GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(*Published By*: Global Institute for Research & Education)

www.gifre.org

ERGONOMIC COMPLIANCE: A PILOT STUDY OF ONE FACULTY AT A ZIMBABWEAN ACADEMIC INSTITUTION

Tecla Mlambo*[1] (MSc OT, MSc Clin Epi), Churchill Chirubvu[1] (BSc HPT) & Shamiso Muteti[2] (MBA Environment and Energy)

[1]Department of Rehabilitation, College of Health Sciences, University of Zimbabwe
[2]Department of Community Medicine, College of Health Sciences, University of Zimbabwe
*Correspondence Author

Abstract

Work-related injuries and diseases are a major cause of concern worldwide. Despite the emergence of information technology and sedentary office work in third world countries like Zimbabwe, there is paucity of literature pertaining to ergonomic compliance. Certain ergonomic principles if adhered to can prevent work related musculoskeletal problems. We sought to analyse the level of compliance to workspace design ergonomic principles at one faculty of a Zimbabwean academic institution. We analysed the compliance to ergonomic principles among a cross section of randomly selected offices in 2011. The analysis covered information technology hardware, furniture and potential sources of stress using a questionnaire and checklist adapted from Marmaras and Papadopoulos (2003). Data were analysed descriptively. Participants were 36 employees, mostly female (83%) who held secretarial positions (58%). Most compliant aspects of the workstations were information technology hardware (80.5%) and the least compliant was furniture (45%). Information technology hardware and work environment were ergonomically friendly but positioning of the devices was not. There is need to upgrade the furniture as it had numerous shortcomings leading the workers to assume non-ergonomically friendly postures.

Key words: Ergonomic compliance, work stations, academic institution

1.0 Introduction

Work-related injuries and diseases are a major cause of concern worldwide. Musculoskeletal diseases (MSDs) are the most common work-related health problem reported in Europe, affecting millions of workers as the main cause of absence from work in practically all members of the European Union (EU) (ILO 2009). Venables and Allender (2006) found musculoskeletal disorders, mental ill health and skin diseases among major work-related problems diagnosed by physicians in the period 1998–2003 in the United Kingdom (UK). Indirect costs of musculoskeletal disorders, such as replacement-employee wages, training costs for replacement workers, productivity reduction, and quality reduction typically add up to three or four times the direct costs of medical, disability, and rehabilitation expenses (Rempel and Janowitz 2007).

Ergonomics, which is the science of design as applied to the fit between a device and its users can go a long way in alleviating the effects of such problems (HSE 2010), (Aara°s, Horgen and Borset 1998), (Aara°s, Horgen and Borset 2001). Sound ergonomic principles are known to reduce the potential for accidents, injury and ill health and to improve performance and productivity (HSE 2010). It is believed that ergonomics can solve physical, psychological and social aspects of work-related problems, thus optimising human well-being and overall system performance (Jayaratne 2012).

The International Standards Organisation (ISO) and the International Ergonomics Association (IEA) have developed technical standards on many ergonomic aspects related to the material elements of work. However, there is great variation in coverage following the usual divide between developed countries and other developing countries in implementation of the ISO and IEA technical standards (ILO 2009). In Zimbabwe, the National Social Security Authority (NSSA) was established by an Act of Parliament in 1990 with the mandate of providing social security to the Zimbabwean population and addressing the issues of health and safety in the workplace. Most companies in Zimbabwe now have an occupational health and safety policy and system in place to attend to the welfare of employees in terms of prevention of work-related injuries. NSSA has personnel who inspect and enforce the safety compliance of organisations.

Computer screen glare, posture and workspace suitability have all been associated with headaches and other symptoms (Alexander and Currie 2004). The longer the worker is in the workspace during a work shift the more critical the design becomes. Computer usage which is now very prevalent is associated with prolonged sitting hence the need for ergonomically correct work seating and surfaces. Prolonged sitting may lead to numerous general complications such as fatigue or discomfort, diseases of the musculoskeletal system, deep vein thrombosis (DVT), as well as obesity and its health-related consequences (Selby and Triano 2007), (Sudol-Szopinska 2006). Prolonged sitting and neck flexion have also been identified as predictive of neck pain through static loading of the soft tissues (Ariens et al 2001), (Pope,Goh and Magnusson 2002). A study by Ijmker et al (2011) also found self-reported duration of computer use to be associated with onset of arm-wrist-hand and neck-shoulder symptoms. However, ergonomics is still considered a low priority and as a result there is limited use of capital and low levels of enforcement (Purnawatt 2007). It was also noted that most developing countries have non-existent or poorly enforced legislation covering ergonomic working conditions (Purnawatt 2007). Though NSSA has been conceiving ergonomic intervention on a larger scale than is presently happening and has addressed ergonomic issues at the invitation of some multinational companies, who are aware of the multiple benefits of addressing such issues, this area still needs a more concerted effort from multiple stakeholders. According to NSSA's Annual Statistical Reports, great risks for work-related injuries have been noted in the agricultural and mining sectors and much effort has been focussed on these industries (NSSA 2010), (NSSA 2011). However, much still needs to be done in terms of identifying and addressing ergonomic issues in service sectors like academic institutions as shown by the paucity of data on the area.

In the pilot study on which we report, we sought to answer the following question: What is the level of compliance to workspace design ergonomic principles at one faculty of a Zimbabwean academic institution? The specific objectives were to determine the proportion of workstations with ergonomically friendly workspace designs, the level of knowledge of ergonomic principles in the workplace amongst employees and to determine the strengths and weaknesses in the ergonomic attributes of the workstations studied. We hope the findings will provide useful information for individuals, organisations and policy makers to reflect on and map the way forward in terms of providing an environment that is conducive to working and preventing injuries and diseases that may arise due to poor adherence to standard ergonomic principles. The findings may also be used to create awareness amongst various stakeholders so that prophylactic measures to prevent injuries and ensure maximal function in the workplace can be implemented.

2.0 Materials and Methods

A cross-sectional analysis of workstations in one faculty of an academic institution was carried out in 2011. The analysis covered information technology hardware, the furniture and other potential sources of stress. A questionnaire that was adapted from Marmaras and Papadopoulos (2003) was used to collect data. A total of 42 questionnaires were distributed to a cross-section of randomly selected offices. The assessment points related to computer hardware (monitor and keyboard), furniture (work seat and work surface), general work environment and work organisation. The questionnaire solicited both subjective and objective information. The second author collected the data which included a physical assessment of the workstation or office while the owner went about his or her usual business, and asked the owner some questions. In completing the questionnaire, a "YES" indicated compliance with recommended ergonomic standards while a "NO" indicated non-compliance (Marmaras and Papadopoulos 2003). Data were analysed descriptively using Excel and were presented in figures as percentages. Ergonomic conformity indices were calculated for each aspect. Permission to carry out the study was granted by the Dean of the Faculty in the academic institution being studied. The Institutional Review Board of the College of Health Sciences (Joint Research Ethics Committee – JREC/195/11) approved the study as sound and ethical. Informed consent was sought from participants and participation was on a voluntary basis.

3.0 Results

A total of 36 employees participated in the study. The ages ranged from 26 to 55 years with a mean age of 37 years (SD 8.5), 83% were female, 58% held secretarial positions while lecturers and laboratory technicians constituted 8% each.

Compliance of keyboard and monitor/screen

The majority of keyboard assessment points had 81–100% compliance except for insufficient space in front of the keyboard to support the user's hands, where only 14% compliance was found. The most compliant aspects of the computer monitors/screens used were steady images (100%), ease of readability of characters (100%) and absence of glare (89%). The least compliant aspects were eye level (28%) and distance of screen from the eyes (47%) (Figure I). The conformity index for the keyboard was 87% and that for the monitor was 73.7%. The overall conformity index for the two was 81.7%.

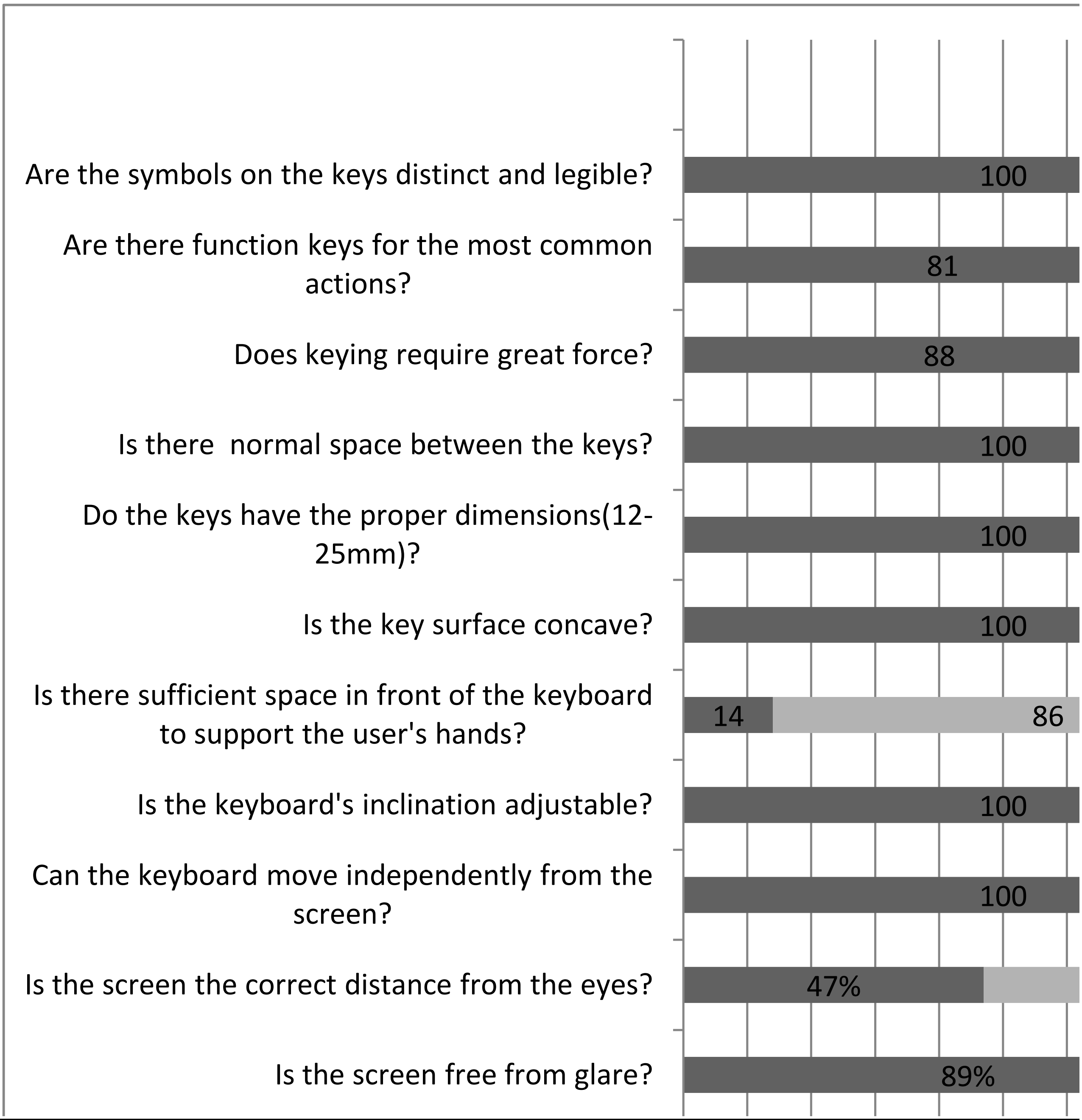

Figure I. Distribution of participants according to ergonomic compliance of keyboard and monitor/screen at one academic institution in Zimbabwe.

Compliance of work seat and work surface

The work seat and work surface/table were problematic in many workstations with overall conformity indices of 45.1% and 43.6% respectively. A number of work seat components were not compliant in terms of correct level of armrests (0%), adequate lumbar support (6%), pressure under the thighs of the participants from the edge of the seat (6%), ease of seat adjustability (8%), seat equipped with armrests (14%), relaxed shoulders (19%), freedom of movement (28%) and seat stability (28%). However, the participants' feet were firmly on the ground in all of the workstations, the thigh-shin angle was 90 to 100 degrees in 94% of workstations and the shin-foot angle was approximately 90 degrees in 94% of the workstations (Figure II).

A number of the work surface/table components were also not ergonomically compliant and these included: rounded table edges (6%), adequate space for the positioning of all equipment (11%), adequate space to support the user's hands (19%) and comfortable placement of legs under the table (22%). However, the work surfaces were all of low reflectivity and 97% had the appropriate height.

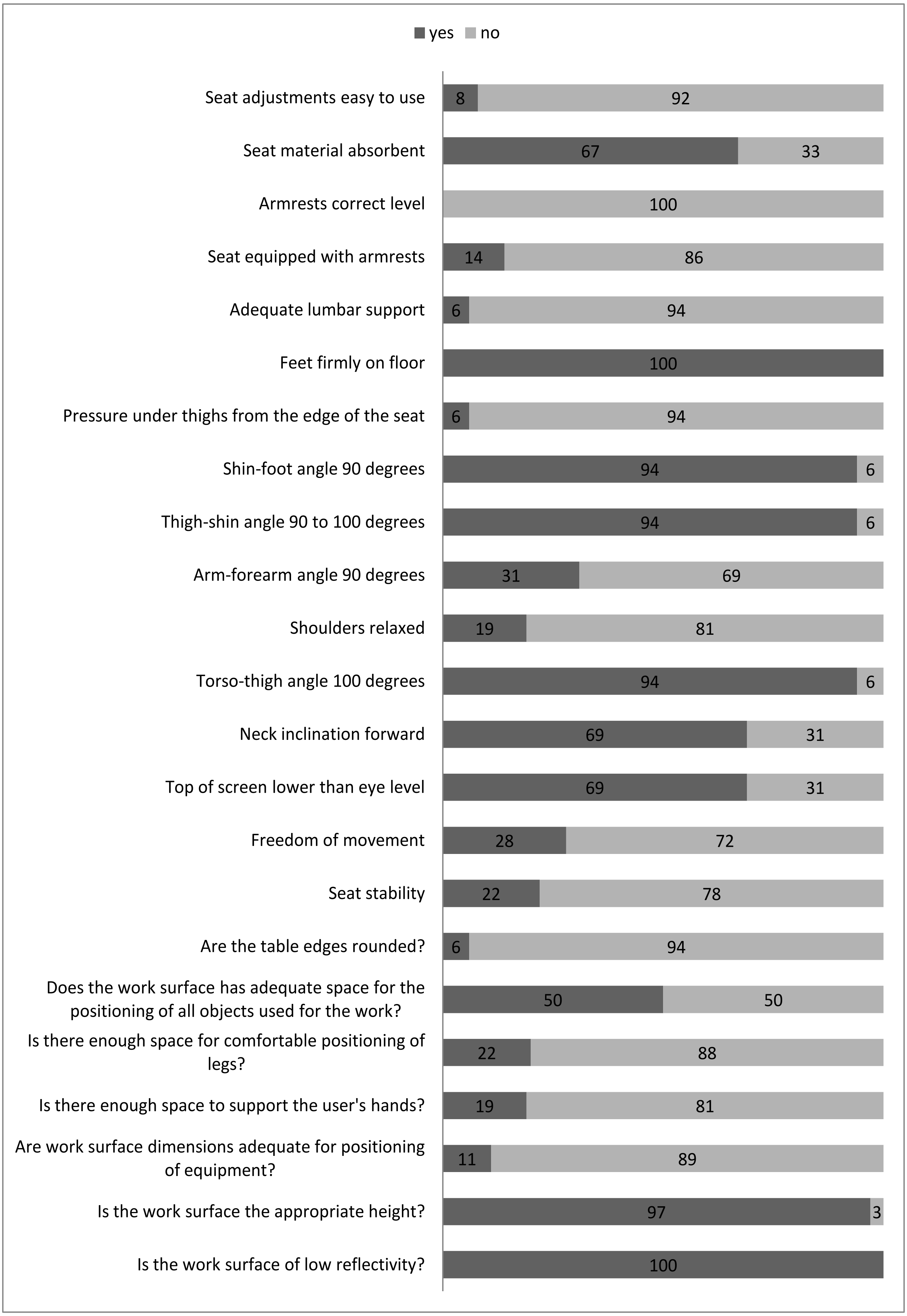

Figure II. Distribution of participants according to ergonomic compliance of work seat and work surface at one academic institution in Zimbabwe.

Compliance of the work environment

The environment component had an overall conformity index of 62.6%. The negative points were adequacy of temperatures in the work area in winter (25%), annoying glares or reflections in general work area (11%), intensity of lighting (8%) and adequacy of personal space for the user (31%). All other assessed environmental aspects (i.e. ventilation, heat from work equipment, temperatures in summer, noise levels, lighting throughout the user's visual field, adequate lighting and undeterred and safe access to the workstation) had 81% to 100% compliance with recommended ergonomic principles (Figure III).

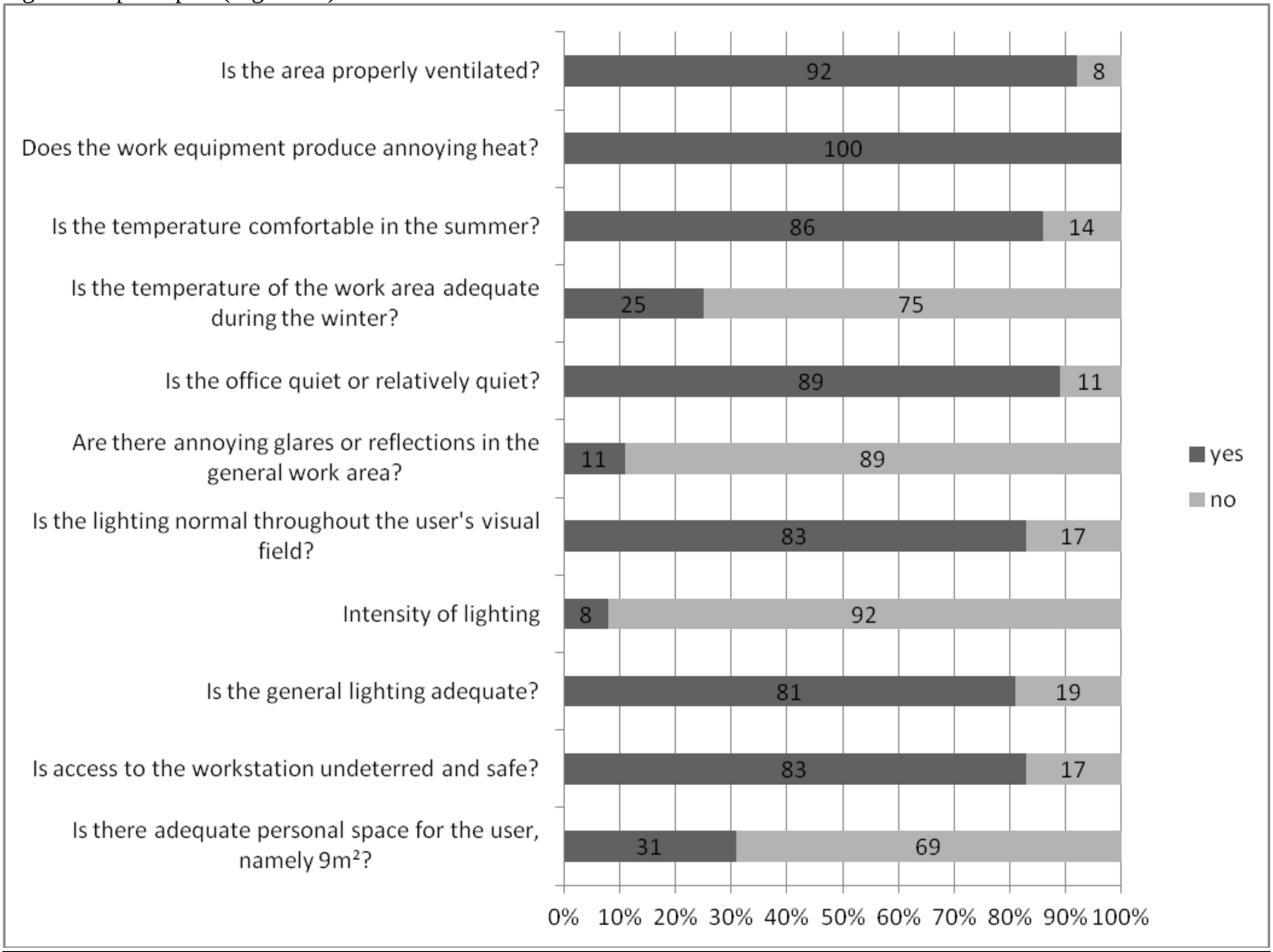

Figure III. Ergonomic compliance of the general work environment of participants at one academic institution in Zimbabwe.

Compliance of work organisation

Work organisation also met the ergonomic requirements with a conformity index of 74% in 15 assessment points. The least compliant aspects were knowledge of the science of ergonomics and the effect of poor ergonomics on the musculoskeletal system with 25% compliance each, taking 15-minute rest breaks after every two hours (14%) and alternating seated work with standing work (42%). All participants were able to correct errors before they caused serious consequences, found interest in their work and considered their work as important. All other aspects of work organisation had a compliance ranging from 72% to 97% (Figure IV).

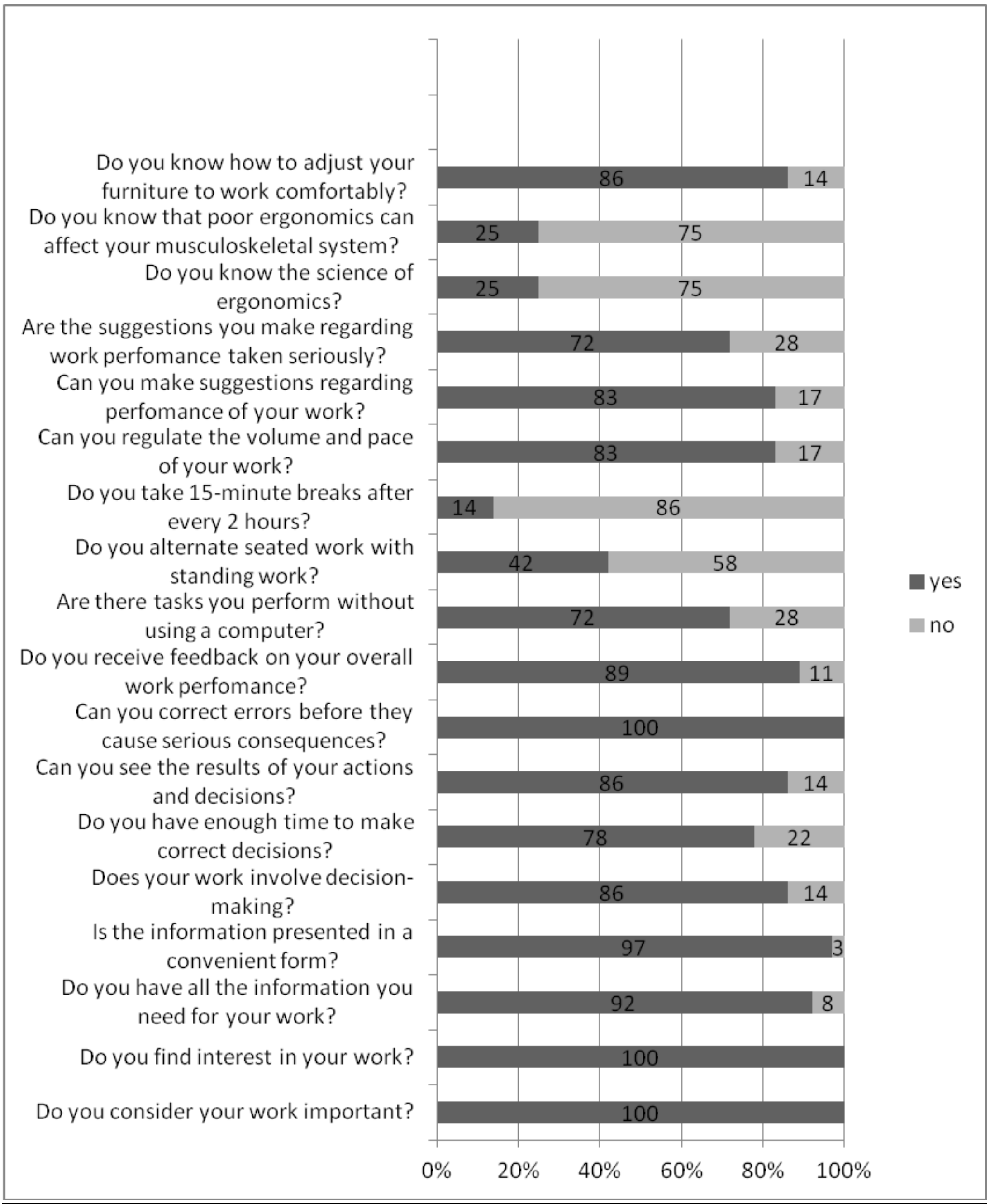

Figure IV. Compliance of the work organisation at one academic institution in Zimbabwe.

4.0 Discussion

Findings from this pilot study indicated that ergonomic principles related to work seat, work surface and general work environment were the least adhered to with conformity indices of 45.1%, 43.6% and 62.6%, respectively. The most adhered to ergonomic principles were related to computer hardware and work organisation with compliance indices of 81.7% and 74% respectively.

The weakest assessment points for the work seat were to do with level of arm rests, lumbar support, seat adjustability, availability of arm rests, relaxed shoulders, freedom of movement and seat stability. This finding is in contrast to what Marmaras and Papadopoulos' (2003) found in their study in which the work seat was not a problem. The difference can be explained by differences in settings as Marmaras and Papadopoulos' study was done in a developed country. Forearm support was found to decrease incident cases of upper extremity musculoskeletal disorders and neck–shoulder discomfort (Conlon, Krause and Rempel 2007). Schierhout, Meyers, and Bridger (1995) also found that workplace ergonomic exposures were significantly associated with musculoskeletal pain of the neck and shoulders. Work chairs should provide adequate support for the user while working, and it should not place stress on any part of the worker's body (Occupational Hygiene Learning Student Handbook 2010). Three major factors to be considered when sitting on a work chair are the posture of the spine (i.e. position and pressure within the discs, the type and amount of muscle work required to maintain work postures), individual fatigue tolerance levels, and compression of tissues (Occupational Hygiene Learning Student Handbook 2010). In addition, chair height should be sufficiently adjustable.

The work surfaces/tables had rounded edges in only 6%, there was adequate space for positioning of all equipment in 11%, adequate space to support the user's hands in 19% and comfortable placement of the legs under the table in 22%. In sitting, there should be enough space between the underside of the work surface and the seat for the legs and to allow movement (Occupational Hygiene Learning Student Handbook 2010). Forearm support and ergonomic training were found to have a protective effect against upper body musculoskeletal disorders (Rempel et al 2006). In the same study, it was noted that a return on ergonomic compliance investment could be realised within 10.6 months. General poor physical environment and poor placement of the keyboard were reported to increase the risk of neck pain (Korhonen et al 2003). Occupational Hygiene Learning recommends that the height of work surfaces be raised to achieve minimal neck flexion in case of fine work involving close visual distances, and arm supports should be provided where appropriate (Occupational Hygiene Learning Student Handbook 2010). The statement below sums up some of the recommended ergonomic principles and suggestions to achieve them:

> "Ideally the desk and chair should be height adjustable, with the chair having a properly shaped and padded adjustable back support. Alternatively, if cost is a problem, different height chairs with an adjustable footstool or foot rail may be a solution. Most importantly, users should be given instructions on how to adjust the workstation for themselves and why it is important" (Occupational Hygiene Learning Student Handbook 2010).

The weakest assessment points with regard to the environment were annoying glares or reflections in the working area, cold in winter, too much lighting and inadequate personal space for the user. According to Occupational Hygiene Learning, "lighting either natural or artificial should create no glare, bright spots or annoying reflections in the visual field of the computer user" (Occupational Hygiene Learning Student Handbook 2010). Positioning of computers away from windows can avoid reflections and reduce glare. This can be achieved using curtains and/or blinds. Work surfaces with high reflectivity or excessive bright lighting can also cause annoying glare. Eyes are unable to adapt to these extreme lighting conditions; hence, need to reduce the problem. The problem is illustrated well in this statement:

> "Visual discomfort, visual fatigue, and reduced vision are consequences of environments that lack well designed or well controlled lighting... luminance that is very high can create glare; high contrasts can contribute to fatigue from the eyes continually readapting; and low luminance reduces the user's ability to detect detail"(Occupational Hygiene Learning Student Handbook 2010).

It is therefore important that issues of lighting in work environments be addressed. Similarly, the human body has a relatively constant temperature (around 37 degrees Celsius, plus or minus 1 degree), which must be controlled to maintain optimal body and brain functioning. Distraction and/or arousal from feeling too hot or cold at work may reduce work performance and productivity, and could also result in increased absenteeism (Occupational Hygiene Learning Student Handbook 2010). Cold can affect psychological responses, mood and personality, and can directly affect performance through decreased arousal, reduced memory capacity, and perception if the body's core temperature drops (Occupational Hygiene Learning Student Handbook 2010).

Under work organisation, only 14% took frequent rest breaks after every two hours and 42% alternated seated and standing work. It is advised that posture should not be maintained for more than 15 to 20 minutes without changing, and "no seat, no matter how comfortable, will allow the user to sit comfortably for more than an hour at a time without having to move and make significant changes in posture"(Occupational Hygiene Learning Student Handbook 2010). It is recommended that seated work be mixed with standing and walking (Schierhout, Meyers and Bridger 1995), (Korhonen et al), (Juul-Kristensen et al 2004). Taking rest breaks have also been found to be important in preventing work-related physical and mental fatigue (Cason 2012).

A quarter of the sample was knowledgeable on the science of ergonomics and the effect of poor ergonomics on the musculoskeletal system. This may be a reflection of the knowledge for most of the ordinary employees in Zimbabwean institutions. There is need to raise awareness among office workers regarding the dangers of poor ergonomics and the small adjustments they can make at an individual or institutional level to address the problems. Improvements in workstation design and procedures have been found to have a payback period of less than one year when costs of intervention are compared with total costs of musculoskeletal disorders (Rempel and Janowitz 2007).

In summary, if adhered to, ergonomics principles can prevent future injuries thereby promoting a healthy workforce with multiplier benefits of higher productivity and reduced compensation claims. To achieve optimal working conditions, the workplace layout and work systems require careful design and all workspaces need regular reviews to ensure that they are adequate and provide a safe and healthy work area.

NSSA initiated some programmes meant to address ergonomic issues in the work place in the 1990s (1997–2000 to be precise) but the programmes stalled due to resource constraints emanating from the prevailing economic conditions at the time. NSSA has since resuscitated the programme and employed an ergonomist who is now putting structures in place to promote ergonomics starting with the development of appropriate risk assessment tools. This is encouraging as it shows that NSSA is aware of the problem and is committed to address it.

Limitations

This was a pilot study with a small sample size of mostly secretarial staff workstations, which as such limits the external validity of the findings. The data was collected shortly after the country had started recovering from more than a decade of harsh economic conditions, which may have led public institutions including Universities not to prioritise furniture.

5.0 Conclusions

Most aspects found wanting in this study were related to furniture and general work environment and many of the shortcomings needed small adjustments to the work area in order to solve. Ergonomic principles related to computer hardware and work organisation were the most adhered to owing to the fact that computer manufacturers follow certain international standards that ensure conformity with safety standards. The few points under computer hardware with low compliance were related to office layout and furniture.

6.0 Recommendations

The curricula of medical and rehabilitation personnel should be reviewed in light of the findings to ensure that these professionals are adequately trained to deal with issues of prevention, identification and treatment of injuries arising from poor adherence to good ergonomic principles. An occupational safety and health system can also be put in place within the institution.

To the institution in question, we recommend an upgrade of the desks and chairs in approximately 55% of the assessed workstations, educating buyers and other people responsible for office workstations layout on ergonomic principles and user's training on adopting comfortable and non-hazardous postures as well as ways in which these postures can be achieved.

Acknowledgements

We are very grateful to the University of Zimbabwe College of Health Sciences for sponsoring the preparation of the manuscript through the SACORE sponsored Chris Kapp Workshop on Manuscript Writing. The data on which this manuscript is based was collected as part of a research report submitted to the department of Rehabilitation, College of Health Sciences in partial fulfilment of the BSc HPT by one of the co-authors. We would also like to acknowledge the input we received from NSSA.

Author's Contributions:

Tecla Mlambo and Churchill Chirubvu were involved in the conseptualisation, data analysis and write-up. Shamiso Muteti was involved in data analysis and write-up.

References

1. Aara˚s, A., Horgen G., Bjørset H.H. (1998). Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic intervention. *Appl Ergon* 29: 334–54.
2. Aara˚s, A., Horgen, G., Bjørset, H.H. (2001). Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic intervention: A 6 year prospective study—Part II. *Applied Ergonomics* 32: 559–571.
3. Alexander, L. M., & Currie, C. (2004). Young people's computer use: implications for health education. *Health Education 104*(4): 254-261.
4. Ariëns, G.A.M., Bongers, P.M., Hoogendoorn, W.E., Houtman, I.L.D., Van Der Wal, G.,G Van Mechelen, W. (2001). High quantitative job demands and low co-worker support as risk factors for neck pain. *Spine* 17: 1896-1903.
5. Cason, D. L. D. (2012). Ergonomic principles and tools for best interdisciplinary psycho-physical stress prevention. *Work: A Journal of Prevention, Assessment and Rehabilitation 41*,:3920-3922.
6. Conlon, C.F., N Krause, N., Rempel, D.M. (2007). A randomised controlled trial evaluating an alternative mouse and forearm support on the upper body discomfort and musculoskeletal disorders among engineers. Occupational and Environmental Medicine 65:311-318.doi. 10.1136/oem.2006.032243
7. Health and Safety Executive (2010). Understanding Ergonomics at work. Retrieved from www.hse.gov.uk/pubns/indg90.pdf
8. Ijmker, S., Huysmans, M.A., Van der Beek, A.J., Knol, D.L., van Michelen, W., Bongers,P.M., Blatter, B.M. (2011). Software-recorded and self-reported duration of computer use in relation to the onset of severe-arm-wrist-hand pain and neck-shoulder pain. Occupational and Environmental Medicine **68**:502-509 .doi:10.1136/oem.2010.056267
9. International Labour Organisation (2009). Occupational safety and health; International Labour Conference 98th Session. Report III (Part B).
10. Jayaratne, K. (2012). Ergonomic considerations in school environments - the need for widening the scope. *Work* 41; 5543-5546 doi: 10.3233/WOR-2012-0877-5543
11. Juul-Kristensen, B., Søgaard, K., Støyer, J., & Jensen, C. (2004). Computer users' risk factors for developing shoulder, elbow and back symptoms. *Scandinavian journal of work, environment & health* 390-398.

12. Korhonen, T., Ketola, R.,Toivonen, R., Luukkonen,R., Hakkanen, M., Viikari-Juntura, E. (2003) 2003. Work related and individual predictors for incident neck pain among office employees working with video display units. Occupational and Environmental Medicine 60:475-482
13. Marmaras, N., Papadopoulos, S. (2003). Studies of computerised offices in Greece are ergonomic requirements being met. *International Journal of Human-computer Interaction* 16(2): 261-281
14. National Social Security Authority (2010). National Social Security Authority Annual Statistical Report 2010
15. National Social Security Authority (2011). National Social Security Authority Annual Statistical Report 2011
16. Occupational Hygiene Learning. Student Handbook :Ergonomic Essentials 2009; Retrieved from http://www.ohlearning.com/Files/Student/JF02%20v1-0%2010Apr10%20W506%20Student%20Manual1.pdf
17. Pope, M.H., Goh, K.L., Magnusson, M.L. (2002). Participatory ergonomics approach to reduce mental and physical workload, International Spine Ergonomics. *Annual Biomedical Journal* 4: 49-68.
18. Purnawatt, S. (2007). Occupational health and safety-ergonomics improvement as a corporate responsibility of a Bali handicraft company: A case study. J. Human Ergo 36: 75-80
19. Rempel, D.M, Janowitz, I.L. (2007). *Ergonomics and the prevention of occupational injuries*, In Joseph LaDou (editor).Current occupational and environmental medicine. 4th edition. McGraw Hill Medical, 151-174
20. Rempel, D.M., Krause, N., Goldberg, R., Benner, D., Hudes, M., G U Goldner, G.U. (2006). A randomised control trial evaluating the effects of two workstation interventions on upper body pain and incident musculoskeletal disorders among computer operators. Occupational and Environmental Medicine. 63:300306. doi:10.1136/oem.2005.022285
21. Schierhout, G. H., Meyers, J. E., & Bridger, R. S. (1995). Work related musculoskeletal disorders and ergonomic stressors in the South African workforce. *Occupational and environmental medicine 52*(1): 46-50.
22. Selby, N.C.S. & Triano, J.J. (2006). Office Chair, Posture and driving ergonomics. Retrieved from http://www.spine-health.com/topics/cd/ergo/ergo03.html. [3 August 2007].
23. Sudoł-Szopińska, I. (2006). Influence of prolonged sedentary work on the development of lower limbs edema and methods of its prevention. *Medycyna Pracy* 57(3):. 263-9. PMID: 17125033 [PubMed - indexed for MEDLINE]
24. Venables, K. M., & Allender, S. (2006). Occupational health needs of universities: a review with an emphasis on the United Kingdom. *Occupational and environmental medicine 63*(3): 159-167.