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The ergonomics of working from home during the pandemic COVID -19

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บทคัดย่อ: เนื่องด้วยการแพร่ระบาดของไวรัสโคโรนา 2019 ทำให้การทำงานจากที่บ้านได้กลายเป็นเรื่องปกติใหม่ที่เปลี่ยนแปลงการทำงานของหลายบริษัท ที่ไม่สามารถทำงานที่บ้านได้ ทำให้เกิดสถานที่ทำงานที่ไม่ถูกหลักการยศาสตร์ ซึ่งทางที่ไม่เหมาะสม การเคลื่อนไหวซ้ำๆ และการทำงานเป็นเวลางานเป็นบัญหา สุขภาพที่สำคัญที่เกิดจาก การใช้คอมพิวเตอร์เคลื่อนที่และท่าทางที่ไม่เหมาะสม นำไปสู่ความผิดปกติของระบบกล้ามเนื้อและกระดูก นอกจากนี้ สภาพแวดล้อมภายในอาคารซึ่งประกอบด้วย แสงสว่าง การระบายความร้อน และสภาพเสียงรบกวนยังเป็นปัจจัยที่ด้านการยศาสตร์ สิ่งเหล่านี้ไม่เพียงแต่ทำให้เกิดความรู้สึกไม่สบายเท่านั้น แต่ยังส่งผลต่อสุขภาพจิตและร่างกายของพนักงานอีกด้วย วัตถุประสงค์ของการศึกษานี้มุ่งเน้นไปที่ผลกระทบของ สภาพแวดล้อมที่ไม่เอื้ออำนวยในสถานที่ทำงานที่บ้านซึ่งเกี่ยวข้องกับการยศาสตร์และปัจจัยสุขภาพ รวมทั้งนำเสนอคำแนะนำในการออกแบบสถานที่ การทำงานตามหลักการทางการยศาสตร์ในสำนักงานที่บ้าน ประกอบด้วยการรอกแบบสถานที่การทำงานของหน้าจอคอมพิวเตอร์ที่ควรอยู่ในระดับเดียวกับกับ ระดับสายตา การจัดที่ห้วยแบบพิมพ์และแม่ล็อต เสื่อม การเพิ่มการเคลื่อนไหวของร่างกายและการจัดสภาพแวดล้อมโดยรอบในสำนักงานที่บ้าน ซึ่งการวิจัยหลาย ชิ้นได้มีการศึกษาและแนะนำให้ปรับปรุงสถานที่งานเพื่อให้เกิดความสะดวกสบายและประสิทธิผลในระหว่างการทำงานจากบ้าน อย่างไรก็ตาม การสำรวจและประเมิน ต่างๆ ของบุคคลเกี่ยวกับความรู้สึกไม่สบายตัวเป็นเรื่องที่มีผลลัพธ์ การวิจัยเพิ่มเติมอาจจำเป็นในการสำรวจโดยใช้แบบสอบถามเพื่อศึกษาผลกระทบของการ ทำงานที่บ้านที่มีต่อความพึงพอใจในงาน ความเครียดที่เกี่ยวกับการทำงาน ประสิทธิภาพในการทำงานรวมถึงความรู้สึกที่ไม่สบายที่อาจจำเป็น คุณภาพผิวกระดูก ของระบบกล้ามเนื้อและกระดูก

ABSTRACT: As the outbreak of the COVID-19 pandemic, work from home has become the new normal which shifted the work from office to work from home reducing face-to-face contact in many companies worldwide. With this rapid change, most of people are abruptly forced to work from home with non-ergonomically home-based worksite. The awkward posture, repetitive movement and prolonged working are the major health issues caused by the use of mobile computer and non-neutral postures which lead to musculoskeletal disorder. Furthermore, indoor environment which are lighting, thermal comfort, and noise condition are ergonomic concerns. These can not only cause discomfort but also affect mental and physical health on home office worker. The purpose of this review was to focus on the impact of the unfavorable conditions at home office relating ergonomic concerns on health issue. The recommendation of ergonomic principles to design workstation in home office was also represented in this review. Design workstation that setting the laptop screen as the eye level, providing the external keyboard and mouse, increasing the body movement and setting up the surrounding environment in home-office was investigated in several researches and was recommended to enhance health, comfort and productivity during working from home. However, it would be interesting to survey the different aspects of individuals regarding body discomfort. Further research might explore through questionnaires to study the role of home working on job satisfaction, stress, perceived productivity including body discomfort leading to MSDs in order to examine the relationship between physical and mental health and working from home.

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Keywords: Work from home, Home working, COVID-19, Ergonomic, Musculoskeletal disorder

1. INTRODUCTION

The idea of working from home is gaining popularity and becoming a new normal due to advanced technology so that we can work remotely. Furthermore, in the early 2020, the coronavirus disease 2019 spread globally. To minimize direct contact among individuals and reduce new infectious cases, several companies in both governmental and private sections utilized “social distancing” and “work-from-home (WFH)” in order to work from their own place without the daily commute using available technological tools. What is more, ergonomics research has not studied the pros and cons of this teleworking style. In general, the positive aspects of WFH were promoted and recognized worldwide that it can considerably reduce the risk of COVID-19 exposure and other advantages i.e., less commuting time, low facility fees, more flexible working schedule, and high productivity gain. However, the disadvantages such as poor physical well-being, substandard working posture, and unregulated indoor environmental quality were yet not profoundly investigated. For a long-term, these downsides can compromise worker’s health and cause ergonomic challenges. This article aimed to uncover and review the new coming unfavorable aspects during the lockdown situation i.e., ergonomic and environmental issues.

2. ERGONOMIC ASPECTS AND HEALTH ISSUES

In the subsequent sections, we present a summary of a scientific literature review focused on the following aspects:

2.1 Workstation

The effect of COVID-19 causing the new normal changed the working style from office to home with mostly laptops. There are health risks associated with body posture. Although a mobile computer is a major equipment for work, it is related to sitting which is fixed, constrained or awkward postures including repetitive movement and prolonged working [1]. Most of the researchers found that laptop affected user’s neck flexion and neck extensor more than a classical desktop computer [2]. In addition, head, shoulder, and wrist position while using laptop on their lap is concerned [1, 2]. The limitation of movement and body discomfort for a long period leads to poor postures resulting in musculoskeletal disorders (MSDs). These can cause muscle strain and back pain [3]. Harrington and Walker [4] presented that almost fifty percent of home workers confronted the computer vision syndromes, which are sore eyes, tired eyes, and blurry vision, as well as body discomforts that include headache, neck, shoulder, back, and wrist pain. With the design of a workstation, some researchers found that the design of computer worksite in the cooperative office is set up as a minimum ergonomics criterion [4]. Furthermore, a checklist for ergonomic office and ergonomist is available to make sure that the company meets the ergonomic standard. However, previous studies have not dealt with the guidelines on how to design ‘mobile workplace’ where workspace is unfavorable.

2.2 Awkward postures

With awkward postures while using laptop, due to laptop is designed as portable, user can bring it to any places with different non-ergonomic postures. These postures include sit or lie down on the floor, bed, chair or sofa causing awkward posture or non-neutral posture. The study of Grozdanovic and Pavlovic-Veselinovic [5] found that telecommuting workers who work at home office performed the tasks in a variety of rooms such as living room, bedroom, dining room, kitchen room and other rooms in the house accounted for 30% , 27% , 22% , 5% , and 16% respectively. Consequently, the telecommuters tend to increase the risk of posture by sitting on folding chairs, sofas, beds or at coffee tables, which is not designed for working. The study of Heidari et al. [6] investigated the different postures in laptop users who performed a variety of postures in any workplace. They presented that 77.3% of those aged 19-30 reported the neck, shoulder, forearm, arms, and wrist discomfort after using laptop. Over half of those surveyed indicated that the most discomfort was the neck. The result of this study demonstrated that posture 1 (Figure 1) which is sitting on the sofa without neck/head support and laptop on the lap and posture 2 (Figure 2) which is sitting on the floor, leaning the wall and laptop on the lap was more proper sitting while posture 3 (Figure 3) which is laptop on the floor and lying with chest support in the position of the chest down and the back up and posture 4 (Figure 4) which is sitting on the ground and laptop on the knee were the worst sitting leading to MSDs. However, although posture 4 was not the most posture they perform, posture 4 which the assessment defined as a non-neutral posture causing neck pain and discomfort was the top three selected by participants [6, 7].



Figure 1: Sitting on the sofa without neck/head support and laptop on the lap



Figure 2: Sitting on the floor, leaning the wall and laptop on the lap was more proper sitting



Figure 3: Laptop on the floor and lying with chest support in the position of the chest down and the back up

Furthermore, the poor design of the keyboard and screen may cause the injury resulting from awkward posture because the laptop computer screen and keyboard are connected as one unit. As a result, the conflict between neck and shoulder occurred regarding work position adjustment [7]. The research revealed that the high level of keyboard can increase risk of injury on shoulder and wrist and the low level of screen can enhance the neck and shoulder pain [8]. This view is supported by Seghers, Jochem and Spaepen [9] that the adjustment of the level of screen to the table height reduced the neck's user flexion while the high level of keyboard improved shoulder and neck discomfort because the shoulder was raised to approach the keyboard. Similarly, the research pointed out that the integration of keyboard and screen affects the body posture resulting in discomfort and injury.



Figure 4: Sitting on the ground and laptop on the knee

2.3 Repetitive movement and prolonged working

Regarding repetitive movement and prolonged working hours, these can increase the risk of MSDs of the wrist and arm [10]. Non-neutral posture, which is repetitive movement especially typing and prolonged working, increased possibility of MSDs [11-13]. The previous study represented that when compared with one factor, the exposure both non-ergonomic posture which is the flexion angle of neck, shoulder, elbow, arm and wrist and repetitive motion for a long time can increase the risk of MSDs [10]. Moreover, in a term of flexible working hour, although home-based working gives employees the scheduling flexibility that they can not only manage their task from home office, a number of researchers have concerned about the prolonged working because of the non-separate between working space and relaxing space [14, 15].

Normally, going home after work allows employees to detach from the stressors from work whereas working from home enhances the difficulty with work and home life separation. This can not only cause burnout and create work-related stress but also lead to MSDs. Although some research findings into the duration and discomfort have been inconsistent [16, 17], the study of Gerr, Marcus and Monteilh [12] explored the relationship between the duration of computer use and the risk of MSDs that the participants reported through a questionnaire regarding neck and shoulder pain when the duration of computer use increases. Fahrbach and Chapman [11] also found that some participants who reported the discomfort used the computer more than four hours per day. Similarly, Bergqvist et al [18] investigated computer users who spent time more than 30 hours per week. The result showed the significant musculoskeletal symptoms on arm and shoulder. However, Blangsted, Hansen and Jensen [19] examined that the repetitive movement of fingers and wrists while typing the keyboard and using the mouse improved forearm and hand/wrist discomfort. This finding is in agreement with Marcus et al [13] findings which showed

the association of hand-arm discomfort from time spent using computer over 15 hours per week. Moreover, they represented that the risks developed more than double when the spending time 20 hours per week. Without using mouse, the risks still increased hand-wrist symptom because of repetitive movement with keyboard. Moreover, previous investigators have examined the effects of working time factors on neck discomfort [20]. It is showed that the working posture which the neck flexion for a long time involved in neck symptom significantly. Some researchers have mainly been interested in concerning working time and body discomfort. The study found that neck symptom was developed with the duration of sitting among office workers because of an increases force on vertebral discs, ligaments and muscles while sitting. This is supported by Kamwendo, Linton and Moritz [21] who surveyed the neck discomfort and found that it was reported by workers who sat for 5 hours per day.

2.4 Indoor environmental aspects

From occupational health and safety standpoint, the workplace environment usually consists of several categories such as aerosols, lighting, noise and vibration, and thermal comfort depending on the products and services. Since the work-from-home (WFH) was ordered to prevent the COVID-19 situation. It can be noted that the newly adapted home-office may not be specifically designed for work as good as the regular office. This section will review some concerning factors related to surrounding environment that workers can possibly experience due to WFH. The discussion below will limit itself to home lighting, thermal comfort, and noise conditions.

2.4.1 Lighting

Lighting was listed as an important physical condition for work [22]. Either too much or poor lighting can affect the performance and visual discomfort. It should be considered that the lighting quality and flexibility at the home and the office is slightly different. Mostly, the office was designed to possess optimal light level according to the task, the angle of workstation, and the working surface. For teleworkers, poor lighting was relatively reported to be an usual problem because it is not easy to adjust and optimize both natural lighting (sunlight) and artificial lighting (fluorescence) [23]. The lighting may not cause any major accident or initiate obvious MSDs, but it can easily generate discomfort, which can affect workers' well-being such as high stress level, poor sleep quality, and mood shifted.

2.4.2 Thermal comfort

The ideal, for most people, relative humidity is between 40%-60% and a room temperature is between 18°C-22°C [24]. These parameters are used as a comfort indicator for human. You may have known that the air quality at the office is usually regulated by the central air system, meanwhile working at home has no such thing [25]. Similar to lighting, working under undesirable temperature and humidity at home may lead to discomfort, which can certainly affect mental and physical health.

2.4.3 Noise

Noise is defined as unwanted sound, which can be sensed by auditory nerves in the ear [26]. The noise generated from workplace and residential area is quite different. It may be true that the noise levels from the work area are usually higher than from the home, but the pattern and the loudness is much more unpredictable at home. The teleworkers may experience excessive or interrupting noise from everywhere such as family members, kitchen, living room, music, or even the traffic. Although the level is not high enough to cause hearing loss, but it can interfere the performance, communication, and their concentration.

3. CONCLUSION AND RECOMMENDATION

Workstation design which included working posture, duration of working, and workplace environment are essential for health and safety including comfort, productivity and performance. Since a homeworker needs to spend several hours in front of the portable computer which is not designed ergonomically for a prolonged working hour, the combination of the parts of laptop, therefore, is the health concern causing work-related musculoskeletal disorder. So, the ergonomic recommendation of design workstation decreasing health issues and improving comfort is included. First of all, selecting suitable equipment in order to adjust the working posture in a neutral posture should be addressed. Janneck et al [27] recommended that the adjustable chair which can modify the backrest to support the worker's spine and the armrest to fit the different postures was the most important because these can avoid body discomfort and improve the performance while working. However, it may hard to find the ergonomic chair for a home-based worksite, so providing the proper equipment and adjusting the posture need to be considered. First, sit in a comfortable, adjustable chair with lumbar support such as additional foam back cushion because this will help reduces the pressure and force on vertebral discs, ligaments and muscles while sitting. However, do not work on sofa although sofa is comfortable since this not only cause the worst posture when performing the task but lead to the relaxing feeling which is difficult to get up and move around.

Set the laptop screen as the eye level without neck bending which means the elevation the laptop by adding the supporter such as computer monitor pedestal, laptop stand or computer riser in order to lift the screen height in any workplace at home. For example, even some home workers may perform their work on a kitchen or dining room table, setting up the display height as eye level can avoid neck discomfort. Provide the external keyboard and mouse. Since the laptop display, keyboard and touchpad are designed as a single unit, it is too complicated to find the optimal position of both display and keyboard without discomfort. Consequently, the external keyboard and wireless mouse with elbows at a 90° position when typing or clicking should be adjusted to decrease the lift of shoulder for approaching the internal keyboard and touchpad.

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Regarding long hours spent working, designing the sit-stand workstation in order to increase physical activity which is body movement and body adjustment can reduce the static posture. There is some study found that the decrease of sitting time while working improved the worker's perception of comfort and productivity [28]. Moreover, take micro breaks every half hour or hour, move around and stretch part of the body.

For the environmental aspects, the employees may need to help the workers to set up their home-office to be as comfortable as possible. This new normal not only can affect their well-being, but also causing poor working performance. Therefore, in order to keep the work and life quality, it is necessary to pay attention and improve the home-office to be as good as working at the office.

REFERENCES

- [1] Montreuil S, Lippel K. Telework and occupational health: a Quebec empirical study and regulatory implications. *Safety Science*. 2003;41(4):339-58.
- [2] Werth AJ, Babski-Reeves K, editors. Assessing posture while typing on portable computing devices in traditional work environments and at home. Proceedings of the Human Factors and Ergonomics Society Annual Meeting; 2012: SAGE Publications Sage CA: Los Angeles, CA.
- [3] de Macedo TAM, Cabral E, Silva Castro WR, de Souza Junior CC, da Costa Junior JF, Pedrosa FM, et al. Ergonomics and telework: A systematic review. *Work*. 2020;66(4):777-88.
- [4] Harrington SS, Walker BL. The effects of ergonomics training on the knowledge, attitudes, and practices of teleworkers. *Journal of Safety Research*. 2004;35(1):13-22.
- [5] Grozdanovic M, Pavlovic-Veselinovic S, editors. Framework for teleworking. 5th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Service TELSIKS 2001 Proceedings of Papers (Cat No 01EX517); 2001: IEEE.
- [6] Heidari H, Arsang S, Mahmoodi M, Ramezani F. Ergonomic Analysis of the Neck Posture in Computer Users and Identifying the Related Risk Factors. *Archives of Occupational Health*. 2019;3(4):430-7.
- [7] Asundi K, Odell D, Luce A, Dennerlein JT. Notebook computer use on a desk, lap and lap support: effects on posture, performance and comfort. *Ergonomics*. 2010;53(1):74-82.
- [8] Ellison JK. Ergonomics for telecommuters and other remote workers. *Professional Safety*. 2012;57(6):86-90.
- [9] Seghers J, Jochem A, Spaepen A. Posture, muscle activity and muscle fatigue in prolonged VDT work at different screen height settings. *Ergonomics*. 2003;46(7):714-30.
- [10] Wahlström J. Ergonomics, musculoskeletal disorders and computer work. *Occupational Medicine*. 2005;55(3):168-76.

- [11] Fahrbach PA, Chapman LJ. VDT work duration and musculoskeletal discomfort. *AAOHN Journal*. 1990;38(1):32-6.
- [12] Gerr F, Marcus M, Monteilh C. Epidemiology of musculoskeletal disorders among computer users: lesson learned from the role of posture and keyboard use. *Journal of Electromyography and Kinesiology*. 2004;14(1):25-31.
- [13] Marcus M, Gerr F, Monteilh C, Ortiz DJ, Gentry E, Cohen S, et al. A prospective study of computer users: II. Postural risk factors for musculoskeletal symptoms and disorders. *American journal of industrial medicine*. 2002;41(4):236-49.
- [14] Lundberg U, Lindfors P. Psychophysiological reactions to telework in female and male white-collar workers. *Journal of Occupational Health Psychology*. 2002;7(4):354.
- [15] Hill EJ, Hawkins AJ, Miller BC. Work and family in the virtual office: Perceived influences of mobile telework. *Family relations*. 1996;293-301.
- [16] Evans O, Patterson K. Predictors of neck and shoulder pain in non-secretarial computer users. *International Journal of Industrial Ergonomics*. 2000;26(3):357-65.
- [17] Sauter SL, Gottlieb MS, Jones KC, Dodson VN, Rohrer KM. Job and health implications of VDT use: initial results of the Wisconsin-NIOSH study. *Communications of the ACM*. 1983;26(4):284-94.
- [18] Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics*. 1995;38(4):763-76.
- [19] Blangsted AK, Hansen K, Jensen C. Muscle activity during computer-based office work in relation to self-reported job demands and gender. *European journal of applied physiology*. 2003;89(3-4):352-8.
- [20] Cagnie B, Danneels L, Van Tiggelen D, De Loose V, Cambier D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. *European Spine Journal*. 2007;16(5):679-86.
- [21] Kamwendo K, Linton S, Moritz U. Neck and shoulder disorders in medical secretaries. Part I. Pain prevalence and risk factors. *Scandinavian journal of rehabilitation medicine*. 1991;23(3):127.
- [22] Preto S, Gomes CC, editors. *Lighting in the workplace: Recommended illuminance (LUX) at workplace environs*. International Conference on Applied Human Factors and Ergonomics; 2018: Springer.
- [23] Davis KG, Kotowski SE, Daniel D, Gerding T, Naylor J, Syck M. The home office: ergonomic Lessons From the “new normal”. *Ergonomics in Design*. 2020;28(4):4-10.
- [24] Wolkoff P. Indoor air humidity, air quality, and health—An overview. *International journal of hygiene and environmental health*. 2018;221(3):376-90.
- [25] Ormandy D, Ezratty V. Health and thermal comfort: From WHO guidance to housing strategies. *Energy Policy*. 2012;49:116-21.

- [26] Lie A, Skogstad M, Johannessen HA, Tynes T, Mehlum IS, Nordby K-C, et al. Occupational noise exposure and hearing: a systematic review. International archives of occupational and environmental health. 2016;89(3):351-72.
- [27] Janneck M, Jent S, Weber P, Nissen H. Ergonomics to go: Designing the mobile workspace. International Journal of Human-Computer Interaction. 2018;34(11):1052-62.
- [28] Allen TD, Golden TD, Shockley KM. How effective is telecommuting? Assessing the status of our scientific findings. Psychological Science in the Public Interest. 2015;16(2):40-68.