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Computer ergonomic hazards in Malaysia: Does daily computer usage matter?

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Abstract

While the ever-increasing usage of computers in workplace has enhanced the speed and efficiency of job tasks, its impact on employees' health due to over-usage cannot be ignored. This study is conducted to investigate whether daily computer usage mediate the influence of workstation design and workplace environment towards computer ergonomic hazards among office staff in Klang Valley. A total of 340 office staff from four district areas were selected using online survey. One Sample t-test, Independent Sample t-test, and mediating testing using SPSS Process Macro Model 4 were used to analyse the data. The study reveals that respondents possess a high level of awareness of computer ergonomics hazards, but nearly all of the office staff surveyed do not pay attention to the practice of ergonomics. Consistent with Activity Theory, the result reveals that daily computer usage mediates the relationship between workstation design and computer ergonomic hazards whereby prolonged usage of computer (more than 10 hours per day) in improper posture and limited movements have created certain associated health problems. This study is significant to the office management in order to create awareness of computer ergonomics practice, establish ergonomic guidelines, and restructuring duties as well as increase variety in activities being performed for the sake to avoid the staff from prolong use of computers.

***Keywords*:** computer ergonomic hazards; daily computer usage; workstation design; workplace environment; activity theory.

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Introduction

Computers have become an integral part of modern life. The use of the computer is rapidly becoming a key component of professional life of human in many parts of the world. It is almost difficult to imagine a job or a task that should be completed without using computers (Simsek, 2011), due to the facts that these days employees performing a lot of tasks using computer and supporting devices. Office staff spend many hours in front of a computer during office hours on a daily basis carrying out job tasks without thinking about the impact on their bodies. They physically stress their bodies daily without realizing it by extending their wrists, slouching, sitting without foot support, and straining to look at poorly placed monitors. These practices can lead to cumulative trauma disorders or repetitive stress injuries, which create a life-long impact on health and return, affect productivity at work (Olasanmi, 2016).

Computer ergonomic hazards linked to the usage of technological equipment often go unnoticed until the user experience some discomfort (Olasanmi, 2016). This is because such hazards usually occur gradually over a long period of time. According to Sirajudeen and Siddik (2017), there are certain percentage of the employee workforce who made heavy usage of computers experienced pain in the neck. Similarly, Serina et al. (2019) discovered that a prolonged used of computer is associated with largest increase in back-ache among computing back, hand, arm, tingling, numbness and exhaustion among professionals and technicians. If people work for a long time in such situations, they may suffer from discomforts in the musculoskeletal system and ultimately experience the occupational burnout (Chinedu et al., 2020). Therefore, working in long hours using computer with the presence of inappropriate working environment conditions and non-compliance with computer ergonomic standards are the most important factors in exploring many health concerns and occupational diseases (Pavlovic-Veselinovic et al., 2016).

Research on computer ergonomic hazards are quite abundant, but with inconclusive results. Generally, the implementation of ergonomics in Malaysia is still below satisfaction level (Loo & Richardson, 2012). Until today, the main questions remain, are the office staff aware of ergonomics of computer uses? Do daily usage mediate the influence of workstation design and workplace environment towards computer ergonomic hazards? Due to the heavy usage of computer among office staff, the present study aims to investigate whether daily computer usage can mediate the influence of workstation design and workplace environment towards computer ergonomic hazards among office staff in Klang Valley.

Literature Review

Computer ergonomics is a field of study which aims to reduce the effects of working at a computer for an extended period of time by improving the placement of computer monitor, desk, keyboard as well as accessories that can be used (Chavda et al., 2013). Among the computers, laptop is found to be not ergonomically designed for prolonged use because of the monitor and keyboard that are close together where they cannot both be in a good position at the same time (Alothman et al., 2017). For instance, previous study concluded that current practice of laptop usage was ergonomically improper posture and has created various musculoskeletal problems among individuals (Segijn et al., 2017). Therefore, awareness of effects of long term use of computer and application of ergonomics in the computer workstation is important for preventing musculoskeletal disorders, eyestrain and other effects.

Previous studies suggested that there is a heavy daily usage of computer among individual indicating that the computer technology has become much more pervasive. For instance, Sampath Kumar et al. (2014) found that majority of faculty members and research scholars of Kuvempu University are heavily depending on computer for academic work. Similar finding also has been suggested by Kumara and Sampath Kumar (2020) whereby majority of the respondents spent more than 6 hours per day to use computers. However, individual's daily computer usage has significantly influence their health status. Ekinci et al. (2019) carried a study regards to computer ergonomic among computer professionals in

India. They concluded that a significant proportion time spent of the computer were found to be having health problems and this denotes that the occupational health of the people working in the computer field needs to be emphasized as a field of concern in occupational health.

Clearly, previous studies argued that there is a positive impact of daily prolong computer usage on computer ergonomic hazards. However, there remains a slight lack of consensus of whether the computer ergonomic hazards happened is due to workstation design or workplace environment. Based on these discussions, this study assumes that daily computer usage difference might have an effect on computer ergonomic hazards either due to its workstation design or workplace environment. Therefore, this study assumes:

H_1: Daily computer usage mediates the influence of workstation design towards computer ergonomic hazards

H_2: Daily computer usage mediates the influence of workplace environment towards computer ergonomic hazards

To understand more about the mediating effect of daily computer usage on computer ergonomic hazards, this study focuses on the perspective of workstation design and workplace environment. Figure 1 shows the research framework for this study. Building upon Activity Theory (Leontyev, 1978; Vygotsky, 1978), this study attempt to sketch a new framework for understanding how office staff interact with computer with the aim to reach specific outcomes related to their daily basis computer usage. Activity Theory aimed at elucidating and explaining the relationships between "subjects," "objects," and "tools" used to transform these objects (Leontyev, 1978; Vygotsky, 1978). Subjects, objects and tools constitute what can be termed "activity system." In plain words, every activity – which consists of a set of intentionally performed goal-directed actions (Roth, 2007) – can be captured as an interaction between a subject and an object with the aim of transforming the object through the use of various tools (Sannino, 2011).

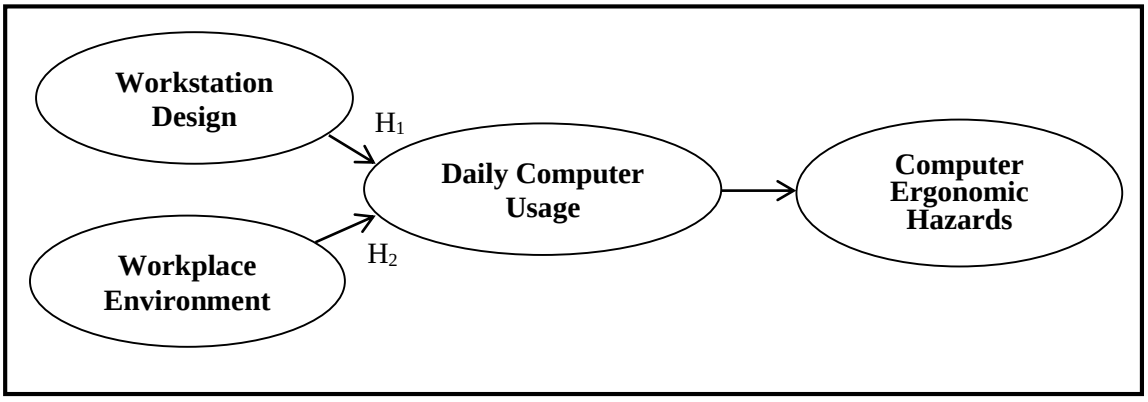

Figure 1: Conceptual Framework

Indeed, as Kaptelinin and Nardi (2018) explain, Activity Theory can frame the human-technology interaction with a meaningful context, offering opportunities to better capture the ways technology affects – and is affected by – individuals and groups, as well as illustrating the real meaning of technology for people. The application of Activity Theory in the study of human-technology interaction represents a shift in scientific focus from the technological inventions to the ways human actors interact with technology and with each other within a framework determined by specific requirements and constraints (Bannon, 1995). Therefore, Activity Theory, by depicting "the doing of the activity in a rich social matrix of people and artifacts" (Kaptelinin & Nardi, 2006) can shed new light on the ways workstation design and workplace environment influence computer ergonomic hazards through its daily usage.

Research Methodology

This study employs a cross-sectional research design using quantitative approach (Sekaran & Bougie, 2016). Besides, self-administered questionnaire has been adopted to collect data about the underlying constructs proposed in the theoretical model. The cross-sectional is used since the data was collected at one particular time across the selected respondents (Creswell & Creswell, 2017). The use of such methods may gather accurate, less bias, and high quality data.

Data Collection Procedure

The sampling frame of this study is office staff in the area of Klang Valley. Specifically, there are four districts area involved in this study namely as Klang, Shah Alam, Subang Jaya, and Petaling Jaya. This study follows decision model table proposed by Krejcie and Morgan (1970) to determine the necessary sample size because their sample decision model is claimed to be able to provide a good sampling decision. Since the population of the office staff in Klang Valley is more than 100 thousand, this study requires at least 384 sample size to establish as representatives of this study's population. The convenience sampling method is used in collecting the data based on who are conveniently available to provide it (Sekaran & Bougie, 2016). A total of 342 valid questionnaires were acquired from the online survey, making a return rate of 89.1% out of 384 targeted respondents. After checking all the survey received, there are two (2) surveys were partially completed and thus excluded from the total returned eligible for analysis. The final number of accepted surveys used in the data analysis was 340 surveys.

Survey Instruments

The survey questionnaire for the present study consists of four (4) sections. Section A contains of five (5) personal information questions that related to gender, age, race, district, and daily computer usage. Section B focused on dependent variable to be tested which is the computer ergonomic hazards faced by the respondents adapted from ergonomic questionnaire developed by Sotoyama et al. (2002). Further, Section C and Section D consists of items regards to independent variables namely as workstation design and workplace environment. Standard Nordic questionnaire adapted from Kuorinka et al. (1987) is used to evaluate workstation design. While workplace environment which consists of room temperature, visual, indoor air quality, acoustics, and lighting were operationalized based on the work of Makhbul (2013). All constructs is measured on a five-point Likert scale with the anchors of (1) "strongly disagree" to (5) "strongly agree".

Data Analysis Method: Mediation Testing

A mediation testing is used to investigate whether daily computer usage can mediate the influence of workstation design and workplace environment towards computer ergonomic hazards among office staff in Klang Valley. The SPSS Process Macro Model 4 add-on function in SPSS is used in this current study to test the direct and indirect effects among all the variables in a model whether it is single or multiple mediator or moderator model (Hayes & Rockwood, 2016). Mediation in statistics is a hypothesised model in which the first variable influences a second variable then the second variable influences a third variable. M is a mediating variable (also called mediator) that mediates the relationship between a predictor variable, X, and an outcome variable, Y as below simple mediation model (Figure 2). Based on Figure 2, X leads to M through path a, and M leads to Y through path b. Therefore, both path a and b have a direct effect. In the mediational effect, X leads to Y through M demonstrating indirect effect.

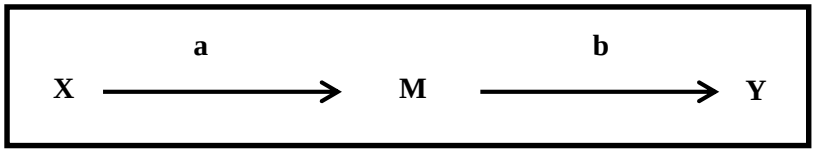

Figure 2: Simple Mediation Model

This current study proposes a research framework where the mediating variable, daily computer usage (M) mediates the relationship of predictor variables, which are workstation design (X1) and workplace environment (X2) on the outcome variable, computer ergonomic hazards (Y). The 'Model 4' in the model templates for SPSS and SAS Process is chosen for the current study to get the results shown in Figure 3.

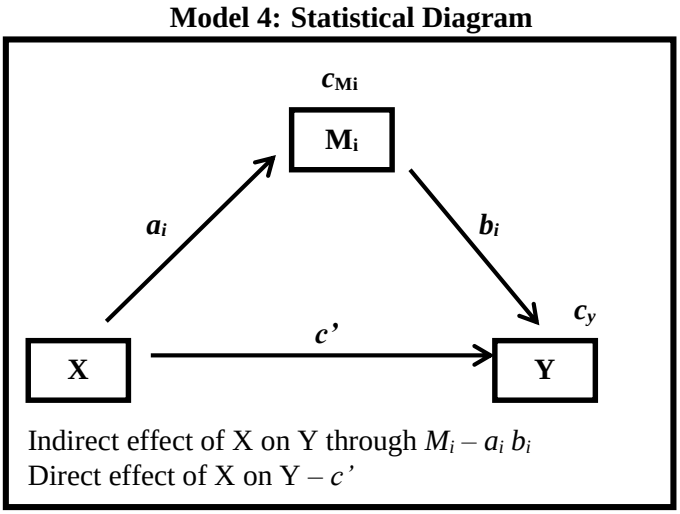

Figure 3: Model Template for SPSS and SAS Process (Model 4)

As a preliminary analysis of the data collected, the reliability assessment of the scales was carried out by calculating the values of the Cronbach's alpha for each subscale separately. According to Sekaran and Bougie (2016), reliability coefficient test indicates how well the items in a set which positively correlated from one another. Variables can be considered as reliable if the Cronbach's alpha value was set to 0.7 and above (Hair et al., 2015; Pallant, 2016). Table 1 depicts that all variables measuring computer ergonomic hazards (workstation design and workplace environment) ranging from values 0.937 to 0.955. Besides, the highest Cronbach's Alpha value is obtained for the subscales of items in the workplace environment construct ($\alpha = 0.983$). Hence, the internal consistencies of all constructs are considered acceptable since each reliability testing exceeds the suggested threshold.

Further, the assessment of normality of the metric variables in this study involves empirical measures of a distribution's shape characteristics (skewness and kurtosis). Table 1 shows that the normality assessment values for workstation design, workplace environment, and computer ergonomic hazards are between ±2.00 as suggested by Hair et al. (2015). Therefore, this assessment confirmed that the data of this study is normally distributed.

Table 1: Reliability and Normality Results

Variables	Cronbach's Alpha	Skewness	Kurtosis	No. of Items
Workstation Design	0.937	-0.018	0.015	10
Workplace Environment	0.983	0.168	-0.073	10
Computer Ergonomic Hazards	0.955	1.630	1.954	7

Next, multicollinearity testing was done to examine the relationship among the independent variables. Multicollinearity exists when the independent variables are highly correlated, with *r* value of more than 0.9 (Pallant, 2016). The correlation coefficient results between the variables are indicated in Table 2. All the independent variables show at least some positive relationship with the dependent variable, and the correlations between independent variables are less than 0.7.

Table 2: Pearson Correlation Coefficient Results

	Workstation Design	Workplace Environment	C. Ergonomic Hazards
Workstation Design	1	.528***	.197**
Workplace Environment		1	.156*
C. Ergonomic Hazards			1

Note: Correlation is significant at *** 1% level, ** 5% level and * 10% level, respectively, using two-tailed tests.

To further check for multicollinearity, a collinearity diagnostics test (tolerance and VIF values) was conducted. As shown in Table 3, the tolerance values are greater than 0.10 and the VIF values are lower than 10; hence, no multicollinearity problem exists (Pallant, 2016).

Table 3: Collinearity Diagnostics Results

Variables	Collinearity Statistics	
	Tolerance	VIF
Workstation Design	0.911	1.097
Workplace Environment	0.959	1.043
Daily Computer Usage	0.927	1.079

Results and Discussion

Figure 4a depicts unsurprisingly that female are more than the male as 62.7% of the study's participants were female as compared to 37.3% males. Further, Figure 4b shows that majority of the respondents are between 22 and 24 years old. They make up more than half (57.3%) of the total responses to the survey given.

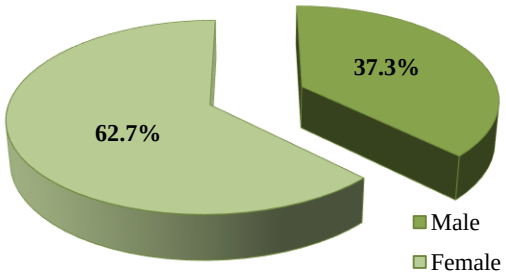

Figure 4a: Gender of Respondents

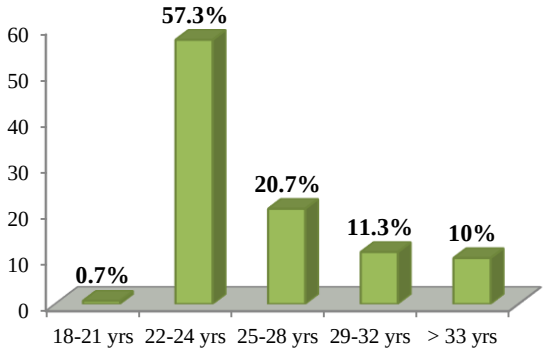

Figure 4b: Age Group of Respondents

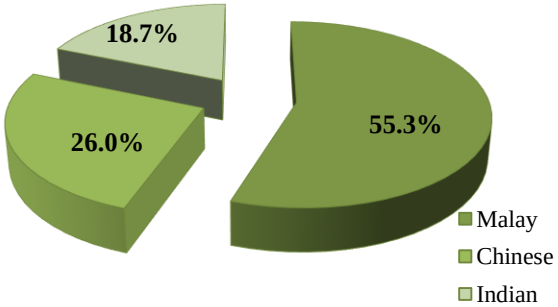

Figure 4c: Race of Respondents

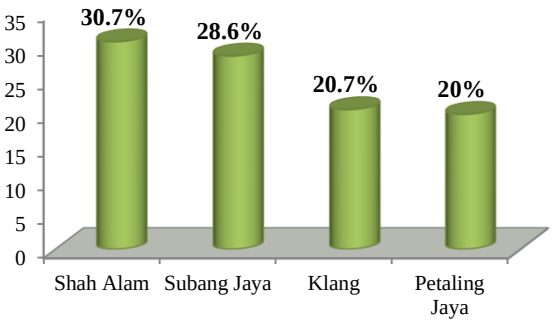

Figure 4d: District Area of Respondents

The race status of the respondents as depicted in Figure 4c shows that 188 (55.3%) of respondents are Malay, while Chinese make up the second largest respondents in this study with 26% of participation. Indian respondents are the least participate in this study (18.7%). In terms of district area of working (Figure 4d), majority of the respondents (30.7%) currently worked in Shah Alam, followed by Subang Jaya (28.6%). There are almost equal participation from respondents worked in Klang and Petaling Jaya.

The Awareness of Computer Ergonomic Hazards

This section reports the finding which relate to the awareness of computer ergonomics hazards by the office staff in Klang Valley. One sample t-test was conducted to test whether the mean of overall perceived awareness of computer ergonomic hazards is significantly equal to or different from a specified constant. Table 4 shows the mean result of 4.065 for computer ergonomic hazards which indicates that respondents considered themselves as aware of the hazards for not practicing the computer ergonomic, and it is statistically significant at 1% level. Overall, majority of the respondents reveals that they were aware that the long hours of computer usage can affect their health condition. Besides, respondents also revealed they know that staying in the same position and using the same muscle for hours at a time is not good for their back and neck. In addition, respondents also strongly agreed that poor ergonomic position can cause ergonomic pain. This result is consistent with a finding by Jaafar et al. (2019) whereby they found that there are high level of ergonomic benefit awareness among multidiscipline engineering technical staff in Malaysia.

Table 4: Awareness of Computer Ergonomic Hazards Perceived by the Office Staff

	n	**Mean**	**One Sample T-Test**	
			***t*-statistic**	***p* value**
Computer Ergonomic Hazards	340	4.065	89.773	**.000*****

Note: Result is significantly different at *** 1% level and ** 5% level, respectively, using two-tailed tests.

Daily Computer Usage

Figure 5 shows that majority of the respondents in this study have been used computer between 4 to 6 hours on a daily basis (67.3%). While there are 18.7% of respondents worked using computer between 7 to 9 hours. Respondents with daily computer usage of more than 10 hours are only 6.7%. This group of respondent can be considered as heavy usage of computer in their daily work. This is consistent with a finding by Priyanka et al. (2018) whereby they found that 72.5% of the respondents were spent time using computers more than two hours. This result indicates that office job inevitably expose the staff to various health risks associated with prolong computer usage. As more office tasks are being done using computers, the higher the likelihood of office staff suffering from computer-related health problems.

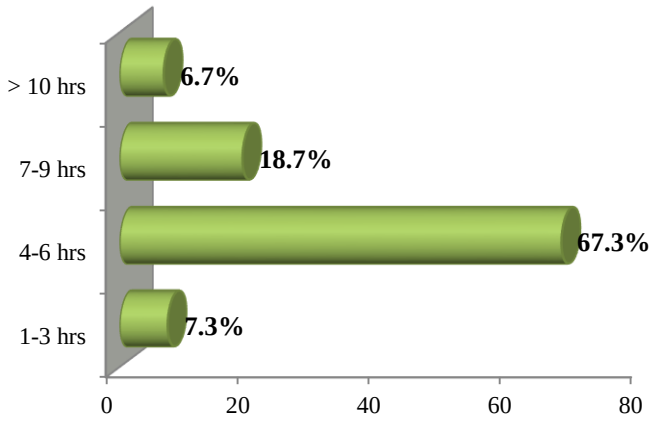

Figure 5: Daily Computer Usage

Mediating Role of Daily Computer Usage on the Computer Ergonomic Hazards

This section discusses the results of mediating testing in order to examine whether daily computer usage is a possible mediator to the influence of workstation design and workplace environment towards computer ergonomic hazards among office staff in Klang Valley. Since this study consists of two independent variables (workstation design and workplace environment), therefore the model testing was divided into two (2) parts, which are Model Testing 1 and Model Testing 2.

Hypothesis H_1 conjectures daily computer usage is a potential mediator on the relationship between workstation design towards computer ergonomic hazards. Figure 6 depicts the outcome of Model Testing 1 whereby the R^2 value of 0.527 means that both workstation design and daily computer usage explains about 52.7% of the variance in the computer ergonomic hazards. The mediation testing result reveals that workstation design has a positive effect on daily computer usage (β = 0.5468, p < .05). Next, daily computer usage does significantly predict computer ergonomic hazards (β = -0.3021, p < .05). Further, the result shows that the direct effect of workstation design significantly influence computer ergonomic hazards (β = 0.9556, p < .05). Finally, the β-value of indirect effect of workstation design on computer ergonomic hazards is 0.0071 (p < .05) and the 95% confidence interval (CI) falls between 0.2459 and 0.2601. Since the 95% CI does not include 0, the indirect effect is statistically significant (i.e. mediation is supported). This result indicates that there is a mediation role of the daily computer usage on the relationship between workstation design and computer ergonomic hazards, hence H_1 is supported.

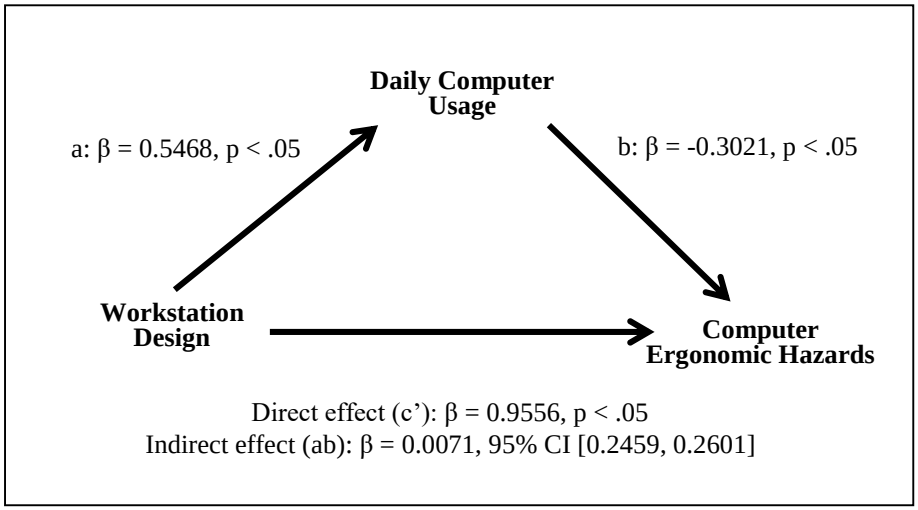

Figure 6: Model Testing 1 (IV is Workstation Design, MV is Daily Computer Usage)

This mediation testing result is supported by the One-way Anova test result whereby Table 5 shows that there is a significant difference in the scores of workstation design perceived by the respondents based on different daily computer usage time (F-statistic = -4.175***). Perhaps, a mediation role of daily computer usage on the relationship between workstation design and computer ergonomic hazards is due to different perception as possessed by office staff in Klang Valley. The mean value of workstation design shows that respondents with daily computer usage of more than 10 hours per day perceived that the workstation is poor (mean = 3.500) as compared to respondents with daily computer usage of less than 10 hours. Perhaps, an increase in computer usage during work is associated with health complaints such as upper limb and neck pain because of work posture and movements of individual areas of the body are limited in their workstation. Awkward posture and movements of computer employees results from prolong use of computer had been confirmed as massive chance causes for musculoskeletal pain in the arm field (Elsheikh, 2015).

Table 5: Perception of Workstation Design in Different Daily Computer Usage

Daily Computer Usage	n	Perception of Workstation Design		One-way ANOVA	
		Mean	SD	*t*-statistic	*p* value
1 to 3 hours	23	3.900	0.512	**4.175**	**.000*****
4 to 6 hours	224	3.883	0.505		
7 to 9 hours	68	3.557	0.441		
More than 10 hours	25	**3.500**	0.424		

Note: Result is significantly different between mean at the *** 1% level and ** 5% level, respectively, using two-tailed tests.

Hypothesis H_2 assumes daily computer usage is a potential mediator on the relationship between workplace environment and computer ergonomic hazards. Figure 6 depicts the result of Model Testing 2 whereby the R^2 value 0.0614 means that both workplace environment and daily computer usage explains only 6.14% of the variance in the computer ergonomic hazards. The mediation testing reveals that workplace environment has a positive effect on daily computer usage ($\beta = 0.2140$, $p > .05$), but it is not significant. Next, it is observed that daily computer usage does not significantly predict computer ergonomic hazards ($\beta = -0.1859$, $p > .05$). On the other hand, there is a non-significant direct positive effect of workplace environment on computer ergonomic hazards ($\beta = 0.8711$, $p > .05$). Finally, the β-value of indirect effect of workplace environment on computer ergonomic hazards is 0.0197 ($p > .05$) and the 95% confidence interval (CI) falls between -0.2194 and 0.2587. Since the 95% CI does include 0, the indirect effect is not significant (i.e. mediation is not supported). This result indicates that there is no mediation role of the daily computer usage on the relationship between workplace environment and computer ergonomic hazards, hence H_2 is not supported.

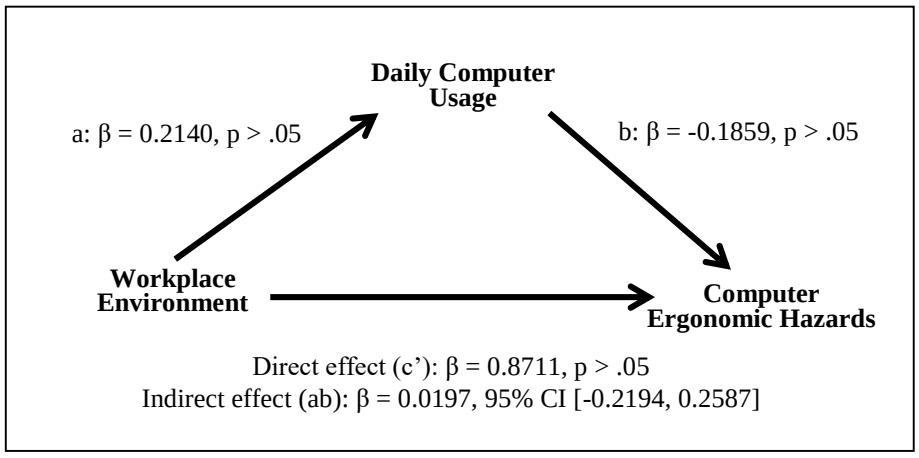

Figure 7: Model Testing 2 (IV is Workplace Environment, MV is Daily Computer Usage)

One-way Anova test is conducted to support the mediation testing result whereby Table 6 shows that there is no significant difference in the perception of working environment based on different time of daily computer usage (F-statistic = 1.477^{NS}). Perhaps, a missing mediation role of the daily computer usage on the relationship between workplace environment and computer ergonomic hazards is due to similar perception of as possessed by office staff in Klang Valley. The mean value of workplace environment shows that respondents with daily computer usage of more than 10 hours per day perceived that the working environment in their office is better (mean = 3.436) than those with daily computer usage of less than 10 hours. However, the daily computer usage and workplace environment does not contribute to the computer ergonomic hazards. Perhaps, the respondents are able to work in whatever condition of workplace environment and it is not an important factor for ergonomic in the workplace.

Table 6: Perception of Workplace Environment in Different Daily Computer Usage

Daily Computer Usage	n	Perception of Workplace Environment		One-way ANOVA	
		Mean	SD	*t*-statistic	*p* value
1 to 3 hours	23	3.390	0.448	1.477	.223[NS]
4 to 6 hours	224	3.203	0.415		
7 to 9 hours	68	3.300	0.434		
More than 10 hours	25	**3.436**	0.673		

Note: Result is significantly different between mean at the [***] 1% level and [**] 5% level, respectively, using two-tailed tests.

Conclusion

This study highlights the awareness of computer ergonomics hazards among office staff in Klang Valley, and the results showed that they possess a high level of awareness of computer ergonomics hazards. Further, this study discovers that prolong use of computer usage during work in less ergonomic workstation design is associated with health complaints because of uncomfortable work posture and limited body movements. This signifies that current practice of computer's usage was ergonomically improper whereby office staff mostly spent a long hours with computer without realizing that it could affect their health conditions. Inappropriate design, poor computer facilities, repetitive work, and close distance of the monitor screen cause ergonomic hazards such as shoulder and neck pain, musculoskeletal disorder problems, and body posture. Contrary, this study suggests that daily computer usage does not influence the relationship between workplace environment and computer ergonomic hazards. Overall, the influence of daily computer usage of the relationship between workplace design tand computer ergonomic hazards is consistent with the Activity Theory (Leontyev, 1978; Vygotsky, 1978) that argued the interaction of office staff with computer and poor workstation design caused ergonomic hazards.

The findings of the study will be helpful for the office management in order to know the awareness level of their staff. The study reveals that nearly all of the office staff surveyed do not pay attention to the practice of ergonomics. In addition, this study suggests that prolonged usage in improper posture and limited movements have created certain associated health problems. Hence, there is a need to create awareness of computer ergonomics practice to improve the current practice of computer's usage and to minimize health-related problems among office staff in Klang Valley. Besides, the management need to review individual jobs with a goal of restructuring duties and increase variety in activities being performed for the sake to avoid the staff from prolong use of computers. Ergonomic guidelines need to be establish in order to improve ergonomic practice. Finally, the office staff are encourage to take regular physical exercises.

The findings need to be interpreted with consideration for its limitations. First, the responses of this survey are representative of office staff in four district areas of Klang Valley only. One area for further research might be to conduct the study using a larger sample and a broader geographical base. Second, the selection for the determinants of computer ergonomic hazards is not exhaustive. There may be other predictors that may contribute or be a reason of ergonomic hazards which might provide more insight. Thus, further research may consider to include other predictors such as human factor, knowledge, or attitude towards computer ergonomic safety to enrich findings in various perspectives. Third, the self-reported behavior on which this study relied are vulnerable to response bias. There is an uncertainty regarding the accuracy of responses because self-reports of computer ergonomic hazards and their awareness may be less accurate. To reduce response bias, it is suggested for future research to use in-depth techniques applied to secondary data sources such as interviews or observations. This might help researcher to explore certain aspects that cannot be discover using survey questionnaire.

Competing Interest

Authors have declared that no competing interests exist.

Author's Contribution

This work was done in collaboration among all the five authors. Each of the authors managed their own parts as distributed in the earlier stage of research, but all the authors have proofread and approved the final manuscript

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