Are laptop computers a health risk for an aging population?

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N. Charness, K. Dijkstra, T.S. Jastrzembski, S.J. Weaver, M. Champion. Are laptop computers a health risk for an aging population? Gerontechnology 2010; 9(3):415-420; doi:10.4017/gt.2010.09.03.005.00 Younger (age<40 years) and older (age>50 years) workers who used desktop and laptop computers at home were assessed in their homes for posture and self-reported arm and/or shoulder and wrist pain. Adherence to ergonomic guidelines was significantly worse at home than at work. More wrist pain was reported at work than at home, though arm and/or shoulder pain was more prevalent than wrist pain. Younger workers who used laptops at home reported more pain (average of arm and/or shoulder and wrist) than those using a desktop computer at home, and there was no relation between pain and type of computer used at home for older workers. These results suggest that laptop users, particularly younger workers, should be educated on how to use these devices safely in order to minimize the development of musculoskeletal disorders, and these findings reinforce the importance of prevention as one of the goals for gerontechnology, as advocated by Fozard.

Keywords: laptop, desktop, computer, musculoskeletal disorder, aging, health

Much of the attention of gerontechnologists has focused on finding and employing technology to augment normative declining abilities or substitute for functions that are more seriously impaired. Fozard[1] also points to the value of prevention for ensuring that today's younger generation ages well: ".... my hopes for an improved quality of life for current and future generations of aging people."

Prevention is recognized by healthcare professionals as an important tool in maintaining a healthy population. It is usually less expensive to prevent the complications of disease through, for example, inoculation than to treat them once someone has become infected. A good example of an age-associated risk that is being addressed with preventive measures is hearing loss where many industries mandate protective headgear for those exposed to loud sounds.

It is particularly salient that, as noted by Fozard and Gordon-Salant[2], presbycusis, age-related hearing loss in the high frequency range, is attributable to a variety of factors, including cumulative noise exposure, an environmental influence. One definition of aging, by a founder of gerontology, James Birren, is: "Aging refers to the regular changes

that occur in mature, genetically representative organisms living under representative environmental conditions as they advance in chronological age"[3]. It was impossible to damage your hearing by adopting too high a volume on an MP3 player 25 years ago (such music players became commercially available in the late 1980s). Today it is a distinct possibility for those listening to music as a leisure activity to exceed recommended noise exposure guidelines.

As this example illustrates, 'representative environmental conditions' have changed dramatically in the past century, particularly in terms of the ubiquity of technology devices such as computers[4]. With such pervasive technology spread, each new tool raises the possibility of a use-related injury, one that might be prevented with better design and training. Indeed, musculoskeletal disorders are a major source of physical and economic pain for those working in settings requiring frequent repetitive physical movements[5]. Yet although computer use has been identified as an important risk factor for some forms of pain, for instance, wrist pain as well as arm and shoulder pain[6], there are reasonable guidelines available to help people adopt postures to avoid incurring such injuries while working at traditional computer workstations[7].

As many have noted[4,8] technologies are diffusing into society at an accelerating pace. A good example is the changeover taking place between desktop and laptop computer systems. Sales of laptop computers outpaced desktop sales in May 2005 in the United States[9]. A recent Pew Internet & American Life study[10] showed that ownership for adult Americans consisted of 58% desktop computers and 47% laptop computers. Ownership of the two types varied systematically with age such that in the 18-29 year old group laptops (66%) were more frequently owned than desktop computers (53%) whereas for those aged 65+ desktops (37%) predominated over laptops (18%). If one examines OSHA/NIOSH guidelines for safe computing[11] none of the configurations shown involves laptop computer systems.

Telework is becoming a popular option for government and industry service work, with companies encouraging employees to work from home. Telework may reduce commuting costs for the worker, reduce office space requirements for the company, and in all likelihood, reduce the 'carbon footprint' for service sector work, though apparently very slightly[12]. Further, part-time work from home may be well suited to less physically mobile older adults who wish to remain in the paid workforce beyond normal retirement age[13]. However, there is a risk that companies that assign telework may not provide the same in-person support to teleworkers for ensuring that workstations meet ergonomic guidelines. Employers are likely to have much less control over the workstation setup at home. From a cost standpoint, companies may also have a bias for issuing a laptop computer for a teleworker so that they do not incur the time and expense of maintaining two separate systems at the office and at home in cases when workers shift between venues. However, from a worker's ergonomic health perspective, laptop use may pose several potential hazards compared to desktop use.

Due to packaging requirements which may make it more difficult to cool processing or hard drive components, laptops may build up excessive heat, and if placed on laps for long time intervals can, in rare cases, result in burns[14] or potentially, affect male fertility[15]. A more likely risk to health however, is the poor posture than laptop use may encourage. Given their size and portability, laptops and today's even smaller netbook computers, afford working in positions such as reclined on a sofa, slumped in airport seating, lying on a bed, etc. None of those positions is likely to conform to recommended ergonomic postures.

In this study, we asked whether the type of computer used (desktop versus laptop) has an impact on the probability of reporting arm and/or shoulder or wrist pain in a sam-

ple of older and younger workers. We also assessed whether the postures adopted at office workstations are different than those for home workstations. Generally, responsible employers attempt to provide sound workstation environments at work, but home computer users may not be as careful in the way that they set up their own equipment and they may not have the financial resources to purchase expensive office equipment such as ergonomically appropriate chairs. Our aim was to assess the risk of pain and to offer advice for safe use that will prolong health and safety for future generations of computer users as they reach old age. We assessed a subset of workers who agreed to participate in a home study of workstation ergonomics[6] during the time period when people were beginning to switch to laptop use.

Method

Participants

The initial sample comprised a group (n=206) of randomly sampled younger (M age<40 yr) and older (M age>50 yr) workers from a large Southeastern university in the United States. These two age bands were chosen primarily to bracket the age at which people become presbyopic (typically the decade of the 40s) in order to examine a series of issues concerning vision and computer use not dealt with in this paper. Details can be found in the original publication[6]. Participants were measured initially on office workstations, remeasured (n=87) approximately a year later, and then asked if they had a workstation setup at home (a home office) and if we could perform similar measurements to those in the office. A total of 64 individuals agreed to participate in the home study portion following their participation in the two at-work studies and provided informed consent. We had complete data concerning laptop and desktop use at home for a subset of 56 participants, though sample size dropped to 54 (n=24 younger, M age=32.1; n=30 older, M age=57.4) for type of computer analyses after we eliminated those who reported use of both a laptop and desktop at home (1 older and 1 younger worker). Of the older workers, 5 used a laptop exclusively at home and for younger workers, 2 used a laptop exclusively at home. The rest used a desktop computer workstation. Sample size varies somewhat from analysis to analysis given missing data values. We used variable-wise deletion to maintain as much power as possible in these analyses.

To assess bias in the sample agreeing to be measured at home, we compared the NIOSH workstation ergonomics scores at work for those in the initial sample (n=196 with complete data) with those in the home study sample (n=55 with complete data). The mean proportion correct NIOSH item score at work was not significantly different for the initial sample (0.803) compared to the home sample (0.807). That is, participation in the home study was not biased in terms of at-work workstation ergonomics ratings.

Procedure

The home visit lasted up to one hour and used the protocol described earlier[6]. The participants seated themselves in their normal posture in front of a computer or laptop while viewing a document on the monitor or screen. Base posture was assessed via the NIOSH Tray 5-G Computer Workstation Checklist[16] with items pooled initially into 11-item posture and ergonomics scales based on initial assessments and via photos and video taken of the workstation configuration while participants assumed their "usual" posture (posture they are in majority of computer work time). For example, in assessing wrist position, the experimenter provided a yes (1) or no (0) rating for whether the participant maintained a neutral position for the wrists (as opposed to pronated up or down) when the participant's hands were on the keyboard. Comfort (0-10 rating scale) was assessed with questionnaire items for: temperature, glare, fonts for workstation, noise, light levels, eye strain, pain reported from arm and/or shoulder, and pain reported from wrist. Ambient readings were taken for many of those variables (for instance, actual temperature, actual noise levels, luminance

levels) and for distance to monitor, screen resolution, screen size, screen contrast ratio, computer and monitor type, operating system used, a number comparison task, and other variables not of relevance to this study. We limit discussion here to workstation ergonomics measures, specifically postural and pain measures.

Results

Workstation ergonomics

A mixed model analysis of variance assessed the effects of between subjects factors of age (younger, older) and the within subjects factor of location of assessment (work, home) on overall workstation ergonomics (proportion correct scores for items on the ergonomics checklist). The only significant factor was location of assessment, $F(1,53)=6.18$, $p<0.02$, $MSe=0.009$, with better ergonomics experienced at work ($M=0.81$,$SE=0.019$) than at home ($M=0.76$, $SE=0.017$).

Pain

Analysis of variance assessed the effects of age (younger, older), location (work, home), and type of pain (arm and/or shoulder, wrist). A main effect of pain type was moderated by a significant interaction, $F(1,52)=4.88$, $p<0.033$, $MSe=0.858$, for type of pain and location of assessments (*Figure 1*).

Arm and/or shoulder pain was more in evidence than wrist pain, but wrist pain was experienced to a greater extent at the office than at the home. Reports of arm and/or shoulder and wrist pain were very stable over occasions of measurement (at work, and approximately one year later at home): $r=0.74$, $r=0.75$, respectively, for arm and/or shoulder and wrist pain.

To assess the impact of type of workstation, we restricted analysis to people who used either a desktop or a laptop but not both at home. Computer type (desktop, laptop) and age group (younger, older) were between subject factors and pain type (arm and/or shoulder, wrist) were within subject factors in the mixed model ANOVA. The main effect of age group (younger workers experiencing more pain than older workers) was moderated by a significant age group by computer type interaction for pain, $F(1,55)=5.08$, $p<0.03$, $MSe=5.15$ (*Figure 2*).

Younger workers (age<40) reported significantly more pain (averaged across arm and/or shoulder and wrist) if they used a laptop than if they used a desktop. For older workers (age>50) the (non-significant) trend was in the opposite direction.

To see whether time at the workstation and NIOSH ergonomics score mediated the relation between age and pain we used these three variables as predictors in a multiple regression.

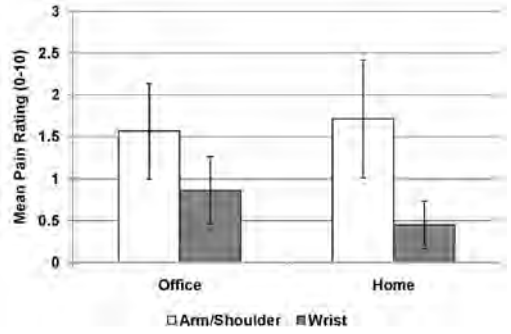

Figure 1. Pain type by location of assessment interaction; error bars represent 95% confidence intervals for the mean

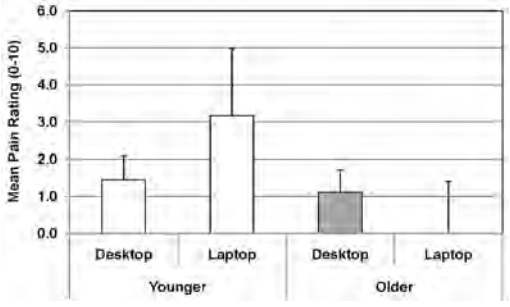

Figure 2. Age group by computer type interaction for pain; error bars represent 95% confidence interval for the mean, with laptop score near zero for older adults

For wrist pain, only age was a significant negative predictor variable (less pain reported as age increased). For arm and/or shoulder pain, there was a non-significant regression equation when all three variables were included. However, time at the (home) workstation was a modestly significant bivariate predictor of arm and/or shoulder pain (r=0.27).

Conclusions

We have several noteworthy findings. Although the reported pain levels in the arm and/or shoulder and wrist locations were in the low to moderate range, we found more problems for younger (age<40) than older (age>50) workers, a finding consistent with that obtained with the initial large sample in at-work office settings[6]. In that prior study, we also observed gender effects with women reporting a greater incidence of moderate to severe arm and/or shoulder pain than men. Given the small sample here we did not attempt to analyze for gender effects. Here we also found that younger workers seem more at risk than older workers for arm and/or shoulder pain associated with laptop use. It should be kept in mind that someone who reports pain may be incurring it from leisure as well as work activities. The reports of greater pain at work than at home may be attributable to greater time and intensity for typing and mousing activities at work than at home.

To help safeguard future generations of older adults from the risk of musculoskeletal disorders, guidelines need to be disseminated concerning notebook use. Saito and colleagues[17] have proposed such guidelines for laptop users. Their guidelines basically consist of converting the laptop into a more typical desktop workstation by attaching it to a docking station on a desk (equipped with an ergonomic office chair) linked to a keyboard, mouse, and monitor, which then can be arranged to conform to standard workstation guidelines. Changing the laptop setup during prolonged use in this way should also obviate heat problems mentioned earlier. That is, for the case of extended use, the notebook computer should become a desktop computer through the use of suitable peripheral devices. Given the falling price of technology generally, such peripherals should be affordable for most users, though retired older adults may not be as able to purchase these as those in the working population. For casual use over short periods of time, the benefits of being able to use a laptop in relaxed postures may outweigh the risks associated with those postures, though only an informed user population can properly weigh such choices.

It is also clear that, on average, workstation setups at home do not meet OSHA/NIOSH guidelines as well as do workstation setups at work. We investigated which items on the NIOSH scale contributed to the differences and found that the type of chair appeared to differ significantly between work and home (as tapped by items such as ability to adjust height, provide lumbar support, have arm rests). People often used household chairs rather than office chairs with their workstation setups. Thus, we can recommend that people who create a home workstation consider purchasing an ergonomic office chair to ensure that they can more easily maintain recommended postures for computer work.

Caveats. The sample we obtained was relatively small for the home study component so we need replication of these findings to assure their robustness. Also, at our time of sampling ownership of notebook computers was quite low compared to desktop ones for home users. Thus, we had minimal power to detect differences for the factors of interest.

Computers are becoming ubiquitous in society and are required tools for some types of information seeking (for instance, health information from the Internet; indexing services in libraries). Computers are also essential for cost effective use of some services (for instance, booking airline flights). No matter what form they take (for instance, smartphones, desktops, laptops, tablets) there are risks associated with prolonged, repetitive interaction with such systems. If we hope to have future generations reach old age with

relatively intact musculoskeletal capabilities, there is a need to educate today's younger adults on how to use these devices safely. As one practical approach, manufacturers could include guidelines for sound workstation ergonomics as part of their instructional materials. As well companies could be encouraged to subsidize the purchase of office equipment such as laptop docking stations and ergonomic chairs for teleworkers much in the same way that they currently provide computers and telecommunication connectivity. Both users and designers of such equipment should heed the classical medical dictum "primum non nocere" (first, do no harm). Encouraging users of all ages to adopt proper computer workstation ergonomics can serve as one small step toward Fozard's goal of "an improved quality of life for current and future generations of aging people".

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