THE EFFECT OF SOME WORKER-RELATED VARIABLES ON WORK ABILITY, WORK TECHNIQUE, AND NUMBER OF ERRORS IN A PACKING JOB

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A study was conducted to determine the effect of some worker-related variables on work ability, work technique, and number of errors for a group of nine female employees aged 25 to 55 working as packers at a global distribution center located in the U.S.A. Work ability questionnaires (from the Finnish Institute of Occupational Health) were given, quality ratings (as indicated by the number of errors) from the previous month were obtained, and employees were videotaped. Correlation analysis indicated that tenure was inversely related to work ability. Analysis of variance indicated that age and height were significantly related to the number of errors. Post-hoc tests indicated that older employees and taller employees had fewer errors. This finding was especially interesting considering that the workstations were designed for men or very tall women. This research serves as a pilot for a study aimed at discerning different working techniques through the development of a model that uses frequency and types of movements.

INTRODUCTION

As we enter into the 21st century, demographic changes in the age and composition of the labor force coupled with an expanding economy and a declining birth rate in the western continent will necessitate older employees remaining in the labor force. The Bureau of Labor Statistics predicts that by 2008, Americans aged 55 and over will represent 30% of the population and the labor force participation for this group will grow to 36.8% (Schwerha and McMullin, 2001, Fullerton, 1999). Additionally, by 2008 the labor force is expected to reach 155 million, and the rate of growth of women in the labor force will increase at a faster rate than of men, with the proportion of women in the labor force growing to 48% (Fullerton, 1999). The predicted median age of the labor force for 2008 is estimated at 40.7 years, an increase over the median age for 1998 (38.7 years) and 1988 (35.9 years).

In addition to this explosion in the number of older Americans, the post-modern American economy is becoming post-industrial and service oriented. Of special interest is the rapidly growing sector of the economy associated with the Internet and e-commerce. E-commerce represents a change in retailing, a reduction in the use of conventional stores, an increase in mail delivery services, and increases in warehouse activity. From 1996 to 1997 sales through e-commerce more than doubled from $15.5 to $38.8 billion. New estimates are for total e-commerce to reach $1 trillion a year by 2005 (Organization for Economic Co-operation and Development, 1999). E-commerce presents new challenges for the ergonomist because it involves jobs that contain both high repetition and excessive force. Many of these jobs, such as packing and inspection, are staffed nearly exclusively by women.

Packing is an occupation that is adversely affected by several identified musculoskeletal disorders: tendinitis of the shoulder and wrist, tension neck, carpal tunnel syndrome, and De Quervain's syndrome (Putz-Anderson, ed., 1994). These overuse syndromes can result from the high repetition and the types of movements required by the job. Typical movements include flexion above the shoulder as well as abduction of the arm to collect the material from the bins, to reach and assemble the boxes or bags, to place additional materials in the box or bag (such as catalogues), to tape the box, and to place the package on the

conveyor belt. For many of these movements, the pinch grip is used.

Although the physical demands asked of the worker in warehousing are great, and demographics point to an increase of older women in these types of jobs, the literature is very limited in showing how older women perform these types of jobs (or even other jobs) despite normative physical declines due to the process of aging. For instance, deterioration in tactile sensations has been documented, but there are no data to suggest that such declines affect work performance (Clark et. al., 1990, Stevens and Cruz, 1996). In a study of university employees, Williams and Crumpton (1997) found no difference in work ability, yet differences in functional ability (physical and cognitive skills) were significantly pronounced between different age groups. Cognitive declines have been documented in reaction time, some forms of memory, and fluid intelligence. However, in the classic study that sought to address aging and performance for a typing task, no significant age differences were found (Salthouse, 1984). Instead, Salthouse discovered compensatory measures that allowed the older workers to perform as well as the younger workers. The aim of this study was to determine the effect of aging and work technique on work ability and the number of errors made by female employees working in a packing job.

METHODS

This study consisted of evaluating nine female packers at a large distribution center located in the U.S.A. The packers were aged 25-55, and they all packed at approximately the same speed. The packers' job consisted of retrieving the items to be shipped from the bins (the bins were filled periodically by material sliding off a tilt train above the bins), organizing the items according to order, and packing the items. The types of orders were randomized between employees so that during any given work schedule an employee may pack single-item or multi-item packages, or both. The items may be packed in bags or in boxes. The employee is given several types and sizes of bags and boxes from which to choose. The material to be packed ranges from intimate apparel to outerwear. Both folded and hanging items are packaged. The employees pack at least eight work schedules a day, and they may pack up to 64 packages per schedule, for a minimum of 512 orders per day.

The experiment consisted of the following steps:

1) The subjects were asked to complete a work ability questionnaire.
2) Each subject's most recent quality assurance ratings were obtained (this is number of errors per number of packages randomly checked).
3) The subjects were videotaped so that their work techniques could be studied later.

The work ability questionnaire was developed by the Finnish Institute of Occupational Health. The questionnaire provides questions pertaining to the subject's perceptions of the work demands, his/her perceptions about how their ability matches the job requirements, and questions about their health conditions. Its conceptual definition was explained by the question, "How good are workers at present and in the near future and how able are they to do their job with respect to work demands, health, and mental resources." (Ilmarinen et. al., 1997). A poor rating on the work ability index was a good predictor of work disability in 4 years (Ilmarinen et. al., 1997).

The work ability index is the sum of scores in 7 different areas: perception of current work ability, work ability in relation to the demands of the job, number of current diagnosed diseases, estimated work impairment due to diseases, sick leave during the past year, own prognosis of work ability two years from now, and psychological resources. The answers in each category are tallied to provide a single score that can range anywhere from 7 to 49. The 4 categories for the work ability index score are poor (score 7-27), moderate (score 28-36), good (score 37-43), and excellent (score 44-49) work ability (Ilmarinen et. al., 1997).

Because of time constraints, the subjects were videotaped during one randomly chosen schedule of the day. In this way, packers were packing at approximately the same rate, but each one received a random distribution of the types of orders to be packed. A schedule is a 40-minute period in which a certain amount of material is dropped into the bins for the packer. All of the videotaping was done

during the course of one day. The method of how each packer organizes her materials to prepare for packing was not measured but may be studied in the future.

Data were collected for the following dependent variables that were used in the subsequent statistical analysis: work ability score, number of errors, time to complete a brown bag, and time to complete a brown box. The time to complete a package was determined from the video. The time was measured as the moment when the packer goes for the box (or bag) until the moment when the package is thrown on the conveyor belt.

Age, tenure, and height were used as the independent variables in the statistical model. Age ranged from 25 to 55 years, tenure ranged from 2 to 11 years, and height ranged from 60 to 70 inches. The mean age was 40.78 years, the mean tenure was 5.28 years, and the mean height was 65.33 inches. The packers were divided into two groups according to age with ages ≤ 40 considered "low" and ages ≥ 41 considered "high." Four subjects were in the younger group and 5 subjects in the older group. Tenure was divided into two categories with ≤ 5 years considered "low" and ≥ 6 years considered "high." Height was divided into two groups with heights ≤ 64 inches considered "low" and ≥ 65 inches considered "high." Correlation analysis was performed and the general linear model was used with a two-level factorial design to perform the analysis of variance.

RESULTS

Descriptive Data

The work ability scores ranged from 26 to 48 with a mean of 38.22. The mean work ability score for the younger subjects was 38.25 and the mean work ability score for the older subjects was 38.2. Approximately 11.1% of the subjects had poor work ability, 22.2% had moderate work ability, 44.4% had good work ability, and 22.2% had excellent work ability.

Analysis of the work ability index by individual categories according to the procedure by Pohjonen (2001) yielded no significant differences between age groups for any of the categories of the work ability index.

The number of errors was recorded as a percentage and was collected from quality assurance procedures from the month previous. The percentages varied from 0 (no errors in the packages that were randomly checked) to 0.764% errors.

Correlation Analysis

Initially, a correlation analysis was performed to determine which variables were correlated and to what extent. The Pearson's Correlation coefficient was used. A 0.10 significance level was used since the sample size was fairly small. For work ability, tenure was found to be inversely related to work ability (p-value=0.092). For the number of errors, the time taken to pack a brown box was inversely related to the number of errors (p-value=0.032), and height was inversely related to number of errors (p-value=0.029).

Analysis of Variance

The general linear model procedure was used to perform the analysis of variance. There were no significant results for the work ability scores. However, the analysis of the model using number of errors as the response variable produced four significant results:

- Age was significant with a p-value of 0.011
- Height was significant with a p-value of 0.013
- The age*tenure interaction was significant with a p-value of 0.012
- The age*height interaction was significant with a p-value of 0.042

Post-hoc tests indicated that the older employees and taller employees had fewer numbers of errors. Employees in the older group, however, did not have a greater average number of years of tenure. These data, along with the fact that tenure alone was not significantly related to the number of errors, suggest that in this model the effect of tenure on the number of errors was dependent on the age of the subject.

DISCUSSION

Correlation analysis indicated that tenure was inversely related to the work ability index score.

Research has suggested an increased risk of poor work ability for workers with reduced possibilities to control their own work, with perceived excessive work demands (ergonomics), with perceived time pressure and those with moderate or poor experiences with management (Pohjonen, 2001). Correlation analysis also indicated that employees who took longer to pack brown boxes incurred fewer errors.

The results from the analysis of variance indicated that the independent variables had more of an effect on how the jobs were done and the number of errors made by each employee than on the work ability scores. Analysis of variance showed that the work ability scores were not significantly related to any of the independent variables. However, more than half of the work ability index scores were in the good or excellent category (score of 37-49), with the mean score being 38.22 points. These scores are in the range of European data where the mean work ability index score for women aged 45 years working in mixed physical and mental work was found to be 39.8 (Ilmarinen et. al., 1997) and the work ability index score of women aged 40-44 employed in home care work was found to be 38.1 (Pohjonen, 2001).

The lack of statistical significance in work ability scores may be due to the small sample size or the reluctance of the workers to disclose personal information about their health or their perception that expressing difficulties might be viewed as a weakness. Since the questionnaire has been validated in Europe and since there is data to which to compare our findings, the questionnaire is seen as a good element of an ergonomic exposure profile and will continue to be used in future research.

The significant results from the analysis of variance using the number of errors indicated that age, height, and the age*tenure and age*height interactions were significant. These results can be attributed to two factors: 1) the workstations are designed for men or very tall women and thus make the work much more difficult for short to average height women, and 2) tenure and age may reflect the role of expertise in packing and effort to produce the very best product possible. These results indicate that poorly designed workstations have the potential to influence the quality of the work produced at them. Future research will be focused on improving the ergonomics of the workstations and determining how the number of errors changes as a result of improved workstation design.

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