Minimizing Musculoskeletal Discomfort in the Workplace: An Age Based Approach

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Abstract

America's work force is aging but very little is known about functional limitations (e.g., changes in vision, hearing, musculoskeletal system) and how that affects individual performance, productivity and the needs of aging workers. Four hundred eight employees at a college campus completed a web-based questionnaire. There was a significant difference between older and younger workers with regards to both mental and physical health compared to five years ago. Older workers (ages 45 and over) reported greater degrees of physical declines than younger respondents. The largest decline in older respondents was found in eyesight followed by upper/lower back strength and muscle strength. As for specific changes in mental health characteristics, older respondents showed greater degrees of decline in memory, reaction time, and learning ability. Workers that participated in ergonomics training were more likely to change their work environment to reduce discomfort and enhance their performance. Health promotion programs of this type should be encouraged by employers.

Keywords: aging, musculoskeletal injury, workplace, health

America's work force is aging, with 38.5% of the workforce over the age of 45 employed in 2004 (U.S. Department of Labor, 2006). According to the Bureau of Labor Statistics, between 1998 and 2008, the number of civilian workers 55 and over will increase by 49.9%, while those 25-54 will increase by only 5.5% and those 16-24 will actually decrease by 2.8% (Fullerton, 1999). Very little is known about the aging workforce in terms of psychological, social and physiological (functional) characteristics.

As people age, they are at a higher risk for several diseases and their resistance to harmful exposures is reduced and injuries are often much more severe if not fatal (Healy, 2001). Several studies have indicated that musculoskeletal diseases have increased as a result of the aging population (McClure, Adams & Dahm, 2005; Garg, 1991; Green, 2002). The escalating use of computers has created a cluster of musculoskeletal discomforts (neck ache, shoulder pain, tendonitis, etc). In 2003, MSD's accounted for 33% of the injuries and illnesses with days away from work. Carpal tunnel syndrome- averaged 32 days away from work while fractures averaged 30 days. Employers pay more than $15-20 billion in workers' compensation costs for musculoskeletal disorders every year, and indirect costs total $45-60 billion (Bureau of Labor Statistics, 2003). In addition $1 of every $3 spent on worker's compensation claims is due to musculoskeletal disorders.

Very little is known about functional limitations (e.g., changes in vision, hearing, musculoskeletal system) that may affect individual performance, productivity and the needs of the worker through his/her lifespan.

Vision

There are a number of changes in visual abilities that have potential to impair work performance among aging individuals. These changes include: a decline in static and dynamic visual acuity, a reduction in the range of

accommodation, a loss of contrast sensitivity, a decrease in dark adaptation, an increase in susceptibility to glare, a decline in the ability to detect targets against a background, and a decline in ability to discriminate between certain colors (primarily blue-green) (Czaja, 1995; Kline & Scheiber, 1985). In addition, diseases such as cataracts, glaucoma, and macular degeneration are more common as we get older. The lens of the eye after sixty years old becomes thicker, harder, and more yellow and the pupil reduces in size. The hardening of the lens reduces its ability to change shape and therefore to accommodate for variations in distance. Impaired depth perception may cause a person to perceive a shadow as a step or a hole and the visual misinterpretation can severely impair an individual's ability to function safely (Gaither, 2003). These alterations can have a substantial impact on the older worker's ability to "sense" cues from the environment and can increase the likelihood of falling (Walton, 2001).

Hearing

Age related hearing loss (presbycusis) is thought to begin at about age thirty-five, but becomes more pronounced with advancing age (Haight, 2003). Most older adults experience some decline in auditory function. Age-associated loss of hearing includes; a loss of sensitivity to pure tones, high frequency tones, difficulty understanding speech, problems localizing sounds, increased sensitivity to loud noises, and an imbalance in equilibrium can occur (Czaja, 1995; Scheiber, Fozard, Gordon-Salent & Weiffenbach, 1991). This may lead to an older worker's inability to hear/recognize alarms, understand speech, develop vertigo and maintain balance (Province, Hadley, Hornbrook, Lipsitz & Miller, 1995).

Research performed in a multiple task environment shows that older workers score significantly lower than younger workers in auditory task performance. Older workers show poor auditory discrimination performance because of a reduced ability to strategically allocate attention toward performance of auditory monitoring (Haight, 2003).

Musculoskeletal Changes

Decrease in Muscular Strength

Muscular strength, in general, peaks between the ages of 25 and 30. On average, a person's strength at 51-55 years of age is approximately 80% of what that person's strength was at age 31-35 years. There is a decline from age 71-75 years of approximately 40% when compared to strength at age 31-35 (Viitasalo, Era, Leskinen & Heikkenen, 1985). Reduction of physical strength with increasing age is generally believed to be hazardous, especially to older workers in jobs requiring exertion of high muscular forces such as lifting, lowering, carrying of moderate to heavy loads, and pushing and pulling of heavy carts on broken or inclined floors.

Reduction in Joint Mobility and Manual Dexterity

The most significant changes in our ability to move occur in our joints, particularly small motor movements associated with grasping, gripping, twisting and turning, and large motor movements associated with walking, bending, sitting, climbing, stooping and reaching. Changes in our small motor movements affect our dexterity and ability to grasp, hold and manipulate objects. As our ability to locate and identify textures and surfaces becomes impaired, it is increasingly difficult to grasp, hold, or manipulate small, smooth objects (Pirkl, 1995). Schwoerer and May (1996) examined the relation between age, quality of tool design, and job performance. Results indicated that among younger workers, tool quality was unrelated to job performance. However, among older workers, quality of tool design made a significant difference. Those older workers with tools viewed to be poorly designed had the lowest performance ratings of all groups. In contrast, older workers with tools of high design quality had the highest performance ratings of all groups.

Older adults also tend to exhibit a more conservative reach by keeping elbows closer to the torso and do not elevate the shoulder as much as younger adults. The difference is more pronounced in longer reaches. Reach should be minimized for tasks performed by older workers.

Driving and similar tasks (e.g., operating a large piece of machinery) require responding continuously to spatial and temporal information from the environment and the equipment. In doing so, one must coordinate movement of the head, neck, and upper and lower limbs. Motor control is critical when one must brake, steer, turn, change lanes, merge, recover from a skid, start a pump, drop the level in a storage tank, etc (Haight 2003). One of the most pervasive findings in age related research is that motor performance slows with aging.

Slowing of Reaction and Movement Times

With age, all behavioral responses slow down. Part of this slowing down is explained by the declining efficiencies of the sensory organs and the musculoskeletal system (Davies & Mebarki, 1983). Depending on task complexity, older adults are slower to respond. Response speed has a linear relationship with task complexity (Haight 2003). Older adults have more difficulty managing or coordinating multiple tasks. Some research has suggested that age-related difference in performance of multiple tasks is reduced through training (Haight 2003). Other research has suggested that performance is improved further if tasks performance order is flexible- meaning that the worker can decide what order to perform tasks without penalty. From a performance standpoint, however, older workers have much more experience than younger workers. Through selective optimization by compensation (SOC) older workers apply previously learned skills to current situations resulting in comparable performance with younger workers (Baltes & Baltes, 1990). This experience may enable older workers to achieve satisfactory performance, which will help them compensate for any slowing. However, when the job demands exceed the worker's capacity, the older worker may compensate by using increased physical effort or taking fewer rest periods to complete the task in a timely manner. Key considerations include allowance of longer response time, additional practice to increase familiarity, frequent refresher training, frequent reinforcement of task priority, reduction in the need for simultaneous performance of multiple tasks, or designing the system to be operated with low sensitivity to task order (Haight, 2003).

Among the most urgent research needs in worker health and safety are to determine the types of changes, adaptations and coping strategies utilized to minimize the impact of physiological changes associated with aging. This research study aims to identify the current practices used by staff in a university setting to reduce musculoskeletal discomfort and examine the relationships between age and such practices.

Methods

This study employed a cross-sectional research design. Over the winter/intersession semester break, an electronic mail message was sent to all 1431 full and part-time staff at the California State University, Fullerton (CSUF) campus requesting their participation in a research study entitled “Worksite Modifications and Reduction of Musculoskeletal Discomfort Among College Staff”. Specifically, participants were asked to complete a questionnaire and submit their responses by going to a specified URL on the web. Thirty-two employees were out of the office over intersession and 21 were on medical leave/retired (as stated from the e-mail automated responses). Thirteen hundred seventy eight e-mails were successfully delivered. From those 1378, 408 (30%) of the staff employees completed the research questionnaire. Only two respondents politely declined from completing the survey. All participants completing the survey had the opportunity to be entered in a raffle drawing for movie tickets (two sets of two) and dinner (one award). There were no follow-up e-mails attempted. The questionnaire was confidential and met all requirements of the institutional review board for the use of human subjects at the University.

The questionnaire comprised of three sections. The first section contained questions on work environment, job tasks, and work experience. Questions were taken from the California Work and Health Survey (2000) and modified to fit the parameters of this study. The second section of the questionnaire focused on physical and mental health and changes that individuals made at their workstation as a result of functional

losses (e.g. poor vision, hearing loss, head, neck and shoulder strain, back fatigue/pain, decreased sensitivity to touch, and decreased muscle strength and joint inflexibility). These questions were created by utilizing the "Working Safely with Video Display Terminals, Checklist (1997)" created by the Occupational Safety and Health Administration. The final section provided demographic questions. The questionnaire was developed using Microsoft FrontPage® for administration online, and completed responses to the questionnaires were sent anonymously to a web-page database. Data were analyzed using version 13 of the Statistical Package for the Social Sciences (SPSS).

Results

Demographics

Of the 408 staff employees that completed the questionnaire, 307 (75.2%) were women and 72 (17.6%) were men (29 or 7.1% did not report their sex). Their age-range was between 20 and 70 years of age with the mean age of 42.6 (SD = 12.19). Among those whose age was known (age was unknown for 35 respondents), almost half of the respondents were aged 45 and older (47.7%; n=178). Over a half (52.3%, n=195) were younger than 45. Other demographic information is presented in Appendix A. Almost a quarter (n=100; 24.5%) of the respondents were single, almost a half or 48.8% (n=199) married, 14.5% (n=59) separated/divorced. 2.7% (n=11) widowed, 2.7% (n=11) other, and 6.9% (n=28) did not report their marital status. The majority of respondents listed themselves as White/Caucasian 56.1% (n=229) followed by Latino/Hispanic or Mexican-American 16.7% (n=68), Asian 8.6% (n=35) and Black or African-American 4.7% (n=19), Filipino, Native-American or other 6.7% (n=26). Thirty employees (7.4%) did not respond to this item. All respondents completed at least high school or the high school equivalency examination. Most respondents 38.2% (n=156) were college graduates, 26.2% (n=107) had some college and 22.5% (n=92) had a baccalaureate degree with additional schooling or professional degree, 4.5% (n=17) had technical school training and 7.1% (n=29) did not respond to their educational level. Household income was variable. Over a quarter of respondents, 27.5% (n=112), reported a household income between $30,000 and 49,999. This was followed by 18.6% (n=76) of the respondents reporting a household income of $90,000 or more. Respondents worked at the University from one month to 35 years with the average length of time reported at eight years and two months. Those worked in their present position ranging from one month to 33 and a half years with the average reported at five years and three months. Eighty-three percent (n=340) of the respondents reported that they strongly or somewhat agree with the statement "I am satisfied with my job". No difference was found in the levels of job satisfaction between the younger employees (under 45 years old) and the older employees (45 and older).

Physical and Mental Health

The majority of the respondents (54.4%; n=222) rated their physical health as "good" with almost a quarter of the respondents (24.3%; n=99) rating as "excellent" and only 2.2% (n=9) reporting their "poor" physical health status. In rating their mental health status, the respondents who reported "excellent," "good," "fair," and "poor" were 36.0% (n=147), 47.3% (n=193), 8.6% (n=35), and 2.0% (n=8), respectively. A paired t-test to examine the relationship between physical health ratings and mental health ratings revealed that mental health were rated lower than physical health ($p < .001$).

Chi-square tests showed that there were no relationships of the age category (under 45 years old vs. 45 or older) to physical health or mental health (Due to small numbers of expected values for "fair" and "poor" ratings, the two rating categories were merged in performing a chi-square on mental health).

When asked to compare to five years ago, 45.6% (n=186) stated that their physical health had improved and 17.2% (n=70) said it had stayed the same. Thirty-one percent (n=128) said their physical health had declined in the past five years. Younger individuals (under 45 years old) were more likely to say that their physical health had improved over the past five years (23.6%) than older workers (12.9%). The relationship between the age category and the change

category in physical health was significant at .05 level.

As for mental health, 34.3% (n=140) stated their mental or emotional health had improved compared to the past five years, 14% (n=57) stated it was declining and 46% (n=187) stated it had stayed the same. Younger individuals were more likely to state that their mental health had improved (42.6%) than older workers (30.3%). The relationship was significant at .05 level.

In looking into the specifics of their perceived changes over five years in physical health, the change scores derived from the subtraction of current ratings from the year-year ago ratings for each of the physical factors were used as the dependent variable in ANCOVA where the age category was the dependent variable and the five-year ago rating score was used as a covariate. The value coding was done in such way that negative numbers in the change scores represent declines and positives improvements. With a few exceptions (breathing ability and eyesight), the older respondents reported greater degrees of physical declines than the younger respondents (Table 1). The largest decline in the older employee sample was found in eyesight followed by upper/lower back strength and muscle strength. As for specific changes in mental health characteristics, the older respondents showed greater degrees of decline in all but in attention spans. The largest decline among the older employees was reported in the area of memory followed by reaction time and learning ability.

Table 1
Physical/Mental Changes and Age

Physical and Mental Characteristics	Under 45	45 and Older	p*
Physical characteristics			
Eyesight	-.34	-.47	.056
Hearing	-.07	-.21	.001
Sense of smell	-.03	-.10	.003
Sense of taste	.00	-.03	.000
Sense of touch	.01	-.08	.000
Muscle strength	-.23	-.40	.000
Breathing	-.08	-.15	.264
Back strength	-.27	-.41	.004
Mental characteristics			
Memory	-.28	-.48	.000
Alertness	-.05	-.18	.013
Attention span	-.16	-.20	.401
Reaction time	-.07	-.24	.000
Problem solving	.08	-.07	.001
Learning ability	-.02	-.21	.000

* significant for f values of the age category in ANCOVA

Computer Use

The time spent on their computer at work ranged from 0 minutes to 12 hours with the mode and median of 6 hours and the mean of 5 hours and 47 minutes (SD = 1 hour and 55 minutes). Almost three quarters (n=296) of the respondents reported their computer use at home. The average length of their computer use at home was 60 minutes (mode), 52.5 minutes (median) and one hour and 5 minutes (mean)

with the standard deviation of 1 hour and 8 minutes. Table 3 displays a listing of computer related devices used at home and at work. All the devices assessed were more often reported being utilized at work than at home. The use of computer-related devices was not different between the two age categories.

Table 2
Use of computer related devices home and work

Device	Work	Home
Ergonomic Chair	65%(n=267)	33% (n=133)
Adjustable Monitor	54% (n=220)	39% (n=158)
Foot Rests	16% (n=66)	5% (n=21)
Wrist Rests	37% (n=150)	21% (n=84)
Anti-Glare Screens	15% (n=59)	9% (n=37)
Document Holder	21% (n=84)	14% (n=57)
Adjustable Keyboard	6% (n=26)	----------
Track Ball	6% (n=26)	----------

In identifying workstation and personal modifications to accommodate their vision changes, 72% (n=292) have purchased reading or other types of glasses, 40% (n=161) changed their lighting to see better, 34% (n=140) made changes to the font size on their computer. Other changes included utilizing anti-glare screens, lasik eye surgery, changes in monitor positioning and taking eye breaks (rest). There was a significant difference between the younger and the older individuals with respect to purchasing reading or other types of glasses. Older individuals (90.4%) purchased glasses more often than younger individuals (62.6%; p=.01). Older individuals (49.4%) also reported more changes to their lighting conditions as compared to younger individuals (34.4%; p=.01). Older individuals (31.6%) were also more likely to use anti-glare features on their reading glasses compare to younger individuals (11.3%) The significance was at .01 level. When asked about changes in hearing, 16% (n=64) stated they reduced their noise exposure and 8% (n=32) wore hearing protection. Very few 1.2% (n=5) purchased a hearing aid. Only a few participants 5.6% (n=23) wore gloves to protect sensitivity to touch usually heat cold and chemicals. Thirty percent (n=124) stated they participate in weight training and 41% (n=166) participate in other types of stretching/yoga programs. Thirty-seven percent (n=151) mention they have increased their aerobic activity and 7% (n=29) have stopped smoking. Younger employees (43.1%) were more likely to participate in weight training programs as compared to older workers (21.8%; p<.01). Younger workers were also more likely to participate in stretching or other types of relaxation programs (49.5%) compared to older workers (39.1%; p<.01) and aerobic programs (younger, 44.6% and older 34.3%; p<.01). Many participants 60% (n=244) adjusted their workstation chair to prevent back pain. Thirty-four percent (n=140) reduced the amount of weight they lifted and 53% (n=214) re-designed their workstation to minimize twisting. Five percent (n=20) use anti-fatigue mats when standing for long periods of time. Older employees (8.0%) use anti-fatigue mats more often than younger workers (3.1%; p<.05).

In looking at the modifications/adjustments that participants made to accommodate changes in mental/emotional health, 60% (n=246) state that they take short breaks to rest when performing repetitive tasks. Sixty-six percent (n=271) vary

tasks to prevent monotonous activities, 32% (n=130) take exercise breaks, 11% (n=46) rotate jobs with co-workers and 54% (n=221) take training classes. None of the modifications/ adjustments for declines in mental/ emotional health was different between the two age categories.

Ergonomics Training

Twenty percent (n=80) of the participants have taken the ergonomics training program provided at the University. Those individuals participating in the ergonomics training program were more likely to arrange their workstation to minimize glare ($p<.001$), arrange seat and backrest to support comfortable postures ($p<.01$), perform keying in a relaxed manner with elbows close to the body ($p<.01$) and arrange their keyboard so they can keypunch in a neutral position ($p <.01$). A chi-square test revealed that there was a relationship of the age category to whether they had taken the ergonomics training program ($p = .027$ with continuity correction). The older employees were more likely to have taken the ergonomics training program (26.6%) than the younger employees (16.6%).

Discussion

Four-hundred eight staff employees (30%) completed the questionnaire during a winter break at the university. Most of the participants were women (75%) typical of clerical/ administrative type of positions at this university. Most of the participants (83%) really enjoyed their jobs and rank job satisfaction very high. This was evident by their length of service to the university, an average length of time of over eight years.

The average length of time spent on their computer was five hours and forty minutes, but most commonly reported was six hours. Although, the issue of musculoskeletal disorders was not raised in this questionnaire, spending long periods of time at a VDT increases the risk of musculoskeletal related problems such as carpal tunnel syndrome. A study conducted at a major Midwestern University indicated that the most significant factor resulting in carpal tunnel syndrome was length of time working with a computer. In fact, increasing daily work duration from one to four hours increased the probability of carpal tunnel syndrome from .45 to .92 (Matias, Salvendy, Kuczek, 1998).

For purposes of analyses, the groups were divided below age 45 and 45 and older based on other studies using age 45 and older as the definition of an older worker. When comparing older with younger workers, there was a significant difference in physical changes compared to five years ago. The greatest physical changes that were seen among older workers was with respect to vision followed by upper/low back strength. There were significant differences between older and younger workers on purchasing eyewear, changing lighting, using anti-glare features, etc. Greene (2004) suggests that the time has come to "pronounce aging worker issues". Studies are beginning to identify a reduction of musculoskeletal pain and eyestrain by implementing these age-based strategies such as employing optometric corrections, installing Venetian blinds, purchasing adjustable seating, etc. (Aaras, Horgen, Ro, Loken, Mathiasen, Bjorset et al., 2005; Wolska, Widerszal-Bazyl, Roman-Liu, & Aaras, 2005).

Another difference that was seen between older and younger workers was that younger workers were more likely to participate in exercise related programs. Exercise programs such as weight training, cardiovascular (aerobic) and stretching/relaxation (yoga, tai-chi, etc) have been effective in reducing musculoskeletal discomfort (La, Yang, and Seo, 2004; Hess & Hecker, 2003; Tsauo, Lee, Hsu, Chen & Chen, 2004).Yoga has been found to reduce stress and relieve musculoskeletal tension/ pain in the work setting (Sequeria, 1999). However exercises must be carefully evaluated. NIOSH conducted a study on worksite exercises and found some exercises actually exacerbate biomechanical stresses common to computer users. Taking breaks has not declined productivity levels and in fact has shown to increase productivity (Henning, Jacques, Kissel, Sullivan, Alteras-Webb, 1997).

There was also a significant difference between older and younger workers with regards to

mental health compared to five years ago. The greatest mental health changes that were seen were in memory and reaction times. It has been demonstrated that mental processing and reaction time become slower with age. On tests of intelligence that require the person to perform tasks within a short time frame, older adults often do worse than younger counterparts. In the past, this was considered to be a measure of decreased cognitive functioning. However, on intelligence tests with liberal time limits, older adults are often able to perform just as well as younger people. Therefore, it is now thought by some experts that older adults don't lose mental competence; it simply takes them longer to process the necessary information (Roth, 2005). Giving older adults sufficient time to complete a task, additional practice to increase familiarity, frequent refresher training, and reinforcement of task priority will enhance mental health. Fortunately, for those that experience declines, they are usually not disabling.

In the U.S. musculoskeletal disorders cause more work absenteeism or disability than any other group of diseases. Those individuals that participated in the ergonomics training program were more likely to change their work environment to reduce discomfort and enhance their performance. It appears that aging employees at this University seem receptive to health information. This may suggest the potential further impact of such programs on their health and productivity. Active ergonomics training programs have been demonstrated that participative training in workstation ergonomics can improve work postures, work practices, risk factor exposure and pain in employees (Green, DeJoy and Olejnik, 2005). These types of programs should be actively pursued to reduce discomfort and increase satisfaction among aging employees.

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Appendix A
Demographic Information

Demographic Characteristics	N	Percent
Martial status		
Single	100	25.0
Married	199	48.8
Separated/Divorce	59	14.5
Widowed	11	2.7
Other	11	2.7
DNR	28	6.9
Race/Ethnicity		
White/Caucasian	229	56.1
Latino/Hispanic or Mexican-American	68	16.7
Asian	35	8.6
Black or African-American	19	4.7
Filipino, Native American or Other	26	6.7
DNR	30	7.4
Education Level		
Professor/Technical school	92	22.5
College graduate	156	38.2
Some college	107	26.2
Technical school	17	4.5
DNR	29	7.1
Household Income		
Less than $29,999	46	11.3
$30,000-49,999	112	27.5
$50,000-69,999	71	17.4
$70,000-89,999	59	14.5
$90,000 or more	76	18.6
DNR	44	10.8