercise, rapid upper limb assessment, exercise benefit

Introduction

Information and communication technology play a major role in contemporary society especially in the fields of business and education. Universities and other educational institutions are increasingly using computers for a variety of administrative and teaching and learning purposes. Electronic facilities have spawned a variety of e-learning techniques for distance education and higher education programs. Computers are gradually finding their way into urban homes and educational institutions in the developing countries. The Internet has greatly increased people's access to information and knowledge sources and email facilities have greatly increased the ease and promptness with which people can communicate with each other.

Despite the benefits of computer technology for individual or corporate needs, the purpose of the research reported in this article is to alert computer users to the adverse effects it may have on their physical well-being.

In general, the use of computers in office or classroom environments limits bodily movements. Hence it affects a person's posture and leads to various posture related injuries, for instance, aches and pains in the back, neck, shoulder, arm, elbow, wrist and fingers. Musculoskeletal injuries in computer users are an increasing occupational health and safety issue as the use of computers proliferates throughout the various levels of organizations (Evans & Patterson, 2000). These musculoskeletal injuries are known as *Occupational Overuse Syndrome* and were formerly known in Australia as Repetitive Strain Injury (Hagberg et al., 2000; Zelmer 2000; Verhagen et al., 2007). The symptoms of *Occupational Overuse Syndrome* include muscle discomfort, soreness, fatigue, aches, pains, muscle tightness, numbness, tingling, cold and hot feelings, muscle stiffness and muscle weakness.

Waldrop (1985) stated that colleges and universities are becoming test sites for the much heralded 'information society' as they incorporate a new series of information technologies. These include on-line databases, magnetic and optical data storage, digital telecommunications, computer networks, and personal computers. The transition is presenting administrators and faculties with major challenges.

Computers in education at DWU

Papua New Guinea is a large developing nation in the South Pacific. The use of computer technology is relatively new to this nation. Divine Word University, in the Madang Province, stands out from other universities by its provision of widespread access to high quality computer facilities for both staff and students. Each staff member has an independent workstation and students have access to computers in the library and in laboratories in addition to being issued laptops or having their own. Staff and students have email accounts and Internet access. Intranet sites enhance communication throughout the university. Lectures are delivered through multimedia projection, and student assignments are collected and marked electronically. Physiotherapy staff observed that an awareness of physical fitness and how to achieve it for using computer in day-to-day life amongst university staff were generally lacking.

Relevant literature

Research studies (Bergqvist et al., 1995; Knave et al., 1985; Gerr et al., 2002; Hunting et al., 1981) have found that the use of computer video display terminals can lead to musculoskeletal discomfort in users' shoulders, neck and back. It was claimed that symptoms such as ocular discomfort, musculoskeletal complaints, headaches and certain skin disorders have been noted ever since the computer video display terminal was introduced to work life. Occupational surveys reported that regular keyboard use was the risk factor for developing neck and upper limb pain and neck and shoulder pain (Palmer et al., 2001;

Rossingnol 1987). It was found to be common that over-use of computers led to upper extremity discomfort. The longer a person works at a computer on a daily basis the greater the risk of associated injuries or musculoskeletal discomfort (Faucett & Rempell, 1994).

Hours of computer use per day, perceived stress levels and workstation factors have also been found to be associated with upper extremity musculoskeletal pain. Kamwendo, Linton and Moritz (1991) have found that working with office machines for five or more hours a day was associated with a significantly increased risk of neck pain, shoulder pain and headache. Cook, Burgess-Limerick and Chang (2000) found that the prevalence of musculoskeletal disorders in adults related to computer use has been reported to be as high as 76%. The use of computers often caused musculoskeletal discomfort in neck, shoulders, wrists, hands, back, buttocks and chest (Barredo & Mahon, 2007).

Rapid Upper Limb Assessment has been identified as a valid assessment tool for work related upper extremity injuries (Cook & Kothiyal, 1998; Fabrizio, 2009; Jamjumrus & Nanthavanij, 2008; Kelly, et al. 2009; Sen & Richardson, 2007). *Rapid Upper Limb Assessment* (RULA) is a survey method which was developed to investigate the exposure of individual workers to risk factors associated with work-related upper limb disorders. It was developed through the evaluation of the postures adopted, forces required and muscle actions of both computer visual display unit operators and operators working in a variety of manufacturing tasks where risk factors associated with upper limb disorders may be present (McAtamney & Corlett, 1993).

It is argued that exercise, massage, relaxation training, stretching, strengthening exercise, ergonomics and rest breaks were effective to reduce musculoskeletal discomfort for computer users (Verhagen et al., 2007). The *Exercise Benefit and Barrier Scale* (EBBS) is useful in evaluating exercise perceptions and the impact of interventions to change them (Sechrist, Walker & Pender, 1987). Studies have shown that use of exercise reduces the musculoskeletal discomforts while using computers. Strategies for the prevention management of *Occupational Overuse Syndrome* are training and education, design of equipment and tasks, the organization of work, the work environment, and the development of appropriate policies (New Zealand Department of Labour, 1991).

Omer et al., (2003/2004) promote posture training and appropriate exercises as ways to reduce musculoskeletal discomfort when using computers. They observed a significant post-treatment difference where improvement of patient posture eliminated the incorrect weight distribution in the muscles and the concurrent increase in muscle flexibility and power reduced the pain disability scores. They contend that appropriate identification of musculoskeletal symptoms and early intervention will assist in preventing work related musculoskeletal disorders and associated disability.

Jepsen and Thomsen (2008) also reported that exercises and posture education were effective forms of preventive measures for musculoskeletal discomfort at computer workstations. Saltzman (1998) argued that short stretch breaks were effective in reducing stiffness, muscle ache and stress. The increased awareness of the need for frequent mini breaks and proper workstation ergonomics was found to increase productivity and enjoyment for people working at a personal computer.

Design of the study

This study aimed to identify the musculoskeletal discomforts experienced by university staff using computers, to provide education about therapeutic exercise to those identified with musculoskeletal discomfort and, later, to evaluate the effectiveness of therapeutic exercise on them.

Sample

The sample of participants for this single group experimental study consisted of volunteer academic and non-academic members of the university. Criteria for excluding staff were those diagnosed with rheumatoid arthritis, posttraumatic problems, whiplash injury, or any previous surgery to arm, wrist or hands.

Data gathering instruments

Questionnaire: An electronic questionnaire was designed in accessible portable document format to obtain general information such as job title, nature of work, age and gender. Other questions sought computer related information such as number of years as a user, average hours per day working at a computer, types of computer activities, associated pain and its symptoms, and the use of a body chart to identify areas of musculoskeletal discomfort.

Wong-Baker Faces Pain Rating Scale: This scale was used to identify the level of pain or discomfort before and after exercise. The scale has a score of zero to ten with six faces, with each face describing a different level of comfort. *(See Figure 1.)*

Figure 1: Wong-Baker faces pain rating scale, with permission from Wong-Baker Faces Foundation

Rapid Upper Limb Assessment (RULA): This is an observational survey method to obtain data on work related upper limb injuries. The instrument was used for quick assessment of the posture of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A printable version of the *Rapid Upper Limb Assessment* worksheet was downloaded from the Internet and used to monitor the posture alignment manually. The data was entered into *ErgoFellow v1.0* (Windows trial software downloaded from FBF SISTEMAS which assists professionals and companies to evaluate workplaces). The software is an ergonomic tool which determines the action level. These action levels indicate the level of intervention required to reduce the risk of injury due to physical loading on the computer operator.

Exercise Benefit: The benefit of the exercise was measured using a ten question instrument with a highest score of 40 and lowest score of 10 derived from the *Exercise Benefit and Barrier Scale* and the *Wong-Baker Faces Pain Rating Scale.* This was used to identify the level of pain or discomfort after exercise.

Procedures

Ethical clearance was obtained from the Divine Word University Research Ethical Clearance Committee.

Questionnaire: The list of staff members of the university was retrieved from the local intranet and the questionnaire was sent via email with a follow up email being sent two weeks later. A pilot study was carried out among five participants in order to check the construct validity of the questionnaire. The consent form was duly filled in by the participants and forwarded by e-mail. The volunteer participants completed the questionnaire and returned it within two weeks.

Application of Rapid Upper Limb Assessment: The investigators worked in pairs to administer *Rapid Upper Limb Assessment* at each participant's workstation. The participants were allowed to do their normal computer activities. The working posture of each participant was observed twice by the investigators, each observation lasting 20 minutes. The observations of both investigators were compared and final observations were entered on the worksheet. The findings were then coded in *ErgoFellow v1.0* to obtain the scores and action levels.

Therapeutic Exercise Session: An invitation was sent to the participants to participate in exercise sessions. The participants were grouped into academics and non-academics. The facilitators of the sessions explained the importance of 'good and bad posture' and taking 'rest breaks'. Following that, the facilitators demonstrated simple therapeutic exercises (a range of motion and gentle stretching exercises) pertaining to neck, back, shoulder and arm, wrist and hand, leg and ankle. The exercise techniques performed by the participants were monitored during the session.

Two subsequent sessions were conducted for each group in order for them to gain greater familiarization with the exercises and appropriate posture. An exercise booklet and a log sheet were given to the participants. The participants were requested to make entries on the log sheet as they did the exercises on a daily basis for about four weeks.

Posture education: Monitoring participant working posture at computers was further assisted by visiting each participant's workstation and checking on the position of the computer, height of the chair and desk, eye level, shoulder, elbow and wrist alignment and the support of the back, thighs and feet.

Benefits of therapeutic exercise: After four weeks, the log sheets were collected and the *Exercise Benefit and Barrier Scale* and the *Wong-Baker Faces Pain Rating Scale* were applied to identify the effects/benefits of therapeutic exercise.

Data analysis

The data were coded and analysed using the computer program *Statistical Package for the Social Sciences* (SPSS v15). The descriptive statistics were used to identify the frequencies. Pre and post test scores of *Wong-Baker Faces Pain Rating Scale* were analysed using Student *t*-test.

Results

Demographical information

The questionnaire was sent to 142 (80 academic and 62 non-academic) staff of Divine Word University. Forty staff members (31.7%) responded. One staff member withdrew after initial consent due to a busy work schedule. The remaining 39 participants (23 academics, 16 non-academics) who met the selection criteria were recruited as participants for this study. There were 22 males and 17 females and their mean age was 45 years (24–74years). The university has staff members of different nationalities and the study population consisted of 29 PNG nationals, 4 Australians, 2 Filipinos, 1 Indian, 1 American and 2 Europeans.

Computer usage and nature of computer related activities

The results revealed that non-academic staff participants used the computer for an average of 8.3 hours (range: 3 hours to 15 hours) per day. About 50% of the non- academic staff participants were using computers for 8–10 hours per day. The results showed that academic staff participants used the computer for an average of 6.7 hours (range: 2½ hours to 11 hours). About 44% of academic staff participants were using the computer for 5–7 hours per day. (*See Figures 2 & 3.*)
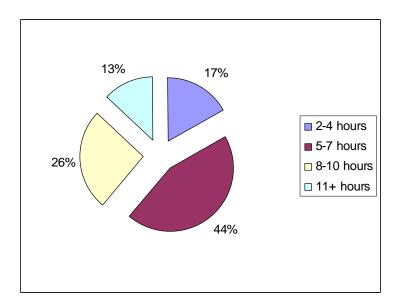
Figure 2: Hours of computer use per day by academic staff participants
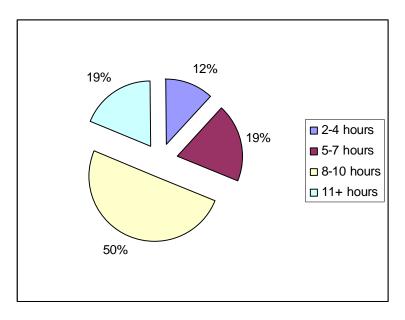

Figure 3: Hours of computer use per day by non-academic staff participants

The nature of typing was measured using three criteria: normal touch, last two/three fingers, and hunt and hand pick keys. It was estimated that the least number of participants (n=7) were using hunt and hand pick keys and there was an equal distribution for both normal touch (n=16) and fast two/three fingers (n=16).

The main uses of computers by the staff members were categorized as typing, preparing lectures, web search, web mail, data entry and games. The findings were: typing 95% (n=37); preparing lectures 66.7% (academic n=22, non-academic n=4); web mail 84.6% (n=33); data entry 66.7% (n=26); web search (n=33); and games 20.5% (n=8). (*See Figure 4.*)
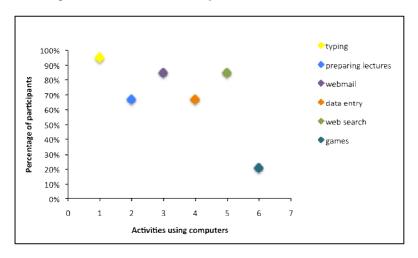

Figure 4: Varieties of activities using computers

Musculoskeletal discomforts

Of the 39 subjects who participated in the study, 63.2% (n=24) of them experienced pain or discomfort while using computers. Some 59% (n=23) had pain or discomfort after using computers and some 52.6% (n=20) often had pain at rest.

The area of discomfort experienced by the participants was identified using the body chart. The highest frequency was discomfort in neck 76.9% (n=30). Lower back 51.3% (n=20) and upper back 38.5% (n=15) were found to be the second most frequent area of discomfort. In regard to upper limb the most frequently reported area of discomfort were the right shoulder 46.2% (n=18) wrist and fingers 41% (n=16). (*See Figure 5 for the areas of discomfort.*)
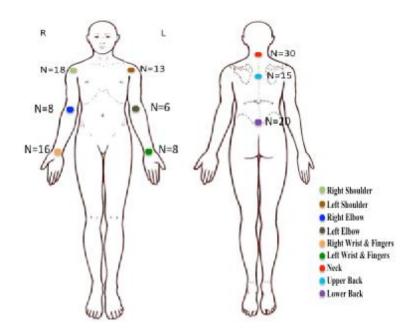
Figure 5: Areas of discomfort

Other discomforts

The other complaints related to the nature of pain were found to be 43.6% dull (n=17), 41% (n=16) aching, 5.1% (n=2) sharp and 4 did not score anything. The pattern of pain included 71.8% (n=28) transient pain, 15.4% (n=6) rhythmic pain and 5 had a missing score. Radiating pain was reported to be 15.4% (n=6). Numbness, tingling in the hand and legs, itching of eyes, headache, and emotional stress were also collected from the participants to identify more appropriateness of discomfort. Most of the participants expressed that they occasionally experienced itching of eyes, headache and emotional stress. (*Refer to Table 1.*)

Table 1: Other discomforts

Discomforts	Never	Always	Occasionally	Missing
Itching of eyes	5	5	26	3
Headache	9	3	24	3
Emotional stress	15	2	19	3

Analysis of working posture

The *Rapid Upper Limb Assessment* was used to observe the working posture of participants. The scores identified from each participant established the action level. (*See Table 2 for the scores and the corresponding action levels.*) 51.3% (n=20) of participants were in level 2, 43.6% (n=17) were in level 3 and 5.1% (n=2) were in level 4. (*SeeFigure 5 for the distribution of action level.*)

Table 2: Action levels of Rapid Upper Limb Assessment retrieved from ErgoFellow v1.0

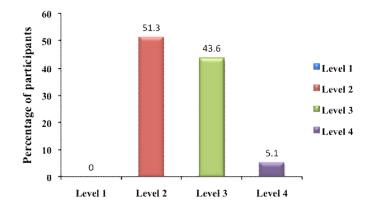| Score	Action level	Indicators
1 or 2	Level 1	Posture is acceptable if it is not maintained or repeated for long periods
3 or 4	Level 2	Further investigation is needed and changes may be required
5 or 6	Level 3	Investigation and changes are required soon
7	Level 4	Investigation and changes are required immediately

Figure 6: Distribution of action levels of following Rapid Upper Limb Assessment

Benefits of exercise

The benefit scale was applied to 35 participants who attended the sessions. The results of the *Exercise Benefit and Barrier Scale* among the participants were with a mean score of 33.8 and 80% (n=28) of participants scored a highest score ranging between 31 and 40. (*See Figure 6 – the range of exercise benefit score.*)
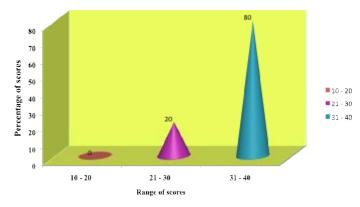
Figure 7: Exercise Benefit Score

Wong-Baker faces pain rating scale

To assess the level of discomfort, the *Wong-Baker Faces Pain Rating Scale* (WBFPRS) was used before and after exercise. This score evaluated the effect of exercise that assisted the participants in overcoming their discomforts. It was found that all the scores were distributed from Face 0 to 10 before exercise. Before exercise Face 4 was marked by 45.7% of the participants, 34.3% for Face 2, 11.4% for Face 6, 2.9% each for Face 0, Face 8, and Face 10.

Whereas, after the exercise training sessions, the distribution of scores were only between Face 0 – Face 4 and none of the participants marked Face 6, Face 8 and Face 10. Face 2 score stands high with 60%, Face 4 with 31.4% and Face 0 with 8.6%. (*See Figure 7 for the distribution of scores.*) The pre-test and post-test of the WBFPRS are represented in Table 3. Student t test values of pre and post-tests for WBFPRS found to be significant with $p > 0.001$ at 95% confidence interval of the difference.
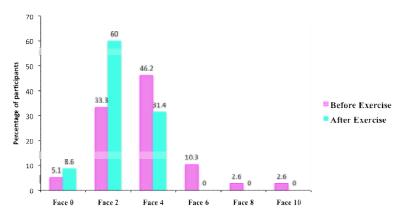

Figure 8: Wong-Baker faces pain rating scale (before and after exercise)

Table 3: Mean, variance and standard deviation for before and after exercise

Test	Mean	SD	df	*t* value
Before Exercise	3.71	1.95	34	3.709
After Exercise	2.46	1.20		

Summary

This is the first known experimental study of work-related musculoskeletal discomforts by computer users in Papua New Guinea. The study involved investigators from the physiotherapy department and volunteer academic and non-academic staff of Divine Word University. The study aimed to identify work-related musculoskeletal discomforts from using computers and to explore the effect of exercise to decrease such discomforts.

This study showed that the majority of the participants reported having pain from frequent computer use, especially in the neck, shoulder, and upper and lower back. Other discomforts such as headaches and eye problems were also found to be associated with frequent computer use. The *Rapid Upper Limb Assessment* was used to observe the working posture of participants. The analysis of working posture showed that no participant had an acceptable posture (level 1). The results were 51% at level 2, 44% at level 3 and 5% at level 4. These results indicated that the participants needed to make changes to their posture at the computers to reduce the risk of work related injuries.

To address the perceived needs, the physiotherapy staff instructed the participants on good and bad posture and the need for rest breaks when using computers and also conducted therapeutic exercise sessions. This involved a range of motion and gentle stretching exercises pertaining to neck, shoulder, upper back, lower back, arm, elbow, wrist and hand, hip, knee and ankle. The participants were advised to continue the exercises, rest break and posture correction for four weeks as part of their daily activity and to record entries in a log sheet.

The *Exercise Benefit and Barriers Scale* and *Wong-Baker Faces Pain Rating Scale* identified the effectiveness of the exercise. Before exercise, the highest number of participants was recorded for face 4 (hurts little more). After exercise sessions, the highest number of participants were for face 2 (hurts little bit), with a significant score of $p > 0.001$. The *Exercise Benefit and Barriers Scale* showed a mean score of 33/40. This indicated that the staff perceived the exercise to have positive benefits and that exercise and posture education enabled them to reduce work-related musculoskeletal discomfort.

It is acknowledged that the study was limited to a small number of university staff and that the benefits of exercise or posture correction were only monitored over four weeks. However, the results suggest that long-term use of computers

may lead to work related musculoskeletal discomfort and that education on appropriate posture and therapeutic exercises can be beneficial. With increasing use of computers by staff and students across the university, it is critical that they are aware of the risk of musculoskeletal discomforts and know ways to minimise such discomforts for their own well-being.

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