REVIEW ARTICLE

Occupational repetitive strain injuries in Hong Kong

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Objective To review currently available evidence on the epidemiology and management of occupational repetitive strain injuries with particular reference to Hong Kong.

Data sources and study selection Medline, PubMed and Cochrane Library searches of local and internationally published English journals from 1990 to 2007 regarding repetitive strain injuries.

Data extraction All articles involving occupational repetitive strain injuries in Hong Kong were included in this review.

Data synthesis There were 16 articles contributing data on the impact of repetitive strain injuries both in Hong Kong and around the world. There were seven articles dealing with the problem of computer station set-ups and methods for improving the workstation environments.

Conclusion Currently there were significant data on the impact of repetitive strain injuries in Hong Kong. The data took the form of compensation claims, days away from work, and cost of medical consultations. Other articles described proper workplace adjustments to help prevent repetitive strain injuries. However, there were no figures in the current literature showing the impact of these adjustments in reducing the incidence of repetitive strain injuries. More research could help to delineate the relationship between different types of interventions and occupational repetitive strain injuries.

Key words
Chronic disease; Cumulative trauma disorders; Occupations; Primary health care; Recurrence; Workplace

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Introduction

Repetitive strain injury (RSI) is a common and serious occupational health problem. About 60% of all occupational injuries are caused by repetitive strain.[1] The injury is characterised by discomfort or persistent pain in muscles, tendons, and other soft tissues. Repetitive strain injuries are caused by repetitive movement, sustained or constrained postures, and forceful movements as well as stress and unfavourable working conditions.

In RSI, the repetition of movements does not allow muscles, tendons, or ligaments sufficient time to recover and thus can damage these structures. In these occupational injuries, the holding of the upper limb in a certain position for prolonged periods of time induces local ischaemia in the muscles and accumulation of lactic acid. Tissue microtrauma occurs as a consequence of repetitive tasks and such injury leads to inflammation, followed by fibrotic and other structural tissue changes.[2] Posture can increase pressure on nerves at entrapment sites or can shorten muscles to cause an adaptive shortening and secondary nerve compression. Keeping the wrist in positions of flexion or extension increases pressures applied to the median and ulnar nerves. Muscles can be elongated into a weakened position with certain prolonged postures. This leads to overuse of other muscles and ultimately contributes to muscle imbalance and secondary nerve compression.[1] Recent studies show that rapid, nearly simultaneous, stereotypical repetitive fine motor movements can degrade the sensory representation of the hand and lead to a loss of normal motor control of a targeted task, commonly referred to as occupational hand cramps or focal hand dystonia.[3]

Repetitive strain injury is an occupational disease that imposes a considerable impact on workers' lives and has significant socio-economic repercussions. One third of private industry workers' compensation costs in the United States are due to RSI and the direct costs with compensation exceeded US$20 billion between 1990 and 1998 in the state of Washington alone.[4] The US Department of Labor states that 65% of recordable illnesses from the occupational settings were due to repetitive trauma of the upper extremities.[5] In the years 2001 and 2002, it was estimated that 4.1 million full working days were lost to work-related musculoskeletal disorders in the United Kingdom.[4]

In Hong Kong, using random telephone interviews, painful conditions amounting to chronic pain (defined as pain persisting longer than 3 months) was reported to be as high as 10.8%.[6] Furthermore, over 34% of these patients described the pain to be related to an injury at work.[6] The common musculoskeletal conditions experienced by workers include carpal tunnel syndrome, epicondylitis, de Quervain's disease, Dupuytren's disease, ganglia and carpometacarpal arthritis. Of these, carpal tunnel syndrome is most commonly associated with repetitive motion injuries related to industrial production. Among all musculoskeletal disorders involving occupation, the prevalence of carpal tunnel syndrome was 14.5%.[5] In a cohort of 598 workers, the prevalence of lateral epicondylitis was 12.2% as was the annual incidence.[7] In the same study, the prevalence of wrist tendinitis was 11.2% and the incidence was 5.7% per year. Prolonged and abnormal postures serve as a cause of these disorders. Frequent flexion (odds ratio [OR]=4.436; 95% confidence interval [CI], 1.833-10.734), frequent extension (OR=2.691; 95% CI, 1.106-6.547), and frequent sustained forceful motion of the wrist (OR=2.588; 95% CI, 1.144-5.851) are associated with an increased risk of developing carpal tunnel syndrome, but not neutral wrist positioning.[8] Abnormal postures and positions may result in chronic nerve compression or may shorten muscles and if a muscle crosses a nerve, compression may occur. Due to increasing awareness of such diseases by the general public, there is an increasing trend towards recognition of such work-related musculoskeletal disorders.[9]

Methods

A literature search using electronic databases, including Medline, PubMed, and the Cochrane library, was performed. Search terms included 'Hong Kong', 'repetitive strain injury', 'occupational injury', 'work related disorder', and 'cumulative injury'. The same investigator screened each article for inclusion. The inclusion criteria for articles were: (1) publication in English between 1990 and 2007, (2) description of RSI in an occupational setting, and (3) upper limb disorder involvement. Major exclusion criteria were articles discussing traumatic injuries and sports injuries. Articles were reviewed and data regarding the epidemiology, management, and long-term outcomes (such as compensation claims and time-off work) were included. Bibliographies of review articles were searched for potentially relevant studies not identified through the electronic searches. All articles describing occupational RSI in Hong Kong were included in this review. The same investigator undertook the data extraction from these articles.

職業性重複性勞損在香港的情況

目的 回顧有關職業性重複性勞損的流行病學及治療方法，尤其是在香港的情況。

資料來源與研究選取 從1990至2007年於Medline、Pubmed及Cochrane Library發表過的本地及外國有關重複性勞損的英文文獻。

資料選取 所有有關香港職業性重複性勞損的研究都包括在內。

資料綜合 共有16篇討論香港及其他地方的重複性勞損所帶來的影響。另有7篇關於電腦枱設計及一些可改善工作環境的方法。

結論 文獻中有記載重複性勞損在香港的影響，一般來説都包括因重複性勞損而申領的賠償、病假及醫療費用。另有一些研究討論如何改善工作環境以避免重複性勞損的發生。可是，對於實施改善工作環境的措施後，所帶來重複性勞損的減少則未有資料。我們需要做更多研究來找出不同的干預措施與職業性重複性勞損的關係。

There were articles on the impact of RSI,[1,4-18] and also on computer workstations.[19-25]

Risk factors

Work-related disorders are multifactorial. Known risk factors included personal attributes, working posture, repetitive movements, and workstation design.[10] One study showed that somatic and depressive symptoms were associated with lateral epicondylitis and wrist tendinitis.[7] Furthermore, the presence of depressive symptoms predicted the first occurrence of lateral epicondylitis.[7] Subjects who expressed widespread somatic symptoms also reported more pain attributed to their jobs.[26] Pain experienced by individuals could be the feature of a somatisation process.[27] Psychological symptoms were often characteristic of patients with work-related musculoskeletal disorders.[2] Studies have shown that mental stress could induce muscle tension and could contribute to the development of work-related upper extremity disorders.[28] High job demands appeared to confer the strongest work-related psychosocial risk.[29,30]

According to a study in the US, mental workload (doing extra tasks while typing) and time pressure (accomplishing extra tasks in the same time period) imposed increased burdens.[31] The typists in the study were given a task to complete a set of exercises while doing verbal arithmetic (mental workload) within certain typing speed constraints (time pressure). The presence of additional mental workload and time pressure increased key strike force and increased typing errors.

The risk of RSI was increased with higher levels of psychological distress.[27] These psychosocial predictors included dissatisfaction with support from work supervisors or colleagues, stress, worry, job pace, and level of interest.[27] High levels of psychological demands and physical exertion were important predictors of future work-related RSI (OR=1.61; 95% CI, 1.07-2.91 and OR=2.00; 95% CI, 1.29-3.12, respectively).[32] Conversely, maintaining an active lifestyle during leisure time was associated with a lower prevalence of work-related upper-body RSI (OR=0.84; 95% CI, 0.75-0.95).[11] Ergonomic adjustments to the workplace could decrease repetition of tasks and correct poor posture to allow better rehabilitation.[33]

Effect of repetitive strain injuries on Hong Kong workers

Certain occupational groups have an increased risk of developing RSI. Among these are bank workers, particularly cashiers whose repetitive movements appear to increase the risk of upper limb symptoms due to RSI. In Hong Kong, a survey of musculoskeletal problems among bank workers showed that the prevalence of complaints in various body parts was: neck 31.4%, back 30.6%, shoulder 16.5%, hand and wrist 14.9%, and arm 6.6%.[10] Hong Kong's working classes are busy at work, encounter high pressure, and repeat the same movements in their working environment.

The University of Hong Kong carried out a study in 2005 showing that most (90%) frontline service workers (travel, retail, catering, outdoor, medical professionals, office executives, persons involved in manufacturing) reported feeling pain, paralysis, inflexibility, and stiffness in more than one area.[12] Among these, 58% repeated the same movement and gesture regularly in their daily working environment, and 51% knew that their sitting posture was incorrect. During working hours, nearly 48% of the respondents did not take regular short breaks and 47% were required to keep the same posture for extended periods of time. Incorrect postures during working (sitting cross-legged and repeatedly bending knees) were also regarded as contributing to joint problems. Most (55%) workers pointed out that joint problems or limited movement had a direct or indirect impact on their work efficiency and performance, and 36% felt that they directly affected their family or social life.

In a report about 166 subjects with work-related injuries in Hong Kong, 34% were involved in pain-related litigation and 32% were receiving disability or unemployment benefit.[13] Regarding these patients, 24% were unemployed, 34% were involved in litigation related to the painful condition, and 32% received social welfare benefit for disability. Pain and discomfort had led to approximately 14% of patients being absent from work and 30% had sought medical advice.[19] In the US, 45% of subjects, who changed jobs or were absent from work, did so due to work disabilities.[14]

Among patients with carpal tunnel syndrome who received work interventions, 54% had moderate improvement of symptoms; only 13% had minimal or no improvement.[15] The claim incidence rate of rotator cuff syndrome was two thirds that of carpal tunnel syndrome (19.9 vs 27.3).[16] The corresponding rate for epicondylitis was half that for carpal tunnel syndrome, but was still a major cause of time lost from work. In a Canadian study, 26% of absent workers with RSI reported a second injury-related problem, quite apart from back pain (18%) and fractures (12%).[17]

Reports show that 58% of patients with chronic non-malignant pain suffered from depression or anxiety, and their sleep and quality of life were significantly impaired compared to that of the general population.[13] Clinical anxiety and depressive disorders were present in 66% and 64% of the population, respectively.[13] For their conditions, 63% of these patients attended three or more medical specialties or allied health disciplines such as physiotherapy, occupational therapy, clinical psychology, and medical social work. Of all patients requiring such pain management, 42% consulted an orthopaedic specialist.

The high-risk group of Hong Kong workers

Musculoskeletal pain and visual discomfort were the main health problems reported by computer workers and were the major contributors to workdays lost. The prevalence of disorders in keyboard users was as high as 81% in a Swedish study.[19] In comparison with other office workers, the risk of neck and shoulder complaints was nearly four-fold greater in typists and 10-fold greater in data entry operators.[18] Studies showed that there was a 'dose-response' relationship between computer use and upper limb pain.[20] A cross-sectional study in the UK showed that the prevalence ratio (probability of disease with exposure/probability of disease without exposure) for shoulder pain in male keyboard users (>4 hours' use a day) was 1.4 (95% CI, 1.1-1.7), and in female keyboard users it was 1.2 (95% CI, 1.0-1.5).[18] Thus, in males, the probability of shoulder pain in keyboard users was 1.4 times that in non-keyboard users. In the same study the prevalence ratio of elbow pain in keyboard users was 1.2 (95% CI, 0.8-1.7) in males and 1.0 (95% CI, 0.7-1.5) in females.[18] The corresponding ratios for wrist or hand pain in keyboard users was 1.4 (95% CI, 1.0-1.8) in males and in females it was also 1.4 (95% CI, 1.1-1.7).[18]

The use of computers has been growing

exponentially worldwide. According to the Computer Industry Almanac, there were an average of 106 computers in use per 1000 workers worldwide in 2002.[21] The increase in computer and mouse use has been associated with an increased prevalence of disorders in the neck and upper extremities. Poor workstation design, continuous computer use for the entire workday, and repetitive computer work (such as data entry) were associated with an increased risk of developing symptoms. Computer work was a substantial part of the work in most companies and 93% of computer workers used a computer for over 4 hours a day.[22] Psychosocial factors such as high job demands, time pressure, and more than 15 hours of keyboarding per week were identified as risk factors for forearm pain.[22] A survey by the Occupational Health and Safety Council of Hong Kong in 2002 showed that computer workers complained of musculoskeletal discomfort in the neck (56%), shoulders (57%), upper back (47%), and eye discomfort (74%).[21]

As the number of workers using computers was increasing, injuries and ill-health and consequential costs related to computers can be expected to increase if no action is taken.

Usually overlooked problems in computer users

Data processing staff attributed their pain and discomfort to work, citing poor seating (49%), constant keying (24%), sitting in the same position for hours (23%), and computer set-up (12%) as possible causes.[19] Interestingly, 94% of workers in Hong Kong had adjustable chair heights, 98% had backrests, and 32% had armrests.[21] Most (60%) computer workers adopted a leaning forward or backward posture position when looking at the computer monitor, and only 43% of people set their keyboard at elbow height.[21]

Unfortunately, most operators were not aware of the height to which furniture should be adjusted and most were reluctant to change the setting for fear of losing the previous setting that conferred an optimal degree of comfort. Nearly 99.9% of users of adjustable furniture made only one adjustment prior to use.[21]

Computer monitor

A lack of adjustability on the computer table and a prolonged static posture compounded the discomfort and pain. Generally, computer users try to use their body to compensate for the necessary height matching for the eyes, hands, and feet. These awkward postures were blamed for disorders of the neck, shoulders, and back. Workers should be able to see the display, support their hands in an optimal position for the task such as typing, or being able to rest their back, feet, and buttocks to support any necessary loads. Recent recommendations included positioning the monitor to form an angle of between 15 to 45 degrees inferior to an imaginary horizontal extended from the eye, whilst monitor should be 5 to 20 cm above the work table.[21] A monitor placed too low caused forward slouching and stress to the neck, shoulders, and upper back (Table).

TABLE. Computer table set-up recommendations

	Recommendations to reduce repetitive strain injuries
Posture	Sitting up straight Not leaning forwards or backwards
Computer monitor	15 to 45 degrees below eye level 5 to 20 cm above the work table
Keyboard	Elbow height Incline from 0 to 40 degrees
Mouse	Located in keyboard Slanted angles

Keyboard

Generally the keyboard and mouse were supposed to be at around elbow height so that the forearm could be at 90 degrees with the wrist straight.[21] The keyboard should have an incline from 0 to 40 degrees.[21] A review article suggested that there was evidence for the efficacy of specific keyboards with an alternative force-displacement or geometry only for patients with carpal tunnel syndrome.[23] These ergonomic keyboards were designed to reduce activation force, vibration, and finger travel distance for keying that could help reduce upper limb symptoms.[24]

Mouse

When the mouse was located beside the keyboard, the risk of pain in the fingers increased. This caused finger pain if there was unsatisfactory room for the mouse and the need to raise the mouse to make necessary movements. The mouse was located beside the keyboard for 55% of office workers, 70% of customer service workers, and 72% of designers.[22] Poor placement of both the keyboard and the mouse increased the risk of pain in all body regions studied. For office workers, poor placement of the keyboard increased the risk of pain in the shoulders, elbows and fingers, and poor placement of the mouse was a risk factor for pain in the neck, shoulders and fingers. Working at least 5.6 hours a week with a computer mouse increased the risk of musculoskeletal symptoms in the shoulder joint (upper arm), elbow, wrist and hand or fingers.[22] Furthermore, increased muscular activity ensues in the neck using the mouse as opposed to the keyboard.[30] The likely reason for this could be a higher visual demand when the mouse is used.

Frequent use of a non-slanted computer mouse may cause musculoskeletal discomfort and symptoms in the forearms and shoulders. Ergonomic mice with different slanted angles had various effects on forearm and shoulder muscle activity.[25] As the slanted angles increased, the surface electromyography levels of extensor carpi ulnaris, pronator teres and upper trapezius muscles decreased.[25] Increasing the slanted angles resulted in larger wrist extension and higher muscle activity in terms of the extensor digitorum muscle.[25] Working with a mouse having suitable slanted angles provided users more neutral hand positions, so forearm and shoulder muscle activity and the risk of musculoskeletal disorders appeared to be reduced.

Approach to public health

Hong Kong occupational therapy clinics are seeing more and more patients with RSI, and currently there are methods to identify problem jobs and specific tasks associated with these disorders. The analysis of patients' physical attributes, videotaping of work, ergonomic evaluation, and assessment of workstation designs have been implemented in some workplaces.[34]

The basics for prevention entail: the design of equipment and tasks, the organisation of work, the work environment, training and education, and the development of health and safety policies. Workers must learn the basic skills of body use including work techniques, relaxation and rhythm, the different types of work breaks, the reasons for taking them, and the correct use of equipment.[35] Rest and exercise breaks for computer users were shown to increase the likelihood of recovery from symptoms: 55% versus 34% in users without breaks.[36]

Modified work programmes were designed to facilitate return to work for employees with a work-related injury. Most arrangements offered to injured workers consist of temporary modifications such as reduced hours (24%), flexible work hours (25%), or a lighter work (57%), rather than more permanent changes to the way that work was conducted such as changes to the work layout or equipment (8%).[30] Only 36% of injured workers reported that their employer offered to make arrangements to help them return to work in their first year post-injury.[37,38]

A US study emphasised an Integrated Case Management (ICM) education programme for nurse case managers working within a workers' compensation health care delivery system.[39] With a view to reducing barriers to returning to work, the programme trained nurses to conduct ergonomic assessments, to use ergonomic evaluations as the basis for implementing workplace modifications, and to train claimants to use a problem-solving approach. Claimants with upper extremity disorders were randomly assigned to nurse case managers who had had ICM training and to nurse case managers without such training. The study showed that claimants assigned to ICM nurses received 1.5 (95% CI, 1.1-2.0) times as many recommendations for modifications and were 1.4 (95% CI, 1.0-2.0) times as likely to have recommendations implemented as control claimants (assigned to nurses without ICM training).[39] However, the implementation rates for the two groups were very similar—ICM-trained nurses achieved a 73% rate compared to 77% for nurses without training.[39] Modifications included: lifting restrictions, modified or lighter duties, increased work breaks and computer-related changes.[39] Thus, better case manager training only improved the identification of workplace recommendations but did not affect the overall implementation rates. There were still significant barriers in the workplace and a lack of data describing the effect of these modifications on the overall incidence of RSIs. There was great potential for research as currently data on work-related outcomes in most trials are lacking when it comes to assessing workplace modifications.[40,41]

There was a consensus that occupational musculoskeletal disorders were a major problem leading to adverse health and economic consequences. Workers with occupational musculoskeletal disorders had poorer self-perception of physical and mental health.[42] An effective approach to dealing with work-related musculoskeletal disorders was primary prevention. The development of interventions such as workplace alterations could help eliminate the risk factors, such as awkward posture, excessive force, and high repetition rates.

Discussion

This review provided in-depth data regarding the prevalence, risk factors, and impact of RSI on society. Repetitive strain injuries create a great burden on both Hong Kong and international workforces. Work-related injuries were similar in both Hong Kong and overseas. There were 16 articles included in this study describing the impact of RSI; the data show that more overseas workers took time away from work than locally.

Some articles assessed the risk of psychological complaints such as depression or anxiety with the incidence of RSI. One such article showed that mental workload and time pressure increased workload and the key strike force.[16] However, these articles failed to associate psychological risks with a substantially increased risk of RSI. Furthermore, no articles were based on the Hong Kong workforce. It would also be interesting to explore any relationship between subjects with psychological risks and subjects seeking litigation and compensation.

A major focus of this review was to assess the benefit of workplace adjustments. However, there was a lack of evidence, as only seven articles in this review described the methods of modifications such as lifting restrictions, modified or light duties, increased work breaks and computer-related interventions. There were no articles documenting reasons for barriers to interventions or their benefits for reducing RSI. In Hong Kong, the importance of company profit and employee job security could be restricting modifications (such as increased work breaks). Thus, it would appear worthwhile interviewing employers to assess reasons for restricting modifications. More data are required to clarify the effectiveness of these interventions and for discovering the barriers preventing higher rates of uptake.

References

1. O'Neil BA, Forsythe ME, Stanish WD. Chronic occupational repetitive strain injury. Can Fam Physician 2001;47:311-6.
2. Barbe MF, Barr AE. Inflammation and the pathophysiology of work-related musculoskeletal disorders. Brain Behav Immun 2006;20:423-9.
3. Byl NN, McKenzie A. Treatment effectiveness for patients with a history of repetitive hand use and focal hand dystonia: a planned, prospective follow-up study. J Hand Ther 2000;13:289-301.
4. Lacerda EM, Nácul LC, Augusto LG, Olinto MT, Rocha DC, Wanderley DC. Prevalence and associations of symptoms of upper extremities, repetitive strain injuries (RSI) and 'RSI-like condition'. A cross sectional study of bank workers in Northeast Brazil. BMC Public Health 2005;5:107.
5. Rosecrance JC, Cook TM. Upper Extremity Musculoskeletal Disorders: Occupational Association and a Model for Prevention. Central European Journal of Occupational and Environmental Medicine 1998;4:214-31.
6. Chen PP, Chen J, Gin T, et al. Out-patient chronic pain service in Hong Kong: prospective study. Hong Kong Med J 2004;10:150-5.
7. Leclerc A, Landre MF, Chastang JF, Niedhammer I, Roquelaure Y; Study Group on Repetitive Work. Upper-limb disorders in repetitive work. Scand J Work Environ Health 2001;27:268-78.
8. Fung BK, Chan KY, Lam LY, et al. Study of wrist posture, loading and repetitive motion as risk factors for developing carpal tunnel syndrome. Hand Surg 2007;12:13-8.
9. Ho MY, Lo WK. Common occupational diseases in Hong Kong. Hong Kong Pract 2001;23:208-211.
10. Yu IT, Wong TW. Musculoskeletal problems among VDU workers in a Hong Kong Bank. Occup Med (Lond) 1996;46:275-80.
11. Ratzlaff CR, Gillies JH, Koehoorn MW. Work-related repetitive strain injury and leisure-time physical activity. Arthritis Rheum 2007;57:495-500.
12. Latest survey shows: Hong Kong working class across different industries are at risk of joint problems. Hong Kong: University of Hong Kong Press Release; 2005 Nov 17.
13. Lee S, Chen PP, Lee A, Ma M, Fong CM, Gin T. A prospective evaluation of health-related quality of life in Hong Kong Chinese patients with chronic non-cancer pain. Hong Kong Med J 2005;11:174-80.
14. Katz JN, Lew RA, Bessette L, et al. Prevalence and predictors of long-term work disability due to carpal tunnel syndrome. Am J Ind Med 1998;33:543-50.
15. Barthel HR, Miller LS, Deardorff WW, Portenier R. Presentation and response of patients with upper extremity repetitive use syndrome to a multidisciplinary rehabilitation program: a retrospective review of 24 cases. J Hand Ther 1998;11:191-9.
16. Silverstein B, Welp E, Nelson N, Kalat J. Claims incidence of work-related disorders of the upper extremities: Washington state, 1987 through 1995. Am J Public Health 1998;88:1827-33.
17. Baldwin ML, Butler RJ. Upper extremity disorders in the workplace: costs and outcomes beyond the first return to work. J Occup Rehabil 2006;16:303-23.
18. Palmer KT, Cooper C, Walker-Bone K, Syddall H, Coggon D. Use of keyboards and symptoms in the neck and arm: evidence from a national survey. Occup Med (Lond) 2001;51:392-5.
19. Woods V. Musculoskeletal disorders and visual strain in intensive data processing workers. Occup Med 2005;55:121-7.
20. IJmker S, Huysmans MA, Blatter BM, van der Beek AJ, van Mechelen W, Bongers PM. Should office workers spend fewer hours at their computer? A systematic review of the literature. Occup Environ Med 2007;64:211-22.
21. Goonetilleke RS, Witana CP, Punchihewa HKG, editors. Utilizing advancements in data acquisition and control in the design of computer workstations. Kuching: Proceedings of SEAMEC; 2003:40-44.
22. Sillanpää J, Huikko S, Nyberg M, Kivi P, Laippala P, Uitti J. Effect of work with visual display units on musculo-skeletal disorders in the office environment. Occup Med (Lond) 2003;53:443-51.
23. Verhagen AP, Karels C, Bierma-Zeinstra SM, et al. Ergonomic and physiotherapeutic interventions for treating work-related complaints of the arm, neck or shoulder in adults. A Cochrane systematic review. Eura Medicophys 2007;43:391-405.
24. Ripat J, Scatliff T, Giesbrecht E, Quanbury A, Friesen M, Kelso S. The effect of alternate style keyboards on severity of symptoms and functional status of individuals with work related upper extremity disorders. J Occup Rehabil 2006;16:707-18.
25. Chen HM, Leung CT. The effect on forearm and shoulder muscle activity in using different slanted computer mice. Clin Biomech (Bristol, Avon) 2007;22:518-23.
26. Helliwell PS, Mumford DB, Smeathers JE, Wright V. Work related upper limb disorder: the relationship between pain, cumulative load, disability, and psychological factors. Ann

Rheum Dis 1992;51:1325-9.
27. Macfarlane GJ, Hung IM, Silman AJ. Role of mechanical and psychosocial factors in the onset of forearm pain: prospective population based study. BMJ 2000;321:676-9.
28. Lundberg U. Psychophysiology of work: stress, gender, endocrine response, and work-related upper extremity disorders. Am J Ind Med 2002;41:383-92.
29. Andersen JH, Kaergaard A, Frost P, et al. Physical, psychosocial, and individual risk factors for neck/shoulder pain with pressure tenderness in the muscles among workers performing monotonous, repetitive work. Spine 2002;27:660-7.
30. Bongers PM, Kremer AM, ter Laak J. Are psychosocial factors, risk factors for symptoms and signs of the shoulder, elbow, or hand/wrist?: A review of the epidemiological literature. Am J Ind Med 2002;41:315-42.
31. Hughes LE, Babski-Reeves K, Smith-Jackson T. Effects of psychosocial and individual factors on physiological risk factors for upper extremity musculoskeletal disorders while typing. Ergonomics 2007;50:261-74.
32. Cole DC, Ibrahim S, Shannon HS. Predictors of work-related repetitive strain injuries in a population cohort. Am J Public Health 2005;95:1233-7.
33. Uhl TL, Madaleno J. Rehabilitation concepts and supportive devices for overuse injuries of upper extremities. Clin Sports Med 2001;20:621-39.
34. Ping CL, Keung SC, Yee PL. Functional assessment of repetitive strain injuries: two case studies. J Hand Ther 1996;9:394-8.
35. Repetitive strain injury (RSI)—an ergonomic problem in workplaces. Hong Kong Occupational Safety & Health Association website: http://www.hkosha.org.hk/news2.htm. Accessed 10 Oct 2007.
36. Williams RM, Westmorland MG, Schmuck G, MacDermid JC. Effectiveness of workplace rehabilitation interventions in the treatment of work-related upper extremity disorders: a systematic review. J Hand Ther 2004;17:267-73.
37. Brooker AS, Cole DC, Hogg-Johnson S, Smith J, Frank JW. Modified work: prevalence and characteristics in a sample of workers with soft tissue injuries. J Occup Environ Med 2001;43:276-84.
38. Wellman H, Davis L, Punnett L, Dewey R. Work-related carpal tunnel syndrome (WR-CTS) in Massachusetts, 1992-1997: source of WR-CTS, outcomes, and employer intervention practices. Am J Ind Med 2004;45:139-52.
39. Lincoln AE, Feuerstein M, Shaw WS, Miller VI. Impact of case manager training on worksite accommodations in workers' compensation claimants with upper extremity disorders. J Occup Environ Med 2002;44:237-45.
40. van Tulder M, Malmivaara A, Koes B. Repetitive strain injury. Lancet 2007;369:1815-22.
41. Huang GD, Feuerstein M, Sauter SL. Occupational stress and work-related upper extremity disorders: concepts and models. Am J Ind Med 2002;41:298-314.
42. Cheng JC, Li-Tsang CW. A comparison of self-perceived physical and psycho-social worker profiles of people with direct work injury, chronic low back pain, and cumulative trauma. Work 2005;25:315-23.