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Applied Ergonomics 102 (2022) 103749

Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

The effect of training and workstation adjustability on teleworker discomfort during the COVID-19 pandemic

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ARTICLE INFO

Keywords:
Working from home
Employee wellbeing
Office ergonomics
Remote assessment

ABSTRACT

Technological advancements have increased occupational flexibility for employees and employers alike. However, while effective telework requires planning, the COVID-19 pandemic required many employees to quickly shift to working from home without ensuring that the requirements for telework were in place. This study evaluated the transition to telework on university faculty and staff and investigated the effect of one's telework setup and ergonomics training on work-related discomfort in the at-home environment. Fifty-one percent of respondents reported increases in their existing discomfort while 24% reported new discomfort since working from home. These results suggest a need for ergonomic interventions including ergonomic training and individual ergonomic assessments for those who work from home.

1. Introduction

Technological advancements such as the proliferation of portable devices (e.g., laptops, tablets) and the maturation of conferencing software have made telework a viable option to increase occupational flexibility for employees and employers alike (Montreuil and Lippel, 2003). The term telework describes work done from home or another remote location that uses technologies to link work done remotely with that done at the central organization (Nilles, 1994; Olson, 1981; Pinsonneault and Boisvert, 2001). The increases in telework opportunities and the number of individuals working remotely have prompted the need for research on telework ergonomics to better understand the conditions that exist in telework settings and the needs of teleworkers.

Researchers studying the benefits of telework and flexible work arrangements report that voluntary telework, employer support, and proper workstation setups are the keys to its success. The most important of these is that telework should be voluntary (Åborg et al., 2002; Beauregard et al., 2019; Jaakson and Kallaste, 2010; Ng, 2010). The benefits of voluntary telework include better work-life balance, increased productivity, and a reduced risk of burnout (Baert et al., 2020). Furthermore, successful teleworkers have a particular set of skills that include the ability to work independently and to separate their work life from their home life (Beauregard et al., 2019). Therefore, when selecting employees for telework, one should consider both the nature of the job itself and the qualities of the employee (O'Neill et al., 2009). Finally, part-time telework is best with some days in the office and other days at home (Åborg et al., 2002; Lundberg and Lindfors, 2002; Ng, 2010; Raišienė et al., 2020).

Early in 2020, employee health and protection from the novel coronavirus (COVID-19) took precedence over these best practice guidelines. When COVID-19 struck, employees were asked to work from home if possible and to maintain a safe distance from others. Overnight, the proportion of the US population working from home increased from approximately 15% to upwards of 60% (Katsabian, 2020). Likewise, the proportion of Canadians working from home increased from 4% to 32% (Mehdi and Morissette, 2021). There was no voluntary opting-in, no self-selection based on job responsibilities, no selection of employees who fit the telework profile, and, more importantly, there was no time to prepare a space in the home to accommodate a full-time teleworking job – all aspects of successful telework as outlined by pre-pandemic research (Åborg et al., 2002; Lundberg and Lindfors, 2002; Ng, 2010; Raišienė et al., 2020).

Under the right conditions, non-voluntary teleworking can be a positive experience. Telework improves work-life balance by allowing individuals to easily move between their professional and family responsibilities (Baert et al., 2020; Buomprisco et al., 2021; De Macêdo et al., 2020; Morilla-Luchena et al., 2021). Other benefits of the forced telework imposed during the pandemic include feelings of safety with

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https://doi.org/10.1016/j.apergo.2022.103749
Received 21 October 2021; Received in revised form 10 March 2022; Accepted 14 March 2022
Available online 22 March 2022
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regards to COVID-19 exposure and a decrease in commuting time and its associated risks (Bouziri et al., 2020; Morilla-Luchena et al., 2021). However, this forced shift to telework had negative psychosocial, emotional, and physical effects. In terms of psychosocial factors and emotional factors, Baert et al. (2020) reported that when working from home survey respondents felt disconnected from their colleagues and that their opportunities for promotion were diminished. Furthermore, Buomprisco et al. (2021) and Davis et al. (2020) reported a risk of overworking and highlighted the negative effect of the decreased availability of ergonomic office equipment and dedicated workspace. However, given the immediate need for social isolation and fear of the unknown related to COVID-19, many of these factors were not considered. Nevertheless, improper workstation setup and its associated risks could have been controlled and possibly overcome if employers and employees had been able to prepare for the sudden telework situation.

Prior to the COVID-19 pandemic, most studies of home office workstations focused on the ideal home office workstation setup and the benefits thereof (Ng, 2010). Generally, individuals who self-selected to work from home had more space in their house than typical workers (Moos and Skaburskis, 2008). Most full-time teleworkers preferred to have a separate, dedicated office space at home (Ahrentzen, 1990; Ammons and Markham, 2004; Gurstein, 1996; Hartig et al., 2007; Karnowski and White, 2002; Magee, 2000; Montreuil and Lippel, 2003; Zavotka and Timmons, 1996), which was often set up in a guest/spare bedroom (Gurstein, 1996; Magee, 2000; Nilles, 2000) or in the basement (Gurstein, 1996; Magee, 2000). Office noise, while inevitable, especially in an open floor plan, impairs concentration and increases cognitive load (Banbury and Berry, 2005; Smith-Jackson and Klein, 2009), but typically it does not prevent employees from getting their work done. The noise in a home setting is different from workplace noise as it often requires the worker to stop what they are doing and intervene (e.g., household appliances, children fighting/crying, guests/deliveries at the door), which is why many teleworkers prefer their home workstation be away from noisier areas of the house (Ahrentzen, 1990; Gurstein, 1996). Additionally, having adequate and suitable equipment is especially important for home-based teleworkers (Hill et al., 1998). While employers will likely provide a computer or laptop to facilitate telework (Karnowski and White, 2002; Montreuil and Lippel, 2003), they are less likely to supply office equipment, such as desks and ergonomic chairs (Karnowski and White, 2002). The considerations for ergonomics should be the same in the home workspace as in the office workspace; however, this is not generally the case (Gurstein, 1996; Magee, 2000). In fact, many teleworkers report discomfort such as eye strain or soreness in the wrists, neck, or back while working at a home-based computer workstation (Harrington and Walker, 2004), all of which might be mitigated by properly designed ergonomic workstations.

An important ergonomic consideration for telework, especially with the inability to prepare beforehand, is that most employees work on laptops. For example, Gerding et al. (2021) recently found that approximately 85% of teleworkers surveyed were working from a laptop at home and only 45% of them had an external monitor. The main problem with laptops is that the screen is coupled to the keyboard, making it impossible to maintain a neutral body position with one's head, neck, and spine aligned vertically, shoulders relaxed, and elbows at 90-degrees (Harris and Straker, 2000; Moras and Gamarra, 2007; Price and Dowell, 1998; Sommerich et al., 2002; Straker et al., 1997). The addition of peripheral devices such as an external monitor, keyboard, and mouse to a laptop computer, while not common practice, is often the focus of laptop ergonomics training modules. Studies focused on the efficacy of such training modules show that ergonomics knowledge, posture, body awareness, and work practices while using a laptop improve with training (Bowman et al., 2014). Furthermore, the combination of training with appropriate, adjustable office equipment produces better working postures and improves working conditions than either training or adjustable equipment alone (Amick et al., 2003).

One's office workstation is likely different than one's home workstation due to a difference in equipment and services, such as ergonomic consultations, that might be required to ensure a proper setup. Even those who received workstation evaluations, modifications, a list of recommendations, and education specific to their work office may not have the knowledge needed to set up their home workstation properly. This could mean that general ergonomic training may be more helpful for workers than workstation-specific training, as such training prepares workers for unforeseen circumstances, such as the COVID-19 pandemic when ergonomists were not readily available to help workers with their home office workstations. Ensuring that workers are provided with the general knowledge necessary to properly set up their home workstation is an important first step; however, it is equally important to adapt ergonomic services so that they may be offered virtually.

Traditional hazard assessment tools may not fully capture the complexities of the home office environment. For example, the Rapid Upper Limb Assessment (RULA) evaluates neck, trunk, and upper limbs postures as well as muscle function and the loads experienced by the body (McAtamney and Corlett, 1993). RULA, with its focus on posture and external loads, can be used in various situations including an office setting, although it does not consider the quality of the workstation setup. To address this limitation, ROSA (Rapid Office Strain Assessment) was created specifically to evaluate office work (Sonne et al., 2012). Similar to RULA, ROSA is a scoring system based on body positioning; however, it also evaluates how the individual interacts with their office equipment. Moreover, ROSA scores are positively correlated with musculoskeletal discomfort (Sonne et al., 2012) and have good inter-observer reliability (Sonne et al., 2012). Simple observational analysis tools such as RULA and ROSA could be used by ergonomists to evaluate a workstation virtually, although they would require photos of the employee interacting with their workstation. Requiring photos introduces the potential for error in the evaluation process as joint angles and body positions may be misrepresented due to an incorrect viewing angle. These types of analyses are also time-consuming and inefficient. In a situation such as that caused by COVID-19, where a large proportion of employees suddenly began working from home, it is imperative to quickly identify ergonomic issues. Therefore, the methods discussed above are inadequate. Another limitation is that these observational analysis tools focus only on posture at one moment in time and do not consider factors such as workflow and psychosocial demands of a job. Self-report techniques, including surveys by Blake and Taylor (2021), allow for data to be collected that evaluate both the physical and psychosocial demands of a job (David, 2005).

In this study, we used a survey to evaluate the transition to telework on university faculty and staff. We investigated the effect of ergonomics training on one's home office workstation setup and the combined effectiveness of ergonomics training and workstation setup at mitigating work-related discomfort in the at-home work environment. We also evaluated the feasibility of using a survey, without any accompanying assessment (virtual or in-person), to have clients self-report the office equipment available to them. We hypothesized that workstations that were set up according to ergonomic best practices and allowed for the most adjustability would be associated with lower levels of reported discomfort. We also hypothesized that those workers who had received ergonomic assessments and training on-campus would have improved home office workstations and would experience less discomfort as a result.

2. Materials and methods

2.1. Materials

2.1.1. Survey development

A survey (Appendix I) gathered information similar to that collected during an in-person ergonomic assessment. The first part of the survey included standard demographic questions including age, gender, and occupation. We asked about the respondents' work habits before and after they started working from home to quantify the time spent in different postures, the time spent at the computer, and the number of times they change positions or change tasks throughout the day. To understand the respondents' workstation setup, we included a list of typical office workstation devices/elements and office configurations that respondents could choose from. They selected all that applied and added any extra features that were not included.

The next part of the survey focused on perceived discomfort while working. Participants were shown a discomfort map with 23 body regions highlighted (Fig. 1A) and were asked to select all the areas where they experience discomfort while working from home. For all the regions where they indicated that they experience discomfort, they quantified that discomfort on a scale from "No discomfort at all" to "Worst discomfort imaginable". They were asked to quantify the degree of discomfort for the time before they started working from home (pre-pandemic) and for how they felt currently while working from home.

Furthermore, we wanted to assess respondents' ergonomics knowledge to determine if it was related to the quality of their home office workstation setup. They provided information about any ergonomics training they received including the format in which this training took place (e.g., online vs. in-person) and how this training came to be (e.g., initiated by employer vs. self-directed).

Lastly, the survey asked questions related to psychosocial risk factors and demands imposed by their living situation (e.g., number of people in the house, number of pets, availability of a separate home office space …). While not a focus of the current paper, data pertaining to these psychosocial risk factors were collected and their analysis will be detailed in a subsequent paper.

2.2. Methods

Prior to beginning the study, the General Research Ethics Board at Queen's University and the Oakland University Institutional Review Board reviewed and approved all elements of the study, including the recruitment materials and the survey questions.

2.2.1. Participant recruitment

Study participants were all staff, faculty, and administration at Queen's University, a large university that provides comprehensive ergonomic consulting services to all employees on campus. We sent recruitment emails to the administrative assistants in all departments, asking them to forward the email to their faculty and staff. All university employees who worked at least part-time at a computer workstation and had been required to work from home during the COVID-19 pandemic were invited to participate in this study. Employees who did not work at computers for at least half of their workday were not recruited for this study. In total, 131 participants completed the survey and were included in the analysis.

All participants who completed the survey and provided their email address were entered into a draw to win a $50 gift card to be used at local businesses.

2.2.2. Study administration timeline

As this study aimed to assess the chronic effects of the telework situation imposed by the COVID-19 pandemic, we waited one full year after employees were originally forced to transition to teleworking before distributing the survey. At that point, very few employees had returned to their on-campus offices with the vast majority having settled into this "new normal". Those who did return to their on-campus offices were doing so sporadically, as the campus was not yet fully operational. This delay in distributing the survey ensured that any equipment that would have been purchased/provided by the organization would have already been in place and any policies surrounding expectations for working from home would have already been developed.

2.2.3. Outcome measures

2.2.3.1. Workstation score. As this study was developed in part to evaluate whether assessments of workstation quality could be completed using a survey, a novel scoring system to represent workstation quality was created. We had originally intended to develop our scoring system based on a previously validated "Work Environment and

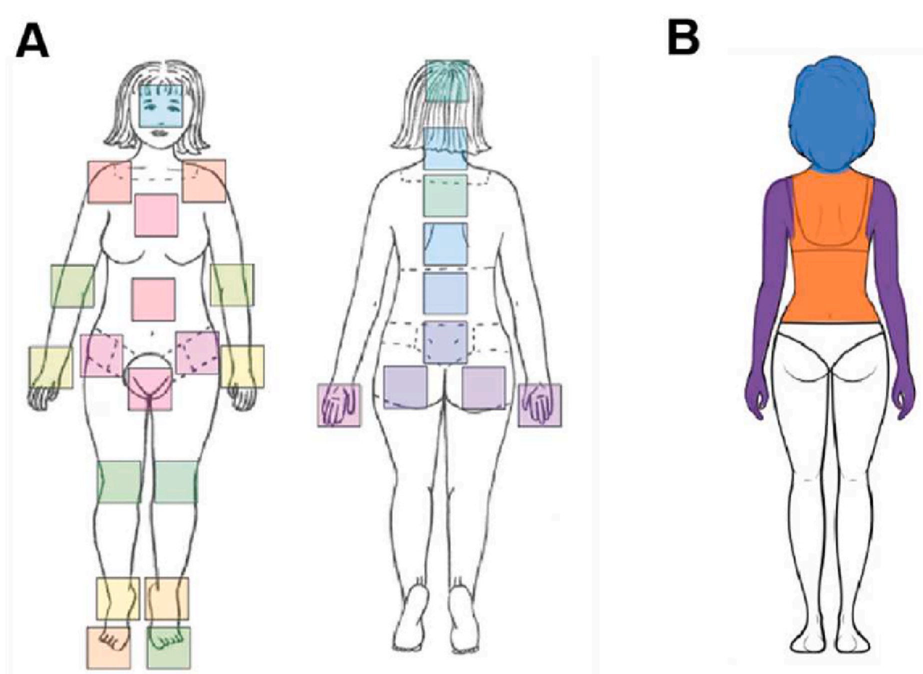

Fig. 1. Discomfort map used in the survey. A) The body with 23 body regions highlighted. Respondents selected all the areas where they experience discomfort while working from home. **B)** For analysis, discomfort areas were defined for three regions: arm (purple), neck (blue), and back (orange). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Health (WEH) survey" that assesses the adjustability of the workstation and its elements (Robertson et al., 2009). However, the specific details of that analysis were not available, therefore we designed a tool for assessing the work environment based on our understanding of what had been completed in that study and our combined 20+ years of experience in assessing individual office workstations. In the survey we provided a list of equipment and workstation configurations instructing respondents to "Select all that apply". The options presented to participants are shown in Table 1.

We used the workstation elements listed in the survey to calculate a workstation score based on the expected effect of the equipment on the user's posture. For example, a workstation with a monitor, mouse, and keyboard would promote a better posture than a workstation with a laptop alone. Likewise, a workstation with an adjustable office chair or a height-adjustable desk would be considered an improvement over a workstation on a dining room table using a non-adjustable chair. As such, a workstation consisting of an office chair, a monitor, a keyboard, and a mouse received a categorical score of 0 and was considered a baseline computer workstation setup. A workstation consisting of less equipment than this baseline setup (i.e., working directly on a laptop with no external keyboard or mouse or sitting on a non-adjustable dining room chair) received a categorical score of −1. Conversely, a workstation consisting of more equipment than the baseline setup (i.e., a height-adjustable desk or an additional monitor) received a categorical score of +1. Of note, we initially implemented a weighted score to each element based on their potential influence, where a score of 1 would be minimally influential and a score of 3 would be maximally influential. However, we could not be certain that these elements were used properly by the survey respondents and ultimately decided to remove the weighting of different elements.

2.2.3.2. New and worsening discomfort. We categorized data from the discomfort map into three key body regions that are the most prevalent among office workers (Andersen et al., 2010; Basakci Calik et al., 2020; Shariat et al., 2018a): low back, neck, and arm (Fig. 1B). Respondents reporting discomfort in these three body regions were then further subdivided into groups according to whether that discomfort was new (discomfort did not exist before beginning to work from home), or worsening (discomfort has worsened since beginning to work from home). We used a clinically relevant threshold of ±15 to indicate whether discomfort had increased or decreased, which is a conservative value compared to those used in acute (Li et al., 2001; Todd et al., 1996) and chronic settings (Tashjian et al., 2009; Wolfe and Michaud, 2007).

Table 1
Workstation elements contained in the survey to calculate a "Workstation Score".

Which of the following elements are you using in your "home office" setup? Select all that apply.			
Laptop computer	Three or more external/standalone monitors	Height-adjustable desk	Adjustable office chair
Desktop computer	Mouse (not built-in laptop trackpad)	Desk lamp	Separate number pad
One external/ standalone monitor	Keyboard (not built-in to laptop)	Footrest	Separate sketchpad/ trackpad
Two external/ standalone monitors	Treadmill or pedal ergometer under your desk	Standard-height table	Bar-height table
Standing desk	Standard-height computer desk	Sitting on the couch	Sitting in a recliner/easy chair
Sitting/laying in bed	With a window directly in front of you	With a window beside you	With a window behind you

2.2.3.3. Ergonomics training. Participants were grouped according to the type of ergonomics training they had received. Anyone who received individualized or group-based ergonomics training and assessments from an experienced professional was classified into the "In-person" group, those who completed self-directed online searches (virtual webinars, ergonomics "tip sheets", general "how-to" articles, and other such informational products) were classified into the "Online" group and those having no training were placed into the "No training" group.

2.2.4. Statistical analysis

To test the association between workstation score, ergonomics training, and new and worsening discomfort, we conducted a total of six loglinear analyses (new discomfort for arm, neck, and back, and worsening discomfort for arm, neck, and back). A three-dimensional cross-table was obtained according to workstation score (poor = −1, baseline = 0, improved = 1), ergonomic training (no training = 0, online self-directed = 1, in-person = 2), and new/worsening discomfort in each of the three body regions (no = 0, yes = 1). We used backward elimination with a significance of $p < 0.05$ to identify which terms would be included in the final model. Therefore, in our three-way model, we tested the significance of the main effect terms (workstation score, ergonomic training, discomfort), two-way interactions between two of the main effect terms, and the three-way interaction between all three main effect terms.

3. Results

3.1. Telework negatively impacted working conditions

We conducted our analysis on all 131 survey respondents. Of these respondents, 101 identified as females, 29 identified as males, and one preferred not to disclose; with the largest proportion of respondents falling within the 35–44 years age range. We found that working conditions worsened when working from home. Most respondents (71.0%) reported working their usual 30–40 h per week (Fig. 2A); however, 64.9% of respondents reported that the amount of time spent at the computer had increased since working from home, while only 3.1% of respondents reported that the amount of time spent at the computer has decreased since working from home (Fig. 2B). Moreover, 53.4% of respondents reported changing positions less frequently when working from home, while 17.6% reported no change, and 29.0% reported changing positions more frequently since working from home (Fig. 2C). In addition, most respondents (51.9%) reported no change in the number of times they changed tasks (e.g., going from computer to filing), while 22.1% reported changing tasks more frequently, and 26.0% reported changing tasks less frequently (Fig. 2D).

3.2. Telework catalyzed new and worsening discomfort

A large proportion of respondents reported worsening and new discomfort since working from home (Fig. 3). In total, 51% of respondents reported worsening discomfort in one or more regions: 34% reported worsening arm discomfort, 35% reported worsening neck discomfort, and 32% reported worsening back discomfort (Fig. 4). Note that participants could report pain in more than one region. Additionally, 24% of respondents reported new discomfort in one or more regions: 18% reported new arm discomfort, 3% reported new neck discomfort, and 18% reported new back discomfort. Only 7% of respondents reported an improvement in existing discomfort since working from home: 3% reported improved arm discomfort, 5% reported improved neck discomfort, and 3% reported improved back discomfort.

3.3. Relationship between workstation score, ergonomic training, and discomfort

Most respondents received a score of average (0) or better (1) for

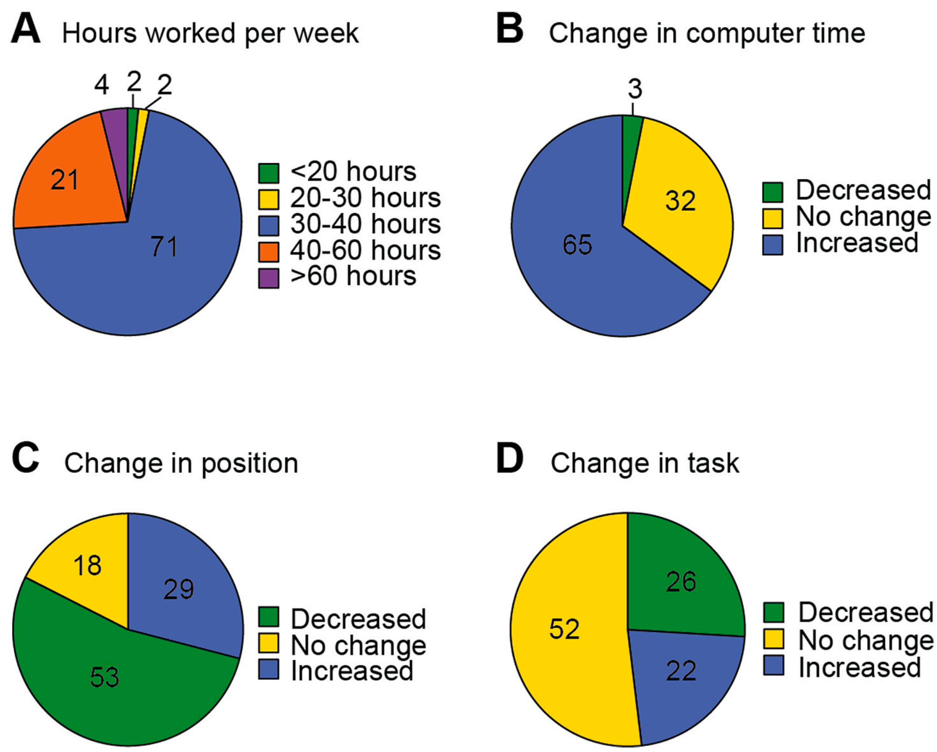

Fig. 2. Change in work habits when working from home. In each pie chart, n = 131 and the full "pie" = 100% of responses. Each "wedge" of the chart represents the proportion of the responses for each category. A: Reported number of hours worked per week. B: Reported change in time spent working at the computer. C: Reported difference in position changes throughout the workday. D: Reported difference in task changes throughout the workday.

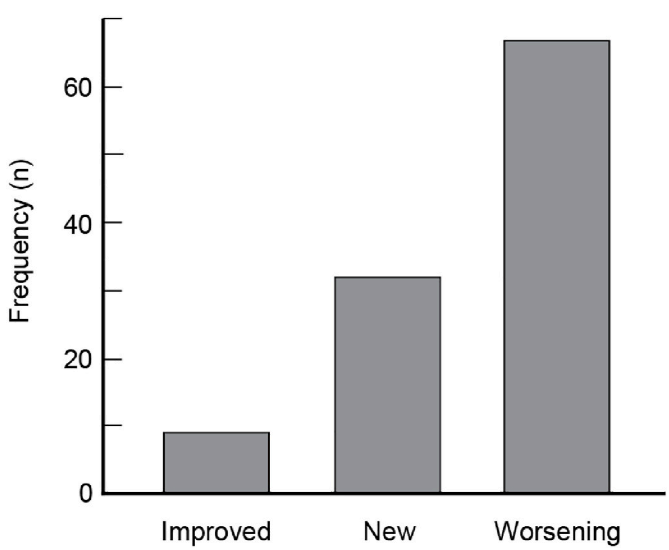

Fig. 3. Frequency of improved, worsening, and new discomfort since working from home. Frequency is shown as the number of respondents (n) (total n = 131)..

their workstation equipment. A total of 28 respondents (21%) scored a −1, which is less adequate than a basic setup that would have a height-adjustable office chair, monitor, keyboard, and mouse. Seventeen respondents (13%) scored a 0, equivalent to a basic setup, and 86 respondents (65%) scored a 1, indicative of an improved workstation setup. As for ergonomic training, 43.5% of respondents reported no training, while 51.1% reported having received an in-person ergonomic assessment and 5.4% reported online training (e.g., Google search). A correlation analysis revealed no relationship ($r = 0.13$, $p = 0.16$) between training and workstation score.

The six three-way loglinear analyses produced a final model that retained only the main effects of workstation score, ergonomic training, and discomfort ($p < 0.001$ for the one-way interactions in all loglinear analyses, see Appendix 2 Table S1). There were no significant lower-order interactions between main effects (i.e., workstation score × discomfort, workstation score × training, training × discomfort, and workstation score × training × discomfort); removing all lower-order interactions did not affect how well the model fits the data (Appendix 2 Table S1).

4. Discussion

In the present study, we evaluated the effect of transitioning to telework on university faculty and staff, the impact of ergonomics training on home office workstation setup, and the combined effectiveness of ergonomics training and workstation setup at mitigating work-related discomfort in the telework environment. In the telework environment, participants tended to work at the computer longer and move less, which is intuitive as work that was typically completed in-person (e.g., meetings, teaching, collaborative research), moved from physical spaces to the screen. With telework, moving or changing positions requires conscious effort and an understanding that movement reduces the risk of many musculoskeletal problems, which is unlikely without proper training.

We found that transitioning to telework had a negative effect on university faculty and staff. Only 7% of respondents reported an improvement in their discomfort, while 51% reported worsening discomfort and 24% reported new discomfort. These findings align with other research conducted during this timeframe (Celenay et al., 2020; Moretti et al., 2020; Šagát et al., 2020; Siqueira et al., 2020; Gerding et al., 2021) that reported an overall increase in discomfort while working from home. Some researchers also noted that reported discomfort was modulated by physical activity level, such that increased physical activity reduced discomfort, but the magnitude of this effect

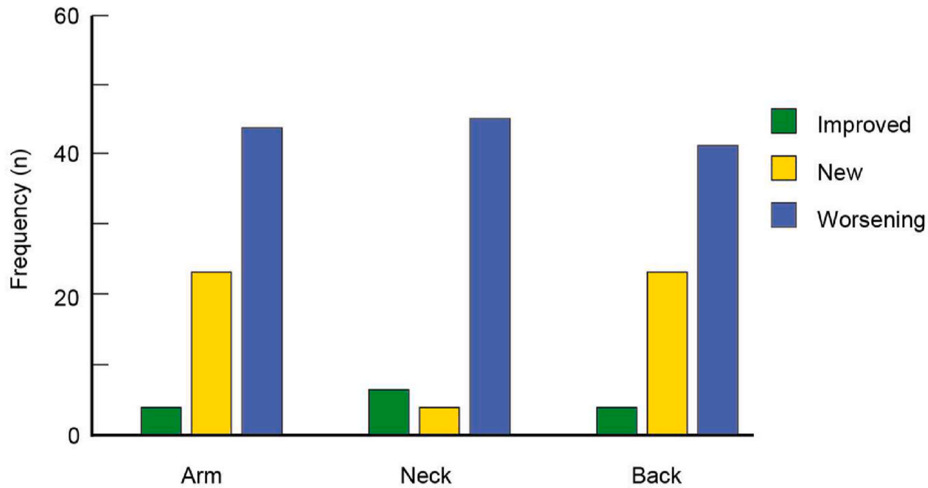

Fig. 4. Frequency of improved, worsening, and new discomfort since working from home separated by body region. Frequency is shown as the number of respondents (n) (total n = 131).

varied (Rodríguez-Nogueira et al., 2021; Šagát et al., 2020). In the current study, we did not specifically ask respondents about their physical activity outside of working hours but we did note that our respondents tended to move less frequently throughout the day and remained seated for longer periods. This could partially explain the increased discomfort ratings (Mahmud et al., 2014). Researchers have also reported that the number of discomfort regions prior to the COVID-19 pandemic was significantly correlated with the number of discomfort regions during isolation (Rodríguez-Nogueira et al., 2021), which could explain the high percentage of respondents reporting worsening discomfort. Furthermore, the increase in discomfort reported by our respondents may have been associated with their psychological or emotional wellbeing. Previous studies have associated stress and psychosocial risk factors such as low job control with an increase in reported discomfort for tasks with an inherent physical ergonomics risk (Vandergrift et al., 2012; Mahmud et al., 2014). With the stress, depression, anxiety, and loss of job control associated with the COVID-19 pandemic and the forced telework (Salari et al., 2020; Shevlin et al., 2020) the risks associated with home office work could be compounded. We recognize that the data presented here did not account for these psychosocial risk factors and that some people may be more accepting of a work-from-home situation, which may reduce their reported discomfort, while others, less satisfied with their work-from-home situation, may report higher levels of discomfort. These important but complex interactions will be discussed in another paper.

Furthermore, we found a positive but insignificant ($p = 0.08$) association between workstation score and ergonomic training, where workstation scores improved slightly as ergonomic training increased from “No training” to “Online” to “In-person”. Many studies have shown that office ergonomics training reduces reported musculoskeletal discomfort among office workers (Robertson et al., 2000; Robertson & O’Neill, 2003; Sasson and Austin, 2005; Robertson et al., 2009; Mahmud et al., 2011; Mahmud et al., 2015; Shariat et al., 2018b). The lack of significant findings in our study is likely because the survey evaluated the equipment at hand but not how the workstation fit the worker. Another limitation is the lack of specificity of the self-directed training received as all self-directed training was included in a single category (whether it be video webinars, infographics, or some generic online search). Furthermore, the quantity and quality of training likely differed between training groups. The individualized in-person training was about an hour in duration, whereas online training was not as structured and highly variable between respondents. Since we did not ask respondents to quantify the time spent completing self-directed learning online, we cannot control for the effect of training duration on our results. It is possible that the lack of any observed differences between training groups is due to the variability in training quality or quantity between training groups and further research is warranted.

Lastly, the three-way loglinear analyses between discomfort, workstation score, and ergonomic training produced a final model that retained only the highest-order interactions (discomfort × workstation score × ergonomic training; $p < 0.001$ for one-way interactions in all loglinear analyses). There were no significant interactions between ergonomics training, workstation score, and either new or increased discomfort for any body region. That we found no significant two-way or three-way interactions may be due to the high variability of discomfort scores and the relatively low number of respondents ($n = 131$). Discomfort is subjective, so there is some inherent variability when individuals rate their discomfort, especially when asked to compare their current discomfort to their previous discomfort. However, discomfort scales have been validated and continue to be the most accurate and reliable measure of one’s discomfort (Karcioglu et al., 2018). We reduced the inter-individual variability by asking participants to rate their discomfort before and after transitioning to telework and calculating the difference in their discomfort scores. By using “change in discomfort”, we normalized these scores using each respondent as their own control. However, this normalization required that participants recall their discomfort from months ago, which poses its own challenges. Unfortunately, the nature of our research question did not allow for meaningful objective observations – change in discomfort could only be assessed subjectively by the respondent. Although the discomfort ratings were variable and subjective, the reporting of new and worsening discomfort (24% and 51%, respectively) raises serious concern for the telework environment.

The telework environment varies from home to home and may not be an ideal work environment for some employees. Past research has shown that telework can have a positive influence on work and personal life. However, these findings assume that telework is voluntary and that there is an equivalent workstation setup at home (De Macêdo et al., 2020; Hill et al., 2003; Montreuil and Lippel, 2003). Other researchers report that telework has a negative influence on work-related musculoskeletal disorders (Davis et al., 2020; Escudero-Castillo et al., 2021; Green et al., 2020; Junkin, 2020). Our results agree with these more recent studies, suggesting that forced telework during the COVID-19 pandemic may be related to an increased risk of work-related musculoskeletal disorders. In our study, only 7% of respondents reported an improvement in discomfort since transitioning to telework. Perhaps even more alarming is that 24% of respondents reported new discomfort when working from home that they did not experience when working at their office. Furthermore, more than half (51%) of the respondents reported an increase in the severity of their pre-existing work-related discomfort since transitioning to their telework environment. These alarming proportions suggest a need for ergonomic interventions for those who work from home.

With telework being a potentially permanent solution for many employees (Barrero et al., 2021; Bick et al., 2020), we must develop more effective ergonomic standards and best practices for employees working from home to help mitigate the influence of telework on reported discomfort, especially for those with pre-existing musculoskeletal discomfort. As suggested by Michael and Smith (2015), telework should always be supported by workplace ergonomics programs that provide training, conduct risk assessments, and alleviate potential risks of work-related musculoskeletal disorders. The most effective telework ergonomics program would include three components: 1) an individualized assessment to uncover risks and provide solutions to mitigate injury risk in the home office workstation 2) proper ergonomic office equipment for the home office, and 3) a training component to provide employees with necessary ergonomics knowledge about work practices and body positioning. Amick et al. (2003) found that workers who received ergonomic training plus a highly adjustable office chair reduced musculoskeletal symptoms over the workday. In comparison, simply adding an adjustable ergonomic office chair while not providing training on its use and setup did not mitigate the musculoskeletal discomfort (Amick et al., 2003). As highlighted by our findings, these ergonomics training programs for teleworkers should also emphasize the importance of taking breaks and/or changing position every 30 min to help mitigate the risks associated with not changing position as frequently while working from home (Davis and Kotowski, 2014). Although individualized assessments may not seem possible in a telework environment, Blake and Taylor recently validated an approach to provide employees with virtual assessments (2021). Their proposed approach included three parts: 1) a pre-assessment discomfort survey (much like the one we used in this study), 2) videos of the employee working at their workstation, and 3) a live virtual assessment where the assessor provides recommendations for improving the workstation (Blake and Taylor, 2021). Therefore, if we could limit workstation variability by ensuring that everyone has a baseline workstation when working from home (adjustable chair, mouse, keyboard, monitor) and provide training on adjusting this workstation, we would expect a reduction in reported discomfort among teleworkers.

Although we found a positive trend between ergonomics training and workstation scores, we did not find any interactions between ergonomics training, workstation scores, and discomfort. One reason may be that the survey and the workstation score did not assess the interaction between the employee and their workstation. In our survey, we asked respondents to select the equipment that was available in their home workstation. That we found no interaction between workstation score and discomfort suggests that the mere availability of equipment does not relate to one's comfort at their workstation. A more robust approach would be to develop a framework that considers how well the equipment fits the employee and how they are using the adjustable elements of their workstation.

In summary, employees working in a telework environment should be supported by an ergonomics program that provides adjustable office equipment, necessary ergonomics training, and a virtual assessment to ensure proper workstation setup. Future work should include the development of a standardized telework package, such that any employee who transitions to teleworking is provided the same set of adjustable ergonomic office equipment, the training needed to adjust this equipment, and access to a trained ergonomist who can help address any unique issues faced in setting up the equipment in the home office. Although it would be an added cost for employers in the short term, implementing this type of program would standardize home office setups such that discomfort is person-specific. Such a program could improve employee morale and productivity – benefits that employers could use to justify the added cost of implementing a progressive ergonomics program. However, it is important to note that this system only works if all three elements are present – a sufficiently adjustable workstation, appropriate training, and person-specific alterations are all needed. Without all three elements, the discomfort might persist or even worsen when a worker transitions to a teleworking arrangement.

Funding

This work was supported by a Vanier Canada Graduate Scholarship (M.J.M. grant number 294181) and by funds provided by Oakland University's School of Health Sciences.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We would like to thank employees from Queen's University for their time and participation in our survey.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apergo.2022.103749.

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