# An Ergonomics Assessment Methodology for Work-Worker Systems

## Final Report


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## List of abbreviations

| | |
|---|---|
| DPC | Desktop personal computer |
| MSD | Musculoskeletal disorder(s) |
| NIOSH | National Institute for Occupational Safety and Health |
| NPC | Notebook personal computer<br>*(used with or without a docking station or peripheral input devices)* |
| NRC | National Research Council |
| PDA | Personal digital assistant |
| SF-12 | Short Form 12 question version of the SF-36 – provides general assessments of physical and mental health composite scores, referred to as PCS and MCS, respectively. |
| VDT | Visual display terminal (computer) |
| WMSD | Work-related musculoskeletal disorder(s) |

## Abstract

Typically the goals of ergonomic research are one or more of the following: establish a (causal) link between hazards and health outcomes; characterize dose-response relationships between hazards and health outcomes; identify exposure thresholds for hazards; or demonstrate efficacy of interventions. Efforts persist towards all these goals, in continued attempts to understand the etiology of musculoskeletal injuries. Multi-factorial investigations are the best type of design for studying these complex problems that may involve biomechanics, psychosocial elements, work organization, and personal attributes. The objective of this project was the development and application of a comprehensive assessment methodology for characterizing the work-worker system from an ergonomics perspective. The methodology was applied to mobile computing, an emerging area of office ergonomics. This group was chosen, because it is a new grouping of workers, which presents the opportunity for proactive, prospective investigation.

The study was designed in three phases, the first of which provided qualitative information about the workers and their work conditions. In this study, the workers were professionals who used computers as a primary work tool. Both notebook computer users and desktop computer users were studied, in order to determine whether or not notebook users had similar or different problems than did desktop users. The second phase provide quantitative data, exact measures of computer inputting activity over an extended period of time. The third phase was designed to investigate, in a controlled environment, some of the biomechanical effects of the work conditions that were reported through the first two phases of the study.

The questionnaire phase revealed no differences in computer-use-related discomfort between notebook and desktop computer users. Body part discomfort was more prevalent in female participants than in male participants (consistent with findings of other researchers). In both groups of computer users, there were associations found between awkward working postures while using a computer and the frequent experiencing of physical discomfort associated with using a computer. Discomfort was also related to the propensity for sitting for uninterrupted extended periods of computer use time. In addition to these factors, notebook users were found to be at greater risk for frequent discomfort related to computer use if they used the computer without any peripheral devices. Further, there is a materials handling component to working with a notebook computer which was found to be directly related to body part discomfort. Particular modes of moving the notebook computer were related to the experience of discomfort in certain body parts.

It had been consistently reported that computer users overestimate the time they spend working on their computers. As such, in order to best understand the physical interaction of the user with his/her computer, a software tool that captures inputting activity was utilized to directly measure inputting activity, by event (keystrike, mouse click, etc) and activity time. The key finding from this part of the study was the great amount of variation in day-to-day use of the computer in this group of workers, and the variation in patterns of activity and inactivity throughout the day. Expressions of these patterns may be more useful that averages of usage in determining why some computer users experience discomfort associated with computer use while others do not.

The third phase of the study investigated two alternatives to working with a notebook computer in a stand-alone configuration. Based on considerations of the effects of the different conditions on the participants' biomechanics, productivity, and preferences, and the findings from the questionnaire, recommendations are made that notebook computers not be used in a stand-alone configuration, when working for an extended period of time, such as when a notebook is used in a desktop replacement scenario.

Together, this three phase approach facilitated the construction of a whole picture of these workers and their work conditions, which provides a more solid foundation from which to suggest practical and potentially more effective interventions/modifications to work than otherwise would be the case if working with less information about the worker or his/her work conditions.

## 1. Significant Findings

**Phase 1. Specific Aim 1:** Development and application of a comprehensive worker survey, for the purpose of collecting qualitative, self-report data on workers (demographic, work patterns, psychosocial work factors, and personal attributes), and on their work (work organization, physical ergonomics, and tools).

Significant findings:

- The survey provided reliable data from a large sample of professional computer users.
- By design, all participants were professionals, so, unlike previous studies, there was no inherent confounding due to interactions between sex, job ranking (professional or administrative), and type of computer (desktop or notebook).

**Phase 1. Specific Aim 2.** Analysis of these data, in order to:

a. construct an initial database of worker and work characteristics that describe a large sample of NPC users
b. identify similarities and differences, in work or worker factors, between NPC users and DPC users
c. identify worker or worker factors associated with strain outcomes in NPC users
d. dentify similarities and differences, in work or worker factors associated with strain outcomes, in NPC users and DPC users.

Significant findings:

- As in previous studies, discomfort prevalence tended to be greater in females than in males. This was true both for responses to Nordic questionnaire style inquiries about 12 month and 7 day prevalence of discomfort, as well as discomfort specifically associated with computer use.
- Differences were not found between DPC and NPC groups, in computer-use-related discomfort.
- Both user groups tended to take few work breaks, and did not tend to utilize tools that could help them work more comfortably, such as copystands (document holders), telephone headsets, or speakerphones.
- Risks to all computer users: sitting for longer uninterrupted periods when working with the computer; frequently adopting poor or awkward postures when using the computer.
- Risks were identified for notebook users: use of the computer in a stand-alone configuration, and various modes of carrying the computer.

**Phase 2. Specific Aims:** Quantify computer use and work patterns in a sample of NPC users that is reflective of the NPC user survey respondents.

Significant findings:

- The variation in the use of the computers was great in both the NPC and DPC users. The three week (average) length of data collection was found to be inadequate, based on the coefficients of variation that were calculated from the data.

- The variation in use also signals that simple metrics such as 'daily hours of computer use' may be insufficient for assessing or in any sense regulating computer use.
- The location capture feature of the odometer revealed differences in work patterns by location.

**Phase 3. Specific Aims.** Characterize the effects of work design on user biomechanics, performance, comfort, and preference.

Significant findings:

- This study demonstrated that use of a stand-alone notebook computer (NPCsa) resulted in significantly more postural fixity in several joints compared to the other two computer configurations used in the study (notebook PC with an external mouse (NPCEx), and notebook PC with an external mouse and external keyboard (FULL)).
- The stand-alone configuration also induced more non-neutral postures, in certain tasks, than did the other two configurations.
- Neck posture and discomfort benefited from use of the two external input devices.
- While use of the number pad on the external keyboard produced postural benefits, right forearm discomfort was higher during the number typing task with that configuration, compared to when the number row was used on the notebook PC's keyboard.
- Muscle activity measures indicated some benefit to the first dorsal interosseous m. from using the built-in pointing stick in the notebook PC, while the pectoralis major m. was less active when both external devices were used. However, the former positive finding might be offset by the reduction in productivity found with the built-in pointing stick in comparison to use of the external mouse.

## 2. Translation of Findings

**Phase 1:**

- Parts of the survey were incorporated into a master's level thesis on college students use of computers – this study has been accepted for publication in the *International Journal of Industrial Ergonomics (IJIE)*.
- The reliability analysis of the survey questions may be used to help others utilize components of this survey or develop their own instruments. In particular, one new outcome measure, PCPain, and one new predictor measure, PCSit score, were found to be reliable, and were found to correspond in important ways to other variables.
- Results can be used to educate all professionals who use computers as a primary work tool and their employers about the importance of adopting good computer work habits – taking breaks, sitting for less extended uninterrupted periods of time while using the computer , and working in "good" postures often. For employers, this may mean altering work in some fashion to facilitate breaks, adoption of good postures, and changes in posture.
- For notebook users, the importance of the use of peripheral devices has been confirmed, and the advantages and disadvantages of using a rolling cart for transporting NPCs should be explored further.

**Phase 2:**

- Designers of odometers should consider including additional features to capture more information about mobile users, as these proved useful in this study.
- The variation in the data in this study could be used by other researchers to plan adequate sampling periods for future studies of similar groups of computer users.

- The variation in the data in this study may inspire researchers to expand the taxonomy of computer use activity descriptors beyond averages and totals.

**Phase 3:**

- Based on these results, a recommendation is made for use of either the NPCEx or FULL configurations, over the NPCsa configuration, when working for an extended period of time, such as when a notebook is used in a desktop replacement scenario.
- If an external keyboard is used, it is generally recommended that it not have a built-in number pad, so that the external mouse can be placed directly next to the primary keyboard.
- Although not tested in this study, a stand-alone number pad would seem to be appropriate for someone who performed a lot of numeric entry. This would provide more flexibility, in terms of mouse and number pad placement (either exchanging one for the other depending on task, or placing one on either side of the keyboard if the individual is willing/able to learn to work with both hands, as he/she already must do in typing text).

## 3. Scientific Report

### 3.1 Background

The etiology of work-related musculoskeletal disorders remains contentious, though less so in the wake of recent reviews by NIOSH (Bernard, 1997) and the NRC (2001). The degree of agreement regarding associations between health outcomes and exposures to physical factors seems somewhat stronger for groups of industrial workers than for office workers (computer users). Gerr et al. (1996) succinctly summarized weaknesses in previous studies of MSDs in VDT users, which have lead to conflicting research results. In epidemiologic research, these weaknesses include almost exclusive reliance on cross-sectional studies, imprecise definitions of risk factors, disregard for potential confounding factors, and use of unstable health outcomes. In laboratory work, they include small sample sizes, limited time on task, and lack of connection between dependent variables and chronic health outcomes. One of the main motivations for studying workplace risk factors and work-related health outcomes is to develop predictive models of injury and illness, in order to provide criteria for designing safer work conditions. To date, few of these criteria have been defined, and fewer still have been validated (Leamon, 1994). Mobile computing is a relatively new type of computer-based work, with an even shorter research track record from which to provide design criteria for workers, employers, or equipment manufacturers.

This current research project was designed to address several of the above-mentioned shortcomings, and thereby contribute to the building of a foundation for a comprehensive approach to assessment of the etiology of WMSDs. Specifically, tools were developed &/or utilized to produce multi-dimensional profiles of workers and their work, in order to identify work-related predictors of musculoskeletal impairment and other strain outcomes. The long term goal of this line of research is the development of a predictive model for work-related musculoskeletal impairment, that will be applicable across various types of work, and that can be used to design work (including tools, workstations, and work patterns) such that risk factor exposures are minimized.

### 3.2 Specific Aims

At the time this study was proposed, few ergonomics research studies were investigating the contributory roles of the multiple facets of ergonomics (biomechanics, psychosocial factors, work organization, and personal attributes) to the problem of work-related musculoskeletal disorders (WMSDs). Ergonomics research typically addressed targeted, select pieces of the WMSD puzzle. However, this can lead to incomplete or even erroneous conclusions about the way a work system (people + work) really functions,

and about the potential benefits to be derived by implementing interventions based on limited information. Based on the interactive nature of the problem, a more comprehensive approach is required to resolve conflicting results from previous studies. **The objective of this project was the development and application of a comprehensive assessment methodology for characterizing the work-worker system from an ergonomics perspective.** The methodology was applied to mobile computing, an emerging area of office ergonomics. This group was chosen, because it is a new grouping of workers, which presents the opportunity for proactive, prospective investigation.

The methodology consisted of the application of several standardized tools (questionnaire, work measurement protocols, and biomechanical assessment). The questionnaire provided qualitative information on the worker, work, and workplace (demographics and psychosocial perspectives, work organization and job design). Work measurement protocols supply quantitative temporal information and qualitative biomechanical data. Biomechanical assessment provides a view of the internal activity necessary to carry out activities observed in the workplace. Products of the assessments are multi-dimensional work and worker profiles. The worker profile characterizes the worker's interaction with his or her work (personal attributes, psychosocial perspectives, demographics, work history, and health history and status). The work profile characterizes physical and administrative work elements. Together the profiles are used to identify associations between worker attributes and perceptions, worker health outcomes (musculoskeletal impairment and other strains), and work profiles.

The long term objective of this line of research is development of a predictive model of work-related musculoskeletal impairment, that includes physical, psychosocial, work organization, and personal factors, and has generalized applicability across job types for use in research from initial exploration to intervention demonstration efforts.

The project was conducted in three phases, and each phase had a set of specific aims, which are presented in Table 1.

Table 1. Specific aims of each phase of the project.

| Project phase | Specific aims |
|---|---|
| **Phase 1: Qualitative examination: survey of NPC and DPC users** | **1.** Development and application of a comprehensive worker survey, for the purpose of collecting qualitative, self-report data on workers (demographic, work patterns, psychosocial work factors, and personal attributes), and on their work (work organization, physical ergonomics, and tools) |
| | **2.** Analysis of these data, in order to:<br>a. construct an initial database of worker and work characteristics that describe a large sample of NPC users<br>b. identify similarities and differences, in work or worker factors, between NPC users and DPC users<br>c. identify worker or worker factors associated with strain outcomes in NPC users<br>d. identify similarities and differences, in work or worker factors associated with strain outcomes, in NPC users and DPC users |
| **Phase 2: Measurement of computer use patterns: a quantitative assessment** | **1.** Quantify computer use and work patterns in a sample of NPC users that is reflective of the NPC user survey respondents. |
| **Phase 3: Quantitative assessment of work design through controlled experimentation** | 1. Characterize the effects of work design on user biomechanics, performance, comfort, and preference. |

## 3.3 Phase 1: Qualitative examination: survey of of NPC and DPC users

### *3.3.1 Background*

Computer use has increased rapidly over the last quarter century. In 1975, there were fewer than 200,000 computers in the USA (Juliussen & Petska-Juliussen, 1994); 1994 projections for 1995 exceeded 100,000,000 computers. Surveys reveal widespread use of computers, at work and outside of work. Half of employed adults in the USA used a computer for work in 1997 (Newburger, 1997). Statistics from the USA and UK show that over 80% of those who use computers for work, also use them at home (Newburger, 1997; Heasman, Brooks & Stewart, 2000), providing the potential for a high level of exposure among users.

Personal computers (PCs) account for 90 percent of all computers. Worldwide, the portable PC is a rapidly growing market segment. In 1997, it was estimated that mobile computers would constitute 34% of total USA PC shipments in 2000 (almost 10 million units). Portables already constituted 40% of total computer output in Japan at that time (Villanueva, Jonai & Saito, 1998); in 1998 they were 20% of the computers sold in the UK (Heasman et al., 2000). Initially, portable PCs were used by mobile workers. More recently, however, portables are being used as replacements for desktop computers (DPC), even for workers who do not require PC mobility.

Work requiring the use of desktop style computers has been associated with musculoskeletal discomfort in workers (Bernard, 1991; Hünting, Laubli & Grandjean, 1981; Sauter, Schleifer & Knutson, 1991), and other adverse physical and mental health outcomes (Smith, Cohen, Stammerjohn Jr & Happ, 1981; Bergqvist, Wolgast, Nilsson & Voss, 1995a). Studies of workers who use desktop style computers on the job have identified four categories of influential factors: physical, psychosocial, work organization, and individual factors. The growing use of notebook computers (NPCs) raises concerns for development of discomfort and other adverse outcomes in their users, as well.

There has been little work published to date that has explored jobs requiring the use of portable (notebook) computers, with regard to their potential for having similar associations with adverse health outcomes for workers. Laboratory studies, which address physical factors, have shown that NPC use can affect user posture, increase discomfort and muscle activity, and hamper performance, when compared with DPC use (Straker, Jones & Miller, 1997; Villanueva et al., 1998; Price & Dowell, 1998). One anecdotal report of "repetitive motion disorders" associated with the use of NPCs as dictation devices, by a group of new users, illustrated the potential for interplay between risk factor categories[1].

From two surveys, different perspectives of risk associated with notebook use, or jobs requiring notebook use, emerge. Diederich & Stewart (1997) concluded, from their survey of employees in an Australian company and their review of the literature, that the workers who used notebook computers in a stand-alone configuration were at increased risk for injury. More recently, however, frequency of stress symptoms and physical discomforts were found to be similar across four exclusive computer user classifications (stand-alone portable, portable with external monitor &/or keyboard, DPC, and multiple configurations), in a study of 2192 workers in the United Kingdom (Heasman et al., 2000). Of the 1197 NPC users surveyed, only 9% used a portable in a stand-alone configuration. By contrast, Diederich and Stewart (1997) reported 60% stand-alone use in their respondents.

[1] Laptop Computer usage and OSHA's 11c Program, Memorandum from Byron R. Chadwick, Regional Administrator – VIII to Roger A. Clark, Director, Directorate of Compliance Programs and Leo G. Carey, Director, Directorate of Field Programs. http://gabby.osha-slc.gov/OshDoc/Interp_data/INTERP_19940104.html

To date there have been no studies published of surveys of NPC users in the USA. The specific aims of Phase 1 of the current study were the conduct of such a survey and analysis of the data, in order to provide a comprehensive look at the use of notebook computers. By design, the study focused on professionals who use NPCs as a primary work tool. To provide a point of comparison, professionals who use DPCs also participated in the survey. The purposes of the Phase 1 included: construction of a database of worker and work characteristics describing a large, diverse sample of NPC users; identification of similarities and differences in work factors, worker factors, and/or strain outcomes between NPC and DPC users. The survey was comprehensive, in that it examined computer design and usage patterns, as well as psychosocial, work organization, and individual factors.

### *3.3.2 Methodology*

A web-based questionnaire was designed to gather information on work-related computer use, general information about work (including work organization and psychosocial aspects of work), musculoskeletal discomfort, activities outside of work, and individual factors (including personality type, general assessments of physical and mental health, and demographic information). The population of interest was professionals who use computers to help them perform their jobs. Both desktop and notebook users were included in the study, to facilitate comparisons made on type of computer used, and based on data from the same instrument and protocol. Two similar surveys were administered, 1 year apart, in order to establish the database, and examine changes that might occur over the course of a year.

The survey was populated with questions and scales from existing, validated instruments, as well as new questions that fulfilled unique questions posed by this study. The survey was first tested by asking a few individuals to read the complete questionnaire aloud, with a researcher sitting next to them, so that the understanding of each question could be gauged (considered a pre-pilot stage). As a result, changes in instructions, question wording, or response offerings were made, where needed. The objectives of the first pilot study were to 1) test the administration of the survey (where people able to follow the instructions in their letter of invitation and those on the web-based survey?), and 2) collect data for test-retest reliability assessment of the questionnaire. The second pilot study was conducted in order to test the recruitment methodology ("head's up" message from a superior, followed by a personal invitation from the researchers that arrived by post, followed by up to three personal email reminders; (Dillman, 2000)). Following successful conduct of the second pilot study, recruitment began for the full study.

#### 3.3.2.1 Participants

Nine organizations agreed to participate in the study. Business interests were wide-ranging: manufacturing, software development, consulting, finance, information services, and insurance. They were located in the Southeast, Midwest, Southwest, and Western parts of the USA. The total number of respondents, based on a final web form that respondents completed to acknowledge their completion of the questionnaire, is listed in Table 2. Some subjects missed this form. As such, these numbers and rates are estimates. Another estimate of response numbers and rates was determined based on a tally of respondent identification codes. Response numbers and rates based on that data are 428 and 69%, respectively.

Table 2. Participant tally, based on number of confirmation forms submitted by respondents.

| Organization | Year 1 | | Year 2 | |
|---|---|---|---|---|
| | Number responding | Response rate, % | Number responding | Response rate, % * |
| *Pilot 1* | *29* | *97* | | |
| *Pilot 2* | *33* | *52* | | |
| Engineering consulting services | 17 | 85 | 8 | 53 |
| Human factors consulting services (n=2) | 11<br>2 | 92<br>50 | 4<br>nr | 50 |
| Information services | 8 | 73 | 2 | 25 |
| Computer solutions (n=2) | 12<br>24 | 80<br>53 | 6<br>nr | 50 |
| Educational software | 28 | 56 | 14 | 58 |
| Furniture manufacturer | 31 | 57 | 16 | 76 |
| Diverse manufacturing | 37 | 49 | 25 | 71 |
| Insurance | 142 | 62 | 100 | 74 |
| Financial services | 9 | 90 | nr | |
| *Additional Phase 2 subjects* | | | *8* | *100* |
| **Total** | **383** | **62** | **188** | **69** |

* Response rate for Year 2 is based on the number of Year 1 participants to whom Year 2 invitations were sent.
nr – not recruited for the Year 2 component (the downturn in the economy that occurred during Phase 1 resulted in the loss of some organizations to Year 2 participation).

3.3.2.2 Instrument

The questionnaire was divided into five sections and presented as several different web pages, in order to give respondents the option of completing the questionnaire in one sitting, or responding as they had a few minutes over the course of several days (see Table 3). Where possible, previously validated questions and scales were utilized (particularly in Parts 3, 4, and 5). A copy of each section of the survey is included in Appendix A of this report.

Table 3. Brief descriptions of organization and contents of the questionnaire.

| Part Number | Category* | Question sources* |
|---|---|---|
| Part 1 | DPC use (equipment, software, usage patterns, physical discomfort) | |
| Part 2 | NPC use (equipment, software, usage patterns, physical discomfort, use locations, handling, postures while using) | |
| Part 3 | Work in general (work organization, psychosocial factors, etc) | Caplan, Cobb, French Jr., Van Harrison & Pinneau Jr., 1975; Carayon, 1994; Quinn, 1971 |
| Part 4 | Health (MSD symptoms, other health problems), demographics | Nordic Questionnaire, Kuorinka, et al, 1987 |
| Part 5 | Personal (personality, mood states, education, activities outside of work, etc) | Wickström, Pentti, Hyytiänen & Uutela, 1989; Jenkins Activity Survey; SF-12; Reeder, Schrama & Dirken, 1973 |
| Completion Form | | |

* Listings are representative, not comprehensive.

3.3.2.3 Procedures

For the full Year 1 study, companies and participants were recruited over approximately a nine-month period, with surveys being completed from Dec 2000 to Jun 2001. In addition to completing the survey once for the Year 1 study, participants were also asked, through two additional questions on the completion form (a checklist that helped them ensure they had completed all the parts of the survey that applied to them). The first question asked participants if they would be willing to retake a part of the survey within a few weeks (to provide additional data for the test-retest reliability evaluation). The second asked about their willingness to receive information about Phase 2, in order for them to consider participating in that phase, also. Most subjects that responded to the Year 1 survey were invited to participate in the Year 2 administration. Those that were not invited included work groups that had been disbanded (due to the downturn in the economy) and those few people who indicated displeasure at participating in the Year survey (via the comments section on the completion form). The invitation and reminder process in Year 2 was conducted similarly to the Year 1 process.

The survey software compiled the subjects' responses into emails (one for each part or page of the survey) that were mailed to the PI from the host server (on the PI's campus). These emails were then saved as text files. The open-ended questions or other answers the respondents typed in were processed using Access and a series of macros constructed in Excel (for this project). The answers that were registered via radio buttons or check boxes were processed via Matlab code (also developed for this project).

3.3.2.4 Analyses

Respondents' data were included in the analyses based on correct completion of Parts 1 &/or 2, and Parts 3 and 4. All data were screened for errors at several stages. Subjects were excluded if it could not be determined what type of computer they used (DPC or NPC), or if they incorrectly reported their computer as a DPC, when it was an NPC. (Some NPC users who use the computer fully configured in a docking station do not recognize the computer as an NPC. Some subjects made this error, in spite of instructions that were provided on the survey materials to consider a notebook computer, configured in any way a notebook computer, for purposes of this study. Pictures were provided in year 2 to help reinforce this concept, but some subjects still made this error.)

Test-retest reliability analyses included calculations of kappa for binary categorical data, Fleiss-Cohen weighted kappa for categorical data with more than two categories, and intraclass correlation coefficient (ICC) assessment for continuous data and for some ordinal categorical data with several categories. Response prevalence was also calculated, because kappa misbehaves when prevalence is very low or very high. McNemar's test was also examined, as a gauge of statistically significant differences between test and retest responses. Various gradings for ICC and kappa have been provided. For this study, thresholds are 'excellent if > 0.75', 'fair to good if between 0.40 and 0.75', and 'poor if less than 0.40' (Salerno et al., 2001).

Responses were evaluated for normality. Cronbach's alpha was determined for scale items. Descriptive statistics were determined for all data; various parametric and non-parametric techniques were used to test for associations, as appropriate.

### *3.3.3 Results and discussion*

The specific aims of Phase 1 are listed and reviewed below, in relation to the results of this phase of the study.

3.3.3.1 Phase 1, Specific Aim 1

The first specific aim of Phase 1 was the development and application of a comprehensive worker survey, for the purpose of collecting qualitative, self-report data on workers (demographic, work patterns, psychosocial work factors, and personal attributes), and on their work (work organization, physical ergonomics, and tools).

This aim was achieved. A reliable survey was constructed and administered. Of the 383 respondents from whom a completion form was received for the first administration of the survey ('Year 1'), 335 respondents' data were statistically analyzed. Corresponding numbers for Year 2 were 188 and 164, respectively. Categorization of subjects by type of computer used for work is provided in table 4.

Table 4. Computer users in Phase 1, by type of computer used.

| Year | NPC users | DPC users | NPC/DPC users |
|---|---|---|---|
| 1 | 206 | 95 | 34 |
| 2 | 113 | 42 | 9 |

Tables containing the results of the reliability analyses of most of the non-open-ended questions are provided in Appendix B. The vast majority of questions were found to have either excellent or fair/good test-retest reliability. Concerning questions about work-related computer use, participants were able to provide reliable information on the types of programs they used, how much input they had on the type of computer they used, time periods in the day when the computer was used, self-reported hours of use, use of ergonomic aids (copystand, telephone headset), computer configuration, discomfort associated with using the computer (for most body parts and locations of use), movement of the NPC (how and how often), discomfort experienced when moving the NPC, and where the NPC is used. Concerning questions about work, in general, participants were able to provide reliable information on their companies (numbers of employees), basics of their employment (how they are paid, number of hours they work, number of people they supervise, time in current job and with current employer), work break habits, exposure to certain ergonomic risk factors on the job, frequency of adopting certain work postures, psychosocial scale scores, and work-related travel requirements of the job. Concerning questions about health, participants were able to provide reliable information on body part discomfort and characteristics of that discomfort (frequency, duration, effect on activities, etc) for the eye, shoulder (characteristics only), elbow/forearm, hand/wrist (12 mo prevalence, but not characteristics), upper back, and lower back; headache frequency, and eye exam and correction methods. Concerning questions about themselves, in general, participants were able to provide reliable information on schooling, exposure to certain ergonomic risk factors outside of work, some aspects about their computer use in general (typing instruction exposure, which hand operates the mouse, touch typing ability, etc), personality type, sf-12 scores, daily stress score, and time on regular hobbies and sports.

Information used for categorizing participants or excluding participants from certain parts of the analyses that proved reliable: user categorization (the focus of the study is on those who used computers on a daily or almost daily basis); assumption of awkward postures while using the computer; body part discomfort specifically associated with computer use; PCPain score (composite score of number of body parts in which discomfort specifically associated with computer use is experienced *quite often* or *almost always*); PCSit score (composite, weighted score that describes propensity for sitting for longer or shorter periods of time at the computer); stand-alone configuration of the NPC; Sit score (composite, weighted score that describes propensity for sitting for longer or shorter periods of time during work); body part discomfort

prevalence (with exception of shoulder), demographic information (age, height, weight, race/ethnicity, sex, hand dominance); ob/gynecological information; cumulative scores of severity of 12 month prevalence body part discomfort; traumatic injury to body parts; diagnoses of certain systemic disorders; and typing technique.

Information used for categorizing participants that proved unreliable: the a priori definition of a potential case of work-related musculoskeletal disorder in a specific body part (other than hand/wrist, which had fair/good reliability).

3.3.3.2 Phase 1, Specific Aim 2

The second specific aim of Phase 1 was the analysis of the worker survey data, in order to:

a. construct an initial database of worker and work characteristics that describe a large sample of NPC users
b. identify similarities and differences, in work or worker factors, between NPC users and DPC users
c. identify worker or worker factors associated with strain outcomes in NPC users
d. identify similarities and differences, in work or worker factors associated with strain outcomes, in NPC users and DPC users.

Results related to Aims 2a and 2b are provided first. Information on demographics and other personal state and trait characteristics, health, computer use patterns, and work and work patterns are presented below, in Tables 5-16. Unless specifically noted otherwise, the more detailed information provided in the tables does not include the 34 subjects who used both NPCs and DPCs for work. This information is then followed by a section addressing Aims 2c and 2d.

## AIMS 2A AND 2B: NPC USER DATABASE AND COMPARISONS WITH DPC USERS

**PERSONAL DEMOGRAPHICS.** The mean age of all of the respondents was 42.2 yrs (sd=9.8). 61% were male, 39% female. 92% had educational experience beyond high school; 32% had advanced degrees. Personality types were evenly represented across the group as a whole, with 31% testing as A, 38% as AB, and 31% as B, based on the Jenkins Activity Survey (n=271 respondents); however there were differences when the sample was divided into type of computer used, and that was due to differences between the distribution of personality type between the two groups of male participants. Refer to table 5 for details.

Table 5. Personal demographics of participants, categorized by type of computer used for work and sex.

| | NPC – Notebook-only respondents | | DPC – desktop-only respondents | | |
|---|---|---|---|---|---|
| **Personal Demographics:** | **Female** (n=78) | **Male** (n=127) | **Female** (n=40) | **Male** (n=55) | **Differences between NPC and DPC** |
| Age, years [range] | 41.0 (10.3) [24-60] | 43.9 (9.1) [27-67] | 39.7 (10.9) [23-60] | 41.1 (10.2) [21-65] | |
| Race/ethnicity, % of category of respondents: | | | | | |
| African-American/Black | 1.3 | 1.6 | 12.5 | 7.3 | Female diff, p=0.016; Male diff., p=0.048 |
| Asian | 3.8 | 2.4 | 5.0 | 0 | |
| Caucasian/White | 91.1 | 90.6 | 80.0 | 94.6 | |
| Hispanic/Latino | 1.3 | 4.7 | 2.5 | 0 | |
| Inuit/Aleut/Alaskan Native | 0 | 0 | 0 | 0 | |
| Native American | 0 | 0.8 | 2.5 | 1.8 | |
| Pacific Islander | 0 | 0 | 0 | 0 | |
| Height, cm | 166.0 (6.1) | 181.1 (6.0) | 166.4 (7.1) | 179.7 (5.5) | |
| Weight, kg | 65.9 (13.6) | 90.0 (14.7) | 70.9 (14.9) | 92.4 (16.6) | |
| SF-12 | | | | | |
| PCS * | 52.2 (6.4) | 52.7 (5.6) | 51.0 (7.8) | 50.7 (8.8) | |
| MCS * | 47.8 (10.3) | 50.1 (9.8) | 46.0 (7.5) | 49.0 (10.1) | |
| Personality Type, % of category of respondents: | | | | | Male diff, p=0.0021 |
| AA | 37.7 | 29.5 | 40.0 | 16.7 | |
| AB | 40.6 | 43.8 | 26.7 | 26.2 | |
| BB | 21.7 | 26.8 | 33.3 | 57.1 | |

* The national average for each score is 50 (s.d.=10). Ignoring the small effect of age on each of these scores, generally speaking, PCS that differ from 50 by more than about 7 points differ from the national average; MCS that differ from 50 by more than about 6.25 points differ from the national average.

**EMPLOYMENT DEMOGRAPHICS.** Participants averaged 4.6 years (sd=4.8) in their current jobs; 10.7 years (sd=9.0) with their current employers. Two-thirds of respondents worked at sites with more than 1000 people, while 15% worked at sites with under 100 people. 96% classified themselves as full-time permanent employees. Common job titles and areas included analyst, director, engineer (software, others), human factors specialist, manager (products, groups), purchaser, underwriter, and (technical) specialist. By design, all respondents were professionals (no secretarial or data entry personnel were recruited for this study). Although the vast majority of participants were paid a salary, there were some differences in pay structures between respondent groups. Details are provided in Table 6.

Table 6. Job payment structures. Numbers represent the % of respondents in each sex*computer user category.

| | NPC – Notebook-only respondents | | DPC – desktop-only respondents | | |
|---|---|---|---|---|---|
| **Question:** How are you paid for your work for this company? Mark all that apply. | **Female** (n=78) | **Male** (n=127) | **Female** (n=40) | **Male** (n=55) | **Differences between NPC and DPC** |
| Salary | 92.4 | 96.9 | 77.5 | 89.1 | Female diff, p=0.0373 |
| Commission | 2.5 | 1.6 | 0 | 1.8 | |
| Hourly wage | 6.3 | 3.9 | 25.0 | 12.7 | Female diff, p=0.0069; Male diff, p=0.0462 |
| Piecework | 0 | 0 | 0 | 0 | |
| Incentive | 7.6 | 17.3 | 0 | 5.5 | Male diff, p=0.0354 |

There were some other basic job-related differences between the groups, as well. The NPC users traveled more than the DPC users, both locally and overnight. On average, travel requiring nights spent away from home made up 14.7% of the job for NPC users, but only 4.4% for DPC users ($p<0.0001$). On average, local travel or other trips not requiring nights spent away from home made up 12% of the job for the NPC users, but only 4.8% of the job for DPC users ($p=0.0046$).

**COMPUTER DEMOGRAPHICS.** The average length of time participants had been using computers was 17 years (sd=6). Use of computers outside of work was high: 85% used a DPC outside of work, 69% used an NPC. Average time on computers, outside of work, was 5.3 hrs/wk (sd=6.2). This level of computer use outside of work is consistent with other reports (Heasman et al., 2000; Newburger, 1997).

87% reported using 8-10 fingers for typing; 92% use their right hand for operating the pointing device (though 88% were right-handed). 24% must look at the keyboard to type letter keys (this is used as a surrogate assessment of the ability, or lack thereof, to touch type); 81% had taken a typing class and 16% reported using instructional software to learn to type. Only about 12.6% of the women in either computer group were not touch typists, while 25.5% of the male DPC users and 33.1% of the male NPC users were not touch typists.

In addition to computers, other electronic devices were utilized by the respondents, including pagers, cell phones, and PDAs. These devices were more likely to be used by the NPC users than the DPC users (Table 7).

Table 7. Electronic equipment use. Numbers represent the % of the computer user group using each device for a specific purpose.

| | NPC | | | DPC | | |
|---|---|---|---|---|---|---|
| | **Work-related use** | **Personal use** | **Both work-related and personal use** | **Work-related use** | **Personal use** | **Both work-related and personal use** |
| **Pager** | 18.0 | 1.5 | 5.8 | 3.1 | 0.0 | 4.2 |
| **Cell phone** | 6.3 | 36.4 | 36.4 | 5.3 | 48.4 | 13.7 |
| **PDA** | 13.1 | 0.5 | 18.0 | 1.1 | 3.2 | 11.6 |

**EXPOSURE TO PHYSICAL STRESSORS AT WORK.** Participants were asked about frequency of exposure to heavy or repetitive lifting, forceful or repetitive gripping or pinching, and standing or sitting for longer periods of time. 69% of respondents reported sitting for long periods of time either *fairly* or *very often*. All other exposure prevalences, at those frequencies, were below 9%. Briefcases, books, backpacks, NPCs, NPCs in briefcases, binders, and boxes were the heaviest items most participants regularly handled in the course of their work days.

**DISCOMFORT PREVALENCE AND OTHER HEALTH MATTERS.** Based on responses to a modified Nordic-style questionnaire, 12-month prevalence ranged from 76% for eye discomfort to 35% for upper back; 7-day prevalence ranged from 43% for eye discomfort to 19% for upper back. Potential work-related cases were defined as those participants who reported discomfort that was not in a body part that had experienced trauma, that began after the start of the current job, and which either lasted at least 1-2 weeks or occurred at least once per month. Percentages of potential cases ranged from 38% for eye discomfort to 0% for low back (though recall that this particular classification variable generally did not have good test-retest reliability). Differences were seen between male and female subjects across the various definitions of discomfort, and are illustrated in Figure 1. Generally, discomfort prevalence for females was equal to or greater than that for males. Other studies have also shown differences in prevalence based on case definition and sex, including a study by Jensen, Borg, Finsen, Hansen, Juul-Kristensen, & Christensen (1998) that focused on professionals (CAD operators).

Respondents were also asked to report the frequency with which they experienced discomfort that they associated with work-related computer use, in 13 different parts of their bodies (eyes, neck, etc). There were no differences between distribution frequencies of the NPC and DPC groups. However, there were differences between male and female subjects. Figure 2 depicts the average discomfort frequencies for each body part. A PCPain score (potential range of 0-13), derived from those responses, was calculated as the quantity of body parts in which participants experienced discomfort *quite often* or *almost always* when using a computer. Across all subjects, the average PCPain score was 1.1 (sd=1.8; range 0-8); the averages for males and females were 0.7 (1.4) and 1.6 (2.1), respectively, which were significantly different from each other ($p<.0001$). PCPain scores were not different between NPC and DPC users, with average scores of 1.0 (1.7) and 1.3 (1.9), respectively.

Approximately 85% of the female and 77% of the male participants utilize some form of vision correction (glasses or contact lenses).

**WORK PATTERNS.** Average work schedules for participants included working 5 days/wk (sd=0.5), 44.9 hrs/wk (sd=6.9), 8.8 hrs/day (sd=1.0), and 3.4 hrs on weekends (sd=2.4). Average reported weekly hours of work were greater for NPC users than for DPC users, and were greater for male participants than for females. NPC users also reported working longer daily hours than DPC users. Weekend hours did not differ by user group or sex. Participation in overtime and reasons for overtime differed between groups of respondents, with NPC users indicating more overtime. Details are provided in Table 8.

Table 8. Overtime experience of respondents. Numbers represent the % of respondents in each group.

| **Question:** Which items below describe your experience with overtime at this company? Mark all that apply.<br>• In this study, overtime is defined as working more than 35-40 hours per week. | **NPC – Notebook-only respondents** | | **DPC – desktop-only respondents** | | **Differences between NPC and DPC** |
|---|---|---|---|---|---|
| | **Female (n=78)** | **Male (n=127)** | **Female (n=40)** | **Male (n=55)** | |
| I do not work any overtime. | 10.7 | | 20.0 | | p=0.0453 |
| I work overtime because I want to. | 21.5 | 33.9 | 22.5 | 29.1 | |
| I work overtime because I feel I must to keep up with the workload. | 73.4 | 71.7 | 50.0 | 50.9 | Female diff, p=0.0145; Male diff, p=0.0105 |
| I work overtime because I am asked to or required to. | 11.4 | 12.6 | 10.0 | 25.5 | Male diff, p=0.0485 |

It is interesting to note the responses to the psychosocial scales that are likely to be relevant to work hours, namely quantitative workload, combined quantitative workload, workload dissatisfaction, boredom, and job satisfaction. In spite of differences in work hours and reasons for overtime between the computer groups, there were no differences in quantitative workload perception or in workload dissatisfaction between the user groups. There were differences between computer groups in their perceptions of job boredom (DPC > NPC) and job satisfaction (NPC > DPC). Females perceived a greater quantitative workload than did males, but only on one of the workload scales. Details of work hours and relevant psychosocial perceptions are provided in table 9.

Table 9. Differences in work hours and relevant psychosocial perceptions.

| | **Computer user group** | | | **Sex** | | |
|---|---|---|---|---|---|---|
| **Work patterns and perceptions:** | **NPC** | **DPC** | **P value** | **Male** | **Female** | **P value** |
| Average weekly work hours | 45.3 (6.6) | 43.0 (6.4) | 0.0049 | 45.5 (5.9) | 43.2 (7.4) | 0.0025 |
| Average daily work hours | 9.0 (0.9) | 8.5 (1.2) | 0.0001 | | | |
| Quantitative workload (1=lo, 5=hi) | | | | 3.4 (0.8) | 3.6 (0.8) | 0.0190 |
| Boredom (3=no, 15=hi) | 5.6 (2.5) | 6.2 (2.9) | 0.0398 | | | |
| Facet free job satisfaction (1=lo, 5=hi) | 3.9 (1.0) | 3.7 (1.1) | 0.0434 | | | |

**COMPUTER USE PATTERNS**

Average amounts of work-related computer use appear in Table 10. Self-reported hours of use did not differ between males and females.

Table 10. Self-reported daily computer use among participants, in response to the question, "On average, how much time do you spend using a _____ (desktop/notebook) computer for work on the days that you use one? Do not include the time that it is turned on, but you are not actually using it".

| User | Hours of use estimate | As a Percentage of Work Hrs. |
|---|---|---|
| DPC only | 5.8 (1.7) | 69 (19) |
| NPC only | 5.3 (1.8) | 60 (21) |
| DPC, uses both | 5.1 (1.8) | 57 (22) |
| NPC, uses both | 3.3 (2.2) | 37 (26) |

Participants were asked to describe their pattern of computer use in two-hour time periods throughout the day, by responding to the question, "On days that you use the computer for work, how likely are you to use it for work within each of the time periods listed below?". Over half of DPC users were at least somewhat likely to be using their computers for work in 6 of the 12 2-hr time periods, in comparison to 7 of the 12 periods for the NPC users. Usage likelihood is depicted in figure 3, and was found to differ in four time slots (10am-noon, 6-8pm, 8-10pm, and 10pm-midnight), between the NPC and DPC users.

Breaks. In addition to work time, participants were also asked about the kinds of breaks they took throughout their work days. Five kinds of breaks were described and are listed in Table 11, along with the percentage of respondents reporting taking those types of breaks. One-third of participants reported only taking brief breaks during the day. Another third took only brief breaks and a longer mid-day break. 41% reported only taking one type of break; 44% reported taking only two types of breaks.

Table 11. Types of breaks in work day normally taken by respondents.

| **Question:** What kinds of breaks occur in your workday on most days? Mark all that apply. | **% of Respondents taking these breaks** |
|---|---|
| very brief breaks (restroom, coffee, water, etc.) | 84.7 |
| a 10-15 minute break in the first half of the work day | 16.0 |
| a 10-15 minute break in the second half of the work day | 15.3 |
| mid-day break that is < 30 min long | 10.6 |
| mid-day break that is at least 30 min long | 48.8 |

PCSit Score. *Postural fixity* refers to working in the same posture for a protracted period of time. A concern exists for the tendency towards postural fixity in computer users, and potentially even more so for notebook users, especially when not using any external devices (such as a mouse, which, for example, facilitates at least some change in posture from the typing posture when operating it). A composite value, the PCSit score, describes respondents' tendencies towards uninterrupted periods of sitting and working at the computer. It was derived from responses to the following question:

Question: When working at the notebook computer, how often do you sit continuously ...

| | | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|---|
| | | *1* | *2* | *3* | *4* | *5* |
| ...for more than 30 minutes | *1* | | | | | |
| ...for more than 60 minutes | *2* | | | | | |
| ...for more than 90 minutes | *3* | | | | | |
| ...for more than 120 minutes | *4* | | | | | |

The numbers in italics were not visible the respondents, but are included here to demonstrate how the PCSit score was calculated. The numbers are weighting factors, and their application is best explained via an example. If the following pattern represented a subject's responses to this question,...

| | | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|---|
| | | *1* | *2* | *3* | *4* | *5* |
| ...for more than 30 minutes | *1* | | | | x | |
| ...for more than 60 minutes | *2* | | | | x | |
| ...for more than 90 minutes | *3* | | | x | | |
| ...for more than 120 minutes | *4* | | x | | | |

...then the PCSit score would be calculated as follows, row by row:

$$( 4x1 + 4x2 + 3x3 + 2x4 ) / ( 1+2+3+4 ) = 2.9$$

The higher the score, the more likely the person is to sit for extended periods of time while using a computer. A similar score was also calculated for the respondent's general tendency to sit and work for extended periods of time, and was referred to as the Sit Score. Average PCSit scores for the NPC and DPC users were 3.1 (0.9) and 3.0 (1.0), respectively, and were not significantly different. Average Sit scores for the NPC and DPC users were 3.2 (0.9) and 3.0 (1.0), respectively, and were not significantly different. There were no effects of sex on either the PCSit or Sit scores.

Participants were asked additional questions that directly or indirectly provided additional information about working posture when using the computer. They were asked about the frequency with which they tended to assume poor or awkward postures when using the computer. Over half of all subjects reported being aware of adopting such postures more often than just rarely when using the computer. The distributions of responses from the two groups of computer users are presented below, in table 12. There were no differences in the two distributions. Subjects were also asked about use of a copystand, which can help reduce neck flexion when working with paper documents and a computer. Copystands were never or rarely used by more than 70% of respondents in each group. Subjects were also asked about the use of a speakerphone or headset, as an alternative to using a handset when speaking on the telephone. (Question: Consider all the time you spend talking on the phone for work, which device do you use the most?) Use of handsets can facilitate awkward postures of the neck and shoulder if users try to hold the receiver to their ear with the shoulder. There were no differences the use of these devices by the two computer user groups. Overall, only 4.3% used a speaker phone most often, and only 7.6% used a headset most often.

Table 12. Additional posture-related information. Cell entries are in percentages.

| Question | | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|---|
| When using the computer, I find myself assuming awkward, uncomfortable, or "poor" postures. | NPC | 4.4 | 25.2 | 49.5 | 17.0 | 3.4 |
| | DPC | 4.2 | 20.0 | 46.3 | 21.1 | 7.4 |
| When looking at paper documents while working at the computer, how often do you use a copy stand or document holder? | NPC | 72.8 | 10.7 | 6.3 | 5.3 | 3.9 |
| | DPC | 61.1 | 11.6 | 11.6 | 7.4 | 7.4 |

Software usage. Usage of some software applications was found to differ between the NPC and DPC users (Table 13). DPC users were more likely than NPC users to use their computers for web design and program development. NPC users were more likely than DPC users to use their computers for intranet access, and the use of spreadsheet, presentation, and time management applications.

Table 13. Percentage of respondents in each group who use various software applications for work.

| Software | | NPC | DPC |
|---|---|---|---|
| email | p=0.5735 | 99.5 | 98.9 |
| web access | p=0.6822 | 98.5 | 97.9 |
| word processing | p=0.1158 | 98.1 | 94.7 |
| **intranet** | **p=0.0066** | 95.1 | 86.3 |
| **spreadsheet** | **p=0.0114** | 87.4 | 75.8 |
| **presentation** | **p=0.0089** | 81.1 | 67.4 |
| database | p=0.9311 | 56.3 | 56.8 |
| **time management** | **p=0.0060** | 53.9 | 36.8 |
| graphics | p=0.7771 | 32.0 | 33.7 |
| data analysis | p=0.1825 | 25.2 | 32.6 |
| cad/cam | p=0.3118 | 13.6 | 9.5 |
| **web design** | **p=0.0007** | 11.7 | 27.4 |
| **program development** | **p=0.0213** | 8.7 | 17.9 |
| simulation | p=0.5042 | 6.3 | 8.4 |
| voice recognition | p=0.9471 | 1.0 | 1.1 |

**WORK AND COMPUTER USE PATTERNS SPECIFIC TO NOTEBOOK PCS.** Notebook computers were most commonly used in the respondent's office located at the employer's facility (Table 14). Over half the respondents also used NPCs in hotel guest rooms, at home, on planes, or in meeting rooms (including auditoriums and classrooms), but less than half used their NPCs anywhere other than the office, with any degree of frequency (that is, more than *no time* or *a little time*). The average number of locations reported was 5.3 (sd=2.2). This is higher than the average of 3 locations reported by Heasman et al. (2000).

Table 14. Percentage of NPC users who use NPCs in various locations, for work.

| **Question:** Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent working in each of the following locations? **Response choices:** no time, a little time, some time, a lot of time, almost all the time. | **Any time** | **> a little time** |
|---|---|---|
| My office / cubicle at my employer's facility | 91 % | 81 % |
| Hotel guest room | 83 | 45 |
| Home, but not office setting | 69 | 35 |
| Home office setting (at desk or table) | 66 | 39 |
| Plane | 54 | 14 |
| Meeting room, auditorium, classroom | 52 | 21 |
| My office / cubicle - offsite location (other than home) | 39 | 15 |
| Waiting area | 33 | 8 |
| Office of another person | 25 | 6 |
| Car | 13 | 1 |
| Laboratory | 12 | 7 |
| Other | 7 | 3 |
| Train | 2 | 0 |

Notebook computers were reported to be most commonly positioned on a desk for use (table 15). Over half the respondents also used NPCs on a desk-height table, and on their laps, but less than half used their NPCs anywhere other than on a desk or desk-height table, with any degree of frequency (that is, more than *no time* or *a little time*).

Table 15. Percentage of NPC users who placed the NPC on various surfaces while using it for work.

| **Question:** Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent with the notebook computer positioned on the surfaces listed below? **Response choices:** no time, a little time, some time, a lot of time, almost all the time. | **Any time** | **> a little time** |
|---|---|---|
| Desk | 93 % | 87 % |
| Desk-height table | 75 | 52 |
| Your lap | 69 | 31 |
| Bed | 48 | 18 |
| Countertop or shelf | 35 | 14 |
| Bench, seat, or low table | 32 | 11 |
| Floor | 21 | 3 |
| In your hand | 10 | 0 |
| Other | 4 | 3 |

Notebook computers users were most commonly seated in a chair when using the NPCs (table 16). Over half the respondents also used NPCs while seated on a couch or bed, but less than half used their NPCs other than when they were seated in a chair, with any degree of frequency (that is, more than *no time* or *a little time*).

Table 16. Percentage of NPC users who positioned themselves in various postures when using the NPC for work.

| **Question:** Of the total amount of time you spend performing work with the notebook computer, how much of that time do you spend in the postures listed below? **Response choices:** no time, a little time, some time, a lot of time, almost all the time. | **Any time** | **> a little time** |
|---|---|---|
| Sitting on a chair | 100 % | 99 % |
| Sitting on a couch | 58 | 22 |
| Sitting on a bed | 55 | 19 |
| Standing upright | 27 | 11 |
| Sitting on a stool or bench | 26 | 7 |
| Sitting on the floor | 25 | 4 |
| Standing while leaning/bending | 22 | 5 |
| Lying down | 16 | 3 |
| Kneeling or squatting | 11 | 1 |
| Other | ~0 | ~0 |

Participants were asked about the average number of times they moved their NPCs during the day, and how they were transported. 30% reported that they did not typically move the computer during the day. 52% reported moving it just 1-2 times, while 16% typically moved it 3-5 times per day. The most common way to move the NPC was supported by one shoulder, using a shoulder strap or shoulder bag (79% of respondents). 53% reported they carried the computer in their hand. 14% supported the NPC with both shoulders (backpack style). Only 9% used a rolling cart.

The use of NPCs in a stand-alone configuration has been raised as a point of concern, based primarily of laboratory evaluations. As such, NPC users were asked about the use of peripheral devices with their computers. Frequently used items (those used either *a lot of time* or *almost all the time*) included an external pointing device (73.8% of users), and external CRT monitor (60.2% of users), a standard external keyboard (54.85% of users), and a docking station (67.5% of users). Only 7.3% used an alternative style external keyboard and only 1.5% used an external flat panel monitor. 33% reported never using an external CRT monitor and 35% reported never using a standard external keyboard. Only 15% reported that they never used an external pointing device with their NPC. Figure 4 depicts NPC respondents' frequency of use of each of these external devices.

### AIMS 2C AND 2D: FACTORS ASSOCIATED WITH STRAIN OUTCOMES IN NPC USERS AND COMPARISONS WITH DPC USERS

**DISCOMFORT ASSOCIATED WITH NPC CONFIGURATION.** Two definitions were used in classifying an NPC as being used in a stand-alone configuration or not. Defined as using no peripheral devices with the NPC (SA1), 7% of the notebook-only respondents and 15% of the respondents who used both an NPC and a DPC met this definition. Defined as using only an external pointing device (SA2), the percentages were 21 and 55%, respectively. Heasman et al. (2000) defined a docked NPC as one used with an external keyboard or monitor, so SA2 should be comparable to their stand-alone definition. As it turns out, stand alone usage in the current study is within the range of previous findings (Heasman et al., 2000; Diederich and Stewart, 1997). While Heasman et al. (2000) reported no difference in discomfort between

stand-alone and docked NPC participants, crude analysis of the current data indicate that by either stand-alone definition, the PCPain score was significantly greater for those using a stand-alone configuration (Kruskal-Wallis test: $p_{SA1}$=0.0026, $p_{SA2}$=0.0188).

**DISCOMFORT ASSOCIATED WITH MOVING THE NPC.** Participants were asked to indicate whether or not they experienced discomfort in any body parts which they associated with moving the NPC. Discomfort prevalence for each body part is shown in Table 17. Analyses of 2x2 tables constructed for each body part (pain/no pain v. transport mode used/not used) showed that the most commonly reported method for carrying the computer (over one shoulder; 79% of NPC users) was also strongly associated with shoulder pain prevalence (p=.0002). Carrying the computer by the hand (53% of users) was associated with discomfort in the distal upper extremity, though was "protective" for the shoulder. Two-shoulder support for the NPC (14% of users) did not impact shoulder discomfort, but was associated with upper back discomfort. No discomfort was associated with the least common mode of transport, the rolling cart. Due to the small number of participants that used this mode (9% of users), it would be premature to conclude that that mode is not associated with discomfort, but it is a mode that should be explored further.

Table 17. Discomfort associated with moving the NPC.*

| | | Moving Mode | | | |
|---|---|---|---|---|---|
| **Body Part** | **Dis-comfort prev., %** | **In hand** (53%) | **1 shoulder** (79%) | **2 shoulders** (14%) | **Rolling cart** (9%) |
| Hand | 9 | ↑ p<.0061; 4.5 | | ↓ p=.0511 | |
| Wrist | 6 | ↑ p=.0341; 3.8 | | | |
| Forearm | 8 | ↑ p=.0469; 3.4 | | | |
| Elbow | 3 | ↑ p=.0309 | | | |
| Shoulder | 57 | ↓ p=.0064; 0.5 | ↑ p=.0002; 3.5 | | |
| Neck | 33 | | ↑ p=.0463; 2.1 | | |
| Upper back | 19 | | | ↑ p=.0148; 2.9 | |
| Lower Back | 17 | | | | |

* Cell entries include direction of effect of moving mode on body part discomfort, significance of relationship, and odds ratio.

Given the participants' apparently high exposure to sitting for long periods of time and rather low exposure to breaks, the data were examined for an association between PCPain and sitting patterns during PC work. Discomfort frequency scores for individual body parts and for PCPain were examined for associations with the PCSit score. All correlations were significant (Table 18), with higher correlations for PCPain, eyes, and body parts belonging to the torso. When the associations were calculated separately for male and female subject groups, however, some differences were seen. In particular, while most of the associations remained significant for the males, several of the associations were non-significant for the female group.

Table 18. Discomfort related to composite score for time sitting with PC, PCSit score; Spearman correlation; non-significant associations are shaded.

| Pain location | Correlation, all S | p, all S | Correlation, Female | p, Female | Correlation, Male | p, Male |
|---|---|---|---|---|---|---|
| PCPain | 0.307 | <0.0001 | 0.294 | 0.0006 | 0.287 | <0.0001 |
| Eyes | 0.260 | <0.0001 | 0.258 | 0.0030 | 0.229 | 0.0009 |
| Upper back | 0.233 | <0.0001 | 0.166 | 0.0568 | 0.248 | 0.0003 |
| Neck | 0.227 | <0.0001 | 0.239 | 0.0058 | 0.172 | 0.0132 |
| Low Back | 0.214 | <0.0001 | 0.157 | 0.0752 | 0.217 | 0.0018 |
| Buttocks | 0.207 | 0.0001 | 0.087 | 0.3279 | 0.289 | <0.0001 |
| Lt. hnd/wrst | 0.207 | 0.0001 | 0.194 | 0.0270 | 0.227 | 0.0011 |
| Rt. hnd/wrst | 0.175 | 0.0012 | 0.148 | 0.0919 | 0.174 | 0.0127 |
| Headache | 0.161 | 0.0031 | 0.096 | 0.2757 | 0.174 | 0.0128 |
| Rt. Elbow | 0.160 | 0.0033 | 0.146 | 0.0981 | 0.156 | 0.0259 |
| Lt. Shoulder | 0.138 | 0.0114 | 0.092 | 0.2992 | 0.151 | 0.0313 |
| Legs | 0.137 | 0.0118 | 0.069 | 0.4333 | 0.171 | 0.0144 |
| Lt. Elbow | 0.125 | 0.0212 | 0.153 | 0.0808 | 0.100 | 0.1543 |
| Rt. Shoulder | 0.113 | 0.0380 | 0.004 | 0.9603 | 0.148 | 0.0342 |

Also associated with the PCPain score was the respondent's frequency of assuming awkward postures while using the computer. Frequent adoption of awkward postures was associated with non-zero PCPain scores, that is, with frequent discomfort in at least one body part that is particularly associated with using the computer ($p<0.0001$). Figure 5 illustrates that when respondents were compared on the basis of more frequent (*quite often* or *almost always*) or less frequent (*never*, *rarely*, or *sometimes*) assumption of awkward postures while using a computer, a significantly greater percentage of the former group experiences frequent discomfort in at least one body part (77% with PCPain >0), when compared with the latter group (28% with PCPain >0). The associated odds ratio is 8.7 (95% CI: 4.6 – 16.3). Results were similar for desktop and notebook user groups. These results are similar to those found in the study of college students use of computers, which was modeled, in part, from the Phase 1 portion of the study described in this report (Noack et al., in press).

### *3.3.4 Limitations*

Due to the fairly small number of subjects, the test-retest reliability for some questions could not be evaluated. This study is also limited by the standard chicken-egg limitations of cross-sectional research.

### *3.3.5 Summary of Phase 1*

The first large scale survey of notebook computer users in the USA was conducted in the first phase of this study. The prevalence of discomfort seen in this sample of working professionals indicates that their experience of physical discomfort is similar to other samples of computer users. Work patterns and computer configuration appear to be associated with their discomfort. NPC users have additional exposures to consider, beyond those of DPC users, including more configuration options and materials handling issues. Based on the questionnaire findings and results from the other parts of the study, recommendations can be made for improving working conditions for desktop and notebook computer users (review section 2. Translation of Findings, in this report).

## 3.4 Phase 2: Measurement of computer use patterns: a quantitative assessment

### *3.4.1 Background*

A number of epidemiological studies have sought to determine whether or not computer use is associated with musculoskeletal discomfort or disorders in people who use computers for work. A variety of factors have been explored, including those that describe the physical arrangement of the workstation or worker posture (Hünting *et al.* 1981; Sauter *et al.* 1991; Marcus *et al.* 2002), work organization and psychosocial factors (Smith *et al.* 1981; Hales *et al.* 1994), and temporal descriptors of computer use (Rossignol *et al.* 1987; Bergqvist *et al.* 1995b; Marcus *et al.* 2002). Among these studies, results have been inconsistent regarding associations between MSDs and physical factors or temporal factors (Gerr *et al.* 2004). Inconsistencies may be due to inadequate sample size or inadequate variance in the data in some studies, the type of computer work (or other work) the subjects performed, or may be due to inherent difficulties with cross-sectional design (healthy worker effect, or injured workers reducing their exposure). However, more recent prospective studies also provide differing results regarding temporal factors (Marcus *et al.* 2002; Kryger *et al.* 2003). Another possible reason for inconsistent findings may be that "daily hours of (self-reported) computer use" or a similar variable is not always a valid surrogate for the actual risk factor.

Temporal aspects of computer use are commonly expressed as daily or weekly hours of computer use or typing, and are most often based upon self-report (Bernard *et al.* 1994; Kryger *et al.* 2003; Lindegard *et al.* 2003). Other methods include work sampling via direct observation, diaries, and computer usage monitors (software odometers). Work sampling has been utilized to quantify usage and verify self-reports. Bernard *et al.* (1994) performed work sampling at intervals of 15 minutes for a single, full day on subjects with and without hand/wrist discomfort, obtaining 30 observations per subject. They found both types of subjects overestimated their *hours of typing* by a factor of 2. Both their self-report data and their work sampling data showed a dose-response relationship between hours of typing and hand symptoms. Usually, after finding a problem, via epidemiological study, exposure limits or some other intervention is produced. It would be difficult to develop an intervention based on a perceived amount of exposure to a physical hazard.

In a prospective study by Marcus *et al.* (2002), daily diaries of computer use were maintained by subjects for up to 3 yrs. In that study, associations were found between *number of hours of keying per week* and incidence of hand/arm symptoms and disorders. Matias *et al.* (1998) required subjects to keep logsheets, recording the beginning and end of each VDT task over a period of 4 days, and they found associations between carpal tunnel syndrome and duration of computer work and percentage of workday using the computer. These studies show that more detailed collection of data, though a burden on subjects, may provide more conclusive and consistent evidence of an association between computer use and MSDs.

Computer usage monitors offer a source of supplementary information to traditional surveys and diary methods, or may be used in place of these. A taxonomy for describing computer input device usage, proposed by Dennerlein *et al.* (2003), demonstrates the richness of such data. Further benefits offered by such a tool are the ability to collect those extensive arrays of data over extended periods of time and at minimal added burden to subjects.

### *3.4.2 Methodology*

The last page of the Phase 1 questionnaire was a Completion Form, on which participants could indicate their willingness to be contacted regarding further participation in the study. A total of 99 people were contacted, most from the Phase 1 part of the study, but others were actively recruited when it was recognized that interest in further participation was low within that group. From those 99, 27 people volunteered to participate in Phase 2 of the study. 14 were DPC users (6 male, 8 female), 12 NPC users (8 male, 4 female), and 1 male who used both a DPC and an NPC for work. Phase 2 was designed to produce a more quantitative assessment of computer use, than could be produced via a survey. A computer usage monitor was installed on each participant's computer. The program ran autonomously,

and the only burden on the subject was to send the previous day's data file to the researchers, in the form of an email attachment. Subjects also maintained a diary, into which they entered information about start and stop times for work each day and ratings of discomfort at the beginning and end of the work day.

Once installed, the odometer software initiated on start-up of the computer. A new file was automatically created for each day. Data was logged every 5 seconds. The software provided the number of keystrikes, mouse clicks (by button and single or double), and cursor "mileage", as well as time-based measures. Mileage was recorded in pixels, but converted to screen diagonals in order to have a common measure across subjects, regardless of the resolution of their computer screens. The data were also identified by work location and by application in use.

Similar to Dennerlein *et al.* (2003)'s taxonomy, data representing keyboard, mouse, and idle episodes were recorded by the software, and can be reported in terms of event tallies and durations of activities. In this report, keyboard events are only represented as any keystrike, but the software provides the data in more detail. Mouse episodes are described by quantities of mouse clicks, limited to total clicks in this report, and mouse movement, expressed as cursor movement, in units of screen diagonals traversed. This simplified taxonomy is illustrated in figure 6. Additionally, the data are all linked to a software application (the active application), and to a work location.

Because data are collected continuously, it is possible to describe not only daily counts, but day-to-day variation, variation by location (for notebook computer users), and patterns of use within a day (activity and break periods). It may be data at one of these levels of detail that will help resolve the inconsistencies in the research that current exist, regarding the existence of a causal association between computer use and MSDs.

### *3.4.3 Results and discussion*

The specific aims of Phase 2 are listed and reviewed below, in relation to the results of this phase of the study.

The specific aim of Phase 2 was to quantify computer use and work patterns in a sample of NPC users that is reflective of the NPC user survey respondents. The primary product from this phase are descriptive statistics of the odometer data and self-report diary data. Additionally, comparisons are made between various data sources, where possible, to explore how these different data collection mechanism (diary, odometer, and survey) provide redundant or complementary information, and help to assess appropriateness of durations of direct data collection methods (diary and odometer). This aim was achieved, though there were a smaller number of participants than originally proposed. Instead of only studying NPC users, DPC users were also studied. An average of 17 days of data were collected for each subject (range: 13-33 days).

3.4.3.1 Descriptive statistics of computer use – keystrikes, mouse clicks, usage time, and location.

The average time per day spent inputting to the computer was 153 minutes, across subjects, with one subject's average as low as 90 minutes per day and another's as high as 278 minutes. Expressed as a percentage of the work day, the corresponding values were 30%, 19%, and 50%, respectively. The single day, for any subject, with the greatest amount of activity time contained 482 minutes of inputting activity (just over 8 hours), and was 82.4% of the work time for that day. Within the sampling period, 17 subjects experienced maximum activity days in which inputting activity occurred for more than 4 hours of the day. Activity averages appear in Table 19.

Table 19. Average counts of keystrikes, mouse clicks, and mouse movements, across the 27 subjects.

| Event | Average | Range of subjects' averages |
|---|---|---|
| Keystrikes | 6422 | 1125 - 18719 |
| Mouse clicks | 1660 | 622 - 4906 |
| Cursor movement* | 719 | 170 - 1809 |
| * Units are number of screen diagonals traversed. | | |

Figure 7 use depicts the average weekday use of the NPC and DPC users, in terms of total keystrikes, total mouse clicks (all buttons, and with double clicks counted as two clicks), total number of screen diagonals traveled by the cursor, and total activity time. Activity time refers to the time during which the user was inputting to the computer (including scrolling), but does not account for time during which he/she was only reading from the monitor. Figure 8 shows a lack of correlation between the measured daily usage and the self-report estimates provided via the questionnaire. The average of the overestimate of the usage via questionnaire was 3.1 hours, or about a doubling of the actual measured activity. This finding is consistent with previous comparisons between researcher observations and self-reports (Bernard et al., 1994; Homan and Armstrong, 2003).

Ten of the 12 specific locations on the location list embedded in the odometer software were utilized by the NPC users during the study. Only one participant made use of the "other" location selection, so this seems to indicate the location list was a viable one. The number of NPC subjects utilizing the computer in the various locations is presented in Table 20.

Table 20. Locations where Phase 2 NPC participants used their computers during the study.

| Location | Number of subjects |
|---|---|
| 1) office/cubicle at employer's | 8 |
| 2) office/cubicle offsite location | 2 |
| 3) home office setting (desk or table) | 6 |
| 4) home but not office setting | 2 |
| 5) office of another person | 2 |
| 6) car | 2 |
| 7) train | 0 |
| 8) plane | 1 |
| 9) hotel guest room | 3 |
| 10) waiting area | 1 |
| 11) mgt room/auditorium/classroom | 6 |
| 12) lab | 0 |
| 13) other | 1 |

3.4.3.2 Usage variation

More interesting than the average values are the data when examined at the level of the individual subject, because the extent of the variation in computer use for these professionals then becomes clear. For example, Figure 9 shows the range in daily keystrikes from one subject to another, and the variation within subjects, as well. The average coefficients of variation (CV) for daily keystrikes, across subjects, is 54% and ranges from 22 - 121%. The CVs calculated for each subject's data set provide an approximation of the number of days of data that would have to be collected from the subject in order to achieve a confidence interval of 90% and a margin of error equal to 10% of the mean (assuming a population of 250 work days). With this level of variation, it is no wonder that subjects' estimates of their use of their computers do not match measurements of use. These data also provide important information for the design of future studies of people whose computer use varies from one day to the next.

An example of daily computer inputting activity over a three week collection period (standard time frame for this study) can be seen in Figure 10 for one of the DPC users. The extent of the day-to-day variation is typical of both the desktop and notebook users in this study. The monitoring software that was used to collect these data provide a means to understand the variation in activity. For example, because all of the data are linked to specific applications, we can understand the reason for the maximum data point for this subject on 5/22. Four hours of activity were logged on that day to a word processing program and another 4 hrs to a presentation software program, indicating the subject was working under a deadline that day to prepare a presentation and supporting documentation. The diary data complements the odometer data, and that is illustrated in figure 11, which shows the same subject's data, as a proportion of work time each day, based on work start and stop times entered into the diary.

Within-day usage variation can also be explored through examination of odometer data. An example of computer use variation within a day is provided in figure 12, which shows activity and break patterns for two different work days for the same participant. Breaks, or lack of them, which can be identified in such data, have been identified as an important factor in the computer use/MSD puzzle (Bergqvist *et al.* 1995b). As stated previously, in the Phase 1 section of this report, 34% of the respondents reported only taking "very brief breaks" throughout the work day, and another 34% reported taking only very brief breaks plus a lunch break of more than 30 minutes (similar to the pattern seen in the lower graph of figure 12). Also from Phase 1, the reporting of frequent musculoskeletal discomfort was positively correlated with a score that was derived from each subject's propensity for working at the computer for various, uninterrupted extended periods of time.

The odometer also captures the different ways people work in different locations, how input activity patterns vary by location, as well as how mobile the user is in any given day. An example of this is illustrated in the series of graphs in figure 13, which show how activity varies by location, and how mobile some NPC users are on some work days.

3.4.3.3 Additional comparisons between data sources

One of the questions on the survey inquired about the likelihood of using the computer at various times throughout the day, divided into 2-hour increments. The odometer data were used to assess this likelihood as well, for the Phase 2 respondents. The association between the questionnaire responses and the likelihood based on the odometer data were compared using Spearman's correlation. The adjusted $R^2$ value was 0.85 ($p<0.0001$). An example of this correspondence is depicted in Figure 14. This suggests that questionnaire respondents may be able to provide fairly accurate estimates of their typical computer use patterns in their responses to that question.

There was also generally good correspondence between the locations the respondents said they used the NPCs and where they were used over the Phase 2 data collection period. This is depicted in figure 15. In general, the results also tend to support the conclusion that the sampling period was not quite long enough

to capture all of the locations in which these NPC users use their computers, but for 8 of the 11 subjects depicted, at least 75% of the locations reported on the questionnaire were observed during the collection period.

### *3.4.4 Limitations*

As stated by Dennerlein *et al.* (2003), computer use monitoring software is currently limited to collecting information about input activities, and cannot capture total time spent using the computer, which also includes those periods of time where someone is reading from the computer. This may become a greater limitation to this method of data collection, as more documents are provided electronically. In spite of this limitation, computer usage monitoring programs have the potential to provide objective, quantitative data that describe computer use at a level of detail not possible through more traditional methods.

Two other important limitations of this phase of the research are both concerned with sample size. In spite of sampling subjects for much longer than previous studies, the within-subjects day-to-day variation in use that was captured in the data showed that even three weeks was too brief to adequately sample in order to provide a statistically accurate estimate of the activities of these subjects. The other sampling size limitation was the small number of subjects that were enrolled in this phase of the study, in spite of our best efforts. On the positive side of the ledger, however, data from DPC and NPC were collected, so the variation seen in subjects is known to occur in professionals who use either type of computer.

### *3.4.5 Summary*

The analysis of the Phase 2 data, to date, provides a glimpse of the richness of the data that are provided by computer monitoring software. Variation within and between subjects can be quantified to an extent not possible from self-reported surveys, and with lower burden on subjects than occurs with use of diaries for recording computer use activities. This method of examining computer usage may yield new insight into questions concerning the nature of the association between computer use and MSDs, as well as provide new directions and methods for intervention solutions for computer users

## 3.5 Phase 3: Quantitative assessment of work design through controlled experimentation

### *3.5.1 Background*

The previous phases of the study revealed similar levels of discomfort in both NPC and DPC users. They also revealed a self-reported propensity to take few breaks during the work day, a high exposure to extended periods of sitting, and a significant association between frequency of adopting awkward or poor postures and frequent computer-use-related discomfort. Further, a significant association was identified between use of NPCs in a stand-alone configuration and frequent discomfort specifically associated with computer use. In other words, the previous phases of the study support a concern for postural fixity and awkward work postures among computer users, and in particular for NPC users who use the computer without external peripheral devices.

Concerns about NPC use are related to the design of the computer, as well as expansion and diversification of the user population and use locations (Sommerich, 2000). Issues related to computer design include features that NPCs share with DPCs, such as keyboards that induce ulnar wrist deviation and forearm pronation. Additional NPC features that raise concerns include other keyboard design characteristics (reduced key size and/or spacing, lack of redundant keys, increased thickness), permanent attachment of keyboard and display, and pointing device design (lack of alternative integrated devices and device locations, Kelaher et al., 2001). Each of these features can be cause for concern, because of their potential to increase biomechanical strain in the user and hinder performance.

Only a few lab-based studies have been conducted on NPCs. Results show that NPC use can affect user posture, increase discomfort and muscle activity, and hamper performance in comparison to DPC use. Straker et al. (1997) found increases in head tilt and neck flexion during text typing on an NPC, compared to using a DPC. In both situations, subjects were free to adjust the workstation to their own preferences. Subjects chose to position the keyboards of the two computers similarly, forcing the location of the NPC screen to be lower than that chosen for the DPC screen. Price & Dowell (1998) found differences in user posture and discomfort associated with NPC placement. Comparing lower (keyboard at elbow height) to higher NPC placement (to optimize arm posture and neck posture, respectively), discomfort in all body parts, including the neck, was greater with the higher placement. Price and Dowell (1998) also found that conditions in which the NPC was used stand-alone showed more discomfort in the right wrist/hand than conditions that employed an external mouse (with or without an external keyboard).

Villanueva et al. (1998) compared use of a DPC to use of four progressively smaller NPCs during text entry. Although keyboard dimensions varied across computers, keyboard height relative to each subject was standardized. The authors still found differences in elbow flexion and wrist extension. Medial shoulder rotation increased as keyboard size decreased, though abduction was not affected. Keying difficulty was judged greater for the NPCs compared to the DPC, and was greatest for the two smaller keyboards. Keying performance was reduced for the two smaller NPCs. Smaller screen size was associated with visual discomfort, more non-neutral body postures, and increased neck extensor muscle activity.

Musculoskeletal discomfort associated with computer work, in general, has been attributed to assumed postures, postural fixity, and inactivity (Sauter et al., 1991; Grieco, 1986). While the level of muscle activity required to maintain typical computer work postures is generally low (Wærsted & Westgaard, 1997), the static nature of the activation, the lack of variation in it, and potentially most important, the length of time it is sustained, are thought to be reasons underlying the risk associated with computer work and other static tasks. In reviewing low-level static exertions, Sjøgaard (1999) emphasized the importance of duration in elevating the risk of such exertions. Such exertions may result in problems with microcirculation within the muscle, muscle metabolism, and/or overworking of particular fibers ("Cinderella fibers"), as well as inadequate recovery between work periods.

Phase 3 of the study was designed to investigate postural fixity, some awkward postures, and other indicators of biomechanical strain during use of a stand-alone NPC, and to determine if biomechanical strain would be altered with the use of low cost peripheral devices (mouse or mouse+keyboard). Performance, discomfort, and preference were also examined. This study was unique, in that it explored the effects of task in conjunction with the effects of computer configuration on the various outcome measures. It was expected that the stand-alone configuration would induce more postural fixity and more non-neutral postures than if one or more external input devices were used with the NPC, and that this finding would support the use of peripheral devices when using a NPC, particularly for extended periods of time, as in a desktop replacement scenario.

### *3.5.2 Methodology*

The methodology of Phase 3 is full described in Sommerich et al. (2002), copies of which are included with this report, so only an outline of the methods is provided here. A 10x10 balanced Latin Square design was used to test 10 computer configuration x task conditions (see Table 21); 10 touch typists participated in the experiment.

Table 21. Test conditions for the Phase 3 lab-based experiment.

| Test Condition Designation | Computer Configuration | Task |
|---|---|---|
| Notebook-keying: NK | stand-alone notebook | keying letters |
| Notebook-numbering: NN | stand-alone notebook (using number row) | keying numbers |
| Notebook-mousing: NM | stand-alone notebook (using integrated pointing stick) | editing text styles using pointing device |
| Notebook-combination: NC | stand-alone notebook | combination task (a mix of keying letters and numbers, and editing with pointing device) |
| External-mousing: EM | stand-alone notebook with external mouse | editing text styles using pointing device |
| External-combination: EC | stand-alone notebook with external mouse | combination task (a mix of keying letters and numbers, and editing with pointing device) |
| Full-keying: FK | notebook with external mouse and full-size external keyboard | keying letters |
| Full-numbering: FN | notebook with external mouse and full-size external keyboard (using number pad) | keying numbers |
| Full-mousing: FM | notebook with external mouse and full-size external keyboard | editing text styles using pointing device |
| Full-combination: FC | notebook with external mouse and full-size external keyboard | combination task (a mix of keying letters and numbers, and editing with pointing device) |

The effects of test conditions were assessed from several perspectives. Biomechanical response was assessed by examining electromyographic activity in the first dorsal interosseus (DI1), upper trapezius (TRAP), pectoralis major (PM), and teres minor/infraspinatus (TMI) muscles on the right side of the body (by design, all subjects were right-handed) and a number of postural angles (viewing angle, head tilt, neck angle, thoracic bend, trunk angle, elbow flexion, shoulder flexion, shoulder rotation, and wrist flexion/extension and radial ulnar deviation. Productivity, discomfort and preference were also assessed.

Six males and four females, aged 21 to 44 years, participated in the study, after providing informed consent. Participants were in good health and none wore bifocals. Participants were required to be right-handed, touch typists, and be proficient in using a mouse and a pointing stick (Trackpoint).

### *3.5.3 Results and discussion*

The specific aims of Phase 3 are listed and reviewed below, in relation to the results of this phase of the study.

The specific aim of Phase 3 was to characterize the effects of work design on user biomechanics, performance, comfort, and preference. This aim was achieved. The test conditions were found to differentially and significantly affect muscle activity, posture, body part discomfort, and productivity measures. A summary of the significant effects is presented in Table 22; detailed review of results and discussion are provided in the published paper (Sommerich et al., 2002).

Table 22. Summary of significant results; refer to Sommerich et al. (2002) for details. The sections, figures and tables listed in the column titled "Detailed results" are found in the paper, not in this final report.

| | | Tests of | Tests of Task Effects [b] | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter area** | **Dependent variables** | **Configuration Effects[a]** | **NPCsa** | **NPCEx** | **FULL** | **Detailed results** | **Primary observed differences [c]** |
| **Productivity** | Mousing productivity | M | | | | Sec. 3.1, Figure 1 | Full, NPCEx: greater productivity using external mouse. |
| **Posture** | Viewing angle, mean | N,K,M,C | | | | Sec. 3.2.1 | Full: raising computer provided an appropriate viewing angle. |
| | Head tilt, mean | N,K,M,C | X | X | X | Sec. 3.2.1, Table 5 | Full: raised computer facilitated more neutral head and neck postures. |
| | Neck angle, mean | N,K,M,C | X | X | X | | |
| | Trunk angle, mean | | | X | | Sec. 3.2.2 | |
| | Thoracic bend, mean | | | X | | | |
| | Shoulder flex, mean | | | | X | Sec. 3.2.3 | Full, using number pad, provided only opportunity for neutral posture. |
| | Shoulder flex, variation | M,C | X | | | Sec. 3.2.3, Table 6 | More variation when using external mouse. NPCEx, Full: more variation in combo task. |
| | Shoulder rot., mean | N,M,C | | X | X | Sec. 3.2.3, Table 7 | Full: neutral posture during number pad use. NPCEx: neutral posture during mousing. |
| | Shoulder rot., variation | C | | | | Sec. 3.2.3 | Full > NPCEx > NPCsa |
| | Elbow angle, mean | N,K,M | X | X | X | Sec. 3.2.3, Table 8 | |
| | Elbow angle, variation | C | X | | | Sec. 3.2.3 | Full, NPCEx: provided more variation during the combo task. |
| | Wrist flex/ext, mean | N,K,M,C | X | X | | Sec. 3.2.4, Table 9 | NPCsa: less extension; ulnar deviation was non-neutral when using number row; limited variation during pointing device use. |
| | Wrist rad/uln, mean | N | X | X | X | | |
| | Wrist flex/ext, variation | N,M | X | X | X | Sec. 3.2.4, Table 10 | |
| | Wrist rad/uln, variation | M | X | X | X | | |
| EMG | Static DI1 | M | X | X | X | Sec. 3.3, Table 11 | Full: less PEC activity. |
| | Static Trap | | X | X | | | |
| | Static PEC | N,K,C | | X | | Sec. 3.3, Table 12 | |
| | Static TMI | | | X | X | | |
| Discomfort | Total | | X | X | X | Sec. 3.4, Table 13 | Full: less neck discomfort during text keying. Full, NPCEx: less neck discomfort during combo task. NPCEx, NPCsa: less upper extremity discomfort in text and number typing tasks. |
| | Neck | K,C | | | X | | |
| | Rt. forearm | N | X | | X | Sec 3.4, Table 14 | |
| | Rt. wrist | K | X | | | | |

[a] Indicates which configuration tests were significant; details are provided in the referenced subsection, table, or figure. N=number typing; K=text keying; M=pointing device use; C=combination task.
[b] For a given configuration, indicates where task effects were significant.
[c] If blank, none of the differences appeared to be practically significant.

### *3.5.4 Limitations*

A primary weakness of the Phase 3 study design was the limited time subjects had to experience each condition. This was necessary in order to ensure subjects would not become fatigued, and that the study would require only one day's worth of time from each subject. This restricts our ability to extrapolate our findings to working with these three configurations for entire work days, as many people do. That said,

with the shortened work cycles used for each condition, it is more likely that measured posture variation was indeed due to test condition (task &/or computer configuration), and less likely to have been due to subject fatigue or discomfort.

### *3.5.5 Summary*

This study took a comprehensive approach to evaluating effects of using a notebook computer stand-alone or along with inexpensive peripheral input devices. The study examined effects on posture, postural fixity, muscle activity, productivity, and discomfort, and considered the impact of both computer configuration and task performed. Consistent with the original hypothesis, this study demonstrated that use of a stand-alone notebook computer (NPCsa) resulted in significantly more postural fixity in several joints compared to the other two computer configurations used in the study (notebook PC with an external mouse (NPCEx), and notebook PC with an external mouse and external keyboard (FULL)). The stand-alone configuration also induced more non-neutral postures, in certain tasks, than did the other two configurations. Neck posture and discomfort benefited from use of the two external input devices. However, while use of the number pad on the external keyboard produced postural benefits, right forearm discomfort was higher during the number typing task with that configuration, compared to when the number row was used on the notebook PC's keyboard. Additionally, muscle activity measures indicated some benefit to the first dorsal interosseous m. from using the built-in pointing stick in the notebook PC, while the pectoralis major m. was less active when both external devices were used. However, the former positive finding might be offset by the reduction in productivity found with the built-in pointing stick in comparison to use of the external mouse.

Based on these results, then, a recommendation is made for use of either the NPCEx or FULL configurations, over the NPCsa configuration, when working for an extended period of time, such as when a notebook is used in a desktop replacement scenario. The primary benefit of adding the external keyboard is the ability to elevate the computer's display. If an external keyboard is used, it is generally recommended that it not have a built-in number pad, so that the external mouse can be placed directly next to the primary keyboard. Although not tested in this study, a stand-alone number pad would seem to be appropriate for someone who performed a lot of numeric entry. This would provide more flexibility, in terms of mouse and number pad placement (either exchanging one for the other depending on task, or placing one on either side of the keyboard if the individual is willing/able to learn to work with both hands, as he/she already must do in typing text).

## 3.6 Conclusions from the project

A listing of the significant findings and how those findings can be utilized by researchers, computer users, and employers is provided in table 23.

Table 23. Summary of significant findings and usefulness of findings, by specific aim.

**Phase 1.**

**Specific Aim 1:** Development and application of a comprehensive worker survey, for the purpose of collecting qualitative, self-report data on workers (demographic, work patterns, psychosocial work factors, and personal attributes), and on their work (work organization, physical ergonomics, and tools).

Significant findings:

- The survey provided reliable data from a large sample of professional computer users.
- By design, all participants were professionals, so, unlike previous studies, there was no inherent confounding due to interactions between sex, job ranking (professional or administrative), and type of computer (desktop or notebook).

Usefulness of findings:

- Parts of the survey were incorporated into a master's level thesis on college students use of computers – this study has been accepted for publication in the *International Journal of Industrial Ergonomics (IJIE)*.
- The reliability analysis of the survey questions may be used to help others utilize components of this survey or develop their own instruments. In particular, one new outcome measure, PCPain, and one new predictor measure, PCSit score, were found to be reliable, and were found to correspond in important ways to other variables.

**Specific Aim 2.** Analysis of these data, in order to:

a. construct an initial database of worker and work characteristics that describe a large sample of NPC users
b. identify similarities and differences, in work or worker factors, between NPC users and DPC users
c. identify worker or worker factors associated with strain outcomes in NPC users
d. identify similarities and differences, in work or worker factors associated with strain outcomes, in NPC users and DPC users.

Significant findings:

- As in previous studies, discomfort prevalence tended to be greater in females than in males. This was true both for responses to Nordic questionnaire style inquiries about 12 month and 7 day prevalence of discomfort, as well as discomfort specifically associated with computer use.
- Differences were not found between DPC and NPC groups, in computer-use-related discomfort.
- Both user groups tended to take few work breaks, and did not tend to utilize tools that could help them work more comfortably, such as copystands (document holders), telephone headsets or speakerphones.
- Risks to all computer users: sitting for longer uninterrupted periods when working with the computer; frequently adopting poor or awkward postures when using the computer.
- Risks were identified for notebook users: use of the computer in a stand-alone configuration, and various modes of carrying the computer.

Usefulness of findings:

- Results can be used to educate all professionals who use computers as a primary work tool and their employers about the importance of adopting good computer work habits – taking breaks, sitting for less extended uninterrupted periods of time while using the computer , and working in "good" postures often. For employers, this may mean altering work in some fashion to facilitate breaks, adoption of good postures and changes in posture.
- For notebook users, the importance of the use of peripheral devices has been confirmed, and the advantages and disadvantages of using a rolling cart for transporting NPCs should be explored further.

Table 23, cont.

**Phase 2.**

**Specific Aims:** Quantify computer use and work patterns in a sample of NPC users that is reflective of the NPC user survey respondents.

Significant findings:

- The variation in the use of the computers was great in both the NPC and DPC users. The three week (average) length of data collection was found to be inadequate, based on the coefficients of variation that were calculated from the data.
- The variation in use also signals that simple metrics such as 'daily hours of computer use' may be insufficient for assessing or in any sense regulating computer use.
- The location capture feature of the odometer revealed differences in work patterns by location.

Usefulness of findings:

- Designers of odometers should consider including additional features to capture more information about mobile users, as these proved useful in this study.
- The variation in the data in this study could be used by other researchers to plan adequate sampling periods for future studies of similar groups of computer users.
- The variation in the data in this study may inspire researchers to expand the taxonomy of computer use activity descriptors beyond averages and totals.

**Phase 3.**

**Specific Aims.** Characterize the effects of work design on user biomechanics, performance, comfort, and preference.

Significant findings:

- This study demonstrated that use of a stand-alone notebook computer (NPCsa) resulted in significantly more postural fixity in several joints compared to the other two computer configurations used in the study (notebook PC with an external mouse (NPCEx), and notebook PC with an external mouse and external keyboard (FULL)).
- The stand-alone configuration also induced more non-neutral postures, in certain tasks, than did the other two configurations.
- Neck posture and discomfort benefited from use of the two external input devices.
- While use of the number pad on the external keyboard produced postural benefits, right forearm discomfort was higher during the number typing task with that configuration, compared to when the number row was used on the notebook PC's keyboard.
- Muscle activity measures indicated some benefit to the first dorsal interosseous m. from using the built-in pointing stick in the notebook PC, while the pectoralis major m. was less active when both external devices were used. However, the former positive finding might be offset by the reduction in productivity found with the built-in pointing stick in comparison to use of the external mouse.

Usefulness of findings:

- Based on these results, a recommendation is made for use of either the NPCEx or FULL configurations, over the NPCsa configuration, when working for an extended period of time, such as when a notebook is used in a desktop replacement scenario.
- If an external keyboard is used, it is generally recommended that it not have a built-in number pad, so that the external mouse can be placed directly next to the primary keyboard.
- Although not tested in this study, a stand-alone number pad would seem to be appropriate for someone who performed a lot of numeric entry. This would provide more flexibility, in terms of mouse and number pad placement (either exchanging one for the other depending on task, or placing one on either side of the keyboard if the individual is willing/able to learn to work with both hands, as he/she already must do in typing text).

## 4. Publications

The following papers and conference proceedings are direct or related products of this research project:

1. NOACK, K.L., SOMMERICH, C.M. and MIRKA, G. In press, College students and computers: Assessment of usage patterns and musculoskeletal discomfort, *International Journal of Industrial Ergonomics*. *The aims of Phase 1 contributed to this study: parts of the survey were utilized in developing a survey for college students, and college students' responses were compared to those of the professionals who participated in the NIOSH-sponsored study.*
2. SOMMERICH, C.M., VATAN, S. and ASMUS, A. 2004, Computer input devices: quantification of use and variation in use, *Proceedings of Human Factors and Ergonomics Society 48th Annual Meeting*, New Orleans: Human Factors and Ergonomics Society. *Dissemination of Phase 2 results.*
3. NOACK, K.L., SOMMERICH, C.M. and MIRKA, G. 2004, College students and computers: assessment of usage patterns and musculoskeletal discomfort, *Proceedings of Human Factors and Ergonomics Society 48th Annual Meeting*, New Orleans: Human Factors and Ergonomics Society. *The aims of Phase 1 contributed to this study: parts of the survey were utilized in developing a survey for college students, and college students' responses were compared to those of the professionals who participated in the NIOSH-sponsored study.*
4. DENNERLEIN, J.T., CHEMOR-RUIZ, A., JOHNSON, P. and SOMMERICH, C.M. 2003, A proposed taxonomy for describing computer input device usage, *Proceedings of IEA 2003*, Seoul. *Disseminate basic thinking about importance of Phase 2 data collection.*
5. SOMMERICH, C.M. 2002, A survey of desktop and notebook computer use by professionals, *Proceedings of Human Factors and Ergonomics Society 46th Annual Meeting*, Baltimore, MD: Human Factors and Ergonomics Society. *Disseminate information about Phase 1.*
6. SOMMERICH, C.M., STARR, H., SMITH, C.A. and SHIVERS, C. 2002, Effects of notebook computer configuration and task on user biomechanics, productivity, and comfort, *International Journal of Industrial Ergonomics*, 30, 7-31. *Disseminate information about Phase 3.*
7. SWANSON, N., SOMMERICH, C.M., ALDERSON, M. and DUNKIN, R. 2001, The relationship between keyboard and mouse use and musculoskeletal symptoms, *Computer-Aided Ergonomics and Safety Conference (CAES 2001)*, Maui. *Additional exploration of the usefulness of odometer data collection tool – Phase 2.*
8. SOMMERICH, C.M. 2000, Inputting to a notebook computer, *Proceedings of IEA 2000 / HFES 2000 Congress*, San Diego: The Human Factors and Ergonomics Society, 671-674. *Disseminate basic thinking about notebook computer use as a potential area of concern – related to all three phases of the study.*

The 2003 master's thesis of Karen Noack stemmed from this project (Noack, 2003), and is the basis for publications 1 and 3, in the list above. The questionnaire she utilized was based on a subset of questions from the questionnaire of the NIOSH-funded study. She compared her findings on discomfort and patterns of computer use among college students to the findings in this study on professionals' use of computers.

There are plans for additional publications, concerning reliability assessment of the questionnaire, multivariate statistical analyses of the questionnaire data utilizing CART, and additional methods of characterizing the odometer data.

## 5. Inclusion of gender and minority study subjects

PHS-2590 appears as Appendix D.

## 6. Inclusion of Children

The objective of this study was to better understand a group of professional workers and their interactions with their work environments. As such, children were not involved in the study. This study did, however, contribute to a study of college students use of computers (Noack, 2003).

## 7. Materials available for other investigators

The survey questions are included as Appendix A, in this report.

## 8. Acknowledgements

This study was funded by the National Institute for Occupational Safety and Health (K01-OH00169). Pilot work in support of this research was funded by the Office Ergonomics Research Committee. The Department of Industrial Engineering at North Carolina State University also provided support for this study. The PI also wishes to thank all of the people who participated in the study as subjects or who championed the project within a participating company. Additionally, a number of people participated as researchers in support of the project, in the areas of data collection and/or analysis: Michael McGarrah, Karen Noack Cooper, Sunil Sudhakaran, Komal Bajaj, Hollis Dickens, Dr. David Dickey, Aaron Stewart, Dr. Sharon Bennett Joines, Heather Starr, Christy Smith, Shaun, Carrie Shivers, Sahika Vatan Korkmaz, Amy Asmus, and Dr. Deb Burr Doss.

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Figure 1. Prevalence of self-reported body part discomfort via the questionnaire, by prevalence definition and sex; asterisks indicate significant differences, based on Fisher's exact test.

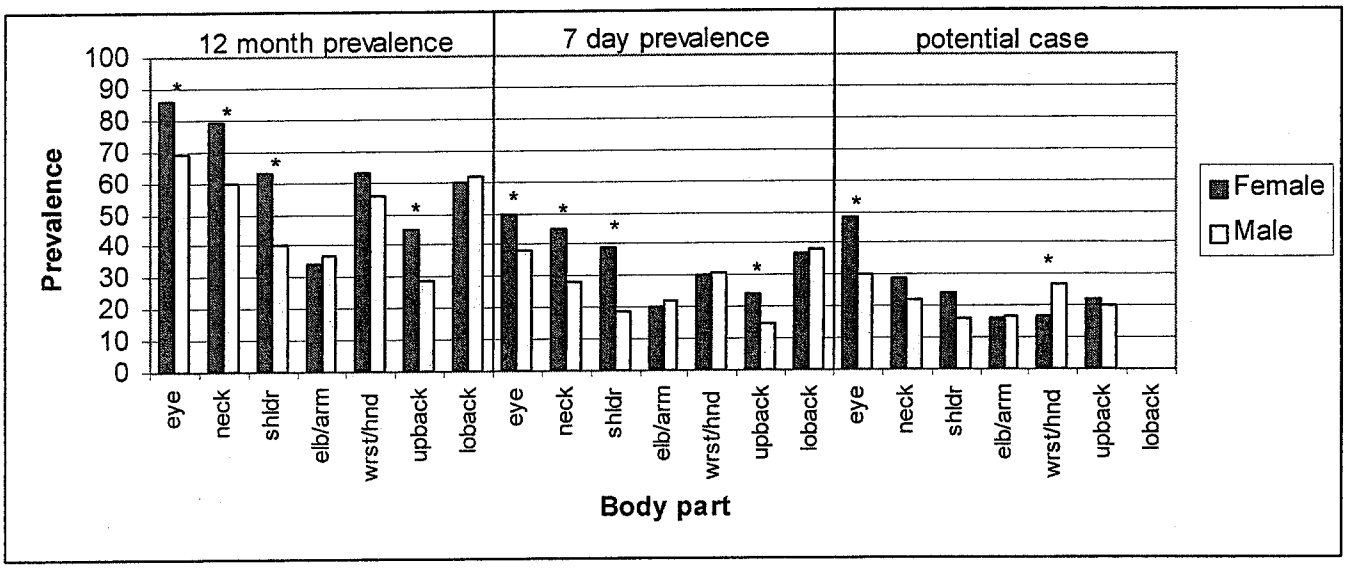



Figure 2. Average frequency of experiencing computer use-related discomfort. * indicates a significant differences between male and female respondents.

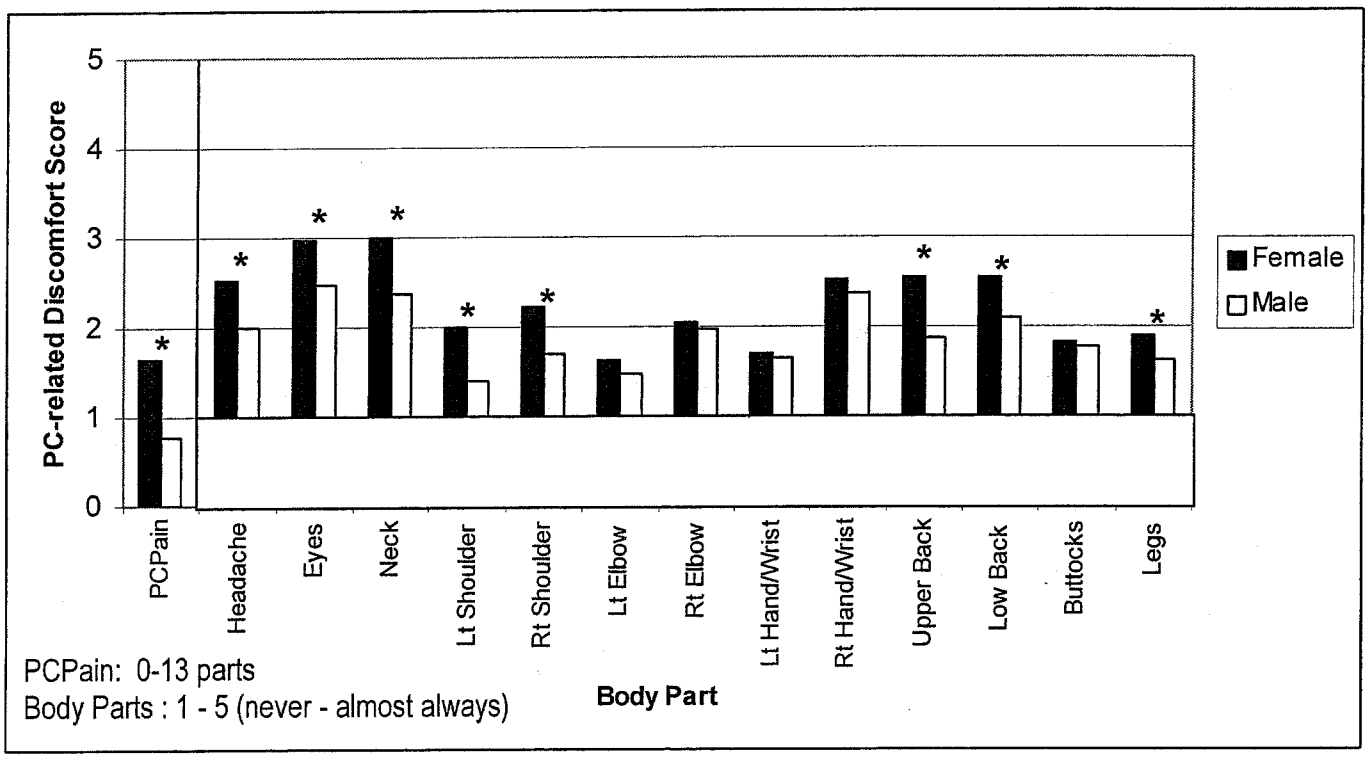


Figure 3. Likelihood of computer use throughout the workday. (a) NPC users; (b) DPC users. *** indicate those time periods for which the distributions differ between user groups.

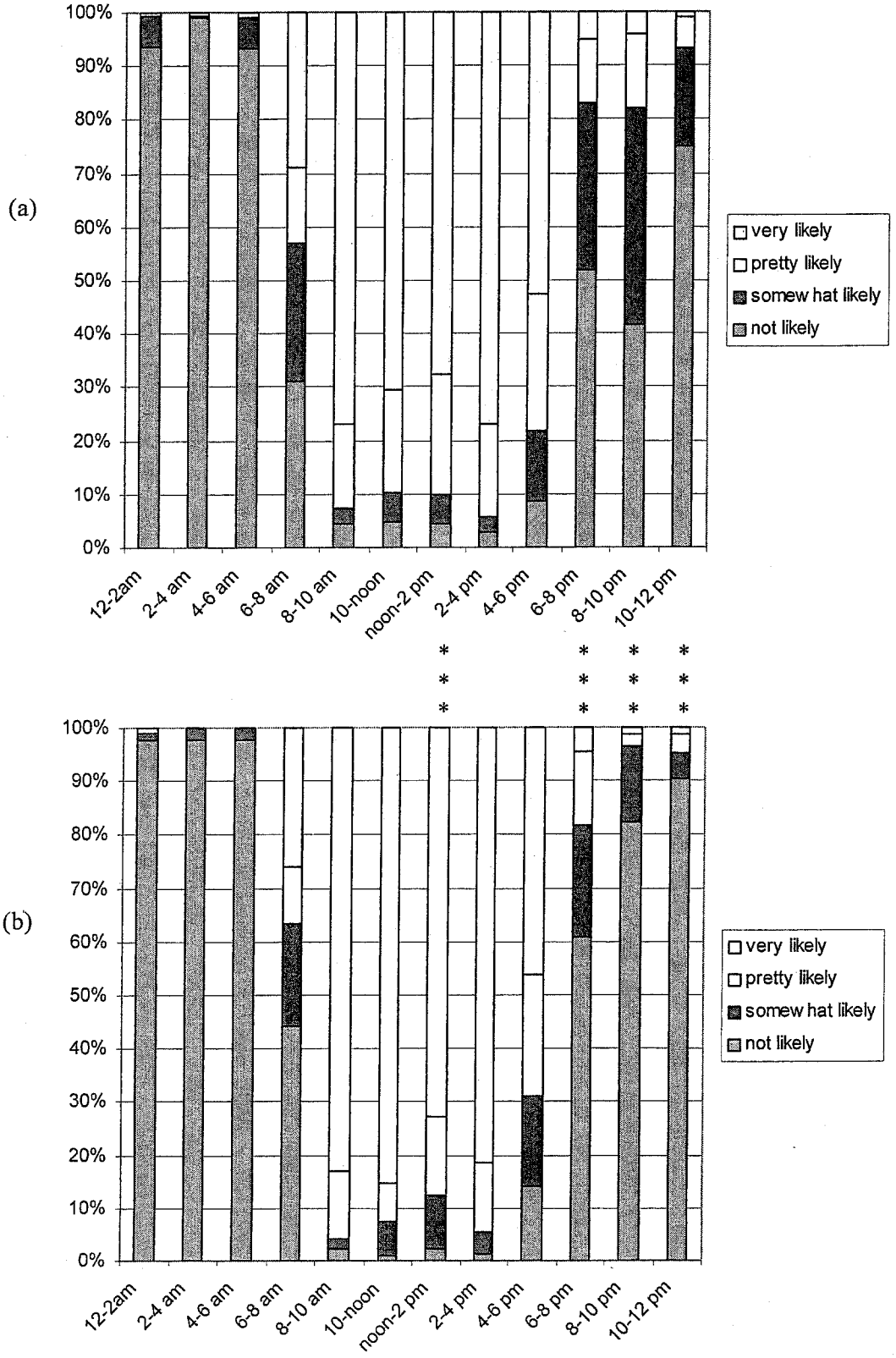


Figure 4. Frequency of use of external devices attached to the notebook computer by NPC respondents.

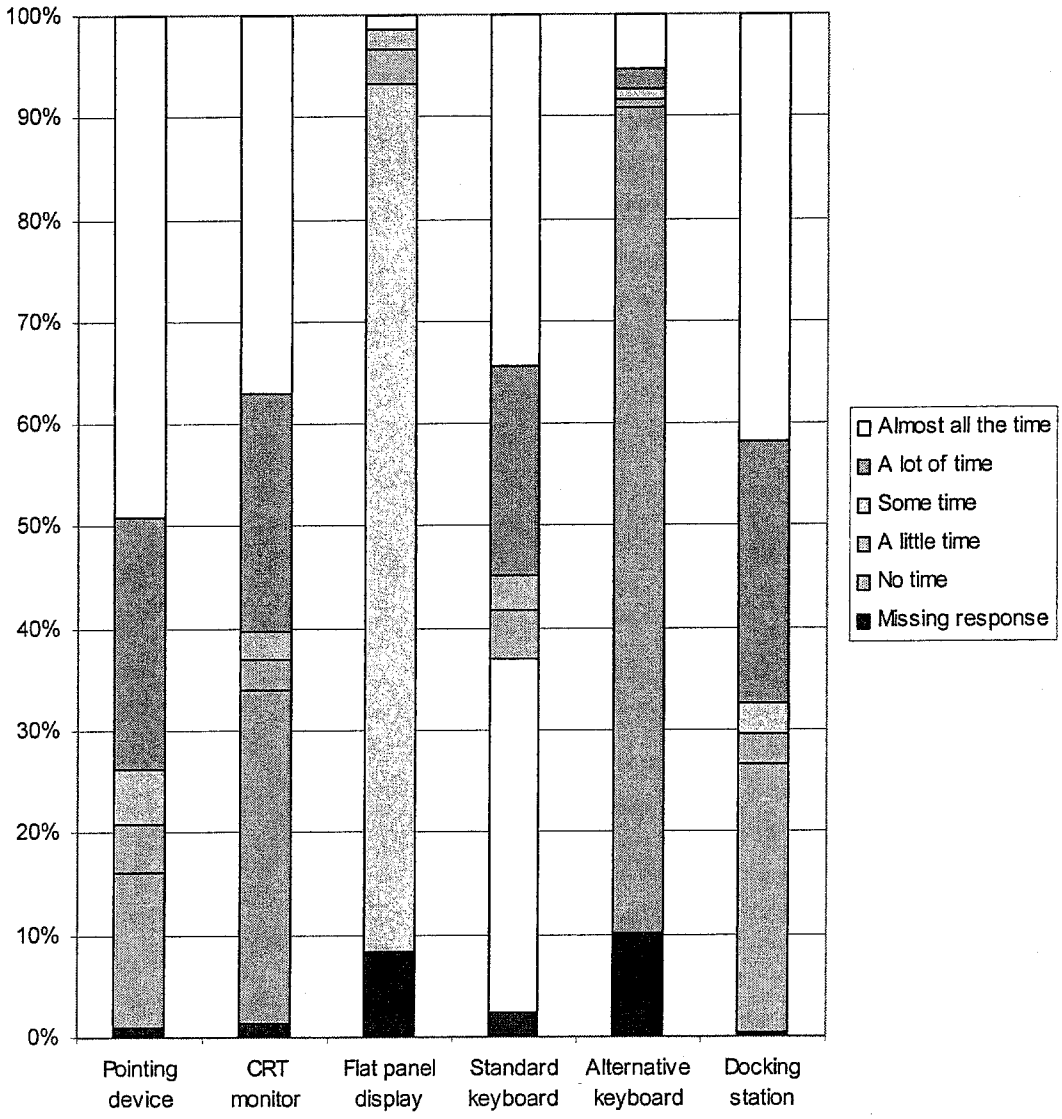


Figure 5. Significant differences in PCPain experience between groups of respondents categorized by frequency of assuming awkward postures when using the computer.

Q: When using the computer, I find myself assuming awkward, uncomfortable, or "poor" postures.... Never....Rarely...Sometimes....Quite often....Almost always.

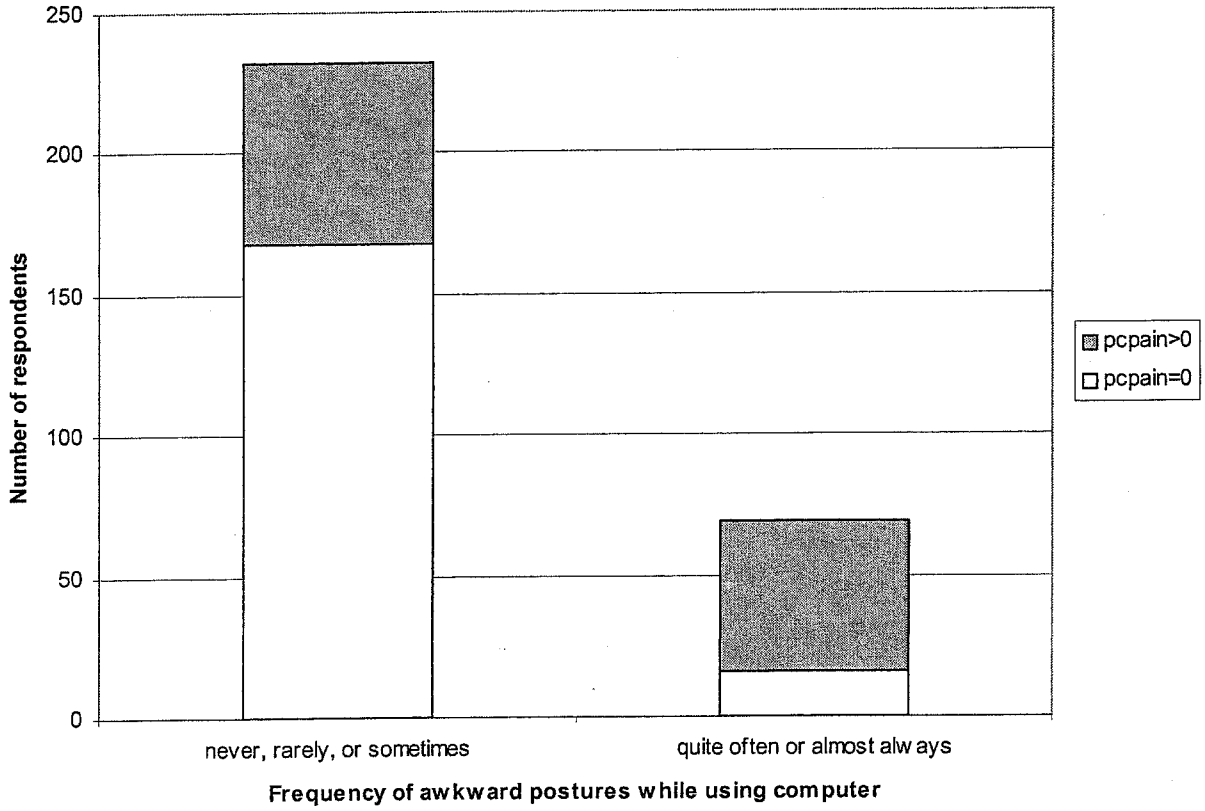


Figure 6. Phase 2 odometer data collection taxonomy.

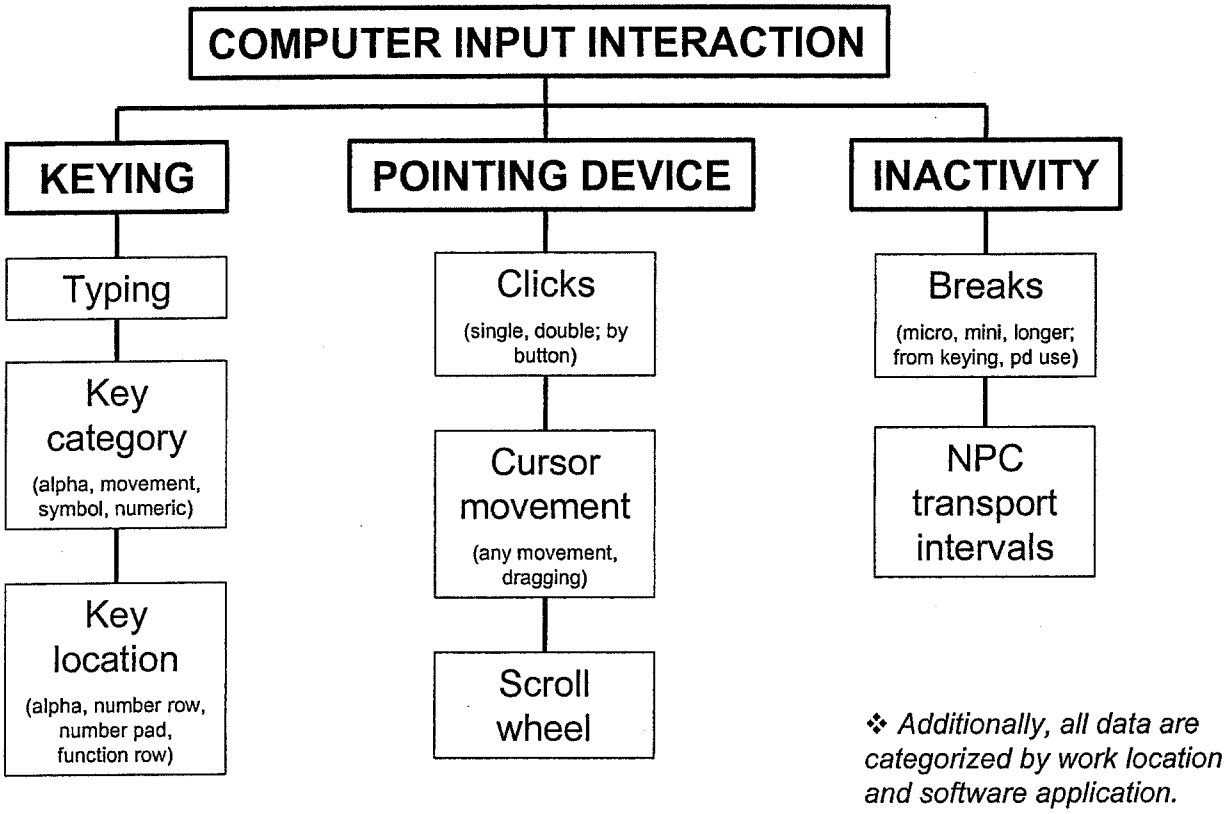


Figure 7. The average daily hours of inputting activity and average numbers of events (keystrikes, clicks of the pointing device, and cursor travel distance in screen diagonals) for all Phase 2 participants.

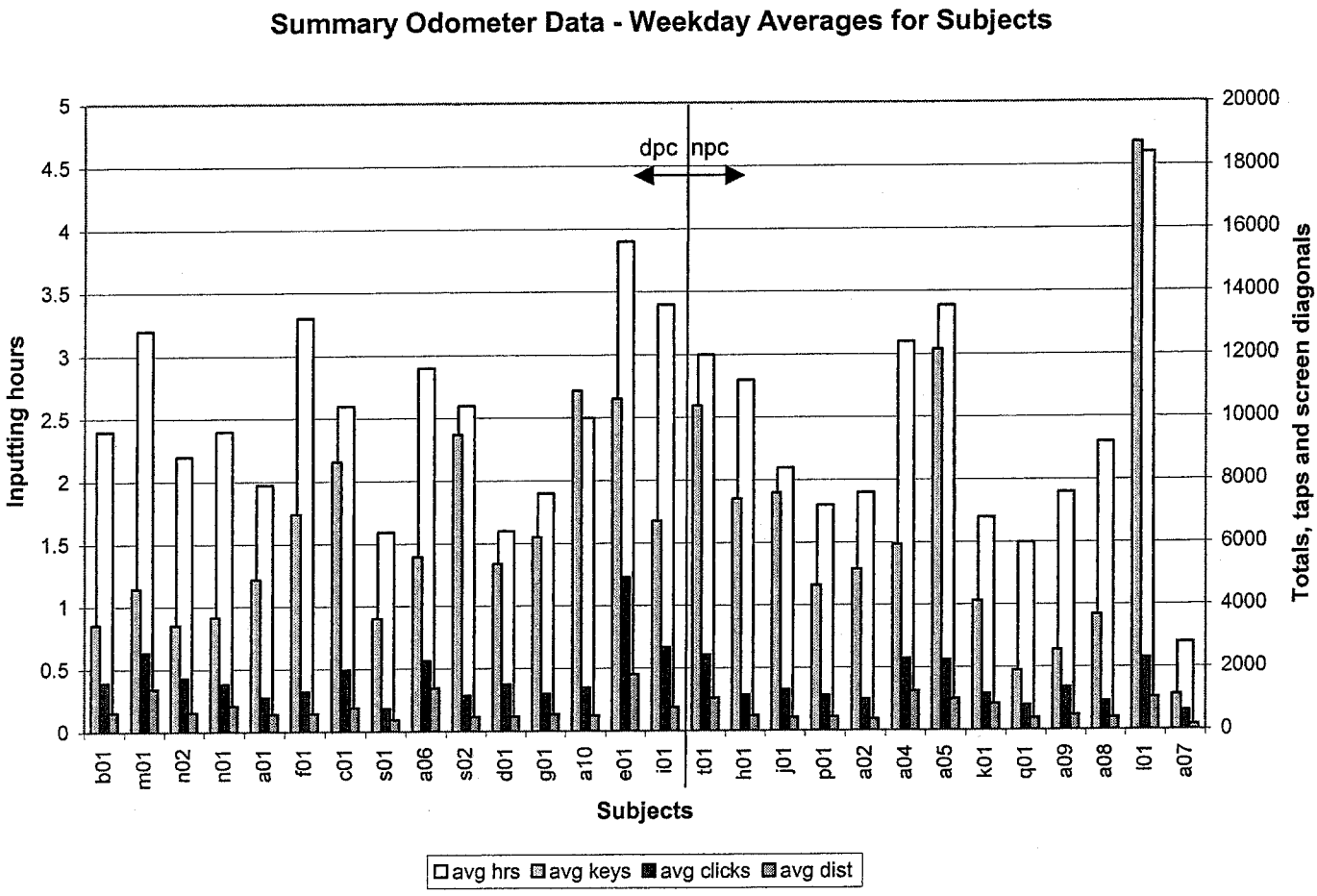


Figure 8. Comparison of daily computer use, from odometer and self-report via questionnaire.

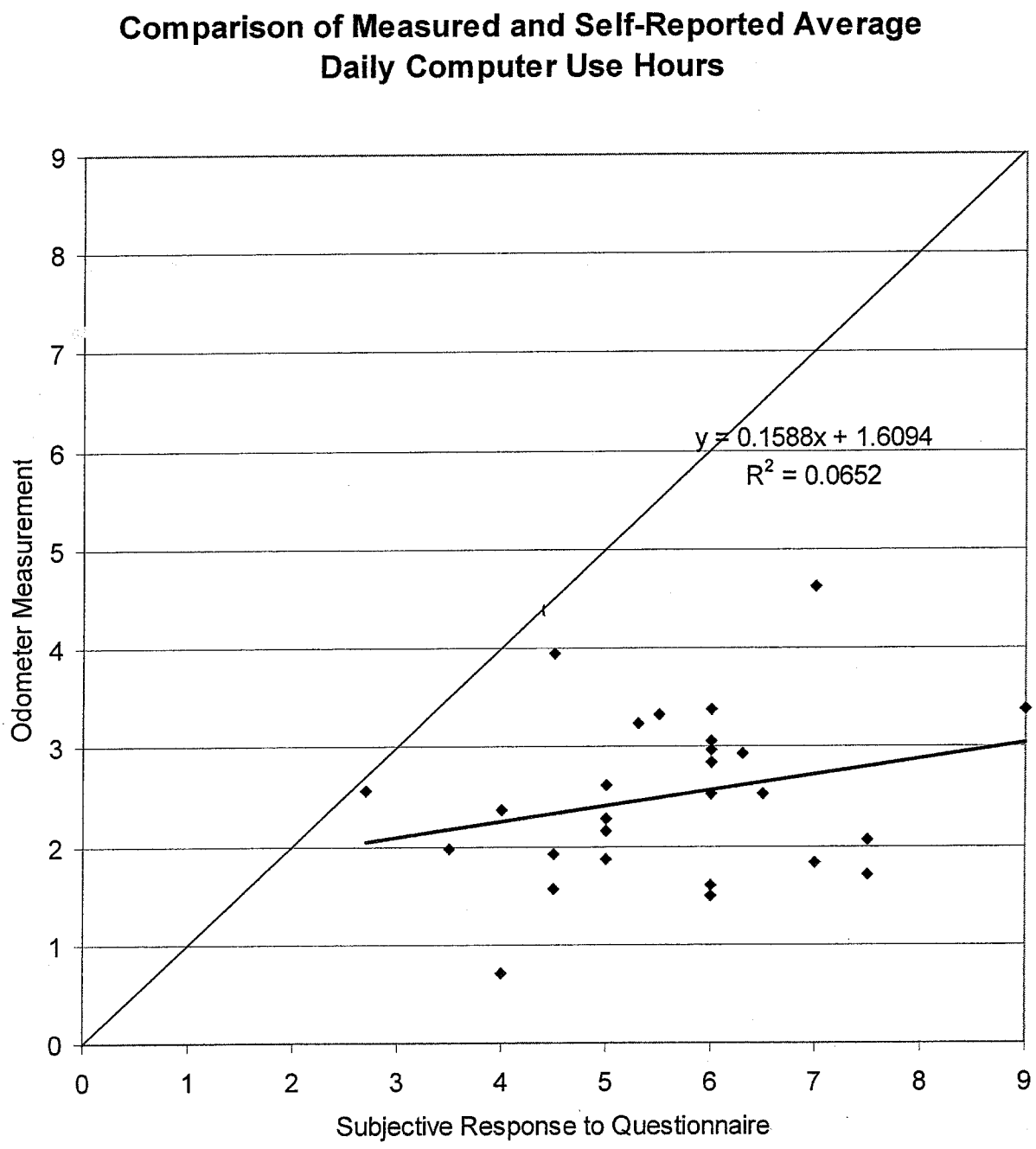


Figure 9. A summary of daily keystrike data for each subject (mean, median, minimum and maximum). Mean and median values are displayed as either end of the box, where a black box indicates the mean exceeds the median and a white box indicates the median exceeds the mean. (Note that there are 28 entries, because one subject provided data from his desktop (primary) and his notebook (secondary) computers and these are treated as separate data sets.).

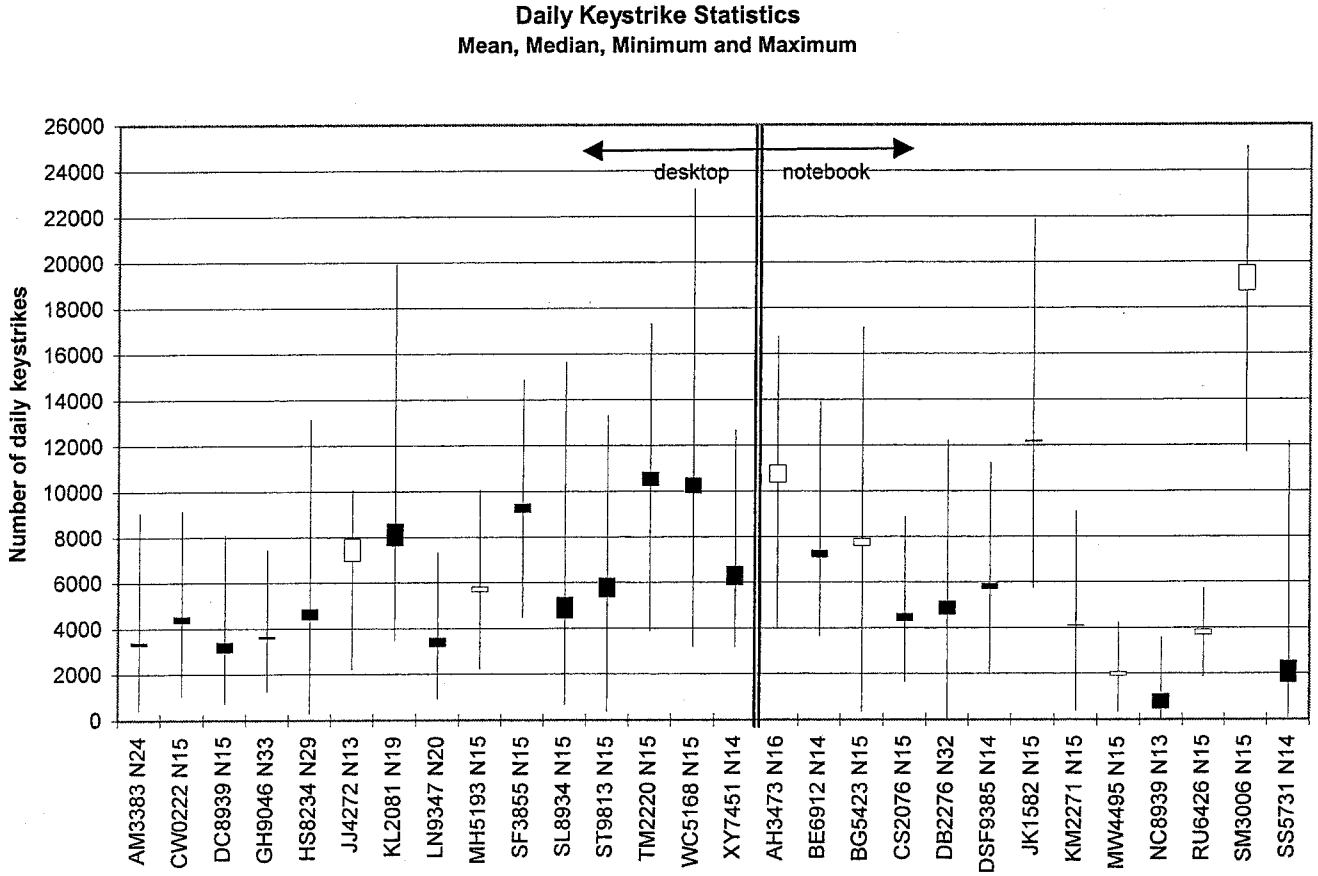


Figure 10. Day-to-day variation in input to the computer for one DPC participant.

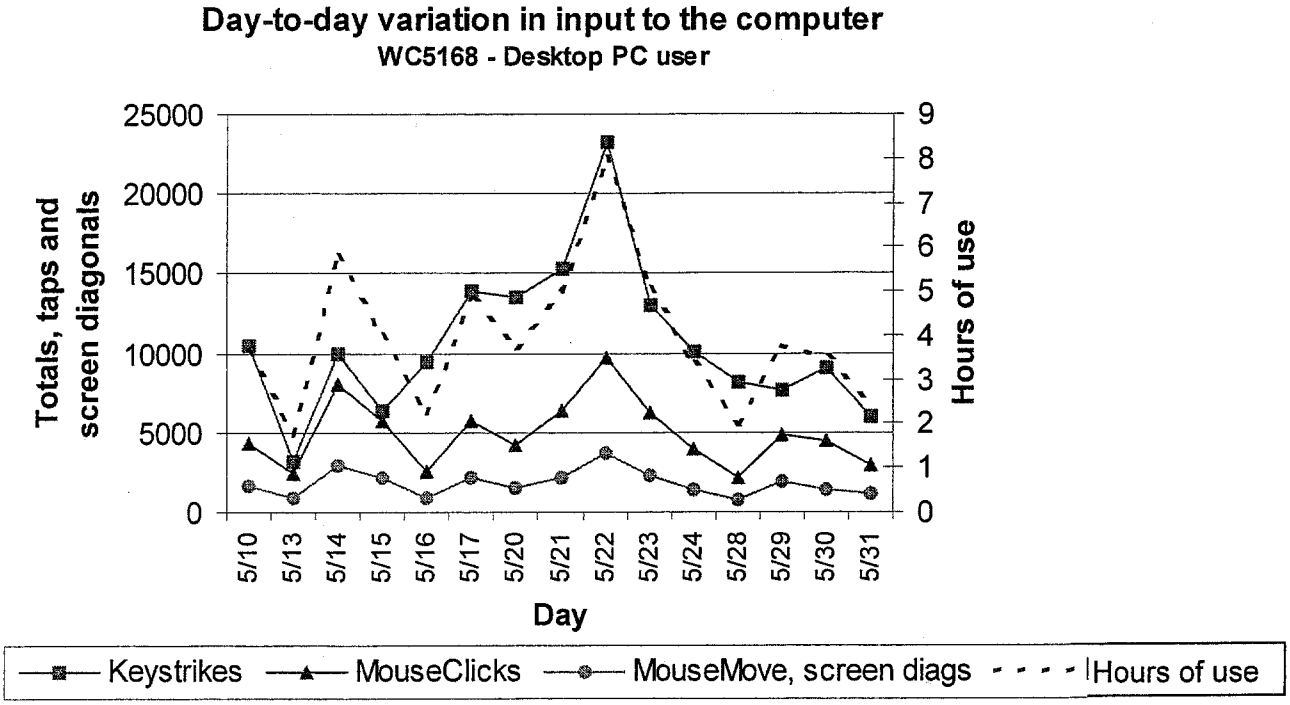


Figure 11. The same subject's data that is depicted in Figure 10 is shown in this figure as a percentage of the hours worked on each day. In this figure, total hours of use are graphed (as in Figure 10), as well as the constituent parts (time spent keying, time spent mousing, and time intervals spent alternating between keying and mousing).

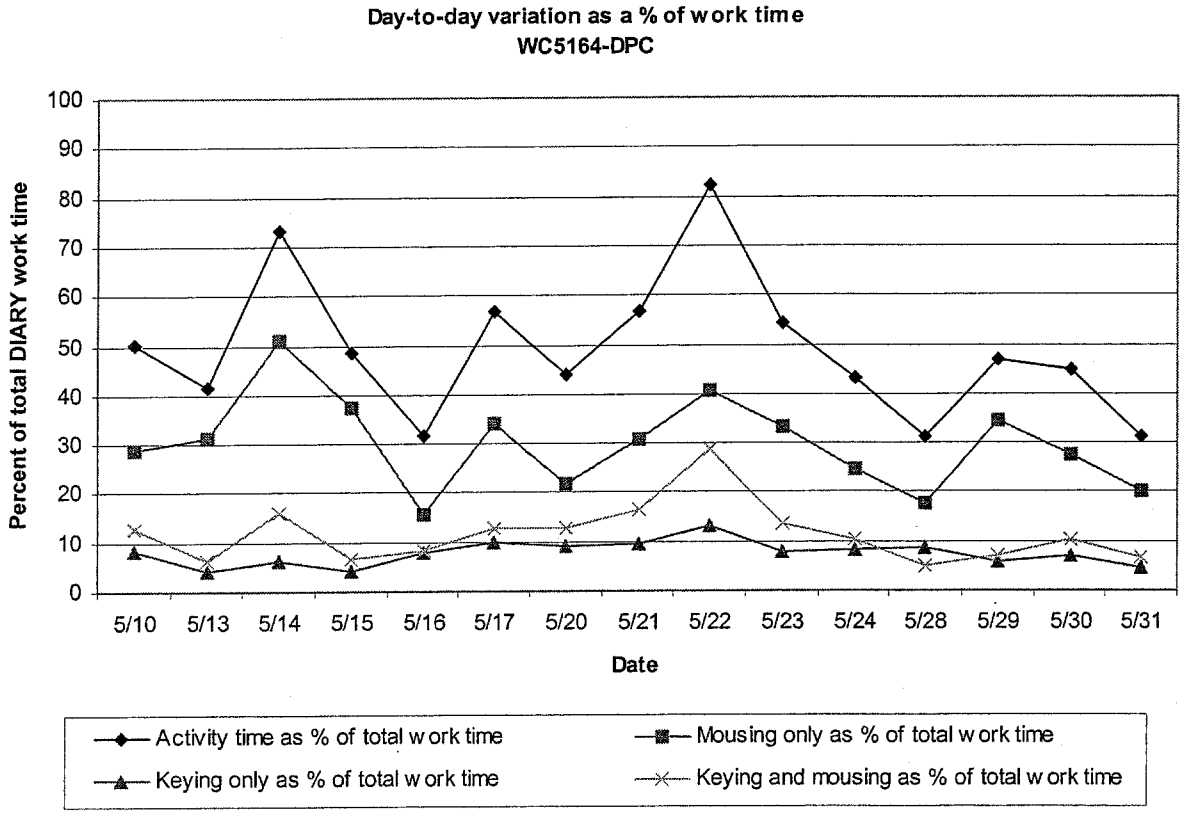
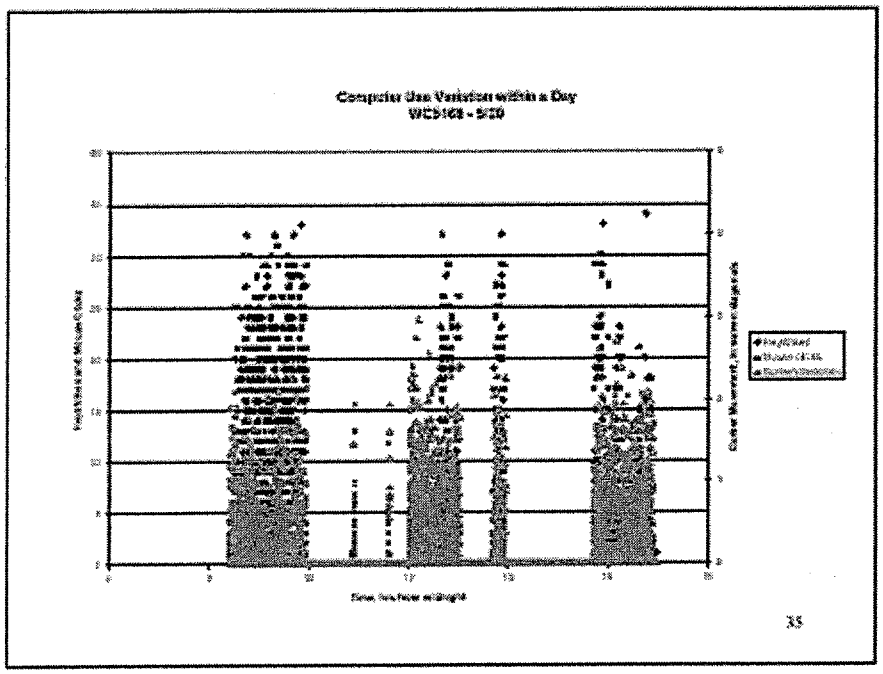


Figure 12. These two figures show patterns of inputting activity and breaks from inputting activity on two different days, for the same subject. It is not necessary to see the details of the graphs – the figures are only meant to convey the impressions of the break and activity patterns and how the odometer data reveals differences in these patterns from one day to the next, and within a day. The x-axis runs from 6 to 18 hrs (on a 24 hour clock).



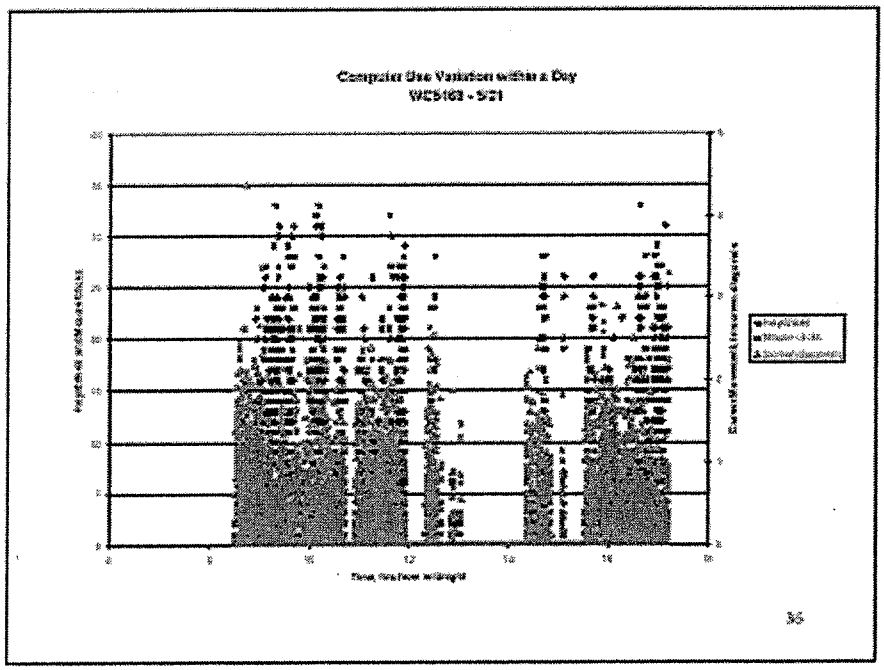
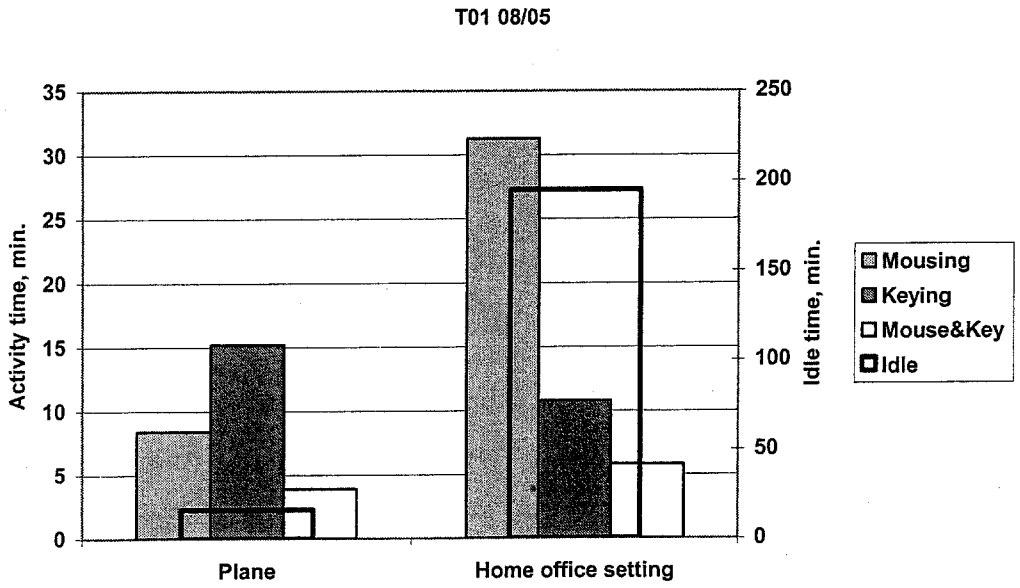


Figure 13. The two graphs on this page and the one on the next represent three successive work days for the same NPC participant. They illustrate how usage patterns vary with location, as well as the mobility of the subject within these three days.



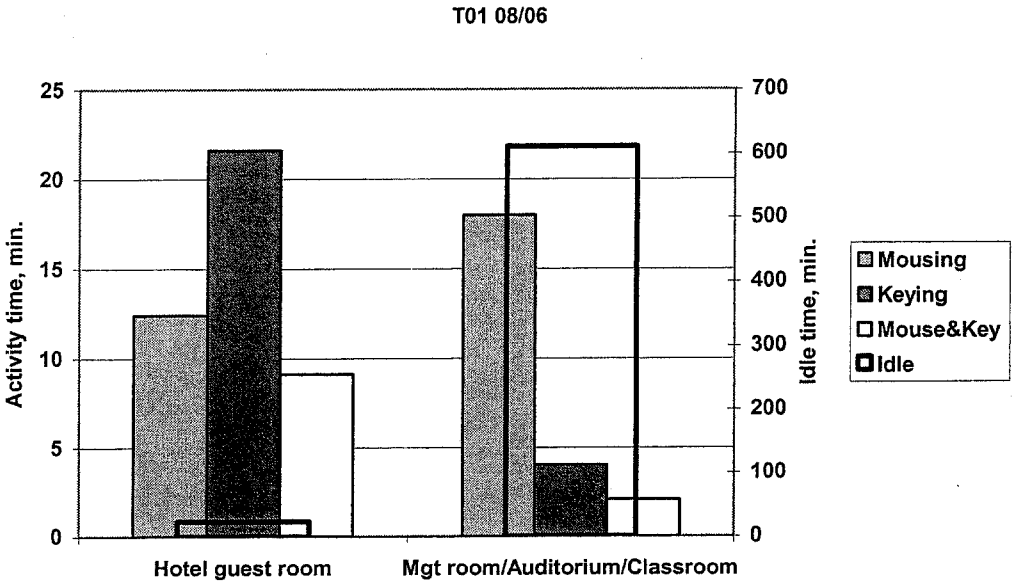



Figure 13, continued.

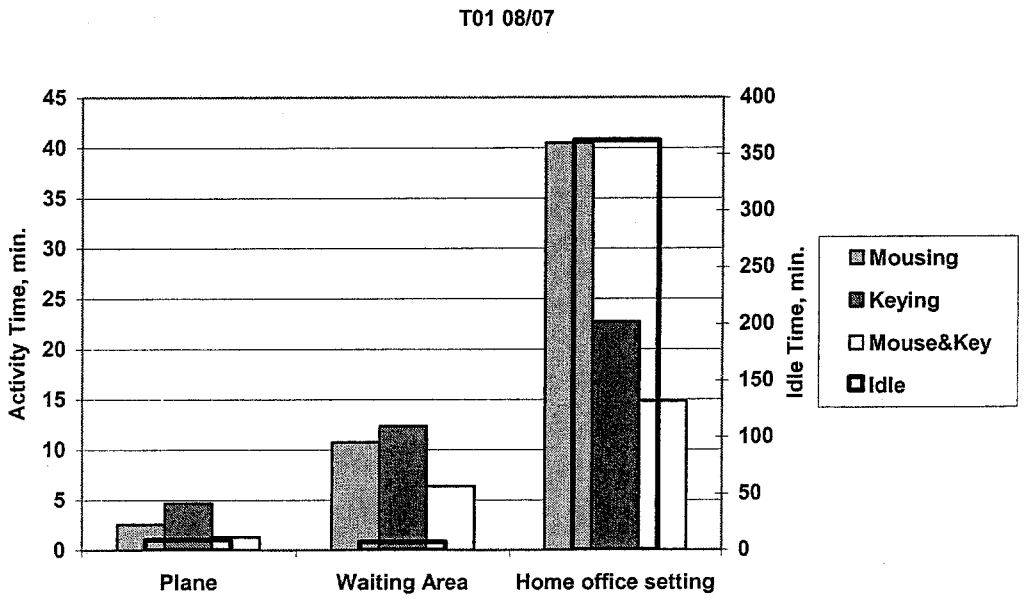


Figure 14. The comparison between a subject's responses to the question on the questionnaire concerning likelihood of using the computer during each 2-hr interval throughout the day (Q EST in the legend; left axis; maximum value is 4) and the likelihood of using the computer during each time interval based on the data measured directly from the subject's computer with the odometer software (ODO AVG in the legend; right axis; maximum value is 1).

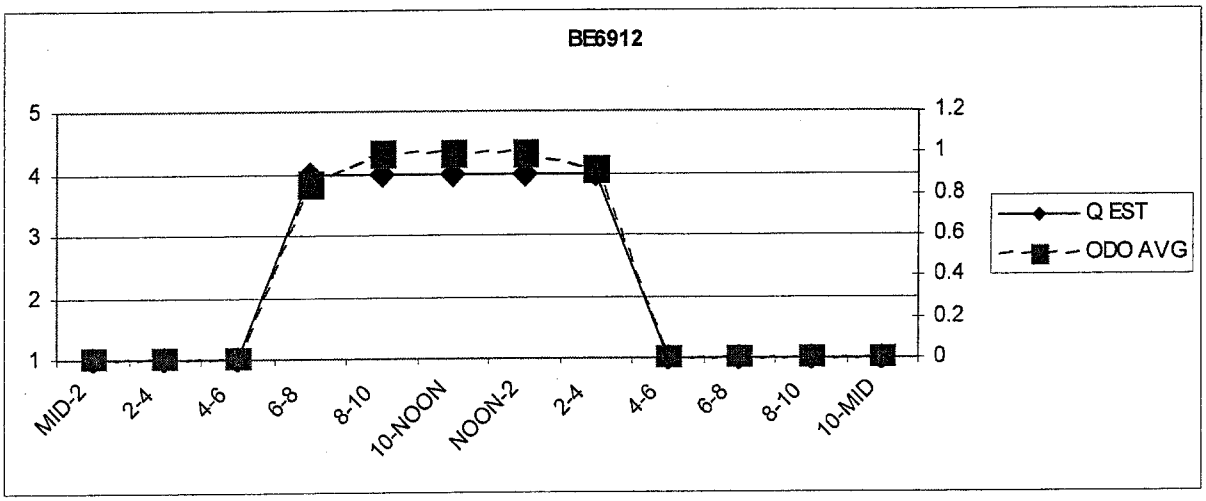
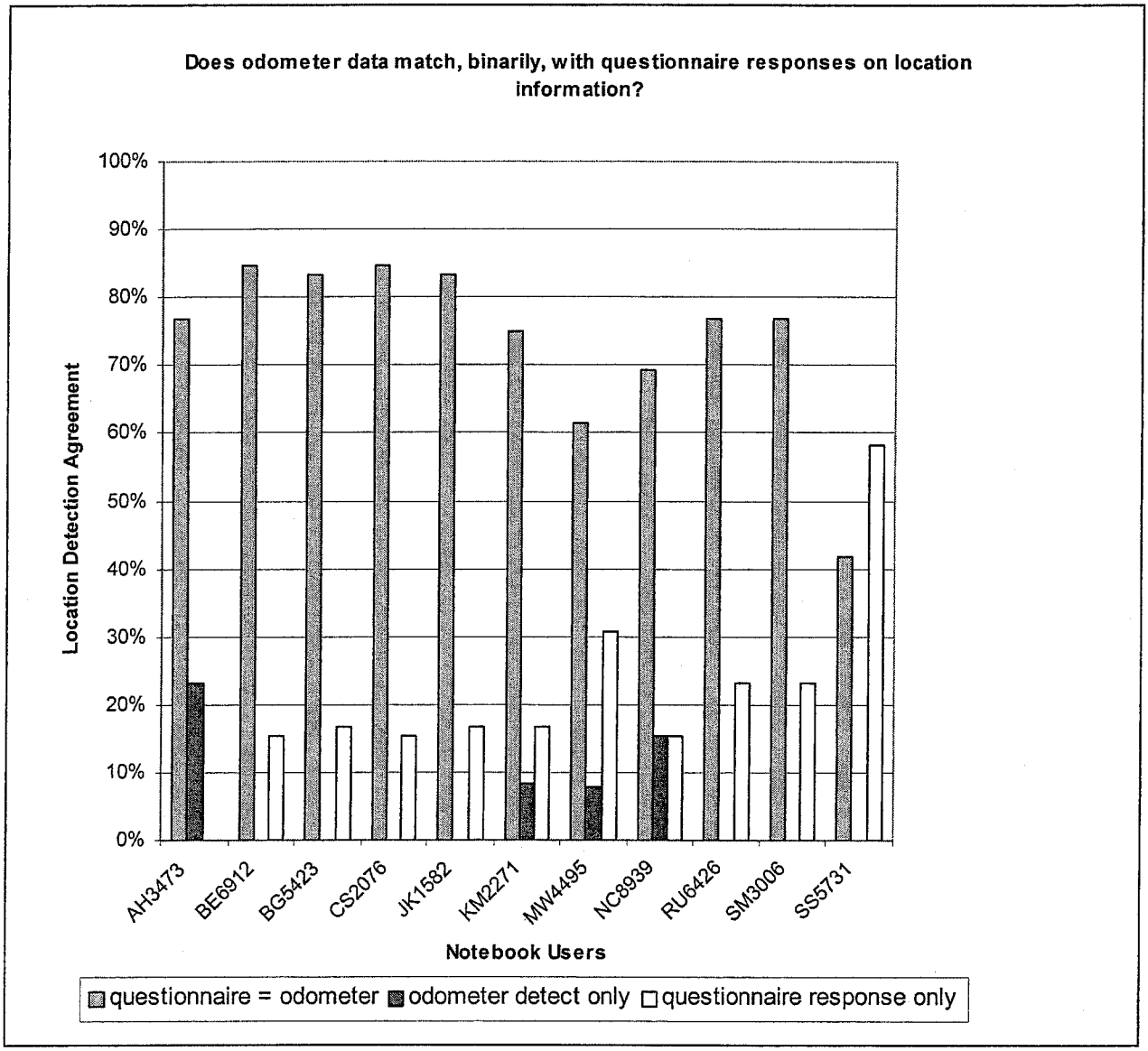


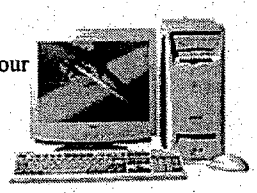
Figure 15. The graph compares the list of locations provided by the participants via the questionnaire with the locations recorded during Phase 2 by the odometer software.



## Appendix A. Questionnaire, Parts 1, 2, 3, 4, and 5.

# Part 1. Desktop Computer (page 1 of 1)

**Please tell us about the desktop computer you use for work...**



+ For multiple choice questions, please choose the answer or answers that come closest to describing you or your situation.

+ Please try to answer all the questions presented to you. Your answers are confidential and will be closely guarded.

**Please take note!** Notebook computers (in docking stations or configured in any other way) should not be described with this part of the questionnaire. You should describe notebook computer(s) you use for work by completing Part 2 this questionnaire, rather than this part.

**The first five questions ask you to describe computer hardware. Make and model information is typically written on the front of the computer and on the tops or undersides of keyboards and pointing devices. If you do not know or cannot find information on a particular item, type a question mark in place of the information.**

**1.** Provide information on the **Desktop** computer you use for work: Make, Model (if known), and Operating System (for example: Gateway, P5-120, Windows 3.1).

Make, Model, Operating System

**2.** Describe the size of your computer monitor's viewing screen. **Don't guess!** You can use a standard 8.5" x 11" sheet of paper to answer this question (in the USA, notebook paper and business letter paper is this size). **Turn the paper** so that you compare the longer side of the paper to the bigger dimension of the computer screen (probably the screen's width), and the shorter side of the paper to the smaller dimension of the screen (probably the screen's height).

- Which statement best describes the size of the viewing screen? Is the screen...

○ Smaller than a standard 8.5" x 11" sheet of paper
○ About the same size as a standard 8.5" x 11" sheet of paper
○ Larger than a standard 8.5" x 11" sheet of paper
○ Not sure (not near that computer right now; no paper nearby; etc.)

**3.** Is the monitor design a CRT (boxy in shape and fairly heavy) or an LCD (a flat panel display - thin)?

○ CRT monitor ○ Flat panel display ○ Not sure

**4.** Describe the keyboard of the desktop computer you use for work. Standard style refers to one that is similar to a typewriter, with keys arranged in straight, flat rows. Alternative style refers to one with keys in rows that are adjustable, split, curved, or tented, such as the Kinesis, Microsoft Natural, or others.

- Which style is the keyboard of your desktop computer?

○ Standard style keyboard
○ Alternative style keyboard
○ Not sure

**5.** What type of pointing devices do you use with the desktop computer (mouse, trackball, touch pad, TrackPoint, etc.)? If possible, provide make and model information. If you do not use a pointing device, type "none" in the first blank (no quotation marks).

Type of device, Make, Model
Type of device, Make, Model
Type of device, Make, Model

**6.** What kinds of software applications do you use for work on the desktop computer? Mark all that apply.

☐ Word processing
☐ Database management
☐ Internet / World Wide Web access
☐ Company Intranet
☐ Email
☐ Simulation
☐ Spreadsheet
☐ Data analysis
☐ Computer program development
☐ CAD/CAM
☐ Web page design
☐ Graphics
☐ Time management
☐ Voice recognition / voice activated

☐ Presentation ☐ Others (please list in next question)

**7.** If there are other kinds of software applications that you use that were not listed in the previous question, please list them here.

**8.** How much did you influence the selection of the desktop computer you are using for work? Mark all that apply.

☐ I chose a desktop computer instead of a notebook computer.
☐ I chose this desktop computer over other desktop models.
☐ I wanted a notebook computer, but was given this desktop computer instead.
☐ I wanted a different desktop computer, but was given this one instead.
☐ Nobody asked my preference in the matter.
☐ I purchased and currently own the desktop computer that I use for work.
☐ None of these apply to my situation.

**9.** Does anyone other than you use this desktop computer?

○ Never ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**10.** In addition to the desktop computer, do you also use a notebook computer for work?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 12]
○ Yes [Go to question 11]

**11.** If you use both notebook and desktop style computers for work, which do you use the most?

○ Notebook
○ Desktop
○ Used equally

**12.** Have you used a desktop computer in your current job, from the time you began the job?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 13]
○ Yes [Go to question 14]

**13.** If "no", when did you start using a desktop computer for this job? Was it within the:

○ last 6 months
○ last 12 months
○ last 2 years
○ last 5 years
○ last 10 years
○ or, longer

**14.** On average, how many days per month do you use a desktop computer for work?

○ Every day that I work (or just about)
○ At least 3/4 of all work days
○ At least 1/2 of all work days
○ At least 1/4 of all work days
○ Only a few work days (1-4 days)

**15.** Do you use a desktop computer for work each week that you work?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ Yes [Go to question 16]
○ Just about each week [Go to question 16]
○ No [Go to question 17]

**16.** If "Yes" or "Just about each week", then how often do you use a desktop computer for work in a typical work week?

- Every day that I work
- Most work days
- At least once during the week

**17.** During typical work days, how much time do you spend using a desktop computer for work? Do not include the time that it is turned on, but you are not actually using it.

- If your usage varies from day to day, provide the range of hours that you typically use the computer for work; otherwise, enter a single value. (For example: for a schedule that varies, you might enter " 3.5 - 5" hours/day; for usage that is pretty steady, you might enter "4.5" hours/day.)

Usage, in hours/day: _____

**18.** On days that you use the desktop computer for work, how likely are you to use it for work within each of the time periods listed below?

| | Not likely | Somewhat likely | Pretty likely | Very likely |
|---|---|---|---|---|
| 12 midnight - 2 a.m. | ○ | ○ | ○ | ○ |
| 2-4 a.m. | ○ | ○ | ○ | ○ |
| 4-6 a.m. | ○ | ○ | ○ | ○ |
| 6-8 a.m. | ○ | ○ | ○ | ○ |
| 8-10 a.m. | ○ | ○ | ○ | ○ |
| 10 a.m. - 12 noon | ○ | ○ | ○ | ○ |
| 12 noon - 2 p.m. | ○ | ○ | ○ | ○ |
| 2-4 p.m. | ○ | ○ | ○ | ○ |
| 4-6 p.m. | ○ | ○ | ○ | ○ |
| 6-8 p.m. | ○ | ○ | ○ | ○ |
| 8-10 p.m. | ○ | ○ | ○ | ○ |
| 10 p.m. - 12 midnight | ○ | ○ | ○ | ○ |

**19.** Does your work-related use of the desktop computer increase or decrease in a predictable way by any of the following? Mark all that apply.

- ☐ Yes, particular work day of the week
- ☐ Yes, particular work day of the month
- ☐ Yes, particular week of the month
- ☐ Yes, particular month
- ☐ Yes, particular season or quarter
- ☐ No, my use increases or decreases unpredictably.
- ☐ No, my use does not increase or decrease in any of these ways.

**20.** How frequently do you encounter problems when using your desktop computer for work?

| | Not Applicable | Never | Rarely | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|---|---|
| Hardware problems | ○ | ○ | ○ | ○ | ○ | ○ |
| Software problems | ○ | ○ | ○ | ○ | ○ | ○ |
| Network problems | ○ | ○ | ○ | ○ | ○ | ○ |

**21.** Where do you seek help to solve desktop computer-related problems you encounter on the job? Mark all that apply.

- ☐ Fix them myself
- ☐ Contact my employer's official technical support provider
- ☐ Ask knowledgeable co-worker
- ☐ Contact manufacturer's technical support
- ☐ Other (list below)

**22.** If you checked "Other" in the previous question, please list the other sources from which you seek help to solve desktop computer-related problems you encounter on the job.

Other sources of help: _____

**23.** Would you like to be able to solve more of these problems yourself?

○ No ○ Yes

**24.** Too much of my work must be done using a desktop computer.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**25.** I would not be nearly so productive without the use of a desktop computer.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**26.** This desktop computer meets all of my computing needs for work.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**27.** When using the desktop computer, I find myself assuming awkward, uncomfortable, or "poor" postures.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**28.** When using the desktop computer, or after using it, how often do you experience any physical discomfort (such as stiffness, soreness, aching, numbness, tingling, pain, etc.) in the areas listed below?

| | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|
| Right hand or wrist | ○ | ○ | ○ | ○ | ○ |
| Left hand or wrist | ○ | ○ | ○ | ○ | ○ |
| Right forearm or elbow | ○ | ○ | ○ | ○ | ○ |
| Left forearm or elbow | ○ | ○ | ○ | ○ | ○ |
| Right shoulder | ○ | ○ | ○ | ○ | ○ |
| Left shoulder | ○ | ○ | ○ | ○ | ○ |
| Neck | ○ | ○ | ○ | ○ | ○ |
| Upper back | ○ | ○ | ○ | ○ | ○ |
| Lower back | ○ | ○ | ○ | ○ | ○ |
| Buttocks | ○ | ○ | ○ | ○ | ○ |
| Legs or feet | ○ | ○ | ○ | ○ | ○ |
| Eyes (burn, itch, dry, sore, etc.) | ○ | ○ | ○ | ○ | ○ |
| Headache | ○ | ○ | ○ | ○ | ○ |

**29.** Tasks I perform with the desktop computer require extensive use of the keyboard.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**30.** Tasks I perform with the desktop computer require extensive use of a pointing device (mouse or other device).

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**31.** Tasks I perform with the desktop computer require extensive reading from or focussing on the computer screen.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**32.** How often do you use the desktop computer to take notes or messages instead of writing them by hand?

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**33.** When working at the desktop computer, how often do you sit continuously ...

| | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|
| ...for more than 30 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 60 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 90 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 120 minutes | ○ | ○ | ○ | ○ | ○ |

**34.** When looking at paper documents while working at the desktop computer, how often do you use a copy stand or document holder?

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**35.** Where do you work with this desktop computer? Mark all that apply.

☐ One of my employer's primary facilities
☐ Vendor or client facility
☐ Home office
☐ Other location (describe in the next question)

**36.** If there are other locations where you work with your desktop computer that were not listed in the previous question, please list them here.

Other locations: _____

- **In answering the last six questions, consider your preferences and your comfort while using the desktop computer...**

**37.** Do you most often feel that the **height of the keyboard** is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**38.** Do you most often feel that the **height of your chair** (or whatever you are sitting on) is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**39.** Do you most often feel that the **depth of the surface your computer monitor is sitting on** (the surface may be a desktop, a tabletop, or something else) is ...

○ Much too shallow ○ Too shallow ○ Just about right ○ Too deep ○ Much too deep

**40.** Do you most often feel that the **height of the computer's viewing screen** is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**41.** Do you most often feel that the **distance from your eyes to the computer's viewing screen** is ...

○ Much too near ○ Too near ○ Just about right ○ Too far ○ Much too far

**42.** Do you most often feel that the **lighting around you** is ...

○ Much too dim ○ Too dim ○ Just about right ○ Too bright ○ Much too bright

**43. You have reached the end of Part 1.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to submit your responses.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

**Thank you for completing Part 1 of the questionnaire! Please submit your responses, using the button below.**

Submit responses

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# Part 2. Notebook Computer (page 1 of 2)

**Please tell us about the notebook computer you use for work...**

**This part of the questionnaire has 2 pages. Please complete the second page immediately after you finish this first page. The second page is not accessible except through this page.**

+ For multiple choice questions, please choose the answer or answers that come closest to describing you or your situation.

+ Please try to answer all the questions that are presented to you. Your answers are confidential and will be closely guarded.

**The first seven questions ask you to describe computer hardware. Make and model information is typically written on the undersides of external keyboards and pointing devices; on notebook computers, information may be on the cover, the underside, or inside around the keyboard or screen. If you do not know or cannot find information on a particular item, type a question mark in place of the information.**

**1.** Provide information on the **Notebook** computer you use for work: Make, Model (if known), and Operating System (for example: IBM, ThinkPad 770, Windows 95).

Make, Model, Operating System: _____

**2.** Describe the size of the viewing screen that is built into your notebook computer. **Don't guess.** You can use a standard 8.5" x 11" sheet of paper to answer this question (in the USA, notebook paper and business letter paper is this size). **Turn the paper** so that you compare the longer side of the paper to the bigger dimension of the computer screen (probably the screen's width), and the shorter side of the paper to the smaller dimension of the screen (probably the screen's height).

- Which statement best describes the size of the built-in computer screen? Is it...

○ Smaller than a standard 8.5" x 11" sheet of paper
○ About the same size as a standard 8.5" x 11" sheet of paper
○ Larger than a standard 8.5" x 11" sheet of paper
○ Not sure (not near that computer right now; no paper nearby; etc.)

**3.** What type of **built-in** pointing device does your notebook computer have?

☐ trackball
☐ pointing stick / TrackPoint
☐ touch pad

**4.** What **external** pointing devices do you use with the notebook computer (mouse, trackball, touch pad, TrackPoint, etc.)? If possible, provide make and model information, too. If you do not use an external pointing device, type "none" in the first blank (no quotation marks).

Type of device, Make, Model: _____
Type of device, Make, Model: _____
Type of device, Make, Model: _____

**5.** Of the total amount of time you spend working with your notebook computer, how much of that time are you using any **external** devices?

| | No time | A little time | Some time | A lot of time | Almost all the time |
|---|---|---|---|---|---|
| External pointing device (mouse or other) | ○ | ○ | ○ | ○ | ○ |
| CRT monitor (traditional style of monitor; boxy and heavy) | ○ | ○ | ○ | ○ | ○ |
| External flat panel display (newer style; thin) | ○ | ○ | ○ | ○ | ○ |
| Standard external keyboard (keys in straight, flat rows) | ○ | ○ | ○ | ○ | ○ |
| Alternative external keyboard (keys in rows that are adjustable, split, curved, or tented, such as the Kinesis, Microsoft Natural, or others) | ○ | ○ | ○ | ○ | ○ |
| Docking station or port replicator | ○ | ○ | ○ | ○ | ○ |
| Other (describe in next question) | ○ | ○ | ○ | ○ | ○ |

**6.** If there are other external devices that you use with your notebook computer, please list them here.

Other external devices

7. When working with your notebook computer, where do you use external devices?

- **First**, mark the locations in which you work with your notebook computer, and then mark any external devices you use in those locations.

| **Primary Work Location Outside Of My Home** | **Home** | **Hotel Guest Room** | **Other Locations** |
|---|---|---|---|
| External pointing device | External pointing device | External pointing device | External pointing device |
| CRT monitor | CRT monitor | CRT monitor | CRT monitor |
| External flat panel display | External flat panel display | External flat panel display | External flat panel display |
| Standard external keyboard | Standard external keyboard | Standard external keyboard | Standard external keyboard |
| Alternative external keyboard | Alternative external keyboard | Alternative external keyboard | Alternative external keyboard |
| Docking station or port replicator | Docking station or port replicator | Docking station or port replicator | Docking station or port replicator |
| Other devices | Other devices | Other devices | Other devices |

8. What kinds of software applications do you use for work on the notebook computer? Mark all that apply.

- Word processing
- Database management
- Internet /World Wide Web access
- Company Intranet
- Email
- Simulation
- Spreadsheet
- Presentation
- Data analysis
- Computer program development
- CAD/CAM
- Web page design
- Graphics
- Time management
- Voice recognition / voice activated
- Others (please list in next question)

9. If there are other kinds of software applications that you use that were not listed in the previous question, please list them here.

10. How much did you influence the selection of the notebook computer you are using for work? Mark any that apply.

- I chose a notebook computer instead of a desktop computer.
- I chose this notebook computer over other notebook models.
- I wanted a desktop computer, but was given this notebook computer instead.
- I wanted a different notebook computer, but was given this one instead.
- Nobody asked my preference in the matter.
- I purchased and currently own the notebook computer that I use for work.
- None of these apply to my situation.

11. Does anyone other than you use this notebook computer?

Never Occasionally Sometimes Fairly Often Very Often

12. In addition to the notebook computer, do you also use a desktop computer (PC, Mac, workstation, etc.) for work?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

No [Go to question 14]
Yes [Go to question 13]

13. If you use both notebook and desktop style computers for work, which do you use the most?

Notebook
Desktop
Used equally

14. Have you used a notebook computer in your current job, from the time you began the job?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

No [Go to question 15]

○ Yes [Go to question 16]

**15.** If "no", when did you start using a notebook computer for this job? Was it within the:

○ last 6 months
○ last 12 months
○ last 2 years
○ last 5 years
○ last 10 years
○ or, longer

**16.** In a typical month, during how many work days of the month do you use a notebook computer for work?

○ Every day that I work (or just about)
○ At least 3/4 of all work days
○ At least 1/2 of all work days
○ At least 1/4 of all work days
○ Only a few work days (1-4 days)

**17.** Do you use a notebook computer for work each week that you work?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ Yes [Go to question 18]
○ Just about each week [Go to question 18]
○ No [Go to question 19]

**18.** If "Yes" or "Just about each week", then how often do you use a notebook computer for work in a typical work week?

○ Every day that I work
○ Most work days
○ At least once during the week

**19.** On average, how much time do you spend using a notebook computer for work on the days that you use one? Do not include the time that it is turned on, but you are not actually using it.

- If your usage varies from day to day, provide the range of hours that you typically use the computer for work; otherwise, enter a single value. (For example: for a schedule that varies, you might enter " 3.5 - 5" hours/day; for usage that is pretty steady, you might enter "4.5" hours/day.)

Usage, in hours/day [_____]

**20.** On days that you use the notebook computer for work, how likely are you to use it for work within each of the time periods listed below?

| | Not likely | Somewhat likely | Pretty likely | Very likely |
|---|---|---|---|---|
| 12 midnight - 2 a.m. | ○ | ○ | ○ | ○ |
| 2-4 a.m. | ○ | ○ | ○ | ○ |
| 4-6 a.m. | ○ | ○ | ○ | ○ |
| 6-8 a.m. | ○ | ○ | ○ | ○ |
| 8-10 a.m. | ○ | ○ | ○ | ○ |
| 10 a.m. - 12 noon | ○ | ○ | ○ | ○ |
| 12 noon - 2 p.m. | ○ | ○ | ○ | ○ |
| 2-4 p.m. | ○ | ○ | ○ | ○ |
| 4-6 p.m. | ○ | ○ | ○ | ○ |
| 6-8 p.m. | ○ | ○ | ○ | ○ |
| 8-10 p.m. | ○ | ○ | ○ | ○ |
| 10 p.m. - 12 midnight | ○ | ○ | ○ | ○ |

**21.** Does your work-related use of the notebook computer increase or decrease in a predictable way by any of the following? Mark all that apply.

☐ Yes, particular work day of the week
☐ Yes, particular work day of the month
☐ Yes, particular week of the month
☐ Yes, particular month
☐ Yes, particular season or quarter
☐ No, my use increases or decreases unpredictably.

☐ No, my use does not increase or decrease in any of these ways.

**22.** How frequently do you encounter problems when using your notebook computer for work?

| | Not Applicable | Never | Rarely | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|---|---|
| Hardware problems | ○ | ○ | ○ | ○ | ○ | ○ |
| Software problems | ○ | ○ | ○ | ○ | ○ | ○ |
| Network problems | ○ | ○ | ○ | ○ | ○ | ○ |

**23.** Where do you seek help to solve notebook computer-related problems you encounter on the job? Mark all that apply.

☐ Fix them myself
☐ Contact my employer's official technical support provider
☐ Ask knowledgeable co-worker
☐ Contact manufacturer's technical support
☐ Other (list below)

**24.** If you checked "Other" in the previous question, please list the other sources from which you seek help to solve notebook computer-related problems you encounter on the job.

Other sources of help: _____

**25.** Would you like to be able to solve more of these problems yourself?

○ No ○ Yes

**26. You have reached the bottom of the first page of Part 2.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to continue on to the next page.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

Please continue on to the next page to complete Part 2

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# Part 2. Notebook Computer (page 2 of 2)

**Please complete Part 2 by answering the questions on this page.**

---

**27.** Too much of my work must be done using a notebook computer.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**28.** I would not be nearly so productive without the use of a notebook computer.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**29.** This notebook computer meets all of my computing needs for work.

○ Strongly Disagree ○ Disagree ○ Agree ○ Strongly Agree

**30.** When using the notebook computer, I find myself assuming awkward, uncomfortable, or "poor" postures.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**31.** When using the notebook computer, or after using it, how often do you experience any physical discomfort (such as stiffness, soreness, aching, numbness, tingling, pain, etc) in the areas listed below?

| | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|
| Right hand or wrist | ○ | ○ | ○ | ○ | ○ |
| Left hand or wrist | ○ | ○ | ○ | ○ | ○ |
| Right forearm or elbow | ○ | ○ | ○ | ○ | ○ |
| Left forearm or elbow | ○ | ○ | ○ | ○ | ○ |
| Right shoulder | ○ | ○ | ○ | ○ | ○ |
| Left shoulder | ○ | ○ | ○ | ○ | ○ |
| Neck | ○ | ○ | ○ | ○ | ○ |
| Upper back | ○ | ○ | ○ | ○ | ○ |
| Lower back | ○ | ○ | ○ | ○ | ○ |
| Buttocks | ○ | ○ | ○ | ○ | ○ |
| Legs or feet | ○ | ○ | ○ | ○ | ○ |
| Eyes (burn, itch, dry, sore, etc.) | ○ | ○ | ○ | ○ | ○ |
| Headache | ○ | ○ | ○ | ○ | ○ |

**32.** Considering various locations where you may work with your notebook computer, do you experience any physical discomfort when using, or after using, the notebook computer in any of those locations?

- **First**, mark the locations in which you work with your notebook computer, and **then** mark any body part in which discomfort occurs.

| ☐ **Primary Work Location Outside Of My Home** | ☐ **Home** | ☐ **Hotel Guest Room** | ☐ **Other Locations** |
|---|---|---|---|
| ☐ Hand | ☐ Hand | ☐ Hand | ☐ Hand |
| ☐ Wrist | ☐ Wrist | ☐ Wrist | ☐ Wrist |
| ☐ Forearm | ☐ Forearm | ☐ Forearm | ☐ Forearm |
| ☐ Elbow | ☐ Elbow | ☐ Elbow | ☐ Elbow |
| ☐ Shoulder | ☐ Shoulder | ☐ Shoulder | ☐ Shoulder |
| ☐ Neck | ☐ Neck | ☐ Neck | ☐ Neck |
| ☐ Upper back | ☐ Upper back | ☐ Upper back | ☐ Upper back |
| ☐ Lower back | ☐ Lower back | ☐ Lower back | ☐ Lower back |
| ☐ Buttocks | ☐ Buttocks | ☐ Buttocks | ☐ Buttocks |
| ☐ Legs or feet | ☐ Legs or feet | ☐ Legs or feet | ☐ Legs or feet |
| ☐ Eyes | ☐ Eyes | ☐ Eyes | ☐ Eyes |
| ☐ Headache | ☐ Headache | ☐ Headache | ☐ Headache |

**33.** Tasks I perform with the notebook computer require extensive use of the keyboard.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**34.** Tasks I perform with the notebook computer require extensive use of a pointing device (mouse or other device).

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**35.** Tasks I perform with the notebook computer require extensive reading from or focussing on the computer screen.

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**36.** How often do you use the notebook computer to take notes or messages instead of writing them by hand?

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**37.** When working at the notebook computer, how often do you sit continuously ...

| | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|
| ...for more than 30 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 60 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 90 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 120 minutes | ○ | ○ | ○ | ○ | ○ |

**38.** When looking at paper documents while working at the notebook computer, how often do you use a copy stand or document holder?

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**39.** How do you move or carry the notebook computer? Mark all that apply.

☐ in hand
☐ supported by one shoulder, using a shoulder strap or shoulder bag
☐ supported by both shoulders (backpack-style)
☐ using a rolling pull cart
☐ I don't move the notebook computer

**40.** During a typical day in which you use the notebook computer, how frequently do you carry the computer? Include transportation to and from home, if applicable.

○ 0 times ○ 1-2 times ○ 3-5 times ○ 6-9 times ○ 10 or more times

**41.** Do you experience any physical discomfort associated with moving or carrying your notebook computer. Mark any body regions in which discomfort occurs.

☐ Hand
☐ Wrist
☐ Forearm
☐ Elbow
☐ Shoulder
☐ Neck
☐ Upper back
☐ Lower back

**42.** Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent working in each of the following locations?

| | No time | A little time | Some time | A lot of time | Almost all the time |
|---|---|---|---|---|---|
| My office / cubicle at my employer's facility | ○ | ○ | ○ | ○ | ○ |
| My office / cubicle - offsite location (other than home) | ○ | ○ | ○ | ○ | ○ |
| Home office setting (at desk or table) | ○ | ○ | ○ | ○ | ○ |
| Home, but not office setting | ○ | ○ | ○ | ○ | ○ |
| Office of another person | ○ | ○ | ○ | ○ | ○ |
| Car | ○ | ○ | ○ | ○ | ○ |
| Train | ○ | ○ | ○ | ○ | ○ |
| Plane | ○ | ○ | ○ | ○ | ○ |
| Hotel guest room | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| Waiting areas | ○ | ○ | ○ | ○ | ○ |
| Meeting room, auditorium, classroom | ○ | ○ | ○ | ○ | ○ |
| Laboratory | ○ | ○ | ○ | ○ | ○ |
| Other (please list in next question) | ○ | ○ | ○ | ○ | ○ |

**43.** If there are locations where you work with the notebook computer that were not listed in the previous question, please list them here.

**44.** Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent with the notebook computer positioned on the surfaces listed below?

| | No time | A little time | Some time | A lot of time | Almost all the time |
|---|---|---|---|---|---|
| Desk | ○ | ○ | ○ | ○ | ○ |
| Desk-height table | ○ | ○ | ○ | ○ | ○ |
| Countertop or shelf | ○ | ○ | ○ | ○ | ○ |
| Your lap | ○ | ○ | ○ | ○ | ○ |
| A bench, seat, or low table | ○ | ○ | ○ | ○ | ○ |
| Bed | ○ | ○ | ○ | ○ | ○ |
| Floor | ○ | ○ | ○ | ○ | ○ |
| In your hand | ○ | ○ | ○ | ○ | ○ |
| Other (please list in next question) | ○ | ○ | ○ | ○ | ○ |

**45.** If there are places where you place the notebook computer when you work with it that were not listed in the previous question, please list them here.

**46.** Of the total amount of time you spend performing work with the notebook computer, how much of that time do you spend in the postures listed below?

| | No time | A little time | Some time | A lot of time | Almost all the time |
|---|---|---|---|---|---|
| Sitting on a chair | ○ | ○ | ○ | ○ | ○ |
| Sitting on a bed | ○ | ○ | ○ | ○ | ○ |
| Sitting on the floor | ○ | ○ | ○ | ○ | ○ |
| Sitting on a stool or bench | ○ | ○ | ○ | ○ | ○ |
| Sitting on a couch | ○ | ○ | ○ | ○ | ○ |
| Standing upright | ○ | ○ | ○ | ○ | ○ |
| Standing while leaning / bending | ○ | ○ | ○ | ○ | ○ |
| Kneeling or squatting | ○ | ○ | ○ | ○ | ○ |
| Lying down | ○ | ○ | ○ | ○ | ○ |
| Other (please list in next question) | ○ | ○ | ○ | ○ | ○ |

**47.** If there are postures you assume while performing work with the notebook computer that were not listed in the previous question, please list them here.

- **In answering the last six questions, consider your preferences and your comfort while using the notebook computer...**

**48.** Do you most often feel that the **height of the keyboard** you are using is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**49.** Do you most often feel that the **height of your chair** (or whatever you are sitting on) is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**50.** Do you most often feel that the **depth of the surface your computer is sitting on** (the surface may be a desktop, a tabletop, your lap, or something else) is ...

○ Much too shallow ○ Too shallow ○ Just about right ○ Too deep ○ Much too deep

**51.** Do you most often feel that the **height of the viewing screen** you are using is ...

○ Much too low ○ Too low ○ Just about right ○ Too high ○ Much too high

**52.** Do you most often feel that the **distance from your eyes to the viewing screen** you are using is ...

○ Much too near ○ Too near ○ Just about right ○ Too far ○ Much too far

**53.** Do you most often feel that the **lighting around you** is ...

○ Much too dim ○ Too dim ○ Just about right ○ Too bright ○ Much too bright

**54. You have reached the end of Part 2.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to submit your responses.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

**Thank you for completing Part 2 of the questionnaire! Please submit your responses, using the button below.**

Submit responses

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# Part 3. About your work (this is page 1 of 2)

**In this part of the questionnaire, you will be asked about various aspects of your "Study Invitation Job". This is the job through which you were invited to participate in this study. In making your responses, think about all aspects of your work, not just those aspects related to your use of computers.**

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**This part of the questionnaire has 2 pages. Please complete the second page immediately after you finish this first page. The second page is not accessible except through this page.**

---

+ For multiple choice questions, please choose the answer or answers that come closest to describing you or your situation.

+ Please try to answer all the questions that are presented to you. Your answers are confidential and will be closely guarded.

---

**1.** What business is your company or employer in? Please be specific.

Employer's business

**2.** How many employees does your employer have working at the location or facility where you work?

- less than 100 employees
- 100 - 1,000 employees
- more than 1,000 employees

**3.** How many employees does your employer have working at its other locations or facilities (that is, how many employees work for your employer, but at a different location from where you work)?

- less than 100 employees
- 100 - 1,000 employees
- more than 1,000 employees
- I work at my employer's only facility or location

**4.** What is your current job title and/or classification? Please be specific.

Job Title:

**5.** Please describe what you do in your job, by listing what you consider to be your three or four primary responsibilities or functions.

a)
b)
c)
d)

**6.** How many people do you supervise?

**7.** How long have you worked in your current job? (For example: 3 years and 2 months)

Years
and Months

**8.** How long have you worked for this company or employer? (For example: 4 years and 11 months)

Years
and Months

**9.** Which best describes you?

- full-time, permanent employee
- full-time, non-permanent employee
- part-time, permanent employee
- part-time, non-permanent employee
- self-employed

**10.** How are you paid for your work for this company? Mark all that apply.

- ☐ salary
- ☐ commission
- ☐ hourly wage
- ☐ piecework
- ☐ incentive

**11.** Based on average number of hours per week, do you consider this job your primary job (of the jobs for which you are paid)?

- ○ This is my only job for pay.
- ○ I spend more time on this job, than on my other for-pay job(s).
- ○ I spend less time on this job, than on my other for-pay job(s).

**12.** What percentage of your job involves travel requiring nights spent away from home?

% _____

**13.** What percentage of your job involves local travel or other trips that do not require nights spent away from home?

% _____

**14.** On average, in your current job how many **days per week** do you work?

- If your schedule varies from week to week, provide the range of days that you typically work; otherwise, enter a single value. (For example: for a schedule that varies you might enter "5-6" days/week; for a schedule that is pretty steady, you might enter "4" days/week.)

Days per week: _____

**15.** On average, in your current job how many **hours per week** do you work?

- If your schedule varies from week to week, provide the range of hours that you typically work; otherwise, enter a single value. (For example: for a schedule that varies you might enter "35-45" hours/week; for a schedule that is pretty steady, you might enter "38" hours/week.)

Hours per week: _____

**16.** On average, in your current job how many **hours per day** do you work during work days?

- If your schedule varies from day to day, provide the range of hours that you typically work; otherwise, enter a single value. (For example: for a schedule that varies you might enter "7.5-10" hours/day; for a schedule that is pretty steady, you might enter "8.2" hours/day.)

Hours per day: _____

**17.** On average, in your current job how many **hours each weekend** do you work?

- If your schedule varies from weekend to weekend, provide the range of hours that you typically work; otherwise, enter a single value. (For example: for a schedule that varies you might enter "0-8" hours/weekend; for a schedule that is pretty steady, you might enter "4.4" hours/weekend.)

Hours per Weekend: _____

**18.** Which items below describe your experience with overtime at this company? Mark all that apply.

- In this study, overtime is defined as working more than 35-40 hours per week.

- ☐ I do not work any overtime.
- ☐ I work overtime because I want to.
- ☐ I work overtime because I feel I must to keep up with the workload.
- ☐ I work overtime because I am asked to or required to.

**19.** What kinds of breaks occur in your workday on most days? Mark all that apply.

- ☐ Very brief breaks (restroom, coffee, water, etc.)
- ☐ A 10 - 15 minute break in the first half of my work day
- ☐ A 10 - 15 minute break in the second half of my work day
- ☐ A mid-day break that is less than 30 minutes long
- ☐ A mid-day break that is at least 30 minutes long

**20.** Considering the various tasks you perform on your job, how often do you sit continuously ...

| | Never | Rarely | Sometimes | Quite Often | Almost Always |
|---|---|---|---|---|---|
| ...for more than 30 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 60 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 90 minutes | ○ | ○ | ○ | ○ | ○ |
| ...for more than 120 minutes | ○ | ○ | ○ | ○ | ○ |

**21.** Consider all the time you spend talking on the phone for work, which device do you use the most?

○ Handset/Receiver ○ Speakerphone ○ Headset/Headphones

**22.** How often do the following activities occur for you on this job?

| | Never | Rarely | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|---|
| Heavy lifting | ○ | ○ | ○ | ○ | ○ |
| Repetitive lifting | ○ | ○ | ○ | ○ | ○ |
| Forceful gripping or pinching | ○ | ○ | ○ | ○ | ○ |
| Repetitive gripping or pinching | ○ | ○ | ○ | ○ | ○ |
| Standing for long periods of time | ○ | ○ | ○ | ○ | ○ |
| Sitting for long periods of time (other than in a motor vehicle) | ○ | ○ | ○ | ○ | ○ |
| Sitting for long periods of time in a motor vehicle | ○ | ○ | ○ | ○ | ○ |

**23.** Considering the various tasks you perform on this job, how much of your working time do you spend in the postures listed below? (Some postures may only apply if you travel or work at home some of the time.)

| | No time | A little time | Some time | A lot of time | Almost all the time |
|---|---|---|---|---|---|
| Sitting on a chair | ○ | ○ | ○ | ○ | ○ |
| Sitting on a bed | ○ | ○ | ○ | ○ | ○ |
| Sitting on the floor | ○ | ○ | ○ | ○ | ○ |
| Sitting on a stool or bench | ○ | ○ | ○ | ○ | ○ |
| Sitting on a couch | ○ | ○ | ○ | ○ | ○ |
| Standing upright | ○ | ○ | ○ | ○ | ○ |
| Standing while leaning / bending | ○ | ○ | ○ | ○ | ○ |
| Kneeling or squatting | ○ | ○ | ○ | ○ | ○ |
| Lying down | ○ | ○ | ○ | ○ | ○ |
| Other (please list in next question) | ○ | ○ | ○ | ○ | ○ |

**24.** If there are postures you adopt while performing this job that were not listed in the previous question, please list them here. If none, leave blank.

Other postures

**25.** On most work days, what are the three heaviest items that you handle during the day? Consider items at work, as well as items you may bring from home such as your briefcase or other personal items.

Item
Item
Item

**26.** Does your workload increase or decrease in a predictable way by any of the following? Mark all that apply.

☐ Yes, particular work day of the week
☐ Yes, particular work day of the month
☐ Yes, particular week of the month
☐ Yes, particular month
☐ Yes, particular season or quarter
☐ No, my workload increases or decreases unpredictably.

☐ No, my workload does not increase or decrease in any of these ways.

**27.** How often do you have more than one week's worth of work piled up for you to do?

○ Never ○ Occasionally ○ Often ○ Always

**28.** How often do you feel pushed by deadlines?

○ Never ○ Occasionally ○ Often ○ Always

**29.** To what extent do you face a backlog of work in doing your own work?

○ None ○ A Little ○ Some ○ A Lot

**30.** To what extent do you face work deadlines in doing your own work?

○ None ○ A Little ○ Some ○ A Lot

**31.** To what extent do you face understaffing in doing your own work?

○ None ○ A Little ○ Some ○ A Lot

**32.** To what extent do you face production quotas or expected rates of performance in doing your own work?

○ None ○ A Little ○ Some ○ A Lot

**33.** How often does your job require your full attention?

○ Never ○ Occasionally ○ Often ○ Always

**34.** How much do you 'daydream' on the job?

○ None ○ A Little ○ Some ○ A Lot

**35.** To what extent does your work require you to pay extremely close attention?

○ None ○ A Little ○ Some ○ A Lot

**36.** If you stop concentrating for a moment, how likely are you to make an error?

○ None ○ A Little ○ Some ○ A Lot

**37.** How much influence do you have over the variety of tasks you perform?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**38.** How much influence do you have over the order in which you perform tasks at work?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**39.** How much influence do you have over the amount of work you do?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**40.** How much influence do you have over the pace of your work, that is how fast or slowly you work?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**41.** How much influence do you have over the quality of the work that you do?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**42.** How much influence do you have over the arrangement of and decoration of your work area?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**43.** How much influence do you have over the decisions concerning which individuals in your work unit do which tasks?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much
○ Not applicable - there are no other individuals in my work unit

**44.** How much influence do you have over the hours or schedule that you work?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**45.** How much influence do you have over the decisions as to when things will be done in your work unit?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**46.** How much influence do you have over the policies, procedures, and performance in your work unit?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**47.** How much influence do you have over the training of other workers in your work unit?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much
○ Not applicable - there are no other individuals in my work unit

**48.** How much influence do you have over the arrangement of furniture and other work equipment in your work unit?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**49.** To what extent can you do your work ahead and take a short rest break during work hours?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**50.** In general, how much influence do you have over work and work-related factors?

○ Very Little ○ Little ○ A Moderate Amount ○ Much ○ Very Much

**51. You have reached the bottom of the first page of Part 3.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to continue on to the next page.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

Continue on to the next page to complete Part 3

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# Part 3. About your work (page 2 of 2)

**Please complete Part 3 by answering the questions on this page.**

**52.** This question concerns your primary workstation. This is defined as the workstation at which you spend the most time for this job. To what extent are you bothered at your primary workstation by each of the following?

| | No problem | Occasionally bothersome | Often bothersome | Constantly bothersome |
|---|---|---|---|---|
| Lack of privacy in speaking (being overheard) | ○ | ○ | ○ | ○ |
| Lack of visual privacy (being in view) | ○ | ○ | ○ | ○ |
| Lack of working surface to lay out your work | ○ | ○ | ○ | ○ |
| Inconvenient arrangement of furniture or equipment | ○ | ○ | ○ | ○ |
| Lack of storage space | ○ | ○ | ○ | ○ |
| Unpleasant appearance/decor | ○ | ○ | ○ | ○ |
| Noise (conversation, office machines, ventilation system, etc) | ○ | ○ | ○ | ○ |
| People passing by your workstation (traffic) | ○ | ○ | ○ | ○ |
| Many people located near you (crowding) | ○ | ○ | ○ | ○ |
| People entering or using your workstation without permission | ○ | ○ | ○ | ○ |

**53.** Where is your primary workstation?

○ In my home
○ In a facility owned or leased by my employer
○ In a facility owned or leased by a client or supplier
○ In another location

**54.** Do you have a supervisor or boss in your current job?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 59]
○ Yes [Go to question 55]

**55.** How much does your immediate supervisor go out of his/her way to do things to make your life easier?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**56.** How easy is it to talk with your immediate supervisor?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**57.** How much can your immediate supervisor be relied on when things get tough at work?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**58.** How much would your immediate supervisor be willing to listen to your personal problems?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**59.** In your current job, do you have any co-workers (including subordinates, but excluding supervisors)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 64]
○ Yes [Go to question 60]

**60.** How much do people at work (other than your supervisor) go out of their way to do things to make your life easier?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**61.** How easy is it to talk with people at work (other than your supervisor)?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**62.** How much can people at work (other than your supervisor) be relied on when things get tough at work?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**63.** How much would people at work (other than your supervisor) be willing to listen to your personal problems?

○ Not at All ○ A Little ○ Somewhat ○ Very Much

**64.** How often are you clear on what your job responsibilities are?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**65.** How often can you predict what others will expect of you on the job?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**66.** How much of the time are your work objectives well-defined?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**67.** How often are you clear about what others expect of you on the job?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**68.** How often are you concerned or bothered about losing your job or being laid-off?

○ Never ○ Occasionally ○ Often ○ Always

**69.** What are the possibilities that in the next few years your job will be eliminated?

○ None ○ A Little ○ Some ○ A Lot

**70.** What are the possibilities that in the next few years your job will be given to someone else?

○ None ○ A Little ○ Some ○ A Lot

**71.** What are the possibilities that in the next few years your job will be replaced by computers or other machines?

○ None ○ A Little ○ Some ○ A Lot

**72.** How often does your job require you to work very fast?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**73.** How often does your job require you to work very hard?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**74.** How often does your job leave you with little time to get things done?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**75.** How often is there a great deal to be done?

○ Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**76.** How much slowdown in the workload do you experience?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**77.** How much time do you have to think and contemplate?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**78.** How much workload do you have?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**79.** What quantity of work do others expect you to do?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**80.** How much time do you have to do all your work?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**81.** How many projects, assignments, or tasks do you have?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**82.** How many lulls between heavy work periods do you have?

○ Hardly Any ○ A Little ○ Some ○ A Lot ○ A Great Deal

**83.** How often does your job let you use the skills and knowledge you learned in school?

○ Rarely ○ Occasionally ○ Sometimes ○ Often ○ Very Often

**84.** How often are you given a chance to do the things you do best?

○ Rarely ○ Occasionally ○ Sometimes ○ Often ○ Very Often

**85.** How often can you use skills from your previous experience and training?

○ Rarely ○ Occasionally ○ Sometimes ○ Often ○ Very Often

**86.** I dislike the amount of work I'm expected to do.

○ Rarely ○ Occasionally ○ Sometimes ○ Often ○ Very Often

**87.** I am dissatisfied with the pace of my work.

○ Never, Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**88.** I am unhappy about my current work load.

○ Never, Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**89.** My work is interesting to do.

○ Never, Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**90.** I feel bored with the work I have to do.

○ Never, Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**91.** The work on my job feels dull.

○ Never, Rarely ○ Occasionally ○ Sometimes ○ Fairly Often ○ Very Often

**92.** All in all, how satisfied are you with your job?

○ Not at all satisfied ○ Not too satisfied ○ Somewhat satisfied ○ Very satisfied

**93.** If you were free to go into any type of job you wanted, what would you choose?

○ Job I have now
○ To retire and not work at all
○ Some job other than the one I have now

**94.** Knowing what you know now, if you had to decide all over again whether to take the job you now have, what would you decide?

○ Decide without hesitation to take the same job
○ Would have second thoughts
○ Would decide definitely not to take the same job

**95.** In general how well would you say that your job measures up to the sort of job you wanted when you took it?

○ Very much like the job I wanted
○ Somewhat like the job I wanted
○ Not much like the job I wanted

**96.** If a good friend of yours told you he or she was interested in working in a job like yours for your employer, what would you tell him or her?

○ I would strongly recommend it
○ I would have doubts about recommending it
○ I would advise the friend against it

**97. You have reached the end of Part 3.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then, use the button at the bottom of the page to submit your responses.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

**Thank you for completing Part 3 of the questionnaire! Please submit your responses, using the button below.**

Submit responses

This questionnaire was created using Perseus SurveySolutions for the Web

# Part 4. Questions about discomfort and health... (page 1 of 1)

**In this part of the questionnaire, you will be asked to provide some general information about your health, and to describe physical discomfort you may have experienced within the last 12 months.**

---

+ For multiple choice questions, please choose the answer that comes closest to describing you or your situation.

+Please try to answer all the questions that are presented to you. Your answers are confidential and will be closely guarded.

---

**Begin by describing any Eye discomfort you experienced within the last 12 months...**

**1. During the last 12 months**, have you had any **eye discomfort** (burning, itching, aching, watering, blurring, tired, dry, etc.)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

C No [Go to question 12]
C Yes [Go to question 2]

**2.** How often during the last 12 months have you experienced your **eye** discomfort?

C Almost never (every 6 months)
C Rarely (every 2-3 months)
C Sometimes (once a month)
C Frequently (once a week)
C Almost always (daily)

**3.** How long does your **eye** discomfort usually last?

C Less than 1 hour
C 1 hour to 1 day
C 1 day to 1 week
C 1 to 2 weeks
C 2.1 to 4 weeks
C 1.1 to 3 months
C Longer than 3 months

**4.** Describe the average intensity of your **eye** discomfort.

C Mild
C Moderate
C Severe
C Worst imaginable

**5.** Within the last 12 months, has this **eye** discomfort resulted in your seeing a health care provider?

C No C Yes

**6.** When did your **eye** discomfort begin?

C Before starting my current job
C After starting my current job

**7.** In the last 12 months, has your **eye** discomfort prevented you from doing your normal activities (on the job or off)?

C No C Yes

**8.** Do activities at work make your **eye** discomfort worse?

○ No ○ Yes

**9.** Have you lost any time from work due to your **eye** discomfort?

○ No ○ Yes

**10.** Do activities off-the-job make your **eye** discomfort worse?

○ No ○ Yes

**11.** Have you had any **eye** discomfort **during the past 7 days**?

○ No ○ Yes

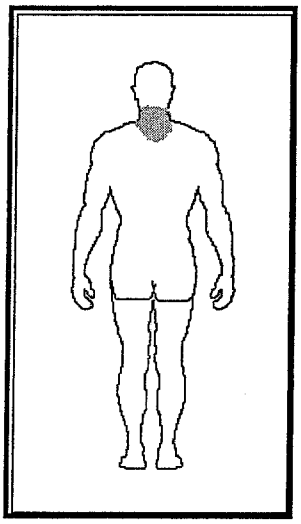
---

● **Describe any Neck discomfort you experienced in the last 12 months...**

**12. During the last 12 months**, have you had any **neck** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 23]
○ Yes [Go to question 13]



**13.** How often during the last 12 months have you experienced **neck** discomfort?

○ Almost never (every 6 months)
○ Rarely (every 2-3 months)
○ Sometimes (once a month)
○ Frequently (once a week)
○ Almost always (daily)

**14.** How long does your **neck** discomfort usually last?

○ Less than 1 hour
○ 1 hour to 1 day
○ 1 day to 1 week
○ 1 to 2 weeks
○ 2.1 to 4 weeks
○ 1.1 to 3 months
○ Longer than 3 months

**15.** Describe the average intensity of your **neck** discomfort.

○ Mild
○ Moderate
○ Severe
○ Worst imaginable

**16.** Within the last 12 months, has this **neck** discomfort resulted in your seeing a health care provider?

○ No ○ Yes

**17.** When did your **neck** discomfort begin?

○ Before starting my current job
○ After starting my current job

**18.** In the last 12 months, has your **neck** discomfort prevented you from doing your normal activities (on the job or off)?

○ No ○ Yes

**19.** Do activities at work make your **neck** discomfort worse?

○ No ○ Yes

**20.** Have you lost any time from work due to your **neck** discomfort?

○ No ○ Yes

**21.** Do activities off-the-job make your **neck** discomfort worse?

○ No ○ Yes

**22.** Have you had any **neck** discomfort **during the past 7 days**?

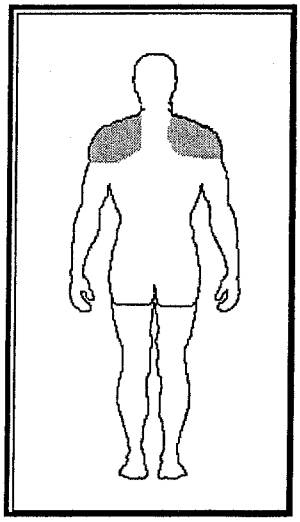
○ No ○ Yes

---

**Describe any Shoulder discomfort you experienced in the last 12 months...**

**23. During the last 12 months,** have you had any **shoulder** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.



○ No [Go to question 34]
○ Yes, Right shoulder [Go to question 24]
○ Yes, Left shoulder [Go to question 24]
○ Yes, both shoulders [Go to question 24]

**24.** How often during the last 12 months have you experienced **shoulder** discomfort?

○ Almost never (every 6 months)
○ Rarely (every 2-3 months)
○ Sometimes (once a month)
○ Frequently (once a week)
○ Almost always (daily)

**25.** How long does your **shoulder** discomfort usually last?

○ Less than 1 hour
○ 1 hour to 1 day
○ 1 day to 1 week
○ 1 to 2 weeks
○ 2.1 to 4 weeks
○ 1.1 to 3 months
○ Longer than 3 months

**26.** Describe the average intensity of your **shoulder** discomfort.

○ Mild
○ Moderate
○ Severe
○ Worst imaginable

**27.** Within the last 12 months, has this **shoulder** discomfort resulted in your seeing a health care provider?

○ No ○ Yes

**28.** When did your **shoulder** discomfort begin?

- ○ Before starting my current job
- ○ After starting my current job

**29.** In the last 12 months, has your **shoulder** discomfort prevented you from doing your normal activities (on the job or off)?

○ No ○ Yes

**30.** Do activities at work make your **shoulder** discomfort worse?

○ No ○ Yes

**31.** Have you lost any time from work due to your **shoulder** discomfort?

○ No ○ Yes

**32.** Do activities off-the-job make your **shoulder** discomfort worse?

○ No ○ Yes

**33.** Have you had any **shoulder** discomfort **during the past 7 days**?

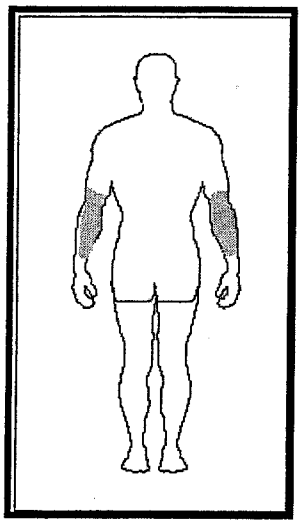
○ No ○ Yes

---

**Describe any Elbow or Forearm discomfort you experienced in the last 12 months...**

**34. During the last 12 months,** have you had any **elbow or forearm** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.



- ○ No [Go to question 45]
- ○ Yes, Right [Go to question 35]
- ○ Yes, Left [Go to question 35]
- ○ Yes, Both [Go to question 35]

**35.** How often during the last 12 months have you experienced **elbow/forearm** discomfort?

- ○ Almost never (every 6 months)
- ○ Rarely (every 2-3 months)
- ○ Sometimes (once a month)
- ○ Frequently (once a week)
- ○ Almost always (daily)

**36.** How long does your **elbow/forearm** discomfort usually last?

- ○ Less than 1 hour
- ○ 1 hour to 1 day
- ○ 1 day to 1 week
- ○ 1 to 2 weeks
- ○ 2.1 to 4 weeks
- ○ 1.1 to 3 months
- ○ Longer than 3 months

**37.** Describe the average intensity of your **elbow/forearm** discomfort.

- ○ Mild
- ○ Moderate
- ○ Severe
- ○ Worst imaginable

**38.** Within the last 12 months, has this **elbow/forearm** discomfort resulted in your seeing a health care provider?

○ No ○ Yes

**39.** When did your **elbow/forearm** discomfort begin?

○ Before starting my current job
○ After starting my current job

**40.** In the last 12 months, has your **elbow/forearm** discomfort prevented you from doing your normal activities (on the job or off)?

○ No ○ Yes

**41.** Do activities at work make your **elbow/forearm** discomfort worse?

○ No ○ Yes

**42.** Have you lost any time from work due to your **elbow/forearm** discomfort?

○ No ○ Yes

**43.** Do activities off-the-job make your **elbow/forearm** discomfort worse?

○ No ○ Yes

**44.** Have you had any **elbow/forearm** discomfort **during the past 7 days**?

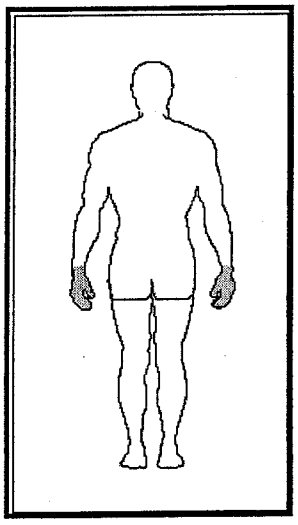
○ No ○ Yes

---

● **Describe any Wrist or Hand discomfort you experienced in the last 12 months...**

**45. During the last 12 months**, have you had any **wrist or hand** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.



○ No [Go to question 56]
○ Yes, Right side [Go to question 46]
○ Yes, Left side [Go to question 46]
○ Yes, both sides [Go to question 46]

**46.** How often during the last 12 months have you experienced **wrist/hand** discomfort?

○ Almost never (every 6 months)
○ Rarely (every 2-3 months)
○ Sometimes (once a month)
○ Frequently (once a week)
○ Almost always (daily)

**47.** How long does your **wrist/hand** discomfort usually last?

○ Less than 1 hour
○ 1 hour to 1 day
○ 1 day to 1 week
○ 1 to 2 weeks
○ 2.1 to 4 weeks
○ 1.1 to 3 months
○ Longer than 3 months

**48.** Describe the average intensity of your **wrist/hand** discomfort.

○ Mild

- Moderate
- Severe
- Worst imaginable

**49.** Within the last 12 months, has this **wrist/hand** discomfort resulted in your seeing a health care provider?

- No
- Yes

**50.** When did your **wrist/hand** discomfort begin?

- Before starting my current job
- After starting my current job

**51.** In the last 12 months, has your **wrist/hand** discomfort prevented you from doing your normal activities (on the job or off)?

- No
- Yes

**52.** Do activities at work make your **wrist/hand** discomfort worse?

- No
- Yes

**53.** Have you lost any time from work due to your **wrist/hand** discomfort?

- No
- Yes

**54.** Do activities off-the-job make your **wrist/hand** discomfort worse?

- No
- Yes

**55.** Have you had any **wrist/hand** discomfort **during the past 7 days**?

- No
- Yes

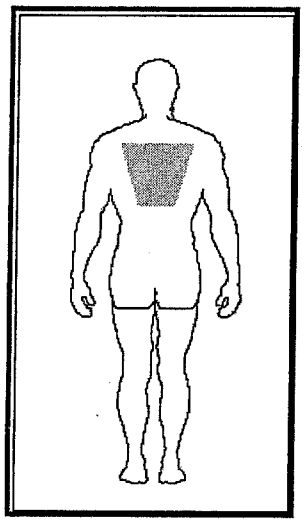
---

● **Describe any Upper Back discomfort you have experienced in the last 12 months...**

**56. During the last 12 months**, have you had any **upper back** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

- No [Go to question 67]
- Yes [Go to question 57]



**57.** How often during the last 12 months have you experienced **upper back** discomfort?

- Almost never (every 6 months)
- Rarely (every 2-3 months)
- Sometimes (once a month)
- Frequently (once a week)
- Almost always (daily)

**58.** How long does your **upper back** discomfort usually last?

- Less than 1 hour
- 1 hour to 1 day
- 1 day to 1 week
- 1 to 2 weeks
- 2.1 to 4 weeks
- 1.1 to 3 months
- Longer than 3 months

**59.** Describe the average intensity of your **upper back** discomfort.

- ○ Mild
- ○ Moderate
- ○ Severe
- ○ Worst imaginable

**60.** Within the last 12 months, has this **upper back** discomfort resulted in your seeing a health care provider?

○ No ○ Yes

**61.** When did your **upper back** discomfort begin?

- ○ Before starting my current job
- ○ After starting my current job

**62.** In the last 12 months, has your **upper back** discomfort prevented you from doing your normal activities (on the job or off)?

○ No ○ Yes

**63.** Do activities at work make your **upper back** discomfort worse?

○ No ○ Yes

**64.** Have you lost any time from work due to your **upper back** discomfort?

○ No ○ Yes

**65.** Do activities off-the-job make your **upper back** discomfort worse?

○ No ○ Yes

**66.** Have you had any **upper back** discomfort **during the past 7 days**?

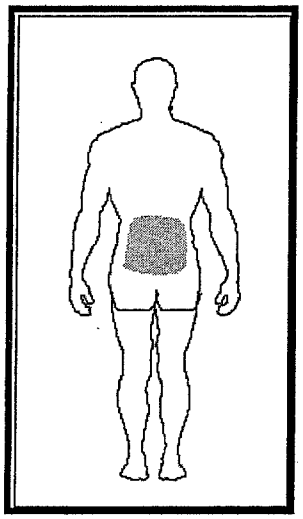
○ No ○ Yes

---

● **Describe any Lower Back discomfort you have experienced in the last 12 months...**

**67. During the last 12 months**, have you had any **lower back** discomfort (ache, pain, stiffness, burning, numbness, tingling, or other discomfort)?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.



- ○ No [Go to question 78]
- ○ Yes [Go to question 68]

**68.** How often during the last 12 months have you experienced **lower back** discomfort?

- ○ Almost never (every 6 months)
- ○ Rarely (every 2-3 months)
- ○ Sometimes (once a month)
- ○ Frequently (once a week)
- ○ Almost always (daily)

**69.** How long does your **lower back** discomfort usually last?

- ○ Less than 1 hour
- ○ 1 hour to 1 day
- ○ 1 day to 1 week
- ○ 1 to 2 weeks
- ○ 2.1 to 4 weeks

- ○ 1.1 to 3 months
- ○ Longer than 3 months

**70.** Describe the average intensity of your **lower back** discomfort.

- ○ Mild
- ○ Moderate
- ○ Severe
- ○ Worst imaginable

**71.** Within the last 12 months, has this **lower back** discomfort resulted in your seeing a health care provider?

○ No ○ Yes

**72.** When did your **lower back** discomfort begin?

- ○ Before starting my current job
- ○ After starting my current job

**73.** In the last 12 months, has your **lower back** discomfort prevented you from doing your normal activities (on the job or off)?

○ No ○ Yes

**74.** Do activities at work make your **lower back** discomfort worse?

○ No ○ Yes

**75.** Have you lost any time from work due to your **lower back** discomfort?

○ No ○ Yes

**76.** Do activities off-the-job make your **lower back** discomfort worse?

○ No ○ Yes

**77.** Have you had any **lower back** discomfort **during the past 7 days**?

○ No ○ Yes

---

**78.** Have you ever had a traumatic (sudden) injury to any of the parts of your body listed below? Mark all that apply.

- ☐ Eye(s)
- ☐ Neck
- ☐ Right shoulder
- ☐ Left shoulder
- ☐ Right elbow/forearm
- ☐ Left elbow/forearm
- ☐ Right wrist/hand
- ☐ Left wrist/hand
- ☐ Upper back
- ☐ Lower back
- ☐ None of the above

**79.** On average, how often do you experience headaches?

- ○ Never
- ○ Almost never (every 6 months)
- ○ Rarely (every 2-3 months)
- ○ Sometimes (once a month)
- ○ Frequently (once a week)
- ○ Almost always (daily)

**80.** Have you had your eyes examined by an optometrist or ophthalmologist (eye doctor) within the last 12 months?

○ No ○ Yes

**81.** Describe any eye glasses or contact lenses that you wear. Mark all that apply.

☐ Contact lenses
☐ Single lens glasses for distance (near-sighted)
☐ Single lens glasses for reading (far-sighted)
☐ Single lens glasses specifically for computer work
☐ Bi-focals
☐ Tri-focals
☐ "Granny" half-lens reading glasses
☐ I do not wear glasses or contacts

**82.** In what Year were you born?

**83.** How tall are you? (Provide your height in the unit of measure with which you are more comfortable.)

Height, in feet and inches:
Or, Height in centimeters:

**84.** How much do you weigh? (Provide your weight in the unit of measure with which you are more comfortable.)

Weight, in pounds:
Or, Weight in kilograms:

**85.** Indicate your race/ethnic origin. Mark all that apply.

☐ African-American/Black
☐ Asian
☐ Caucasian/White
☐ Hispanic/Latino
☐ Inuit/Aluet/Alaskan Native
☐ Native American
☐ Pacific Islander
☐ Other

**86.** Are you predominately right-handed, predominately left-handed, or use both equally well?

○ Right-handed ○ Left-handed ○ Both equally well

**87.** Your sex?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ Female [Go to question 88]
○ Male [Go to question 90]

**88.** Have you had a pregnancy during the last 12 months?

○ No ○ Yes

**89.** Have you taken oral contraceptives during the last 12 months or have you ever had a hysterectomy?

○ No ○ Yes

**90.** Have you been diagnosed with any of the following disorders? Mark all that apply.

☐ Arthritis

- ☐ Thyroid problems
- ☐ Diabetes
- ☐ Cervical spine disease
- ☐ Migraine headaches
- ☐ Lupus
- ☐ Fibromyalgia
- ☐ Gout
- ☐ None of the above

**91.** Which statement best describes your history of smoking?

- ○ Never smoked
- ○ Smoked previously, but quit more than 12 months ago
- ○ Smoked previously, but quit within the last 12 months
- ○ Current smoker

**92. You have reached the end of Part 4.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to submit your responses.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

**Thank you for completing Part 4 of the questionnaire! Please submit your responses, using the button below.**

Submit responses

This page was created using Perseus SurveySolutions for the Web

# Part 5. Off the job... (page 1 of 1)

**Please tell us a bit about yourself and what you do outside of work...**

---

+ For multiple choice questions, please choose the answer or answers that come closest to describing you or your situation.

+ Please try to answer all the questions that are presented to you. Your answers are confidential and will be closely guarded.

---

**The earlier questions in this part of the questionnaire concentrate on your activities outside of work. The term "Study Invitation Job" appears throughout. It refers to the job through which you were recruited to participate in this study.**

**1.** In addition to the job through which you were invited to participate in this study (your Study Invitation Job), do you have another job, or jobs, for which you are paid?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 3]
○ Yes [Go to question 2]

**2.** If you have other jobs for pay, on average how many hours per week in total do you work at other jobs:

Hours per week for pay on other jobs _____

**3.** Within the last 12 months, have you taken courses for either a GED, other certificate, or for college credit?

○ No ○ Yes

**4.** What schooling have you completed? **Mark all that apply.**

☐ middle school
☐ high school
☐ trade or technical school
☐ associate's degree
☐ bachelor's degree
☐ master's degree
☐ doctorate degree (PhD, JD, MD, etc.)

**5.** Please list any hobbies or activities in which you participate at least once a week, on at least a seasonal basis. Exclude exercise or sports you play (those are covered in the next question).

- For each hobby or activity that you list, provide the average number of hours per week and number of months per year to describe the time you spend on that hobby or activity. If there are none, type "none" in the first blank (no quotation marks).

Hobby/Activity, Hours per week, Months per year _____
Hobby/Activity, Hours per week, Months per year _____
Hobby/Activity, Hours per week, Months per year _____
Hobby/Activity, Hours per week, Months per year _____
Hobby/Activity, Hours per week, Months per year _____

**6.** Please list any exercise or sports you play in which you participate at least once a week, on at least a seasonal basis.

- For each exercise or sport that you list, provide the average number of hours per week and number of months per year to describe the time you spend on that exercise or sport. If there are none, type "none" in the first blank (no quotation marks).

Sport/Exercise, Hours per week, Months per year
Sport/Exercise, Hours per week, Months per year
Sport/Exercise, Hours per week, Months per year
Sport/Exercise, Hours per week, Months per year
Sport/Exercise, Hours per week, Months per year

**7.** Outside of your Study Invitation Job, how often do the following activities occur for you?

| | Never | Rarely | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|---|
| Heavy lifting | ○ | ○ | ○ | ○ | ○ |
| Repetitive lifting | ○ | ○ | ○ | ○ | ○ |
| Forceful gripping or pinching | ○ | ○ | ○ | ○ | ○ |
| Repetitive gripping or pinching | ○ | ○ | ○ | ○ | ○ |
| Standing for long periods of time | ○ | ○ | ○ | ○ | ○ |
| Sitting for long periods of time (other than in a motor vehicle) | ○ | ○ | ○ | ○ | ○ |
| Sitting for long periods of time in a motor vehicle | ○ | ○ | ○ | ○ | ○ |
| Working on a desktop computer | ○ | ○ | ○ | ○ | ○ |
| Working on a notebook computer | ○ | ○ | ○ | ○ | ○ |

**8.** Do you lift or carry young children on a regular basis?

○ No ○ Yes

**9.** Do you lift, carry, or move teenagers or adults on a regular basis? (This may occur as part of care-giving responsibilities, or for other reasons.)

○ No ○ Yes

**10.** When did you start using a computer for any purpose?

Year you started using computers:

**11.** Is the majority of the time you spend using computers related to your Study Invitation Job or to other activities?

○ Study Invitation Job
○ All other activities combined
○ Computer time is about equal between Study Invitation Job and all other activities combined

**12.** Do you use a computer at least once per week, on average, for purposes not associated with your Study Invitation Job?

- **Do not click the link** of your answer, **until** after you've clicked in the circle next to your answer.

○ No [Go to question 16]
○ Yes [Go to question 13]

**13.** For what purposes do you use a computer outside of your Study Invitation Job? List the three most common uses for you.

Use
Use
Use

**14.** How much time do you spend on average each week using a computer for purposes other than your Study Invitation Job?

- If your usage varies from week to week, provide the range of hours that you typically use the computer; otherwise, enter a single value. (For example: for usage that varies you might enter "5-10" hours/week; for usage that is pretty steady, you might enter "8" hours/week.)

Hours per week: _____

**15.** Please describe the computer(s) you use for activities not associated with your Study Invitation Job. Include computers that see mixed use (job-related use and personal use).

- Provide Make, Model (if possible), and Style (desktop or notebook).

Make, model, and style (desktop or notebook): _____
Make, model, and style (desktop or notebook): _____
Make, model, and style (desktop or notebook): _____
Make, model, and style (desktop or notebook): _____

**16.** How many fingers do you use when you type, including thumbs?

_____

**17.** Do you have any physical impairment or constraint that influences your ability to type in a traditional style (using 9-10 fingers)?

○ No ○ Yes

**18.** Do you regularly look at the keyboard to type any of the following keys? Mark all that apply.

☐ punctuation (; : ", ? ...)
☐ numbers
☐ Alt/Delete/Shift/Ctl keys
☐ letters

**19.** Have you ever taken a typing class?

○ No ○ Yes

**20.** Have you ever used instructional software to learn how to type?

○ No ○ Yes

**21.** With which hand do you most often use the pointing device (mouse, touch pad, etc) on a computer?

○ Right hand ○ Left hand ○ Both hands equally

**22.** Do you use any of the following electronic devices?

| | Do not use | Work-related use | Personal use | Both work-related and personal use |
|---|---|---|---|---|
| Pager | ○ | ○ | ○ | ○ |
| Cellular phone | ○ | ○ | ○ | ○ |
| Handheld computer (may run Windows CE or similar OS) | ○ | ○ | ○ | ○ |
| Personal digital assistant (PDA: such as WorkPad, PalmPilot, Newton, Pocket PC, etc.) | ○ | ○ | ○ | ○ |

**The remaining questions in Part 5 focus on personality, emotions, and general health. They help complete the "whole person" review that is important for correctly interpreting the data provided through the other parts of the questionnaire. As with all parts of the questionnaire, your responses are confidential.**

**23.** Do you ever have trouble finding time to get your hair cut or styled?

- Never
- Occasionally
- Almost always

**24.** Is your everyday life filled mostly by

- problems needing a solution?
- challenges needing to be met?
- a rather predictable routine of events?
- not enough things to keep me interested or busy?

**25.** When you are under pressure or stress, what do you usually do?

- Do something about it immediately
- Plan carefully before taking any action

**26.** Ordinarily, how rapidly do you eat?

- I'm usually the first one finished.
- I eat a little faster than average.
- I eat at about the same speed as most people.
- I eat more slowly than most people.

**27.** Has your spouse or a friend ever told you that you eat too fast?

- Yes, often
- Yes, once or twice
- No, never

**28.** When you listen to someone talking, and this person takes too long to come to the point, how often do you feel like hurrying the person along?

- Frequently
- Occasionally
- Almost never

**29.** How often do you actually "put words in the person's mouth" in order to speed things up?

- Frequently
- Occasionally
- Almost never

**30.** If you tell your spouse or a friend that you will meet somewhere at a definite time, how often do you arrive late?

- Once in a while
- Rarely
- I am never late.

**31.** When you have to "wait in line" at a restaurant, a store, or the post office, what do you do?

- Accept it calmly
- Feel impatient but not show it
- Feel so impatient that someone watching can tell I am restless
- Refuse to wait in line, and find ways to avoid such delays

**32.** When you were younger, did most people consider you to be

- definitely hard-driving and competitive?
- probably hard-driving and competitive?
- probably more relaxed and easygoing?
- definitely more relaxed and easygoing?

**33.** Nowadays, do you consider yourself to be

- definitely hard-driving and competitive?
- probably hard-driving and competitive?
- probably more relaxed and easygoing?
- definitely more relaxed and easygoing?

**34.** Would your spouse (or closest friend) rate you as

- definitely hard-driving and competitive?
- probably hard-driving and competitive?
- probably relaxed and easygoing?
- definitely relaxed and easygoing?

**35.** Would your spouse (or closest friend) rate your general level of activity as

- too slow -- should be more active?
- about average -- busy much of the time?
- too active -- should slow down?

**36.** Would people you know well agree that you take your work too seriously?

- Definitely yes
- Probably yes
- Probably no
- Definitely no

**37.** Would people you know well agree that you have less energy than most people?

- Definitely yes
- Probably yes
- Probably no
- Definitely no

**38.** Would people you know well agree that you tend to get irritated easily?

- Definitely yes
- Probably yes
- Probably no
- Definitely no

**39.** How was your temper when you were younger?

- Fiery and hard to control
- Strong but controllable
- No problem
- I almost never got angry

**40.** How often are there deadlines on your job?

- Daily or more often
- Weekly
- Monthly or less often
- Never

**41.** Do you ever set deadlines or quotas for yourself at work or at home?

- No
- Yes, but only occasionally
- Yes, once a week or more

**42.** At work, do you ever keep two jobs moving forward at the same time by shifting back and forth rapidly from one to the other?

- ○ No, never
- ○ Yes, but only in emergencies
- ○ Yes, regularly

**43.** If you had your choice, which would you rather get?

- ○ A small increase in pay without a promotion to a higher level job
- ○ A promotion to a higher level job without an increase in pay

**44.** In the past three years, have you ever taken less than your allotted number of vacation days?

- ○ Yes
- ○ No
- ○ My type of job does not provide regular vacations.

**45.** How often do you bring your work home with you at night, or study materials related to your job?

- ○ Rarely or never
- ○ Once a week or less
- ○ More than once a week

**46.** When you are in a group, how often do the other people look to you for leadership?

- ○ Rarely
- ○ About as often as they look to others
- ○ More often than they look to others

For questions 47-50, compare yourself with the average worker in your present occupation, and mark the most accurate description.

**47.** In amount of effort put forth, I give

- ○ much more effort.
- ○ a little more effort.
- ○ a little less effort.
- ○ much less effort.

**48.** In sense of responsibility, I am

- ○ much more responsible.
- ○ a little more responsible.
- ○ a little less responsible.
- ○ much less responsible.

**49.** In being precise (careful about detail), I am

- ○ much more precise.
- ○ a little more precise.
- ○ a little less precise.
- ○ much less precise.

**50.** I approach life in general

- ○ much more seriously.
- ○ a little more seriously.
- ○ a little less seriously.
- ○ much less seriously.

**51.** Are you considered to be at a higher level (in prestige or social position) in your present work or in your work setting of five years ago? If you have not been working for five years, compare your present job with your first job.

- ○ I am at a higher level in my present job.
- ○ I was at a higher level five years ago.

○ Cannot decide

**52.** How many different job titles have you held in the last 10 years? (Be sure to count shifts in kinds of work, shifts to new employers, and shifts up and down within a firm.)

○ 0-1
○ 2
○ 3
○ 4
○ 5 or more

**53.** Below is a list of 10 words that describe feelings people have. For each word, mark the description that best describes how you have been feeling **in the last week, including today**.

| | Not at All | A Little | Moderately | Quite a Bit | Extremely |
|---|---|---|---|---|---|
| Energetic | ○ | ○ | ○ | ○ | ○ |
| Full of pep | ○ | ○ | ○ | ○ | ○ |
| Vigorous | ○ | ○ | ○ | ○ | ○ |
| Fatigued | ○ | ○ | ○ | ○ | ○ |
| Exhausted | ○ | ○ | ○ | ○ | ○ |
| Bushed | ○ | ○ | ○ | ○ | ○ |
| Nervous | ○ | ○ | ○ | ○ | ○ |
| Tense | ○ | ○ | ○ | ○ | ○ |
| Shaky | ○ | ○ | ○ | ○ | ○ |
| Bored | ○ | ○ | ○ | ○ | ○ |

**54.** How often do each of the four statements below describe how you feel?

| | Never | Occasionally | Often | Always |
|---|---|---|---|---|
| In general, I am unusually tense or nervous. | ○ | ○ | ○ | ○ |
| There is a great amount of nervous strain connected with my daily activities. | ○ | ○ | ○ | ○ |
| At the end of the day I am completely exhausted, mentally and physically. | ○ | ○ | ○ | ○ |
| My daily activities are extremely trying and stressful. | ○ | ○ | ○ | ○ |

**55.** Do you consider the emotional support you receive from family and/or friends 'adequate' or 'more than adequate' to meet your needs?

○ Never ○ Rarely ○ Sometimes ○ Quite Often ○ Almost Always

**56.** In general, would you say your health is:

○ Excellent ○ Very Good ○ Good ○ Fair ○ Poor

**57.** The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

| | Yes, Limited A Lot | Yes, Limited A Little | No, Not Limited At All |
|---|---|---|---|
| Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf? | ○ | ○ | ○ |
| Climbing several flights of stairs? | ○ | ○ | ○ |

**58.** During the **past 4 weeks,** have you had either of the following problems with your work or other regular daily activities **as a result of your physical health**?

| | Yes | No |
|---|---|---|
| Accomplished less than you would like? | ○ | ○ |
| Were limited in the kind of work or other activities? | ○ | ○ |

**59.** During the **past 4 weeks,** have you had either of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

| | Yes | No |
|---|---|---|
| Accomplished less than you would like? | ○ | ○ |
| Didn't do work or other activities as carefully as usual? | ○ | ○ |

**60.** During the **past 4 weeks,** how much did pain interfere with your normal work (including both work outside the home and housework)?

○ Not at All ○ A Little Bit ○ Moderately ○ Quite a Bit ○ Extremely

**61.** These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much time during the **past 4 weeks**...

| | All of the Time | Most of the Time | A Good Bit of the Time | Some of the Time | A Little of the Time | None of the Time |
|---|---|---|---|---|---|---|
| Have you felt calm and peaceful? | ○ | ○ | ○ | ○ | ○ | ○ |
| Did you have a lot of energy? | ○ | ○ | ○ | ○ | ○ | ○ |
| Have you felt downhearted and blue? | ○ | ○ | ○ | ○ | ○ | ○ |

**62.** During the **past 4 weeks,** how much of the time has **your physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

○ All of the Time
○ Most of the Time
○ Some of the Time
○ A Little of the Time
○ None of the Time

**63. You have reached the end of Part 5.** Please provide your identification (ID) code, so that your responses on this page can be linked to your responses on the rest of the questionnaire. Then use the button at the bottom of the page to submit your responses.

- Your ID code is the last five (5) digits of your social security number. For example, if your SSN was 129-35-6788, your ID code would be 56788.

Your ID code: _____

**Thank you for completing Part 5 of the questionnaire! Please submit your responses, using the button below.**

Submit responses

This questionnaire was created using Perseus SurveySolutions for the Web

## Appendix B. Reliability analyses of the survey.

Table B.1. Reliability analysis of questions about work-related computer use (dpc and npc participants).

| Questions | Questions components (if any) | Number of subjects (27 DPC & 42 NPC) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Test-retest response agreement, % | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| What kinds of software applications do you use for work? | word processing | 69 | 1 | 1,1 | | 1.00 | 0.99 | 0.99 | | | |
| | program development | 69 | 0.72 | 0.49, 0.95 | | 0.93 | 0.16 | 0.14 | | | |
| | CAD/CAM | 69 | 0.95 | 0.85, 1.05 | | 0.99 | 0.16 | 0.17 | | | |
| | web design | 69 | 0.81 | 0.63, 0.99 | | 0.94 | 0.20 | 0.17 | | | |
| | graphics | 69 | 0.47 | 0.26, 0.69 | | 0.77 | 0.38 | 0.26 | p=.046 (m) | | |
| | time management | 69 | 0.36 | 0.14, 0.58 | | 0.68 | 0.54 | 0.51 | | | |
| | voice recognition | 69 | 0.38 | -0.18, 0.93 | | 0.96 | 0.03 | 0.04 | | | |
| | database | 69 | 0.59 | 0.40, 0.78 | | 0.80 | 0.55 | 0.52 | | | |
| | web access | 69 | 0.66 | 0.04, 1.28 | | 0.99 | 0.99 | 0.97 | | | |
| | intranet | 69 | 0.67 | 0.47, 0.88 | | 0.88 | 0.75 | 0.78 | | | |
| | email | 69 | 0.66 | 0.04, 1.28 | | 0.99 | 0.99 | 0.97 | | | |
| | simulation | 69 | 0.8 | 0.58, 1.02 | | 0.96 | 0.14 | 0.10 | | | |
| | spreadsheet | 69 | 0.51 | 0.13, 0.88 | | 0.93 | 0.93 | 0.91 | | | |
| | presentation | 69 | 0.53 | 0.23, 0.84 | | 0.90 | 0.87 | 0.88 | | | |
| | data analysis | 69 | 0.67 | 0.48, 0.86 | | 0.86 | 0.33 | 0.33 | | | |
| How much did you influence the selection of the computer you are using for work? | chose current type over other type | 69 | 0.71 | 0.54, 0.88 | | 0.87 | 0.38 | 0.30 | | | |
| | chose current pc over another of same type | 69 | 0.61 | 0.35, 0.87 | | 0.90 | 0.13 | 0.17 | | | |
| | wanted that type, got current type | 69 | 1 | 1,1 | | 1.00 | 0.03 | 0.03 | | | |
| | wanted different model | 69 | | | | 0.99 | 0.01 | 0.00 | | | |
| | no choice | 69 | 0.71 | 0.55, 0.87 | | 0.86 | 0.45 | 0.54 | | | |
| | respondent bought work pc | 69 | 0.82 | 0.57, 1.06 | | 0.97 | 0.09 | 0.09 | | | |
| user category (based on response patterns from other q's) | based on responses to q's on month, weekly, & daily use | 68 | 0.78, w | 0.54, 1.02 | | 0.93 | | | | | |
| On days that you use the desktop computer for work, how likely are you to use it for work within each of the time periods listed below? | am 12-2 | 68 | 0.47 | 0.03, 0.91 | | 0.94 | | | | | |
| | pm 6-8 | 67 | 0.64, w | 0.46, 0.82 | | 0.60 | | | | | |
| | pm 8-10 | 65 | 0.68, w | 0.53, 0.83 | | 0.66 | | | | | |
| | pm 10-12 | 63 | 0.62, w | 0.43, 0.81 | | 0.78 | | | | | |
| | am 2-4 | 68 | -0.01 | -0.04, 0.01 | | 0.97 | 0.01 | 0.01 | | | |
| | am 4-6 | 68 | - | - | | 0.91 | | | | | |
| | am 6-8 | 68 | 0.73, w | 0.58, 0.88 | | 0.65 | | | | | |
| | am 8-10 | 68 | - | - | | 0.76 | | | | | |
| | am 10-12 | 69 | 0.62, w | 0.4, 0.81 | | 0.75 | | | | | |
| | pm 12-2 | 68 | 0.69, w | 0.53, 0.86 | | 0.74 | | | | | |
| | pm 2-4 | 68 | 0.57, w | 0.34, 0.81 | | 0.72 | | | | | |
| | pm 4-6 | 69 | 0.58, w | 0.42, 0.74 | | 0.55 | | | | | |
| number of periods of use | only includes *pretty* or *very likely* to use | 69 | 0.45, I | >0.28 | | | | | | 0.47 | <.0001 |
| During typical work days, how much time do you spend using a pc for work? | minimum average hours | 31pairs + 2 | 0.76, I | >0.61 | | | | | | 0.74 | <.0001 |
| | average hours | 69 | 0.85, i | >0.78 | | | | | | 0.81 | <.0001 |
| | maximum average hrs | 31pairs + 2 | 0.70, I | >0.52 | | | | | | 0.59 | 0.0004 |
| Where do you seek help to solve desktop computer-related problems you | self | 69 | 0.73 | 0.57, 0.90 | | 0.87 | 0.57 | 0.58 | | | |
| | company's tech support | 69 | 0.61 | 0.35, 0.87 | | 0.90 | 0.81 | 0.88 | | | |
| | knowledgeable co-worker | 69 | 0.68 | 0.48, 0.87 | | 0.87 | 0.71 | 0.72 | | | |

Table B.1. Reliability analysis of questions about work-related computer use (dpc and npc participants).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| encounter on the job? | manufacturer's tech support | 69 | 0.65 | 0.39, 0.91 | | 0.91 | 0.16 | 0.13 | | | |
| | like to be able to solve more yourself? | 69 | 0.71 | 0.52, 0.90 | | 0.88 | 0.72 | 0.72 | | | |
| When using the computer, I find myself assuming awkward, uncomfortable, or "poor" postures. | | 69 | 0.68, w | 0.49, 0.87 | | 0.65 | | | | | |
| When using the computer, or after using it, how often do you experience any physical discomfort (such as stiffness, soreness, aching, numbness, tingling, pain, etc.) in the areas listed below? | right hand/wrist | 68 | 0.72, w | 0.61, 0.84 | | 0.54 | | | | | |
| | buttocks | 67 | 0.65, w | 0.46, 0.84 | | 0.55 | | | | | |
| | legs or feet | 68 | - | - | | 0.60 | | | | | |
| | eyes | 69 | 0.61, w | 0.46, 0.77 | | 0.51 | | | | | |
| | headache | 67 | - | - | | 0.57 | | | | | |
| | left hand/wrist | 68 | 0.54, w | 0.26, 0.81 | | 0.50 | | | | | |
| | right elbow | 67 | 0.63, w | 0.47, 0.80 | | 0.54 | | | | | |
| | left elbow | 68 | - | - | | 0.59 | | | | | |
| | right shoulder | 67 | 0.75, w | 0.64, 0.86 | | 0.54 | | | | | |
| | left shoulder | 68 | - | - | | 0.63 | | | | | |
| | neck | 68 | 0.71, w | 0.59, 0.83 | | 0.51 | | | | | |
| | upper back | 69 | - | - | | 0.49 | | | | | |
| | lower back | 66 | 0.73, w | 0.61, 0.84 | | 0.52 | | | | | |
| When using the computer, or after using it, how often do you experience any physical discomfort (such as stiffness, soreness, aching, numbness, tingling, pain, etc.) in the areas listed below? *(Composite score, PCPain is based on this categorical division of these responses.)* | right hand/wrist | 68 | 0.58 | 0.27, 0.88 | >3 | 0.91 | 0.10 | 0.13 | | | |
| | buttocks | 67 | 0.85 | 0.56, 1.14 | >3 | 0.99 | 0.04 | 0.06 | | | |
| | legs or feet | 68 | 0.73 | 0.38, 1.01 | >3 | 0.97 | 0.06 | 0.06 | | | |
| | eyes | 69 | 0.85 | 0.69, 1.01 | >3 | 0.96 | 0.17 | 0.19 | | | |
| | headache | 67 | 0.41 | 0.05, 0.76 | >3 | 0.90 | 0.12 | 0.07 | | | |
| | left hand/wrist | 68 | 1.00 | 1,1 | >3 | 1.00 | 0.03 | 0.03 | | | |
| | right elbow | 67 | 0.57 | 0.21, 0.94 | >3 | 0.94 | 0.04 | 0.10 | p=0.0455 (m) | | |
| | left elbow | 68 | -0.02 | -0.05, -0.01 | >3 | 0.96 | 0.01 | 0.03 | | | |
| | right shoulder | 67 | 0.62 | 0.34, 0.90 | >3 | 0.91 | 0.15 | 0.12 | | | |
| | left shoulder | 68 | -0.05 | -0.09, -0.01 | >3 | 0.90 | 0.06 | 0.04 | | | |
| | neck | 68 | 0.58 | 0.35, 0.81 | >3 | 0.85 | 0.26 | 0.18 | | | |
| | upper back | 69 | 0.53 | 0.25, 0.82 | >3 | 0.88 | 0.13 | 0.16 | | | |
| | lower back | 66 | 0.72 | 0.45, 0.98 | >3 | 0.94 | 0.12 | 0.12 | | | |
| PCPain Score | Sum of responses to previous 13 components | 69 | 0.75, i | >0.65 | >3 | | | | | 0.81 | <.0001 |
| When working at the desktop computer, how often do you sit continuously ... | > 30 min | 63 | - | - | | 0.63 | | | | | |
| | > 60 min | 66 | - | - | | 0.56 | | | | | |
| | > 90 min | 64 | 0.79, w | 0.71, 0.86 | | 0.55 | | | | | |
| | > 120 min | 66 | 0.77, w | 0.62, 0.91 | | 0.65 | | | | | |
| PCSit Score | weighted sum of previous 4 components | 62 pair + 5 | 0.84, I | >0.77 | | | | | | 0.84 | <.0001 |
| When looking at paper documents while working at the desktop computer, how often do you use a copy stand or document holder? | | 68 | 0.91, w | 0.85, 0.97 | | 0.76 | | | | | |

Table B.2. Reliability analysis of questions about work-related NPC use.

| Questions | Questions components (if any) | Number of subjects (NPC) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Test-retest response agreement, % | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value |
|---|---|---|---|---|---|---|---|---|---|---|---|
| What type of built-in pointing device does your NPC have? | trackball | 42 | 0.81 | 0.60, 1.02 | | 0.93 | 0.24 | 0.26 | | | |
| | trackpoint | 42 | 0.76 | 0.56, 0.96 | | 0.88 | 0.45 | 0.43 | | | |
| | touchpad | 42 | 0.9 | 0.76, 1.04 | | 0.95 | 0.38 | 0.38 | | | |
| Of the total amount of time you spend working with your notebook computer, how much of that time are you using any external devices? | pointing device | 41 | 0.75, w | 0.53, 0.97 | | 0.63 | | | | | |
| | CRT | 41 | 0.96, w | 0.92, 0.99 | | 0.80 | | | | | |
| | flat screen | 40 | - | - | | 0.88 | | | | | |
| | stnd keyboard | 41 | 0.90, w | 0.80, 1.00 | | 0.83 | | | | | |
| | alt keyboard | 39 | - | - | | 0.92 | | | | | |
| | dock stn | 41 | - | - | | 0.83 | | | | | |
| | other device | 42 | - | - | | 0.50 | | | | | |
| When working with your notebook computer, where do you use external devices - primary work location outside of my home | prim work loc | 42 | 0.39 | 0.06, 0.72 | | 0.79 | 0.79 | 0.76 | | | |
| | dock stn | 42 | 0.57 | 0.32, 0.82 | | 0.79 | 0.55 | 0.52 | | | |
| | other device | 42 | 0.44 | 0.09, 0.78 | | 0.83 | 0.14 | 0.21 | | | |
| | pointing device | 42 | 0.62 | 0.36, 0.87 | | 0.83 | 0.67 | 0.69 | | | |
| | CRT | 42 | 0.67 | 0.47, 0.89 | | 0.83 | 0.55 | 0.48 | | | |
| | flat screen | 42 | -0.03 | -0.08, 0.01 | | 0.93 | 0.05 | 0.02 | | | |
| | stnd keyboard | 42 | 0.71 | 0.49, 0.92 | | 0.86 | 0.43 | 0.43 | | | |
| | alt keyboard | 42 | 0.66 | 0.03, 1.28 | | 0.98 | 0.05 | 0.02 | | | |
| When working with your notebook computer, where do you use external devices - home | home work loc | 42 | 0.22 | -0.11, 0.54 | | 0.71 | 0.74 | 0.79 | | | |
| | pointing device | 42 | 0.77 | 0.58, 0.95 | | 0.88 | 0.43 | 0.55 | p=0.0253 (m) | | |
| | CRT | 42 | 1 | 1.00, 1.00 | | 1.00 | 0.05 | 0.05 | | | |
| | flat screen | 42 | - | - | | 0.98 | 0.02 | 0.00 | | | |
| | stnd keyboard | 42 | 0.79 | 0.39, 1.19 | | 0.98 | 0.07 | 0.05 | | | |
| | alt keyboard | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | dock stn | 42 | 0.66 | 0.03 1.28 | | 0.98 | 0.05 | 0.02 | | | |
| | other device | 42 | 0.22 | -0.24, 0.68 | | 0.88 | 0.07 | 0.10 | | | |
| When working with your notebook computer, where do you use external devices - hotel guest room | hotel work loc | 42 | 0.51 | 0.24, 0.79 | | 0.79 | 0.71 | 0.64 | | | |
| | pointing device | 42 | 0.85 | 0.68, 1.01 | | 0.93 | 0.38 | 0.36 | | | |
| | CRT | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | flat screen | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | stnd keyboard | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | alt keyboard | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | dock stn | 42 | - | - | | 0.98 | 0.02 | 0.00 | | | |
| | other device | 42 | 0.28 | -0.23, 0.79 | | 0.90 | 0.07 | 0.07 | | | |
| When working with your notebook computer, where do you use external devices - other locations | other work loc | 42 | 0.33 | 0.04, 0.61 | | 0.67 | 0.45 | 0.45 | | | |
| | pointing device | 42 | 0.28 | -.07, 0.63 | | 0.79 | 0.14 | 0.21 | | | |
| | CRT | 42 | -0.03 | -0.08, 0.01 | | 0.93 | 0.02 | 0.05 | | | |
| | flat screen | 42 | - | - | | 0.98 | 0.02 | 0.00 | | | |
| | stnd keyboard | 42 | -0.03 | -0.08, 0.01 | | 0.93 | 0.02 | 0.05 | | | |
| | alt keyboard | 42 | - | - | | 0.98 | 0.02 | 0.00 | | | |

Table B.2. Reliability analysis of questions about work-related NPC use.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | dock stn | 42 | 0.66 | 0.03, 1.28 | | 0.98 | 0.02 | 0.05 | | | |
| | other device | 42 | 0.72 | 0.36, 1.09 | | 0.95 | 0.10 | 0.10 | | | |
| Considering various locations where you may work with your notebook computer, do you experience any physical discomfort when using, or after using, the notebook computer in your primary work location outside of your home? | prim work loc | 42 | 0.31 | -0.05, 0.68 | | 0.81 | 0.83 | 0.83 | | | |
| | hand | 42 | 0.51 | 0.24, 0.79 | | 0.79 | 0.29 | 0.36 | | | |
| | wrist | 42 | 0.47 | 0.21, 0.73 | | 0.74 | 0.36 | 0.48 | | | |
| | forearm | 42 | 0.5 | 0.24, 0.77 | | 0.79 | 0.21 | 0.38 | | | |
| | elbow | 42 | 0.66 | 0.35, 0.97 | | 0.90 | 0.17 | 0.17 | | | |
| | shoulder | 42 | 0.64 | 0.40, 0.88 | | 0.83 | 0.36 | 0.38 | | | |
| | neck | 42 | 0.28 | -0.01, 0.57 | | 0.64 | 0.52 | 0.55 | | | |
| | up back | 42 | 0.43 | 0.12, 0.74 | | 0.79 | 0.26 | 0.24 | | | |
| | low back | 42 | 0.26 | -0.06, 0.58 | | 0.71 | 0.26 | 0.26 | | | |
| | buttocks | 42 | 0.38 | -0.06, 0.81 | | 0.88 | 0.10 | 0.12 | | | |
| | leg/foot | 42 | -0.03 | -0.08, 0.01 | | 0.93 | 0.02 | 0.05 | | | |
| | eyes | 42 | 0.2 | -0.09, 0.49 | | 0.62 | 0.33 | 0.43 | | | |
| | headache | 42 | 0.23 | -0.12, 0.58 | | 0.76 | 0.21 | 0.17 | | | |
| Considering various locations where you may work with your notebook computer, do you experience any physical discomfort when using, or after using, the notebook computer in your home? | home work loc | 42 | 0.36 | 0.06, 0.67 | | 0.79 | 0.71 | 0.88 | p=0.0196 (m) | | |
| | hand | 42 | 0.26 | -0.05, 0.57 | | 0.69 | 0.31 | 0.29 | | | |
| | wrist | 42 | 0.36 | 0.09, 0.63 | | 0.71 | 0.21 | 0.40 | p=0.0209 (m) | | |
| | forearm | 42 | 0.58 | 0.29, 0.87 | | 0.86 | 0.17 | 0.26 | | | |
| | elbow | 42 | 0.16 | -0.19, 0.51 | | 0.83 | 0.05 | 0.17 | | | |
| | shoulder | 42 | 0.1 | -0.18, 0.38 | | 0.57 | 0.26 | 0.45 | | | |
| | neck | 42 | 0.38 | 0.10, 0.66 | | 0.69 | 0.45 | 0.47 | | | |
| | up back | 42 | 0.03 | -0.27, 0.32 | | 0.62 | 0.21 | 0.31 | | | |
| | low back | 42 | 0.43 | 0.12, 0.74 | | 0.79 | 0.24 | 0.26 | | | |
| | buttocks | 42 | 0.22 | -0.14, 0.58 | | 0.86 | 0.02 | 0.17 | p=0.0143 (m) | | |
| | leg/foot | 42 | 0.32 | -0.09, 0.73 | | 0.86 | 0.10 | 0.14 | | | |
| | eyes | 42 | 0.33 | 0.03, 0.64 | | 0.71 | 0.29 | 0.33 | | | |
| | headache | 42 | 0.32 | -0.05, 0.68 | | 0.81 | 0.19 | 0.14 | | | |
| Considering various locations where you may work with your notebook computer, do you experience any physical discomfort when using, or after using, the notebook computer in a hotel guest room? | hotel work loc | 42 | 0.65 | 0.39, 0.91 | | 0.86 | 0.71 | 0.71 | | | |
| | hand | 42 | 0.67 | 0.43, 0.91 | | 0.86 | 0.36 | 0.26 | | | |
| | wrist | 42 | 0.50 | 0.23, 0.77 | | 0.76 | 0.36 | 0.40 | | | |
| | forearm | 42 | 0.23 | -0.12, 0.58 | | 0.76 | 0.17 | 0.21 | | | |
| | elbow | 42 | 0.53 | 0.07, 1.00 | | 0.93 | 0.07 | 0.10 | | | |
| | shoulder | 42 | 0.38 | 0.09, 0.67 | | 0.71 | 0.36 | 0.36 | | | |
| | neck | 42 | 0.51 | 0.24, 0.77 | | 0.76 | 0.43 | 0.38 | | | |
| | up back | 42 | 0.56 | 0.27, 0.85 | | 0.83 | 0.24 | 0.26 | | | |
| | low back | 42 | 0.58 | 0.30, 0.86 | | 0.83 | 0.29 | 0.26 | | | |
| | buttocks | 42 | 0.48 | 0.10, 0.86 | | 0.88 | 0.10 | 0.17 | | | |
| | leg/foot | 42 | 0.43 | 0.06, 0.79 | | 0.86 | 0.10 | 0.19 | | | |
| | eyes | 42 | 0.62 | 0.36, 0.87 | | 0.83 | 0.33 | 0.31 | | | |
| | headache | 42 | 0.32 | -0.10, 0.74 | | 0.86 | 0.12 | 0.12 | | | |
| Considering various locations where you may work with your notebook computer, do you experience any physical | other work loc | 42 | 0.55 | 0.29, 0.81 | | 0.79 | 0.40 | 0.38 | | | |
| | hand | 42 | 0.38 | -0.06, 0.81 | | 0.88 | 0.10 | 0.12 | | | |
| | wrist | 42 | 0.61 | 0.27, 0.96 | | 0.90 | 0.12 | 0.17 | | | |
| | forearm | 42 | 0.38 | -0.06, 0.81 | | 0.88 | 0.10 | 0.12 | | | |
| | elbow | 42 | 0.48 | -0.12, 1.08 | | 0.95 | 0.02 | 0.07 | | | |

Table B.2. Reliability analysis of questions about work-related NPC use.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| discomfort when using, or after using, the notebook computer at other locations? | shoulder | 42 | 0.23 | -0.15, 0.60 | | 0.81 | 0.17 | 0.12 | | | |
| | neck | 42 | 0.15 | -0.20, 0.49 | | 0.76 | 0.19 | 0.14 | | | |
| | up back | 42 | -0.09 | -0.16, -0.02 | | 0.83 | 0.07 | 0.10 | | | |
| | low back | 42 | 0.29 | -0.21, 0.79 | | 0.90 | 0.05 | 0.10 | | | |
| | buttocks | 42 | - | - | | 0.93 | 0.00 | 0.07 | | | |
| | leg/foot | 42 | 0.48 | -0.12, 1.08 | | 0.95 | 0.02 | 0.07 | | | |
| | eyes | 42 | 0.22 | -0.16, 0.60 | | 0.81 | 0.14 | 0.14 | | | |
| | headache | 42 | 0.66 | 0.03, 1.28 | | 0.98 | 0.05 | 0.02 | | | |
| How do you move or carry the notebook computer? | in hand | 42 | 0.33 | 0.04, 0.62 | | 0.67 | 0.48 | 0.43 | | | |
| | 1 shoulder | 42 | 0.83 | 0.60, 1.06 | | 0.95 | 0.86 | 0.81 | | | |
| | 2 shoulders | 42 | 0.83 | 0.60, 1.06 | | 0.95 | 0.19 | 0.14 | | | |
| | roll cart | 42 | 0.77 | 0.47, 1.08 | | 0.95 | 0.12 | 0.12 | | | |
| | do not move | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| During a typical day in which you use the notebook computer, how frequently do you carry the computer? | | 42 | 0.78, w | 0.65, 0.91 | | 0.79 | | | | | |
| Do you experience any physical discomfort associated with moving or carrying your notebook computer. Mark any body regions in which discomfort occurs. | hand | 42 | 0.42 | 0.03, 0.80 | | 0.86 | 0.14 | 0.14 | | | |
| | wrist | 42 | 0.53 | 0.07, 1.00 | | 0.93 | 0.07 | 0.10 | | | |
| | forearm | 42 | 0.55 | 0.15, 0.94 | | 0.90 | 0.12 | 0.12 | | | |
| | elbow | 42 | 0.28 | -0.23, 0.79 | | 0.90 | 0.07 | 0.07 | | | |
| | shoulder | 42 | 0.49 | 0.21, 0.77 | | 0.79 | 0.67 | 0.74 | | | |
| | neck | 42 | 0.71 | 0.50, 0.92 | | 0.86 | 0.38 | 0.48 | | | |
| | up back | 42 | 0.26 | -0.06, 0.58 | | 0.71 | 0.26 | 0.26 | | | |
| | low back | 42 | 0.53 | 0.07, 1.00 | | 0.93 | 0.10 | 0.07 | | | |
| Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent working in each of the following locations? | office at employer | 42 | - | - | | 0.81 | | | | | |
| | wait area | 40 | 0.53, w | 0.28, 0.78 | | 0.68 | | | | | |
| | mtg room | 42 | 0.77, w | 0.63, 0.91 | | 0.67 | | | | | |
| | lab | 42 | - | - | | 0.83 | | | | | |
| | other | 42 | - | - | | 0.60 | | | | | |
| | offsite office | 42 | - | - | | 0.48 | | | | | |
| | home office | 39 | 0.69 | 0.47, 0.92 | | 0.62 | | | | | |
| | home not office | 42 | 0.41 | 0.20, 0.63 | | 0.43 | | | | | |
| | other's office | 42 | 0.58 | 0.29, 0.87 | | 0.79 | | | | | |
| | car | 42 | - | - | | 0.83 | | | | | |
| | train | 42 | -0.05 | -0.10, -0.00 | | 0.90 | | | | | |
| | airplane | 42 | - | - | | 0.69 | | | | | |
| | hotel guest rm | 42 | 0.73 | 0.57. 0.89 | | 0.67 | | | | | |
| Of the total amount of time you spend performing work with the notebook computer, how much of that time is spent with the notebook computer positioned on the surfaces | desk | 41 | 0.66, w | 0.39, 0.92 | | 0.71 | | | | | |
| | table | 41 | 0.47, w | 0.16, 0.78 | | 0.44 | | | | | |
| | counter | 41 | - | - | | 0.61 | | | | | |
| | lap | 42 | - | - | | 0.55 | | | | | |
| | bench | 42 | 0.46, w | 0.18, 0.73 | | 0.67 | | | | | |
| | bed | 41 | - | - | | 0.71 | | | | | |
| | floor | 42 | 0.46, w | 0.16, 0.76 | | 0.79 | | | | | |

Table B.2. Reliability analysis of questions about work-related NPC use.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| listed below? | hand | 42 | - | - | | 0.88 | | | | | |
| | other | 42 | - | - | | 0.60 | | | | | |
| Of the total amount of time | Sitting on a chair | 41 | 0.58, w | 0.23, 0.93 | | 0.76 | | | | | |
| you spend performing work | other | 42 | - | - | | 0.57 | | | | | |
| with the notebook | Sitting on a bed | 42 | - | - | | 0.67 | | | | | |
| computer, how much of | Sitting on the floor | 42 | 0.63, w | 0.47, 0.78 | | 0.76 | | | | | |
| that time do you spend in | Sitting on a stool or bench | 42 | 0.64, w | 0.39, 0.89 | | 0.74 | | | | | |
| the postures listed below? | Sitting on a couch | 41 | 0.62, w | 0.46, 0.78 | | 0.59 | | | | | |
| | Standing upright | 40 | 0.76, w | 0.61, 0.91 | | 0.78 | | | | | |
| | Standing while leaning / bending | 41 | 0.69, w | 0.48, 0.90 | | 0.80 | | | | | |
| | kneel/squat | 42 | - | - | | 0.90 | | | | | |
| | Lying down | 39 | 0.48 | 0.12, 0.84 | | 0.85 | | | | | |
| use npc stand-alone? | npcsa (no external devices) | 42 | 0.63 | 0.24, 1.01 | | 0.93 | 0.12 | 0.10 | | | |
| | npcsapd (no ext. dev. or just a mouse) | 42 | 0.78 | 0.57, 0.98 | | 0.90 | 0.31 | 0.31 | | | |

Table B.3. Reliability analysis of questions about work, in general.

| Questions | Questions components (if any) | Number of subjects (48; mix of npc and dpc) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Test-retest response agreement, % | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value | Cronbach's alpha, stnd; rep1/rep2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| How many employees does your employer have working at the location or facility where you work? | | 21 | 0.85, w | 0.62, 1.08 | | 0.90 | | | | | | |
| How many employees does your employer have working at its other locations or facilities | | 21 | 1 | 1,1 | | 1.00 | | | | | | |
| How many people do you supervise? | | 48 | 0.95, l | >0.92 | | | | | | | | |
| Employment conditions? | fulltime/partime; permanent/temp.; self-employed | 48 | - | - | | 0.96 | | | | | | |
| How are you paid for your work for this company? | salary | 48 | 1 | 1,1 | | 1.00 | 0.94 | 0.94 | | | | |
| | commission | 48 | - | - | | 1.00 | 0.00 | 0.00 | | | | |
| | hourly | 48 | 0.64 | 0.19, 1.10 | | 0.96 | 0.06 | 0.06 | | | | |
| | piece rate | 48 | - | - | | 1.00 | 0.00 | 0.00 | | | | |
| | incentive | 48 | 0.45 | 0.00, 0.91 | | 0.92 | 0.08 | 0.08 | | | | |
| Based on average number of hours per week, do you consider this job your primary job | | 46 | 0.75 | 0.51, 0.98 | | 0.91 | | | | | | |
| Which items below describe your experience with overtime at this company? | do not work OT | 48 | 0.51 | 0.17, 0.84 | | 0.88 | 0.10 | 0.19 | | | | |
| | want to | 48 | 0.71 | 0.49, 0.92 | | 0.88 | 0.33 | 0.29 | | | | |
| | to keep up | 48 | 0.72 | 0.51, 0.93 | | 0.88 | 0.67 | 0.67 | | | | |
| | asked to | 48 | 0.63 | 0.30, 0.95 | | 0.92 | 0.17 | 0.08 | p=0.0455 (m) | | | |
| What kinds of breaks occur in your workday on most days? | Very brief breaks | 48 | 0.45 | 0.15, 0.75 | | 0.81 | 0.79 | 0.77 | | | | |
| | 10 - 15 minute break in the first half of my work d | 48 | 0.37 | 0.05, 0.68 | | 0.86 | 0.23 | 0.19 | | | | |
| | 10 - 15 minute break in the second half of my wo | 48 | 0.41 | 0.10, 0.73 | | 0.81 | 0.23 | 0.17 | | | | |
| | midday, <30 min | 48 | 0.67 | 0.37, 0.97 | | 0.92 | 0.13 | 0.17 | | | | |
| | midday, >=30 min | 48 | 0.54 | 0.30, 0.78 | | 0.77 | 0.50 | 0.52 | | | | |
| number of types of breaks | based on previous 5 responses | 47 | - | - | | 0.57 | | | | | | |
| | dichotomized | 47 | 0.46 | 0.14, 0.77 | 1-2 V. 3+ | 0.83 | | | | | | |
| Considering the various tasks you perform on your job, how often do you sit continuously ... | > 30 min | 46 | 0.46, w | 0.20, 0.71 | | 0.65 | | | | | | |
| | > 60 min | 46 | 0.55, w | 0.35, 0.75 | | 0.52 | | | | | | |
| | > 90 min | 45 | 0.72, w | 0.56, 0.88 | | 0.60 | | | | | | |
| | > 120 min | 47 | 0.69, w | 0.49, 0.90 | | 0.57 | | | | | | |
| Sit Score | weighted sum of previous 4 components | 45 pair + 3 | 0.76, l | >0.64 | | | | | | 0.72 | <.0001 | |
| Consider all the time you spend talking on the phone for work, which device do you use the most? | handset/speaker/headset | 47 | 0.67, w | 0.24, 1.09 | | 0.96 | | | | | | |
| How often do the following activities occur for you on this job? | heavy lifting | 48 | 0.67, w | 0.52, 0.83 | | 0.69 | | | | | | |
| | freq. lifting | 48 | 0.68, w | 0.49, 0.87 | | 0.79 | | | | | | |
| | forceful grip/pinch | 48 | 0.63, w | 0.47, 0.78 | | 0.69 | | | | | | |
| | rep. grip/pinch | 48 | 0.36, w | -0.01, 0.72 | | 0.63 | | | | | | |

**Table B.3. Reliability analysis of questions about work, in general.**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standing for long periods of time | 48 | - | - | | 0.60 | | | | | | |
| | Sitting for long periods of time (other than in a mo | 47 | 0.62, w | 0.47, 0.76 | | 0.43 | | | | | | |
| | Sitting for long periods of time in a motor vehicle | 48 | - | - | | 0.65 | | | | | | |
| Considering the various tasks you perform on this job, how much of your working time do you spend in the postures listed below? | Sitting on a chair | 48 | 0.61, w | 0.42, 0.80 | | 0.77 | | | | | | |
| | other | 48 | - | - | | 0.56 | | | | | | |
| | Sitting on a bed | 47 | 0.61, w | 0.35, 0.86 | | 0.79 | | | | | | |
| | Sitting on the floor | 48 | - | - | | 0.79 | | | | | | |
| | Sitting on a stool or bench | 48 | 0.60, w | 0.36, 0.83 | | 0.73 | | | | | | |
| | Sitting on a couch | 48 | 0.68, w | 0.45, 0.91 | | 0.83 | | | p=0.046 (s) | | | |
| | Standing upright | 47 | - | - | | 0.55 | | | | | | |
| | Standing while leaning / bending | 47 | 0.65, w | 0.48, 0.82 | | 0.55 | | | | | | |
| | kneel/squat | 48 | 0.68, w | 0.54, 0.83 | | 0.71 | | | | | | |
| | Lying down | 46 | - | - | | 0.80 | | | | | | |
| Psychosocial scales | work pressure | 43 pair + 5 | 0.74, I | >0.61 | | | | | | | | |
| | requires atten. | 47 pair + 1 | 0.76, i | >0.64 | | | | | | 0.77 | <.0001 | 0.84, 0.83 |
| | control over job | 44 pair + 4 | 0.86, I | >0.77 | | | | | | 0.72 | <.0001 | 0.57, 0.51 |
| | control over tasks | 47 pair + 1 | 0.72, I | >0.59 | | | | | | 0.86 | <.0001 | 0.90, 0.88 |
| | control over decisions | 46 pair + 2 | 0.68, I | >0.52 | | | | | | 0.65 | <.0001 | 0.80, 0.82 |
| | phys environ control | 48 | 0.74, i | >0.61 | | | | | | 0.67 | <.0001 | 0.88, 0.76 |
| | | | | | | | | | | 0.73 | <.0001 | 0.59, 0.74 |
| How long have you worked in your current job? | (years) | 48 | 0.58, I | >0.39 | | | | | | 0.84 | <.0001 | |
| How long have you worked for this company or employer? | (years) | 48 | 0.98, I | >0.98 | | | | | | 0.95 | <.0001 | |
| What percentage of your job involves travel requiring nights spent away from home? | | 38 pair + 2 | 0.96, I | >0.92 | | | | | | 0.89 | <.0001 | |
| What percentage of your job involves local travel or other trips that do not require nights spent away from home? | | 37 pair + 3 | 0.71, I | >0.54 | | | | | | 0.71 | <.0001 | |
| On average, in your current job how many hours per week do you work? | (average) | 48 | 0.83, I | >0.73 | | | | | | 0.84 | <.0001 | |
| On average, in your current job how many hours per day do you work during work days? | (average) | 48 | 0.79, I | >0.68 | | | | | | 0.83 | <.0001 | |
| On average, in your current job how many hours each weekend do you work? | (average) | 37 pair + 8 | 0.77, I | >0.61 | | | | | | 0.74 | <.0001 | |

Table B.3. Reliability analysis of questions about work, in general (cont.).

| Questions | Questions components (if any) | Number of subjects (46; mix of npc and dpc) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Observed percentage agreed | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value | Cronbach's alpha, stnd; rep1/rep2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Problems w/ work environment | | 18 | 0.71, w | 0.48, 0.95 | | 0.50 | | | | | | |
| | People entering or using your workstation | 18 | - | - | | 0.83 | | | | | | |
| | Lack of visual privacy | 18 | 0.85, w | 0.74, 0.96 | | 0.78 | | | | | | |
| | lack of work surface | 18 | 0.78, w | 0.55, 1.03 | | 0.72 | | | | | | |
| | Inconvenient arrangement of furniture or | 18 | 0.91, w | 0.81, 1.01 | | 0.83 | | | | | | |
| | lack of storage | 18 | 0.92, w | 0.83, 1.02 | | 0.83 | | | | | | |
| | Unpleasant appearance/décor | 18 | 0.72, w | 0.37, 1.08 | | 0.72 | | | | | | |
| | noise | 18 | 0.75, w | 0.55, 0.95 | | 0.61 | | | | | | |
| | People passing by your workstation (traffi | 17 | - | - | | 0.71 | | | | | | |
| | Many people located near you (crowding) | 18 | - | - | | 0.67 | | | | | | |
| | no. of freq wrkstn probs | 18 | 0.88, i | >0.75 | | | | | | 0.78 | <.0001 | |
| | cum scr for problems | 18 | 0.93, i | >0.85 | | | | | | 0.85 | <.0001 | |
| Where is your primary workstation? | | 18 | - | - | | 1.00 | | | | | | |
| Psychosocial scales | supervisor support | 41 pair + 3 | 0.88, i | >0.80 | | | | | | 0.85 | <.0001 | 0.88, 0.88 |
| | coworker support | 44 pair + 2 | 0.80, i | >0.68 | | | | | | 0.76 | <.0001 | 0.88, 0.84 |
| | role ambiguity | 45 pair + 1 | 0.77, i | >0.65 | | | | | | 0.84 | <.0001 | 0.89, 0.91 |
| | job future ambiguity | 45 pair + 1 | 0.55, i | >0.35 | | | | | | 0.61 | <.0001 | 0.59, 0.58 |
| | quantitative workload | 44 pair + 2 | 0.70, i | >0.55 | | | | | | 0.71 | <.0001 | 0.72, 0.75 |
| | combo quant workload | 42 pair + 3 | 0.64, i | >0.46 | | | | | | 0.67 | <.0001 | 0.76, 0.82 |
| | under utilization | 44 pair + 2 | 0.84, i | >0.74 | | | | | | 0.83 | <.0001 | 0.84, 0.85 |
| | workload dissatisfaction | 43 pair + 3 | 0.78, i | >0.66 | | | | | | 0.74 | <.0001 | 0.89, 0.82 |
| | boredom | 44 pair + 2 | 0.84, i | >0.76 | | | | | | 0.77 | <.0001 | 0.91, 0.92 |
| | facet free job sat | 44 pair + 2 | 0.83, i | >0.73 | | | | | | 0.74 | <.0001 | 0.84, 0.82 |

Table B.4. Reliability analysis of questions about health and demographics.

| Questions and topic areas | Questions components (if any) | Dataset (dpc, npc, mixed) | Number of subjects (42; mix of npc & dpc) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Test-retest response agreement, % | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **note: when working with missing values, SAS only calculates simple kappa** | | | | | | | | | | | |
| | **note: the "recoded" note means that a value ("10") was substituted for missing values (".") - due to the large number of missing values which reduced the n for the reliab. calcs** | | | | | | | | | | | |
| | **note: correlations are only based on complete pairs of non-missing values** | | | | | | | | | | | |
| | **note: most multi-level variables in this part have distributions that have high freq of 0 values and lower frequencies of other values** | | | | | | | | | | | |
| eye discomfort | 12 month prev. | m | 41 | 0.55 | 0.28, 0.82 | | 0.80 | 0.71 | 0.66 | | | |
| | frequency | m | 42 | 0.33, w | -0.02, 0.68 | | 0.52 | | | | | |
| | frequency | m | 42 | 0.34, l | > 0.09 | | | | | | 0.70 (26 pr) | <.0001 |
| | duration | m | 42 | 0.47, l | > 0.25 | | | | | | 0.85 (25 pr) | <.0001 |
| | intensity | m | 42 | 0.46, w | 0.16, 0.75 | | 0.55 | | | | | |
| | see hcp | m | 42 | 0.42, w | 0.13, 0.72 | | 0.64 | 0.21 | 0.21 | | | |
| | begin before job | m | 42 | 0.45, w | 0.16, 0.73 | | 0.55 | 0.43 | 0.36 | | | |
| | stop norml activty | m | 42 | 0.48, w | 0.20, 0.77 | | 0.74 | 0.05 | 0.05 | | | |
| | does work exacerbate | m | 42 | 0.45, w | 0.14, 0.76 | | 0.76 | 0.50 | 0.55 | | | |
| | lost any time from work | m | 42 | 0.51, w | 0.24, 0.78 | | 0.79 | 0.05 | 0.05 | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.47, w | 0.18, 0.76 | | 0.67 | 0.24 | 0.19 | | | |
| | 7 day prev. | m | 42 | 0.46, w | 0.17, 0.76 | | 0.57 | 0.50 | 0.38 | 0.0096 | | |
| neck discomfort | 12 month prev. | m | 40 | 0.48 | 0.13, 0.84 | | 0.85 | 0.80 | 0.85 | | | |
| | frequency | m | 42 | 0.28, w | -0.10, 0.66 | | 0.45 | | | | | |
| | frequency | m | 42 | 0.29, l | > 0.04 | | | | | | 0.62 (30 pr) | 0.0003 |
| | duration | m | 42 | 0.39, l | > 0.15 | | | | | | 0.68 (30 pr) | < 0.0001 |
| | intensity | m | 42 | 0.37, w | 0.01, 0.72 | | 0.67 | 0.36 | 0.31 | | | |
| | see hcp | m | 42 | 0.37, w | 0.01, 0.72 | | 0.79 | 0.12 | 0.14 | | | |
| | begin before job | m | 42 | 0.37, w | 0.02, 0.72 | | 0.52 | 0.38 | 0.36 | | | |
| | stop norml activ | m | 42 | 0.33, w | -0.02, 0.67 | | 0.74 | 0.07 | 0.07 | | | |
| | does work exacerbate | m | 42 | 0.32, w | -0.02, 0.67 | | 0.64 | 0.48 | 0.60 | | | |
| | lost any time from work | m | 42 | - | - | | 0.79 | | | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.37, w | 0.01, 0.72 | | 0.71 | 0.29 | 0.33 | | | |
| | 7 day prev. | m | 42 | 0.35, w | -0.01, 0.70 | | 0.48 | 0.40 | 0.36 | | | |
| shoulder discomfort | 12 month prev. | m | 42 | 0.33, w | 0.03, 0.63 | | 0.60 | 0.29, 0.02, 0.17 | 0.21, 0.12, 0.21 | | | |
| | frequency | m | 42 | - | - | | 0.57 | | | | | |
| | frequency | m | 42 | 0.41, l | > 0.17 | | | | | | 0.73 (16 pr) | 0.0013 |
| | duration | m | 42 | 0.44, l | > 0.21 | | | | | | 0.78 (16 pr) | 0.0003 |
| | intensity | m | 42 | 0.46, w | 0.19, 0.73 | | 0.62 | | | | | |
| | see hcp | m | 42 | 0.46, w | 0.20, 0.73 | | 0.71 | 0.12 | 0.12 | | | |
| | begin before job | m | 42 | 0.45, w | 0.19, 0.71 | | 0.60 | 0.24 | 0.33 | | | |
| | stop norml activ | m | 42 | 0.45, w | 0.18, 0.72 | | 0.69 | 0.10 | 0.14 | | | |
| | does work exacerbate | m | 42 | 0.46, w | 0.19, 0.73 | | 0.62 | 0.31 | 0.38 | | | |
| | lost any time from work | m | 42 | 0.43, w | 0.16, 0.70 | | 0.71 | 0.02 | 0.02 | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.47, w | 0.20, 0.73 | | 0.64 | 0.21 | 0.26 | | | |
| | 7 day prev. | m | 42 | 0.42, w | 0.15, 0.69 | | 0.57 | 0.33 | 0.31 | | | |
| elbow/forearm | 12 month prev. | m | 41 | 0.62, w | 0.34, 0.91 | | 0.76 | 0.24, 0.05, 0.07 | 0.24, 0.07, 0.10 | | | |
| | frequency | m | 42 | 0.50, w | 0.22, 0.78 | | 0.62 | | | | | |
| | frequency | m | 42 | 0.51, l | > 0.29 | | | | | | 0.87 (12 pr) | 0.0002 |

Table B.4. Reliability analysis of questions about health and demographics.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | duration | m | 42 | 0.38, w | > 0.14 | | | | | | 0.68 (12 pr) | 0.0149 |
| | intensity | m | 42 | - | - | | 0.62 | | | | | |
| | see hcp | m | 42 | 0.53, w | 0.26, 0.79 | | 0.71 | 0.05 | 0.12 | | | |
| | begin before job | m | 42 | 0.53, w | 0.26, 0.80 | | 0.71 | 0.21 | 0.29 | | | |
| | stop norml activ | m | 42 | 0.52, w | 0.25, 0.79 | | 0.79 | 0.12 | 0.12 | | | |
| | does work exacerbate | m | 42 | 0.59, w | 0.34, 0.85 | | 0.74 | 0.24 | 0.24 | | | |
| | lost any time from work | m | 42 | 0.55 | 0.29, 0.81 | | 0.79 | 0.00 | 0.00 | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.52, w | 0.25, 0.79 | | 0.76 | 0.26 | 0.21 | | | |
| | 7 day prev. | m | 42 | 0.55, w | 0.21, 0.66 | | 0.69 | 0.31 | 0.21 | | | |
| hand/wrist | 12 month prev. | m | 41 | 0.65, w | 0.42, 0.88 | | 0.66 | 0.55 (r), 0.10 (b) | 0.45 (r), 0.12 (b) | | | |
| | frequency | m | 42 | 0.22, w | -0.11, 0.55 | | 0.50 | | | | | |
| | frequency | m | 42 | 0.23, l | > -0.03 | | | | | | | |
| | duration | m | 42 | 0.29, i | > 0.05 | | | | | | 0.62 (20 pr) | 0.0034 |
| | intensity | m | 42 | - | - | | 0.60 | | | | | |
| | see hcp | m | 42 | 0.35, w | 0.07, 0.63 | | 0.64 | 0.02 | 0.07 | | | |
| | begin before job | m | 42 | 0.43, w | 0.16, 0.70 | | 0.67 | 0.38 | 0.29 | | | |
| | stop norml activ | m | 42 | 0.38, w | 0.09, 0.66 | | 0.62 | 0.10 | 0.14 | | | |
| | does work exacerbate | m | 42 | 0.30, w | 0.01, 0.59 | | 0.60 | 0.52 | 0.45 | | | |
| | lost any time from work | m | 42 | 0.33 | 0.05, 0.60 | | 0.67 | 0.00 | 0.00 | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.43, w | 0.15, 0.71 | | 0.64 | 0.26 | 0.33 | | | |
| | 7 day prev. | m | 42 | 0.31, w | 0.01, 0.61 | | 0.55 | 0.40 | 0.31 | | | |
| upper back | 12 month prev. | m | 39 | 0.59 | 0.23, 0.78 | | 0.77 | 0.33 | 0.41 | | | |
| | frequency | m | 42 | 0.39, w | 0.09, 0.69 | | 0.64 | | | | | |
| | frequency | m | 42 | 0.40, l | > 0.17 | | | | | | 0.65 (12 pr) | 0.0228 |
| | duration | m | 42 | 0.41, i | > 0.18 | | | | | | 0.72 (12 pr) | 0.0086 |
| | intensity | m | 42 | - | - | | 0.60 | | | | | |
| | see hcp | m | 42 | 0.49, w | 0.22, 0.76 | | 0.74 | 0.07 | 0.05 | | | |
| | begin before job | m | 42 | 0.53, w | 0.28, 0.79 | | 0.69 | 0.19 | 0.19 | | | |
| | stop norml activ | m | 42 | 0.45, w | 0.17, 0.72 | | 0.69 | 0.02 | 0.02 | | | |
| | does work exacerbate | m | 42 | 0.43, w | 0.15, 0.71 | | 0.64 | 0.19 | 0.31 | | | |
| | lost any time from work | m | 42 | - | - | | 0.74 | | | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.49, w | 0.22, 0.76 | | 0.67 | 0.10 | 0.26 | | | |
| | 7 day prev. | m | 42 | 0.42, w | 0.15, 0.70 | | 0.62 | 0.21 | 0.24 | | | |
| low back | 12 month prev. | m | 41 | 0.53 | 0.27, 0.80 | | 0.78 | 0.61 | 0.63 | | | |
| | frequency | m | 42 | 0.47, w | 0.19, 0.75 | | 0.55 | | | | | |
| | frequency | m | 42 | 0.48, l | >0.26 | | | | | | 0.63 (21 pr) | 0.0024 |
| | duration | m | 42 | 0.49, l | >0.27 | | | | | | 0.74 (21 pr) | 0.0001 |
| | intensity | m | 42 | - | - | | 0.64 | | | | | |
| | see hcp | m | 42 | 0.47, w | 0.19, 0.75 | | 0.74 | 0.12 | 0.14 | | | |
| | begin before job | m | 42 | 0.47, w | 0.20, 0.74 | | 0.64 | 0.24 | 0.12 | | | |
| | stop norml activ | m | 42 | 0.49, w | 0.22, 0.76 | | 0.69 | 0.05 | 0.14 | | | |
| | does work exacerbate | m | 42 | 0.48, w | 0.21, 0.76 | | 0.62 | 0.43 | 0.43 | | | |
| | lost any time from work | m | 42 | 0.49, w | 0.22, 0.76 | | 0.76 | 0.02 | 0.02 | | | |
| | Do activities off-the-job make discomfort worse? | m | 42 | 0.47, w | 0.18, 0.75 | | 0.69 | 0.38 | 0.40 | | | |
| | 7 day prev. | m | 42 | 0.50, w | 0.24, 0.77 | | 0.57 | 0.31 | 0.31 | | | |
| headache freq | | m | 42 | 0.91, w | 0.87, 0.96 | | 0.60 | | | | | |
| | | m | 42 | 0.91, l | >0.86 | | | | | | | |
| 12 month eye exam prevalance | | m | 41 | 0.56 | 0.30, 0.82 | | 0.80 | 0.76 | 0.61 | p=.0339 | | |

Table B.4. Reliability analysis of questions about health and demographics.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Any eye correction worn? | based on response to Q81 | m | 42 | 1.00 | 1, 1 | | 1.00 | 0.88 | 0.88 | | | |
| Year born | Age, categorized by decade | m | 42 | 1.00, w | 1,1 | | 1.00 | | | | | |
| | age in years | m | 42 | 0.999, l | >0.999 | | | | | | 0.998 | <.0001 |
| weight | | m | 40 pr + 2 | 0.99, l | >0.99 | | | | | | 0.99 | <.0001 |
| height | | m | 41 pr + 1 | 0.99, l | >0.99 | | | | | | 0.99 | <.0001 |
| hand dominance | | m | 42 | 1.00 | 1, 1 | | 1.00 | | | | | |
| sex | m/f | m | 40 | 1.00 | 1,1 | | 1.00 | | | | | |
| | m/f/not answered | m | 42 | 0.68, w | 0.31, 1.05 | | 0.95 | | | | | |
| ob/gyn | 12 month pregnancy prevalance | m | 42 | 0.90, w | 0.77, 1.03 | | 0.93 | 0.02 | 0.05 | | | |
| | oral bc or hysterectomy | m | 42 | 0.95, w | 0.84, 1.05 | | 0.95 | 0.24 | 0.26 | | | |
| cumulative scores - combined score for frequency, duration, and intensity | eye | m | 42 | 0.65, l | >0.48 | | | | | | 0.74 | <.0001 |
| | neck | m | 42 | 0.67, l | >0.50 | | | | | | 0.64 | <.0001 |
| | shoulder | m | 42 | 0.66, l | >0.49 | | | | | | 0.61 | <.0001 |
| | elbow/forearm | m | 42 | 0.76, l | >0.62 | | | | | | 0.68 | <.0001 |
| | wrist/hand | m | 42 | 0.75, l | >0.61 | | | | | | 0.74 | <.0001 |
| | upperback | m | 42 | 0.70, l | >0.54 | | | | | | 0.67 | <.0001 |
| | low back | m | 42 | 0.63, l | >0.45 | | | | | | 0.6 | <.0001 |
| | total cum score | m | 42 | 0.83, l | >0.73 | | | | | | 0.75 | <.0001 |
| Have you ever had a traumatic (sudden) injury to... | eye | m | 42 | 1.00 | 1,1 | | 1.00 | 0.07 | 0.07 | | | |
| | low back | m | 42 | 0.22 | -0.24, 0.68 | | 0.88 | 0.07 | 0.10 | | | |
| | none | m | 42 | 0.53 | 0.29, 0.78 | | 0.76 | 0.60 | 0.45 | | | |
| | neck | m | 42 | 0.66 | 0.03, 1.28 | | 0.98 | 0.07 | 0.02 | | | |
| | rt shoulder | m | 42 | -0.02 | -0.06, .01 | | 0.95 | 0.02 | 0.02 | | | |
| | lt shoulder | m | 42 | 0.84 | 0.55, 1.14 | | 0.95 | 0.07 | 0.10 | | | |
| | rt elbow | m | 42 | 0.84 | 0.55, 1.14 | | 0.95 | 0.10 | 0.07 | | | |
| | lt elbow | m | 42 | - | - | | 0.98 | 0.02 | 0.00 | | | |
| | rt hand | m | 42 | 0.36 | -0.20, 0.93 | | 0.93 | 0.05 | 0.07 | | | |
| | lt hand | m | 42 | 0.40 | 0.01, 0.79 | | 0.88 | 0.05 | 0.17 | p=.0253 | | |
| | upperback | m | 42 | - | - | | 0.95 | 0.00 | 0.05 | | | |
| Q81. eye correction | contacts | m | 42 | 0.82 | 0.63, 1.01 | | 0.93 | 0.24 | 0.31 | | | |
| | near-sighted | m | 42 | 0.71 | 0.50, 0.92 | | 0.86 | 0.57 | 0.52 | | | |
| | far sighted | m | 42 | 0.76 | 0.50, 1.02 | | 0.93 | 0.19 | 0.17 | | | |
| | pc glasses | m | 42 | - | - | | 0.98 | 0.00 | 0.02 | | | |
| | bifocal | m | 42 | 0.91 | 0.73, 1.08 | | 0.98 | 0.17 | 0.14 | | | |
| | trifocal | m | 42 | - | - | | 0.98 | 0.00 | 0.02 | | | |
| | granny glasses | m | 42 | 1.00 | 1,1 | | 1.00 | 0.05 | 0.05 | | | |
| | none | m | 42 | 1.00 | 1,1 | | 1.00 | 0.12 | 0.12 | | | |
| race/ethnicity | African-American/Black | m | 42 | 1.00 | 1,1 | | 1.00 | 0.10 | 0.10 | | | |
| | Asian | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | Caucasian/White | m | 42 | 1.00 | 1,1 | | 1.00 | 0.88 | 0.88 | | | |
| | Hispanic/Latino | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | Inuit/Aluet/Alaskan Native | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | Native American | m | 42 | - | - | | 0.98 | 0.00 | 0.02 | | | |
| | Pacific Islander | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | other | m | 42 | 1.00 | 1,1 | | 1.00 | 0.02 | 0.02 | | | |
| Have you been diagnosed with any of the following disorders? | arthritis | m | 42 | 1.00 | 1,1 | | 1.00 | 0.07 | 0.07 | | | |
| | thyroid | m | 42 | 0.64 | 0.19, 1.09 | | 0.95 | 0.05 | 0.10 | | | |
| | diabetes | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | cervical spine | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |

Table B.4. Reliability analysis of questions about health and demographics.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | migraine | m | 42 | 0.88 | 0.64, 1.11 | | 0.98 | 0.10 | 0.12 | | | |
| | lupus | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |
| | fibromyalgia | m | 42 | 1.00 | 1,1 | | 1.00 | 0.02 | 0.02 | | | |
| | gout | m | 42 | - | - | | 0.98 | 0.00 | 0.02 | | | |
| | none | m | 42 | 0.56 | 0.28, 0.83 | | 0.81 | 0.71 | 0.67 | | | |
| derived 12 mo prev | eye | m | 42 | 0.49 | 0.21, 0.77 | | 0.79 | 0.74 | 0.67 | | | |
| | neck | m | 42 | 0.38 | 0.04, 0.73 | | 0.81 | 0.79 | 0.83 | | | |
| | shoulder | m | 42 | 0.48 | 0.22, 0.74 | | 0.74 | 0.48 | 0.55 | | | |
| | elbow/forearm | m | 42 | 0.55 | 0.29, 0.81 | | 0.79 | 0.38 | 0.40 | | | |
| | wrist/hand | m | 42 | 0.40 | 0.12, 0.68 | | 0.71 | 0.67 | 0.57 | | | |
| | upperback | m | 42 | 0.51 | 0.24, 0.77 | | 0.76 | 0.38 | 0.43 | | | |
| | low back | m | 42 | 0.50 | 0.22, 0.77 | | 0.76 | 0.62 | 0.62 | | | |
| potential work-related case (based on when discomfort started, 12 mo prevalance*, duration, and no trauma) | eye | m | 42 | 0.37 | 0.09, 0.65 | | 0.71 | 0.40 | 0.26 | | | |
| | neck | m | 42 | 0.22 | -0.11, 0.54 | | 0.74 | 0.21 | 0.26 | | | |
| | shoulder | m | 42 | 0.20 | -0.14, 0.53 | | 0.74 | 0.17 | 0.24 | | | |
| | elbow/forearm | m | 42 | 0.23 | -0.15, 0.60 | | 0.81 | 0.12 | 0.17 | | | |
| | wrist/hand | m | 42 | 0.54 | 0.23, 0.86 | | 0.86 | 0.24 | 0.14 | | | |
| | upperback | m | 42 | 0.23 | -0.12, 0.58 | | 0.76 | 0.21 | 0.17 | | | |
| | low back | m | 42 | - | - | | 1.00 | 0.00 | 0.00 | | | |

Table B.5. Reliability analysis of questions about the participants, outside of work.

| Questions | Questions components (if any) | Number of subjects (40; mix of npc & dpc) | Kappa or ICC | Kappa 95% CI or ICC 5% CI lower bound | If dichotomized, where | Test-retest response agreement, % | Time 1 Prevalence (where applicable) | Time 2 Prevalence (where applicable) | McNemar's (m) or Test of symmetry (s), p for exact test (only if p<.05) | Correlation | Correlation p value | Cronbach's alpha, stnd; rep1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Schooling completed? | highest ed level | 40 | 1, w | 1,1 | | 1.00 | | | | | | |
| In addition to the job through which you were invited to participate in this study (your Study Invitation Job), do you have another job, or jobs, for which you are paid? | | 40 | 0.66 | 0.36, 0.96 | | 0.90 | 0.13 | 0.23 | p=0.0455 | | | |
| Within the last 12 months, have you taken courses for either a GED, other certificate, or for college credit? | any courses in 12 mo | 40 | 0.8 | 0.55, 1.06 | | 0.95 | 0.13 | 0.18 | | | | |
| Outside of your Study Invitation Job, how often do the following activities occur for you? | heavy lifting | 40 | - | - | | 0.58 | | | | | | |
| | repetitive lifting | 40 | 0.67, w | 0.43, 0.90 | | 0.58 | | | | | | |
| | forceful grip/pinch | 40 | - | - | | 0.60 | | | | | | |
| | repetitive grip/pinch | 39 | 0.49, w | 0.25, 0.73 | | 0.59 | | | | | | |
| | long standing | 39 | - | - | | 0.46 | | | | | | |
| | long sit - not car | 38 | 0.26, w | -0.07, 0.60 | | 0.50 | | | | | | |
| | long sit - car | 39 | 0.49, w | 0.23, 0.75 | | 0.56 | | | | | | |
| | off job dpc use | 40 | 0.40, w | 0.12, 0.67 | | 0.43 | | | | | | |
| | off job npc use | 40 | - | - | | 0.58 | | | | | | |
| Outside of your Study Invitation Job, how often do the following activities occur for you? *(answers trichotomized)* | heavy lifting | 40 | 0.66, w | 0.47, 0.84 | 1/2=1,3=2,4/5=3 | 0.70 | | | | | | |
| | repetitive lifting | 40 | 0.60, w | 0.25, 0.94 | 1/2=1,3=2,4/5=3 | 0.80 | | | | | | |
| | forceful grip/pinch | 40 | 0.54, w | 0.19, 0.89 | 1/2=1,3=2,4/5=3 | 0.73 | | | | | | |
| | repetitive grip/pinch | 39 | 0.35, w | -0.02, 0.73 | 1/2=1,3=2,4/5=3 | 0.82 | | | | | | |
| | long standing | 39 | 0.12, w | -0.18, 0.43 | 1/2=1,3=2,4/5=3 | 0.49 | | | | | | |
| | long sit - not car | 38 | 0.30, w | -0.02, 0.63 | 1/2=1,3=2,4/5=3 | 0.61 | | | | | | |
| | long sit - car | 39 | 0.52, w | 0.23, 0.81 | 1/2=1,3=2,4/5=3 | 0.64 | | | | | | |
| | off job dpc use | 40 | 0.40, w | 0.11, 0.69 | 1/2=1,3=2,4/5=3 | 0.55 | | | | | | |
| | off job npc use | 40 | - | - | 1/2=1,3=2,4/5=3 | 0.75 | | | | | | |
| other lifting | Do you lift or carry young children on a regular basis? | 39 | 0.82 | 0.63, 1.01 | | 0.92 | 0.33 | 0.31 | | | | |
| | Do you lift, carry, or move teenagers or adults on a regular basis? | 40 | - | - | | 1.00 | 0.00 | 0.00 | | | | |
| computer use | Is the majority of the time you spend using computers related to your Study Invitation Job or to other activities? | 40 | 0.45, w | -0.00, 0.91 | | 0.93 | | | | | | |
| | Do you use a computer at least once per week, on average, for purposes not associated with your Study Invitation Job? | 39 | 0.06 | -0.27, 0.39 | | 0.77 | 0.90 | 0.82 | | | | |
| | Do you have any physical impairment or constraint that influences your ability to type in a traditional style (using 9-10 fingers)? | 40 | - | - | | 1.00 | 0.00 | 0.00 | | | | |
| | Have you ever taken a typing class? | 40 | 0.84 | 0.63, 1.05 | | 0.95 | 0.80 | 0.80 | | | | |
| | Have you ever used instructional software to learn how to type? | 39 | 0.54 | 0.14, 0.94 | | 0.90 | 0.13 | 0.13 | | | | |

**Table B.5. Reliability analysis of questions about the participants, outside of work.**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | With which hand do you most often use the pointing device (mouse, touch pad, etc.) on a computer? | 40 | 1 | 1,1 | | 1.00 | | | | | | |
| Do you use any of the following electronic devices? | use pager for...? | 38 | - | - | | 0.87 | | | | | | |
| | use cell phone for..? | 40 | 0.91, w | 0.81, 1.02 | | 0.90 | | | | | | |
| | use handheld pc..? | 37 | 1, w | 1,1 | | 1.00 | | | | | | |
| | use pda..? | 37 | - | - | | 0.92 | | | | | | |
| computer use | When did you start using a computer for any purpose? | 40 | 0.73, l | > 0.58 | | | | | | 0.7 | <0.0001 | |
| | How much time do you spend on average each week using a computer for purposes other than your Study Invitation Job? | 30 pr + 9 | 0.91, l* | > 0.84 | | | | | | 0.52 | 0.0031 | |
| | How many fingers do you use when you type, including thumbs? | 40 | 0.92, l | > 0.87 | | | | | | 0.78 | <0.0001 | |
| personality | finnish test (Wickström et al, 1989) | 25 pr + 3 | 0.91, l | > 0.83 | | | | | | 0.9 | <0.0001 | 0.77 |
| sf-12 | physical score | 36 pr + 4 | 0.70, l | > 0.53 | | | | | | 0.49 | 0.0023 | 0.86 |
| | mental score | 36 pr + 4 | 0.72, l | > 0.56 | | | | | | 0.76 | <0.0001 | |
| personality | stndardized Jenkins score (continuous value) | 12 | 0.82, l | > 0.58 | | | | | | 0.86 | 0.0003 | |
| | Jenkins: 4 categories | 12 | 0.85, w | 0.70, 0.99 | | 0.67 | | | | | | |
| | jenkins categories: a, a/b, b | 12 | 0.71, w | 0.41, 1.01 | | 0.75 | | | | | | |
| POMS: moods - the questions refer to "in the last week...", so reliab is not evaluated for mood states (fatigue, vigor, boredom, and tension) | | | | | | | | | | | | |
| | fatigue | | | | | | | | | | | 0.94 |
| | tension | | | | | | | | | | | 0.88 |
| | vigor | | | | | | | | | | | 0.94 |
| | total mood disturb - variety of calculations of the score and the alpha calc - none really strong | | | | | | | | | | | |
| daily stress scale | (Reeder et al., 1973) | 39 pr +1 | 0.74, l | > 0.59 | | | | | | 0.75 | <0.0001 | 0.78 |
| hobbies | no. wkly hobbies | 40 | 0.44, l | > 0.20 | | | | | | 0.39 | 0.0122 | |
| | hrs/wk hobbies | 40 | 0.20, l * | >-0.06 | | | | | | 0.34 | 0.0307 | |
| sports | no. wkly sports | 40 | 0.64, l | > 0.45 | | | | | | 0.62 | <0.0001 | |
| | hrs/wk sport | 40 | 0.63, l | > 0.44 | | | | | | 0.52 | <0.0001 | |
| Do you regularly look at the keyboard to type any of the following keys? | punctuation | 40 | 0.69 | 0.46, 0.92 | | 0.85 | 0.58 | 0.63 | | | | |
| | numbers | 40 | 0.75 | 0.49, 1.02 | | 0.93 | 0.80 | 0.83 | | | | |
| | alt/delete/bkspc | 40 | 0.28 | -0.06, 0.62 | | 0.78 | 0.75 | 0.88 | | | | |
| | letters | 40 | 0.91 | 0.73, 1.09 | | 0.98 | 0.15 | 0.18 | | | | |

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REEDER, L.G., SCHRAMA, P.G.M. and DIRKEN, J.M. 1973, Stress and cardiovascular health: An international cooperative study - i, Social Science & Medicine, 7, 573-584.
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* one outlier is affecting results