Scientia Africana, Vol. 12 (No.2), December 2013. Pp77-85
 ISSN 1118 – 1931

SOFTWARE-ENGINEERING-BASED MODEL FOR MITIGATING REPETITIVE STRAIN INJURY (RSI) AMONG COMPUTER USERS

[1] V.V.N Akwukwuma [2] J. C. Obi and [3] F. Atamewan

[1,2] Department of Computer Science,
University of Benin, P.M.B. 1154, Benin City, Nigeria.

[3]CRPU Unit, Information and Communication Technology (ICT) Department,
University of Benin, Benin City, Nigeria

[1]e-mail: vakwukwuma@yahoo.com; +234(0)8033440003;

[2]tripplejo2k2@yahoo.com; +234 (0)8093088218

[3]fatamewan@uniben.edu; +234 (0)8034028247

Received: 05/13/2013
Accepted:12/12/2013

ABSTRACT

The incorporation of Information and Communication Technology (ICT) in virtually all facets of human endeavours has fostered the use of computers. This has induced Repetitive Stress Injury (RSI) for continuous and persistent computer users. Proposing a software engineering model capable of enacted RSI force break was the bedrock of this research paper. A questionnaires based approach was utilized in eliciting information pertaining to RSI within our environment (University of Benin). Out of 300 hundred questionnaires, 260 were successfully filled and returned; and the data obtained was analyzed. Findings from this study show a dearth of knowledge of the subject matter by computer users within our environment, as only 68 (26.2%) of the respondents in this study reported having heard of the term "repetitive strain injury" though as many as 95.39% of the respondents reported one form of discomfort or the other while working with the computer. 44 (32.30%) respondents indicated arm pain, 84 (32.30%) respondents indicated backache, 16 (6.15%) respondents indicated neck pain, 20 (7.69%) respondents indicated shoulder pains, 12 (4.60%) indicated finger pain, 64 (24.61%) indicated numbness, 8 (3.07%) indicated wrist pain while 12 (4.61%) respondents did not indicate any symptoms. A software engineering proactive model has been proposed based on limitations of previous research works pertaining to inability to enact a formal model capable of force break on computer users when threshold time inducing RSI has been exceeded and our survey results.

Keywords: Software engineering, model framework, Computer users, RSI, Short breaks.

INTRODUCTION

With the advancements in information and communication technology, almost every field of human endeavor has incorporated computer usage into its day-to-day activities.

More often than not, these users all spend long hours in front of the computer systems

and this has led to a situation where users are exposed to potential problems associated with working with these equipment's, Bholah et al, (2000). The dearth of knowledge among computer users have led to one major problem; Repetitive Strain Injury (RSI).

RSI, also known as Repetitive Stress Injury, Repetitive Motion Injuries (RMI), Repetitive Motion Disorder (RMD), Cumulative Trauma Disorder (CTD), Occupational Overuse Syndrome (OOS), Overuse Syndrome (OS), Regional Musculoskeletal Disorder (RMD) is an injury of the musculoskeletal and nervous systems that may be caused by repetitive tasks, forceful exertions, vibrations, mechanical compression (pressing against hard surfaces) or sustained or awkward positions; MNT, (2013).

Marcel et al (1999) defined CTD as disorders of the musculoskeletal and nervous system that may be caused or aggravated by repetitive motions, forceful exertions, and mechanical compression or awkward postures all occurring over extended periods of time. These disorders include joint pain and/or fatigue involving the neck, shoulder, elbow (e.g., tennis elbow), wrist and fingers (e.g., carpal tunnel syndrome and tendonitis), lower back pain (e.g., sciatica) and even knee problems. Experts often refer to two main types of RSI, namely Type I and Type II, NHS, (2013).

The overuse injury due to keyboarding tasks among keyboard users has been recognized worldwide, Schleifer, (1996) and several actions which involve repetitive or forceful movements, the sitting position, the type of chair, use of footrest, Subratty and Korumtollee, (2005) and the maintenance of constrained or awkward postures have also been associated with musculoskeletal disorder Browne et al, (1984). Most Computer users are not aware of the symptoms and risk factors associated with RSI and as such have not applied themselves to healthy computing styles like regular short breaks and exercises which has great impact on their health and general well-being.

Developing a Software Engineering Model that prompts the computer users to take a break after some long time on the computer, taking into consideration idle time is the objective of this research paper. The system was designed as a proactive measure and not a corrective one.

MATERIALS AND METHODS

Donald et al. (2005) assessed predictors associated with work related Repetitive Stress Injury (RSI) using data from four waves of the Canadian National Population Health Survey (CNPH). Job Content Questionnaires were utilized as a survey tool in eliciting Respondents responds in which 2806 participants were involved. The results of their analysis showed clearly that high level of job insecurity, psychological demands and physical exertion were all associated with greater proportion of subsequent work-related RSI. Their findings add to the existing empirical evidence of the role of both physical and psychosocial work factors in the onset of RSI, CTD, and work-related musculoskeletal disorders.Such evidence should lead workplaces and governments to consider the wide range of preventive measures documented by researchers into and practitioners of ergonomics. Manuals have already been

Scientia Africana, Vol. 12 (No.2), December 2013. Pp77-85
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

prepared to guide workplaces in the implementation of ergonomic programs that can reduce the physical demands of work.

Several research works on RSI; Almeida et al. (1999), Feville (2002), Frank et al. (2008), Houtman et al. (2010) and Kuorinka (2005) were geared toward detective approaches in identifying factors relating or inducing RSI within the work-place and other work related areas.Studies have shown that short breaks have a protective effect over the development of RSI, Ortiz et al (2003) and Berghqvist et al, (1995). A study has also shown that breaks at 20 minutes interval are beneficial, whereas micro breaks did not have any protective effect, Berghqvist et al, (1995). It is instructive to note however that observance of breaks is not synonymous with ergonomic exercise. In environments where knowledge of ergonomics is wide spread, it has been shown that ergonomic break/exercise promoted by inbuilt computer software very significantly reduces the incidence of repetitive strain injury.

From our review of related literatures, we have been able to design an ergonomic framework which initiate ***force break*** for computer users when the threshold time period has been exceeded as opposed to previous framework which identify threshold time frame but do not initiate force break.

To achieve the objective of this research, a quantitative questionnaire based survey was first of all carried out to elicit information from the Computer users on the length of time spent using the system daily without any break and if they experience any form of RSI. Three hundred (300) questionnaires with a total number of forty-two (42) questions in three (3) sections were distributed among computer users in the University of Benin community. Two hundred and sixty (260) questionnaires were successfully filled and returned, and the data obtained were analyzed using simple percentages.

RESULTS

The findings which fostered the model development are shown in Tables 1, 2, 3, 4 and 5.

Table 1: Awareness of Repetitive Stress Injury

Aware of RSI	No of respondents (%)
Yes	68 (26.2%)
No	192 (73.8%)

From table 1, most of the respondents 192 (73.8%), have no idea of Repetitive Stress Injury while few of the respondents 68 (26.2%), have heard about RSI.

Table 2: Daily Use of the Computer in the Office

No. of hours	No of respondents (%)
Less than 1hr	40 (15.38%)
1-3hrs	180 (69.23%)
3-5hrs	40 (15.38%)

From table 2, most of the respondents use the computer without a break between 1-3 hours daily (69.23%). 15.38% use it for less than 1 hour per day and as many as 15.38% use it for 3-5 hours daily.

Table 3: Daily Use of Computer at Home

Duration	No of respondents (%)
Less than 1hr	60 (23.07)
1-3hrs	80 (30.76%)
3-5 hrs	120 (46.15%)

From Table 3, sixty (60) of the respondents use the computer for less than 1hr daily at home (23.07%), eighty (80) of them which is 30.76% use it between 1-3hrs at home daily without a break while one hundred and twenty (120) of them which is 46.15% utilize it between 3-5 hours at home daily without a break.

Table 4: Incidence of Symptoms of Repetitive Strain Injury

Occurrence of RSI	No of respondents (%)
Yes	248 (95.39%)
No	12 (4.6%)

From table 4, of the two hundred and sixty respondents, 248 (95.39%) reported some form of discomfort while 12 (4.6%) have not felt any discomfort working with computers.

Table 5: Specific Discomfort Experienced by Respondents

Discomfort	No of respondents (%)
Arm pain	44 (16.92%)
Backache	84 (32.30%)
Neck pain	16 (6.15%)
Shoulder pain	20 (7.69%)
Finger pain	12 (4.60%)
Numbness	64 (24.61%)
Wrist pain	8 (3.07%)
No Discomfort	12 (4.61%)

From table 5, 44 (32.30%) respondents indicated arm pain, 84 (32.30%) respondents indicated backache, 16 (6.15%) respondents indicated neck pain, 20 (7.69%) respondents indicated shoulder pains, 12 (4.60%) indicated finger pain, 64 (24.61%) indicated numbness, 8 (3.07%) indicated wrist pain while 12 (4.61%) respondents did not indicate any symptoms. Hence the need to developing a Software Engineering Model that forces the computer users to take a break.

Scientia Africana, Vol. 12 (No.2), December 2013. Pp77-85
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

The Justification for a Model

Repetitive Stress Injury is as old as the computer system itself. Several approaches have been adopted and implemented in overcoming RSI. These approaches are not proactive (preventive) in nature but detective, they do not force the user to take a break, as a result the users ignore any warning pop ups. This is usually achieved by determining and setting a threshold-time framework period in which RSI is induced but lack the ability to enact involuntary system shut-down. Hence the need to develop a Software Engineering Model that prompts the computer users to take a break. Our model go a step further, it is not only detective in nature, but also preventive through the enforcing of forced system shut-down when the threshold time period has been exceeded, living the system user with no choice but to take a break.

The Proposed RSI Model

The proposed model is an architectural framework which enhances involuntarily system-shutdown from persistent and continues computer users. Unlike the current approaches, in which RSI prevention is solely dependent on the self-control of the recurrent system users, despite the induced RSI indicators, this model is software engineering based; possess three main model components as shown in figure 4.

a. **User Interface Module** is the first module in our proposed model responsible for controlling the display of the splash screen that is displayed when the ergonomics system has taken over control of the system blocking the users from using the system. This module makes use of a timer whose duration is equivalent with the Ergonomics user blockage time (i.e. the number of minutes the user is disallowed from using the system). When the timer elapses, the control of the system is given back to the user who can now interact with the system.

b. **Ergonomic module** is the second module responsible for listening to users' keystrokes and mouse movements. When these keystrokes and mouse movements or mouse clicks are encountered by the system, the system checks if the user is still within his working time (i.e. the number of minutes the user is allowed to use the system continuously), if the user happens not to be within his or her working time, the ergonomics system contact the User Interface Module which then blocks the user from using the computer system for a specified period of time.

c. **System Setup** is the third module responsible for setting up the different timing that is used by the Ergonomics Module and the User Interface Module. Every time any of this timing is changed, the System Setup module notifies the User Interface module as well as the Ergonomics System module about the changes. A list of the timing that can be set using this module are as follows:

a. Maximum activity time (MAT) – this time is used by the Ergonomics module to determine for how long the user of the computer should be allowed to use the computer system.

b. Minimum Idle Time (MIT) – sometimes while the user is using the system, he might for one reason or the other stop using the system and latter return to it. The minimum idle time allows the user to set the minimum time the Ergonomics system sees as the user inactivity time (i.e. the amount of time the user voluntarily – due to whatever reason – refuse to use the system). This inactivity time should not be counted along with the Maximum activity time as the user did not use the computer during that time.

c. Ergonomics Time (ET) - the ergonomics time is used by the User interface module to specify the amount of time the user will be blocked or disallowed from using the computer system.

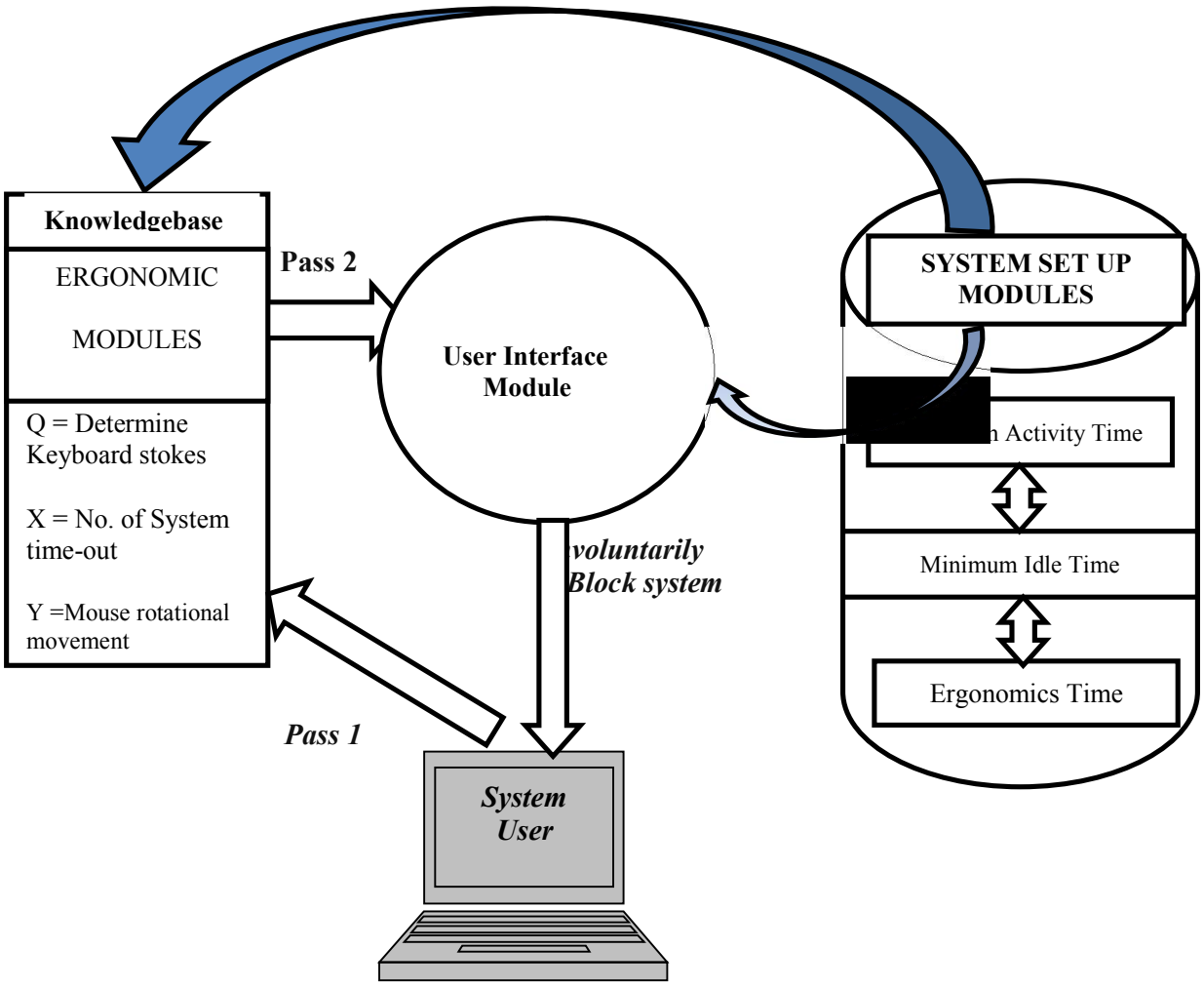

Figure 4: Software Engineering Based Repetitive Stress Injury Model

Scientia Africana, Vol. 12 (No.2), December 2013. Pp77-85
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

The system users interact with keyboard and mouse of the computer system while determining his or her daily activities; these data are usually transit through pass 1 to the ergonomic modules of the model. This information is usually kept within the knowledgebase of the ergonomic module. It compares and contrasts variables Q, X, Y which stands for determine keyboard stoke, number of system time-out and mouse rotational movement respectively with the Maximum Activity Time (MAT), Minimum Idle Time (MIT) and Ergonomics Time (ET) residing in the system set-up modules and determine if threshold-time period has been exceeded. If exceeded the information from the processed dataset is transited through pass 2 to the user interface module which is saddled with the responsibility of force-break or involuntarily system shut-down is enacted and the system users is force to take a break.

System Implementation Design

Unified modeling language was utilized for specifying our design. Unified Modeling Language (UML) is a standard modeling language used for modeling software systems. It provides a number of graphical tools that can be used to visualize a system from different viewpoints. The multiple views (user, structural, behavior, implementation and environment) of the system that is represented by using diagrams together depict the model of the system. This research paper focuses on user and structural view of our proposed system which is specified in Figure 5 and 6.

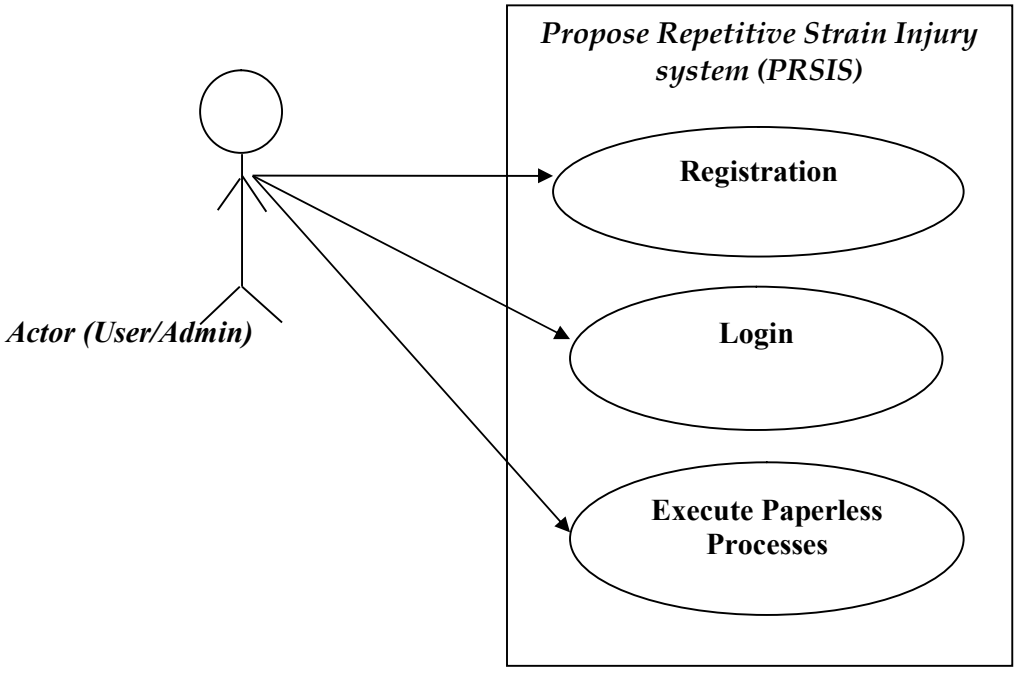

Figure 5: Use Case Diagram modeling PRSIS

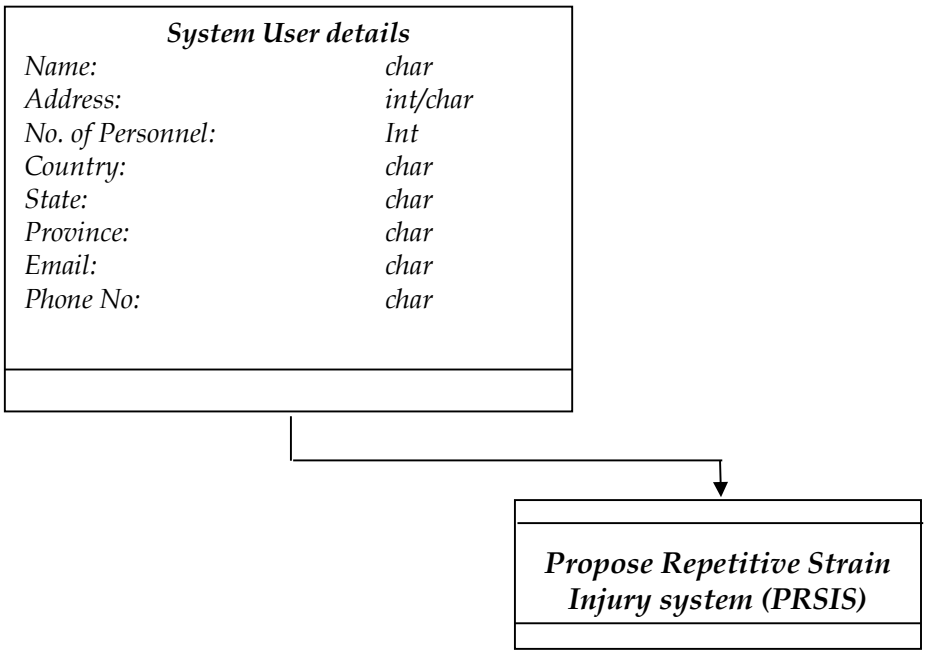

Figure 6: Class diagram Showing Attributes, generation and composition Association for PRSIS

DISCUSSION

Previous proposed models; Donald et al. (2005), Almeida et al. (1999), Feville (2002), Frank et al. (2008), Houtman et al. (2010) and Kuorinka (2005) were geared toward detective approaches in identifying factors relating or inducing RSI within the work-place and other work related areas. Our proposed system, enact a proactive or preventive approach in mitigating RSI by implementing force break for system user when threshold time has been exceeded thereby reducing health issues and cost (time, effort and financial obligation).

Computers have come to stay as an advancement of technology globally. Its use, which is spreading across different, age groups and occupations, for various purposes, is also increasing rapidly. Alongside, this increase in the use of computers in various facets of human activities has evolved a disturbing side effect, known as Repetitive Strain Injury. Most of the approaches previously implemented outline a time-frame in which RSI is induced without enforcing a break-time through involuntary system shut-down. A proactive system framework has been proposed in this research paper, this framework aimed at enhancing forced break through involuntary system shut-down after prior warnings among customer user when a threshold time period has elapsed. This framework when implemented on all corporate and private computer devices and system will force computer users to take short breaks from repetitive computers tasks.

Scientia Africana, Vol. 12 (No.2), December 2013. Pp77-85
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

REFERENCES

Almeida S.A., Williams K.M. and Shaffer R.A (1999), "Epidemiological patterns of musculoskeletal juries and physical training", Med Sci Sports Exerc.1999 31:1176–1182

Berghqvist O .V. Cane U., and Knave, B.G, (1994). "Every discomfort and work with visual display terminals", Scandinavian Journal of Work, Environment and Health. Vol. 20, pp. 27 – 33.

Bholah, R., Fagoonee I., Subratty A. H., (2000), "Sick Building Syndrome in Mauritius: are symptoms associated with the office environment?" Indoor Built Environ; 9:44 – 51.

Browne, C.D, Nolan, B.M, Faithfull D.K, (1984), "Occupational repetition strain injuries: Guidelines for diagnosis and management". Med J. Aust; 140:329-32

Donald C. C. Selahadin I. and Harry S. S. (2005), "Predictors of Work-Related Repetitive Stress Injuries in Population Cohort" retrieved online from http://www.ncbi.nlm.nih.go

Feville H., Jensen C and Burr H (2002), "Risk factors for neck-shoulder and wrist-hand symptoms in a 5-year follow-up study of 3,990 employees in Denmark. Int Arch Occup Environ Health, 75:243–251.

Frank J.W., Kerr M.S., and Brooker A.S. (2008), "Disability resulting from occupational low back pain part I: What do we know about primary prevention?", A review of the scientific evidence on prevention before disability begins. Spine.2008; 21:2908–2917

Houtman I.L.D. Bongers P.M., Smulders P. (2010), "Psychosocial stressors at work and musculoskeletal problems", Scand J Work Environ Health.2010; 20:139–145

Kuorinka I. F., L (2005), "Work-Related Musculoskeletal Disorders (WMSDs): A Reference Book for Prevention. London, England

Marcel D., Kate G. and Lil Y. (1999), "Repetitive Stress Analysis", Journal of Info. Tech. Vol. 4, Iss. 3. Pp. 10-19.

MNT: Medical News Today (2013), "What Is Repetitive Strain Injury (RSI)? What Causes Repetitive Strain Injury" http://www.medicalnewstoday.com/articles/176443.php

NHS (2013), "Repetitive Stress Injury", http://www.nhs.uk/Conditions/Repetitive-strain-injury/Pages/Treatment.aspx

Ortiz H. L., Tamez G. S., Martinez A. S., Mendez R. I. (2003). "Computer use increases the risk of musculoskeletal disorders among newspaper officer workers". Arch Med Res; 34:331-42.

Schleifer M. (1996), "Keyboard Interaction and Repetitive Stress Injury", Journal of Info. Tech. Vol.1, Iss. 1. Pp. 51-60.

Subratty A.H and Korumtollee F. (2005), "Occupational overuse syndrome among keyboard users in Mauritius" retrieved online from http://www.ijoem.com/article.asp?issn=0019-5278;year=2005;volume=9;issue=2;sp