

## ABSTRACT

VATLAND, H.W. A pilot assessment of nonneutral postures and worker discomfort in VDT operators. MPH in Community Health Education, August 1995, 54pp. (D. Duquette)

Objective evaluation of 7 anatomical postural angles was completed on 34 VDT workers (M age = 46.2) as they performed routine tasks. Upon completion of objective evaluation, discomfort was evaluated using the Standardized Nordic Questionnaire for the Analysis of Musculoskeletal Discomfort. Objective evaluation data and subjective questionnaire data were analyzed using the Spearman rank-order correlation to determine the relationship between joint discomfort and postural joint angle. No significant relationship was found between the subjective joint discomfort and postural joint angle in the Ss. Prevalence of ache, pain, and discomfort symptoms in VDT workers was identified in 9 joint areas including neck (58.8%), lower back (55.9%), shoulders (47.1%), wrist/hand (47.1%), and upper back (26.5%). Discomfort questionnaire screening was found to be a valuable method for identifying the prevalence of musculoskeletal discomfort.

A PILOT ASSESSMENT OF NONNEUTRAL POSTURES  
AND WORKER DISCOMFORT  
IN VDT OPERATORS

A THESIS PRESENTED  
TO  
THE GRADUATE FACULTY  
UNIVERSITY OF WISCONSIN-LA CROSSE

IN PARTIAL FULFILLMENT  
OF THE REQUIREMENT FOR THE  
MASTER OF PUBLIC HEALTH DEGREE

BY  
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AUGUST 1995

COLLEGE OF HEALTH, PHYSICAL EDUCATION, AND RECREATION  
UNIVERSITY OF WISCONSIN-LA CROSSE

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this candidate's requirements for the degree:

Master of Public Health - Community Health Education

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## ACKNOWLEDGMENTS

I would like to express my appreciation to all those who have provided assistance in the completion of this thesis. Special thanks to Dr. Dennis Fater for his constructive comments and moral support throughout the thesis process. I would also like to express my appreciation for the support received from Ms. Gail Gruendemann, MPH, Ms. Wendy Zins, Mr. Randy Frank, and those classmates in the MPH program who have yet to complete this milestone.

Completion of the MPH program requirements and thesis was accomplished by unmeasurable sacrifices of my wife, Shirley, and our children, Scott, Lisa, Heather, and Wayne. Their constant support and encouragement throughout this journey made the rough times bearable and the smooth times enjoyable. From the beginning to the end, this was a family accomplishment.

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CHAPTER I  
INTRODUCTION

Background

Musculoskeletal injuries are ranked second in the leading work related diseases and injuries in the U.S. (Millar, 1988). These conditions occur as a result of acute and chronic injury to muscles, tendons, ligaments, bones, joints, nerves, and vascular components. They are often referred to as wear-and-tear disorders, overuse injuries, degenerative joint diseases, chronic microtraumas, cumulative trauma disorders (CTD's), and repetitive strain injuries (RSI's). These injuries are the result of repeated or sustained activities of a musculoskeletal component that expose tissues to mechanical or overexertion stress.

The prevalence of worker discomfort in the work place is generally unknown. The warning provided by musculoskeletal discomfort and job dissatisfaction, in many cases, is a sign of the mismatch between the worker, tools, equipment, and work process. This should be viewed as a call for work place evaluation and intervention (Corlett & Bishop, 1976). Knowledge of the relationship between subjective experiences of discomfort and the use of objective assessments of the work place can contribute significantly to the development of programs designed to intervene or prevent injuries.

Identification of existing injuries and prevention of new injuries are the function of occupational surveillance

programs. Occupational surveillance programs utilize a number of methods to collect information on their workers. Preemployment physical examinations provide exposure history and medical baseline information on the worker's health status. Periodic medical surveillance is used to detect changes in the health condition of workers over time. Questionnaires can be utilized to identify concerns, symptoms, and discomfort in workers. Industrial hygiene evaluations of the interaction of the worker with the equipment and materials, commonly referred to as the work process, can provide valuable information on potential sources of injuries. The effectiveness of an occupational surveillance program is dependent upon the incorporation of preemployment physical examinations, periodic medical surveillance, questionnaires, and industrial hygiene evaluations to identify existing and potential sources of injury. Reliance on the use of only one occupational surveillance method to identify and prevent all injuries in the work place will result in incomplete risk assessment.

With the change in work environment away from the manufacturing setting to service industries, an increasing number of work places require video display terminal (VDT) operation by workers. VDT's have become the most frequently used equipment in the work place (Grandjean, 1987). Injury from repeated use and musculoskeletal discomfort from VDT's are commonplace according to the World Health Organization, 1987.

Due to the high prevalence of musculoskeletal discomfort and injury in VDT operators, occupational surveillance is necessary to identify workers with existing symptoms and to prevent further injuries. The use of questionnaires to identify workers and work sites is an appropriate screening technique. The Standardized Nordic Questionnaire for the Analysis of Musculoskeletal Symptoms (Kuorinka et al., 1987) and discomfort measures employed by Corlett and Bishop (1976) can be effective in many work environments to identify workers with symptoms.

Postural angle measurements of joint areas have been shown to be very effective in identifying workers with existing discomfort, injury, or a potential for injury (Grandjean, 1988). The use of objective postural angle measurements overcome measurement error limitations reported in subjective angle measurements obtained from photographs in the previous study of Starr, Shute, and Thompson (1985) and the measurement of video taped postural angles by Karwowski, Eberts, Salvendy, and Noland (1994). These postural studies evaluated specific work tasks in a specific work place. The findings of these studies have severe limitations on the inferences that can be made to other populations, and in many cases with similar populations, due to differences in equipment, materials, processes, and work environment. Postural angle differences exist between individuals performing the same task due to the physical diversity of individuals, type of work task, equipment, work processes, and environment. Postural studies need to be

performed incorporating the diversity within the population to better understand the potential effects on the population as a whole.

#### Purpose and Scope of the Study

The purpose of this study was to evaluate the relationship between musculoskeletal discomfort of the neck, shoulder, elbow, wrist, upper and lower back, and the use of nonneutral postures in these anatomical joint areas.

#### Hypotheses

Using the subjective data collected with the Standardized Nordic Discomfort Questionnaire (Kuorinka et al., 1987) and objective data collected on nonneutral postures, the following hypotheses were tested:

1. No significant relationship exists between demographic variables of age, height, weight, and tenure with postural joint variables of neck flexion, cervicobrachial rotation, shoulder flexion, shoulder abduction, wrist ulnar deviation, wrist extension, and trunk angle.
2. No significant relationship exists between gender and postural joint variables of neck flexion, cervicobrachial rotation, shoulder flexion, shoulder abduction, wrist ulnar deviation, wrist extension, and trunk angle.
3. No significant relationship exists between neck flexion angle and neck discomfort.
4. No significant relationship exists between cervicobrachial angle and neck discomfort.

5. No significant relationship exists between a combination of neck flexion angle with cervicobrachial angle and neck discomfort.
6. No significant relationship exists between shoulder flexion angle and shoulder discomfort.
7. No significant relationship exists between shoulder abduction angle and shoulder discomfort.
8. No significant relationship exists between a combination of shoulder flexion angle with shoulder abduction angle and shoulder discomfort.
9. No significant relationship exists between shoulder flexion angle and elbow discomfort.
10. No significant relationship exists between shoulder abduction angle and elbow discomfort.
11. No significant relationship exists between a combination of shoulder flexion angle with shoulder abduction angle and elbow discomfort.
12. No significant relationship exists between wrist ulnar deviation angle and wrist/hand discomfort.
13. No significant relationship exists between wrist extension angle and wrist/hand discomfort.
14. No significant relationship exists between a combination of wrist ulnar deviation angle with wrist extension angle and wrist/hand discomfort.
15. No significant relationship exists between trunk angle and upper back discomfort.
16. No significant relationship exists between trunk angle and lower back discomfort.

### Assumptions

The following assumptions were made in this study:

1. The respondents were aware of the frequency and location of discomfort experienced at their work site.
2. The participants were able to interpret the discomfort questionnaire questions and correctly record their answers.
3. All respondents answered the questions truthfully.

### Delimitations

The following were delimitations of the study:

1. Only ergonomic related stresses and symptoms were surveyed.
2. The survey was performed at one location.
3. Only VDT operators were included in the survey.
4. Only workers with more than one year on the job were surveyed.
5. Workers with previously identified musculoskeletal injuries were not excluded from the study.

### Limitations

The following were limitations to the study:

1. Workers surveyed utilize a variety of VDT terminals, desks, and chairs which may have an impact on working posture.
2. The forearm was not an identifiable discomfort area in the discomfort questionnaire which could result in error in assignment of discomfort symptom to wrist or elbow areas.

### Definitions

Cumulative Trauma Disorders - a term used to describe a class of soft tissue injuries and disorders that are caused, precipitated, or aggravated by a number of occupational activities, including repetitive motions, forceful exertions, and awkward postures. Disorders frequently observed in nerves, tendons, tendon sheaths, and upper extremities of workers. Examples include myalgia, tendinitis, tenosynovitis, and carpal tunnel syndrome (Keyserling, Stetson, Silverstein, & Brouwer, 1993).

Discomfort - a broad classification of symptoms including ache and pain (Kuorinka et al., 1987).

Ergonomics - a multidisciplinary science dealing with the interactions between personnel and the total work environment in order to achieve optimum adjustment in relation to the worker and the work environment with the goal of reducing unnecessary physiological and psychological stress (Grandjean, 1987).

Neutral Posture - position of a joint within  $\pm 15$  degrees of the natural resting position with no muscular contraction (Aaras, Westgaard, & Stranden, 1988).

Nonneutral Position - position of a joint beyond  $\pm 15$  degrees of the natural resting position with muscular contraction (Aaras et al., 1988).

Work Environment - the work environment consist of physical, chemical, psychological, and biological factors surrounding personnel in the workplace (Grandjean, 1988).

Work Equipment - the work equipment consists of tools, machines, and devices (i.e., chairs, computer terminals, and other components used at the work site) (Grandjean, 1988).

Work Place - the work place is the place of employment area allocated a person in the work system (Grandjean, 1988).

Work Process - the work process is the sequence in time and space of the interaction of people, work equipment, materials, energy, and information within a work system (Grandjean, 1988).

Work Stress - biomechanically, any external force acting on the body during the performance of a task. Application of work stress to the human body is the inevitable consequence of performance of any task, and is, therefore, only synonymous with "stressful work conditions" when excessive (Grandjean, 1988).

Work System - designed to perform a particular work task, a work system is constituted by people and work equipment acting together in the work process, at the workplace in the work environment under the conditions imposed by the work task (Grandjean, 1988).

Work Task - the work task is an isolative activity performed by a worker (Grandjean, 1988).

## CHAPTER II

### REVIEW OF RELATED LITERATURE

#### Introduction

As early as the 1977 Health Interview Survey of the National Center for Health Statistics, musculoskeletal injuries were ranked first in frequency of health problems that affect the quality of life in the U.S. (Millar, 1988). Musculoskeletal injuries are the leading cause of disability during the working years. They occur in nearly one-half the work force at some time during their working life. The prevalence of these injuries is expected to increase and in the computer work environment the increases are already evident (Grandjean, 1987). Prevention of these injuries requires the implementation of occupational surveillance, written or computer surveys, and risk factor evaluation of work sites.

#### Occupational Surveillance

Occupational surveillance is necessary to detect adverse health conditions and to identify workers at risk from potential and existing health hazards (Mintz, 1986). Some occupations have a greater potential for musculoskeletal injuries and disorders. Medical and industrial hygiene surveillance must be integrated to implement preventive and corrective actions in the work place (Parkinson & Grennan, 1986). Occupational surveillance has been the subject of study in many work environments in many countries. One that

has received widespread attention is carpal tunnel syndrome, the most commonly reported cumulative trauma disorder (Silverstein, Fine, & Armstrong, 1987). Cumulative trauma disorders in supermarket workers have been studied in the U.S. (Margolis & Kraus, 1987) and Australia (Ryan, 1989). The results of the studies support the association between repetitive motions and prolonged activities and the incidence of musculoskeletal discomfort symptoms in supermarket workers. The important finding of these occupational studies has led to widespread changes in the supermarket work place. The information has also been utilized by equipment manufactures, other retail operators, and workers to reduce exposure to the potential risk factors.

The objectives of surveillance can be accomplished by the use of preexisting data, physical examinations, and questionnaires (Fine, Silverstein, Armstrong, Anderson, & Sugano, 1986). Occupational surveillance can include a variety of methods to determine job tasks, work processes, and personnel with existing and potential for exposure to musculoskeletal risk factors. Preexisting data can be in the form of work related medical treatment, workmen's compensation claims, employee complaints and absenteeism, employee work site modifications, unpopular jobs, changes in productivity, and product quality. Physical examinations of new and existing employees can be effective in monitoring symptoms and signs of discomfort and injury (Mintz, 1986). The most effective method for identifying work sites with a

potential for worker injury is in the use of worker surveys. Worker discomfort surveys are the most widely used form of survey. These surveys utilize written and computer generated questionnaires.

#### Written Questionnaires

The measurement of subjective discomfort utilizing written questionnaires is a valuable tool for identification of workers with existing and potential exposure to musculoskeletal risk factors (Grandjean, 1988). Measurement of subjective discomfort can determine the prevalence of musculoskeletal injuries and disorders in a work population. Another use of these instruments can be to measure effectiveness of work site corrective actions in reducing discomfort on the job. The three most commonly used instruments utilize open or structured questionnaires, rating scales, and pictorial presentations (Kuorinka, 1983).

Surveys have historically been conducted utilizing written questionnaires with questions that are forced choice variants that can be self-administered or used in interviews (Kuorinka, et al. 1987). Checklists are used for evaluating ergonomic risk factors leading to cumulative trauma disorders (Keyserling, et al. 1993). In some cases, checklists are designed to be used by representatives of management and/or labor as a screening tool to identify work places with potentially harmful exposure to overexertion risk factors. The diversity of questionnaires is matched only by the diversity of the populations they are designed to evaluate. A number of limitations are inherent to all

questionnaires. Studies have determined that age, education, and experience of persons filling out the questionnaires may directly affect the data and reliability of instruments (Kuorinka, et al. 1987).

#### Computer-Based Questionnaires

Computers are becoming widely used in researching health issues. In many cases, the computer becomes the interviewer of the patient or worker. Slack, Hicks, Reed, & Van Cura (1966) designed a computer-based questionnaire to imitate the physician in collecting symptom information. Their findings concluded that computers could collect patient information effectively without personal interviewers and data handlers. Card et al. (1974) found the majority of patients viewed computer interrogation as acceptable, but the data collected were found to be less accurate than physician interrogation. Computer-based questionnaires have less flexibility in collecting data compared to a human interviewer. Age of individuals completing computer-based questionnaires has been found to influence data collection. Younger patients complete computer based questionnaires in a significantly shorter time than older patients (Quaak, Van Der Voort, Westerman, Hasman, & Van Bommel, 1987). They also found no significant difference in completion times between women and men. However, a study by Slack, Leviton, Bennett, Fleischmann, and Lawrence (1988) found that the time required for a person to respond to computer-based questions is related both to age and formal education. They also describe the concept of excluding potential human

interviewer bias in the collection of questionnaire data obtained using computers. The effect of an interviewer has been a subject of concern in many studies. Pynsent and Fairbank (1989) describe the acceptance of a computer-based interview system by patients with back pain. Additional benefits of using computers include the ease of data collection, efficiency of data analysis, and availability of data by the medical care system.

The use of computer-based surveys will continue to grow due to the acceptability by participants and the efficiency of data collection and analysis (Card et al. 1973; Quaak et al. 1987; Saldana, Herrin, Armstrong, & Franzblau, 1994). The primary concern in the use of computer-based surveys is the availability of surveys for both general work places and specific work processes. A second concern is the standardization and applicability of available survey instruments. The hardware and software requirements and the security required for these systems are also important considerations. Upon evaluation of these concerns, researchers will need to continue to use existing written instruments while monitoring the availability of computer-based instruments as they become obtainable.

#### Risk Factor Evaluation

Chaffin (1973) describes the problems associated with sustained or often repeated contractions of specific muscle groups. Evaluation of risk factors present as a result of fatigue and the increased deviation from the neutral joint posture is essential to the prevention of musculoskeletal

injuries. In 1988, Aaras et al. explored the postural angles of the upper arm as an indicator of load on the shoulder and risk of shoulder injury. Adopting a posture with a shoulder flexion of less than 15 degrees and a shoulder abduction of less than 10 degrees resulted in a significantly lower incidence of sick leaves due to shoulder injury.

Corlett and Bishop (1976) described a technique for recording postural discomfort in the body over the work period. The technique can be used to identify inadequate man-machine interaction and the effectiveness of ergonomic changes implemented. Constrained body postures and deviations from neutral postures are the most frequent source of discomfort in the work place (Corlett, Wilson, & Manenica, 1986). In 1993, Genaidy and Karwowski proposed a ranking system for the assessment of postural deviations based on body movements around various joints. The ranking of potentially hazardous postures allows for the targeting of corrective interventions to areas with the greatest potential for injury in the work place.

Knowledge of the relationship between subjective experiences of discomfort and objective measures will help in the development of methods to identify the existence of inadequate postures in work places at an early stage (Boussenna, Corlett, & Pheasant, 1982). Subjective instruments tend to underestimate discomfort and injury (Ohlsson, Attewell, Johnsson, Ahlm, & Skerfving, 1994). Objective measurements provide more reliable data and can be

more cost efficient when compared to comprehensive questionnaires. In most cases, objective measurement and evaluation will need to be performed on workers identified with discomfort using subjective instruments. This is necessary because the key to reducing discomfort is through the identification of risk factors and implementing corrective actions that will establish neutral working posture. The relationship between neutral postures and increased performance with decreased discomfort has been well established (Bhatnager, Drury, & Schiro, 1985).

#### Summary

Review of related literature indicated that research available on general ergonomic screening and interviewing programs is limited. The majority of research is specific problem analysis. Results of specific problem research generally lead to significant findings in the specific industry being studied. Findings from these studies, in many cases, have limited application to nonrelated fields. The availability of worker discomfort measurement instruments vary in application, complexity, and economic considerations. This is due in large part to the large diversity of equipment, materials, and work processes in the work place. Ergonomic evaluation of the work place was reported to be in its infancy (Fine et al., 1986) 10 years ago and remains at this stage largely due to the lack of evaluation instruments and disease/injury prevention strategies. Careful evaluation of available instruments must be completed prior to use as part of any study. This is necessary due to the limitations of many instruments.

## CHAPTER III

### METHODS AND PROCEDURES

#### Introduction

The purpose of this study was to evaluate the relationship between musculoskeletal discomfort of the neck, shoulder, elbow, wrist, upper and lower back, and the use of nonneutral postures in these anatomical joint areas. Descriptions of the methods and procedures used in this study are provided for the selection of subjects, completion of the worker discomfort inventory instrument, measurement of nonneutral postures, and statistical analysis of the data. Special precautions and considerations used are described in the summary.

#### Subject Selection

The finance and accounting division at a military base experienced a significant number of worker complaints, injuries reported, and lost workdays during the past 24 months related to musculoskeletal injuries (1993 & 1994 Safety Office Injury Logs). The VDT operator population consisted of approximately 500 workers. A random sample of 40 subjects was selected from seven teams on the worker personnel roster. All subjects were adults over 21 years of age. Individuals included in the sample population were required to have more than 12 months on the job and perform VDT tasks more than 4 hours a day. Many of the subjects have attended an ergonomic awareness training course

presented by the occupational health clinic approximately 18 months earlier. A work site assessment that included equipment, work process, and work task modifications to correct potential risk factors was completed for many of the subjects approximately 12 months earlier.

#### Worker Discomfort Inventory Instrument

The Standardized Nordic Questionnaire for the Analysis of Musculoskeletal Symptoms, developed by Kuorinka et al. (1987), was used to identify body areas experiencing musculoskeletal discomfort (see Appendix A). This instrument has been reported reliable by Karwowski et al. (1994) and Ohlsson et al. (1994) in screening work sites for worker discomfort. The instrument is widely used in unmodified and modified forms, and in some cases individual components extracted for use in work place studies.

The Standardized Nordic Questionnaire consists of three components. The first component of the questionnaire was used to collect demographic information pertaining to gender, age, tenure, height, weight, dominant hand, employment status, site identification, date, and subject comments. The second component collected historical data on the prevalence of discomfort in nine general body areas during last 12 months and current prevalence of discomfort during the last 7 days. Subjects indicated discomfort level on a 0 - 10 scale with 0 representing no discomfort, 5 representing moderate discomfort, and 10 representing extreme discomfort. The third component designed to collect medical treatment history information was not completed.

The questionnaire was administered to each worker upon completion of the posture angle measurements. A brief introduction to the discomfort instrument was presented with the recording of a hypothetical discomfort example. The questionnaire was collected from the participant upon completion of the next workers postural measurements. This was found to be adequate time for the worker to complete the discomfort questionnaire throughout the study.

#### Postural Angle Assessment

Seven anatomical joint areas of the body that experience nonneutral postures and awkward movement were examined. They included: (a) neck flexion, (b) cervicobrachial rotation, (c) shoulder flexion, (d) shoulder abduction, (e) wrist ulnar deviation, (f) wrist extension, and (g) trunk angle (see Appendix B). The measurements were obtained using a goniometer and a carpenter's level (Hunting, Laubli, & Grandjean, 1981). The measurements indicated the angle of deviation from the neutral posture reference point for each of the seven anatomical areas of the body. All measurements were obtained as the worker performed routine VDT tasks.

#### Postural Angle Measurements

Upon review of available literature and various recommended guidelines for VDT workstation design (Corlett et al., 1986; Grandjean, 1987; Hunting et al., 1981; Sauter, Schleifer, & Knutson, 1991) the following independent variables were measured in the VDT operators:

Angle A - Neck flexion angle (degrees). Stationary arm of goniometer extends parallel to the long axis of the trunk

and the movable arm extends along a line to the mastoid process in the sagittal plane.

Angle B - Cervicobrachial rotation (degrees). Angle of left or right rotation of the head in the transverse plane.

Angle C - Shoulder flexion angle (degrees). Landmarks were the acromion and lateral epicondyle of the humerus in the sagittal plane (Hunting et al., 1981).

Angle D - Shoulder abduction (degrees). Goniometer is positioned approximately midline against the lateral surface of shoulder, acromion to lateral condyle in stationary axis.

Angle E - Wrist ulnar deviation (degrees). The movable goniometer arm was aligned over the center of the third metacarpal of the second finger and the fixed goniometer arm was positioned midline of the forearm. This was performed for the dominant hand in the transverse plane.

Angle F - Wrist extension (degrees). The goniometer arms were aligned to be contiguous with the dorsal surfaces of the hand along the third metacarpal and midline of forearm in the sagittal plane.

Angle G - Trunk angle (degrees). Landmarks were the acromion and iliac crest in the sagittal plane (Grandjean, Hunting, & Piderman, 1983).

#### Summary

Subject evaluations were conducted on Thursday and Friday of a full work week. This was necessary to allow time for the full development of symptoms that may not become problematic during a short work week or immediately following a weekend. Experience has demonstrated that

individuals who are aware that their activities are being evaluated, may alter their routine leading to bias in the evaluation (Karwowski et al., 1994; Starr et al., 1985). Precautions were taken to ensure the worker was performing routine tasks and working at their assigned work place. The seven postural angle measurements were completed in sequence beginning with Angle A progressing through Angle G for each VDT worker. This sequence was performed three times to determine average postural angles for each anatomical area. Completing the posture measurements required approximately, 20 minutes. This allowed for the evaluation of 10 work sites each day. Four survey days were required to complete the 34 work site evaluations during Thursday and Friday afternoons of 2 successive weeks.

#### Data Analysis

Descriptive statistics for all the study variables are provided in tables in the Results section. Population demographic information including age, tenure, height, and weight was analyzed using forward stepwise regression for null hypothesis number one. Regression analysis was used to examine the effects of biodemographic characteristics on postural angles for each anatomical area. A Mann-Whitney U-test was performed to compare postural angles and gender of subjects in null hypothesis two. The Mann-Whitney U-test was used due to sample groups not meeting the Wilcoxon rank sum test requirement of both groups having a sample size of 10 or greater and normal distribution (Jaccard & Becker, 1990).

Spearman correlation was used to determine the relationship of postural angle measurements and postural joint discomfort levels of VDT workers. The nonparametric counterpart of the Pearson correlation was selected because the dependent variable discomfort was ordinal and the independent variable postural angle was measured at the ratio level. Anatomical areas of the neck, shoulder, and wrist with two postural joint movements occurring in one joint were evaluated for independent effect (null hypotheses 3, 4, 6, 7, 12, and 13), dependent interaction (null hypotheses 9 and 10), and cumulative effect (null hypotheses 5, 8, 11, and 14) of the two postural joint angles. Postural joint measurement of the trunk was used to compare upper and lower back discomfort in null hypotheses 15 and 16. Data were analyzed using the SAS System for Elementary Statistical Analysis, Version 6.8 (Schlotzhauer & Littell, 1991).

CHAPTER IV  
RESULTS AND DISCUSSION

Introduction

This chapter describes the data analysis of study variables in the following sections: Biodemographic Characteristics, Discomfort Questionnaire Characteristics, Postural Angle Measurements, and Results of Null Hypotheses Analyses.

During the data collection process, nonneutral postures were measured and discomfort questionnaires were completed on 35 VDT operators. Data provided by one participant on the discomfort questionnaire resulted in rejection from the sample population. Data analysis was performed on a total sample population of 34 subjects.

Descriptive Biodemographic Statistics

Mean age of subjects was 46.2 years (range 30-66 years) (see Table 1). Physical characteristics included a mean height of 165.9 cm (range 139.7-185.4 cm) and a mean weight of 76.1 kg (range 52.3-135.9 kg). The mean tenure for the subjects was 10.0 years (range 2-20 years).

Table 1. Biodemographic characteristics of VDT workers  
(N = 34)

Variable	Mean	SD	Range
Age (years)	46.2	9.2	30-66
Tenure (years)	10.0	4.0	2-20
Height (cm)	165.9	10.8	139.7-185.4
Weight (kg)	76.1	17.2	52.3-135.9

Gender and dominant hand use was examined in the subject population. There were significantly more females (27) than males (7), and right handed (31) than left handed (3) subjects, as shown in Table 2.

Table 2. Gender and dominant hand of subjects (N = 34)

Variable	n	Percent
Males	7	20.6
Females	27	79.4
Left Handed	3	8.8
Right Handed	31	91.2

#### Descriptive Discomfort Questionnaire Statistics

The prevalence of discomfort in VDT workers is presented in Table 3. The primary areas of discomfort during the last 12 months include the neck 58.8%, lower back 55.9%, shoulders 47.1%, wrist/hand 47.1%, and upper back 26.5%. The number of discomfort symptoms present during the last 12 months in the VDT workers exceeded the number of subjects in the study.

Table 3. Prevalence of discomfort in VDT workers (N = 34)

Anatomical Area	Discomfort Last 12 Months n	Discomfort Last 12 Months Percent	Discomfort Last 7 Days n	Discomfort Last 7 Days Percent
Neck	20	58.8	12	35.3
Shoulder	16	47.1	6	26.5
Elbow	5	14.7	3	8.8
Wrist/hand	16	47.1	6	17.6
Upper back	9	26.5	7	20.6
Lower back	19	55.9	10	29.4

The occurrence of discomfort during the last 7 days provided data on current symptomology in the survey population. Discomfort during the last 7 days occurred primarily in the neck for 35.3% of the survey population. Other discomfort areas included the lower back 29.4%, shoulder 26.5%, upper back 20.6%, wrist/hand 17.6%, and elbow with 8.8% frequency.

#### Descriptive Postural Angle Statistics

Posture angle measurements were performed on seven anatomical joint areas frequently associated with discomfort and injury (see Table 4). Mean goniometer measurements in degrees for the seven postural angles were: (a) head flexion 16.1, (b) cervicobrachial rotation 19.5, (c) shoulder flexion 21.7, (d) shoulder abduction 20.9, (e) wrist ulnar deviation 7.8, (f) wrist extension 28.1 from a neutral reference point of 0, and (g) trunk 90.8 from a neutral reference of 90. Neutral posture was defined as a joint angle within 0-15 degrees of the neutral reference point.

Table 4. Postural angle characteristics in degrees for VDT workers ( $N = 34$ )

Variable	Mean	SD	Range
Neck Flexion (deg)	16.1	8.1	5-43
Cervicobrachial Rotation (deg)	19.5	6.0	8-45
Shoulder Flexion (deg)	21.7	13.0	4-47
Shoulder abduction (deg)	20.9	7.4	3-42
Wrist ulnar deviation (deg)	7.8	6.3	0-21
Wrist Extension (deg)	28.1	10.0	4-46
Trunk (deg)	90.8	5.3	80-108

All postural angle mean measurements in the sample population were within 1 SD of their acceptable neutral posture in their respective planes with the exception of the wrist extension. Wrist extension (28.2 degrees) was within 1.5 SD of the reference neutral point of 0 degrees from the horizontal plane.

#### Results of Null Hypotheses Analyses

Forward stepwise regression analysis was performed to evaluate the relationship between biodemographic variables and postural angle variables. The Mann-Whitney U-test was used to determine if a significant relationship exists between postural angles and gender. This nonparametric test was selected because a normal distribution did not exist and both sample groups did not have a sample size of 10 or greater required by the Wilcoxon rank sum test. The Spearman correlation was used to evaluate the relationship between postural joint angle variables and anatomical discomfort levels of the postural joints. After statistical analyses, the following results to the null hypotheses were found:

Hypothesis 1: No significant relationship existed between demographic variables of age, height, weight, and tenure with postural joint variables of neck flexion and cervicobrachial rotation, shoulder flexion and abduction, wrist ulnar deviation and extension, and trunk angle. Forward stepwise regression was used to determine if a relationship existed between demographic and postural joint angle variables. Age and height were found to explain 16

and 13% of the variance found with neck flexion angle ( $R^2 = .16/.02$ ) and ( $R^2 = .13/.03$ ) respectively, at the .02 and .03 significance levels. The regression equation is: neck flexion angle =  $-43.4 + .34$  (age) +  $.67$  (height). Weight was found to explain 15% of the variance found with shoulder abduction angle at the .01 significance level ( $R^2 = .15/.01$ ). Tenure was found to explain 17% of the variance found with cervicobrachial rotation angle at the .01 significance level ( $R^2 = .17/.01$ ). The amounts of explained variance due to the biodemographic variables age (16%), height (13%), weight (15%), and tenure (17%) were not at levels considered to be meaningful predictors of discomfort for the postural joint variables. Criteria for the determination of predictive values for the variables was a partial  $R^2 \geq .50/.05$ . Upon examination of the total amounts of explained variance, it was concluded that none of these analyses produced meaningful predictors for the biodemographic variables. Results can be found in Table 5.

Table 5. Regression results (partial  $R^2$ ) of biodemographic variables with postural angles in VDT workers ( $N = 34$ )

Regressor	Neck Flex. <sup>1</sup>	Cerv. Rota. <sup>2</sup>	Shoulder Flex.	Shoulder Abd. <sup>3</sup>	Wrist Ext. <sup>4</sup>	Wrist Dev. <sup>5</sup>	Trunk
Age	.16/.02	-	-	-	-	-	-
Height	.13/.03	-	-	-	-	-	-
Weight	-	-	-	.15/.01	-	-	-
Tenure	-	.17/.01	-	-	-	-	-

Note. 1 = Flexion 2 = Cervicobrachial Rotation 3 = Abduction  
4 = Extension 5 = Ulnar Deviation

Note.- Represents  $p > .05$

Hypothesis 2: No significant relationship existed between gender and postural joint variables of neck flexion, cervicobrachial rotation, shoulder flexion, shoulder abduction, wrist ulnar deviation, wrist extension, and trunk angle. The Mann-Whitney U-test was applied to the ranked data comparing female ( $n = 27$ ) and male ( $n = 7$ ) postural angle measurements in VDT operators. The calculated U statistics for neck flexion (60), cervicobrachial rotation (93), shoulder flexion (94), shoulder abduction (78), wrist ulnar deviation (62), wrist extension (68), and trunk angle (92) were compared to the critical value of  $U = 34$ ,  $p < .05$ , for each of the anatomical postural angles and found differences due to gender not to be significant. Statistical results failed to support rejection of the null hypothesis (see Table 6).

Table 6. Statistical comparison of gender postural angles in VDT workers ( $N = 34$ )

Anatomical Area		Female	Male	*U Statistic
Neck flexion (deg)	<u>M</u>	14.8	21.4	60
	<u>SD</u>	6.4	10.7	
Cervicobrachial rotation (deg)	<u>M</u>	19.7	18.6	93
	<u>SD</u>	6.0	5.4	
Shoulder flexion (deg)	<u>M</u>	21.8	21.4	94
	<u>SD</u>	12.8	12.7	
Shoulder abduction (deg)	<u>M</u>	20.8	21.3	78
	<u>SD</u>	6.9	8.7	
Wrist extension (deg)	<u>M</u>	7.1	10.6	68
	<u>SD</u>	6.2	5.5	
Wrist ulnar deviation (deg)	<u>M</u>	27.2	32.0	62
	<u>SD</u>	10.4	6.3	
Trunk (deg)	<u>M</u>	90.6	91.4	92
	<u>SD</u>	4.6	7.2	

Note. \*Mann-Whitney U-test critical  $U = 34$ ,  $p < .05$

Hypothesis 3: No significant relationship existed between neck flexion angle and neck discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = -.10$ . This value indicated a slight negative relationship between the variables. The reported significance probability was .58, which exceeds the  $p < .05$  test criteria established for all hypotheses. Statistical results failed to support rejection of the null hypothesis. These results are found in Table 7.

Table 7. Spearman rank-order correlation of discomfort level and postural angle (N = 34)

Variable		Discomfort Level	Postural Angle(deg)	$r_s$	p-value
Neck Area					
Neck Flexion	<u>M</u>	2.9	16.1	-0.10	.58
	<u>SD</u>	2.9	8.1		
Cervicobrachial Rotation	<u>M</u>	2.9	19.5	0.11	.52
	<u>SD</u>	2.9	6.0		
Flexion & Rotation	<u>M</u>	2.9	35.6	0.10	.56
	<u>SD</u>	2.9	10.1		
Shoulder Area					
Shoulder Flexion	<u>M</u>	2.9	21.7	0.14	.45
	<u>SD</u>	3.4	13.0		
Shoulder Abduction	<u>M</u>	2.9	20.9	0.19	.28
	<u>SD</u>	3.4	7.4		
Flexion & Abduction	<u>M</u>	2.9	42.6	0.20	.25
	<u>SD</u>	3.4	16.5		
Elbow Area					
Shoulder Flexion	<u>M</u>	0.7	21.7	-0.07	.69
	<u>SD</u>	1.7	13.0		
Shoulder Abduction	<u>M</u>	0.7	20.9	0.10	.57
	<u>SD</u>	1.7	7.4		
Flexion & Abduction	<u>M</u>	0.7	42.6	0.04	.98
	<u>SD</u>	1.7	16.5		

(table continues)

Variable		Discomfort Level	Postural Angle(deg)	$r_s$	p-value
Wrist/Hand Area					
Wrist Ulnar Deviation	M	2.1	7.8	0.20	.25
	SD	2.7	6.3		
Wrist Extension	M	2.1	28.1	-0.19	.28
	SD	2.7	10.0		
Extension & Deviation	M	2.1	35.9	-0.12	.51
	SD	2.7	10.3		
Upper Back Area					
Trunk	M	1.8	90.8	-0.07	.71
	SD	3.1	5.3		
Lower Back Area					
Trunk	M	2.7	90.8	0.05	.79
	SD	2.9	5.3		

Note. Critical  $r_s = \pm .344$   $p < .05$

Hypothesis 4: No significant relationship existed between cervicobrachial angle and neck discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .11$ . This value gives the appearance of a weak relationship between variables. The reported significance probability was .52, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 5: No significant relationship existed between a combination of neck flexion angle with cervicobrachial rotation angle and neck discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = 0.10$ . This value gives the appearance of a weak relationship between

probability was .56, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 6: No significant relationship existed between shoulder flexion angle and shoulder discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .14$ . This value indicates a weak relationship between the variables. The reported significance probability was .45, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 7: No significant relationship existed between shoulder abduction angle and shoulder discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .19$ . This value gives the appearance of a weak relationship between variables. The reported significance probability was .28, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 8: No significant relationship existed between a combination of shoulder flexion angle with shoulder abduction angle and shoulder discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = 0.20$ . This value gives the appearance of a weak

relationship between variables. The significance probability was .25, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 9: No significant relationship existed between shoulder flexion angle and elbow discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = -.07$ . This value indicates a very weak negative relationship between the variables. The reported significance probability was .69, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 10: No significant relationship existed between shoulder abduction angle and elbow discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .10$ . This value gives the appearance of a weak relationship between variables. The reported significance probability was .57, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis (see Table 7).

Hypothesis 11: No significant relationship existed between a combination of shoulder flexion angle with shoulder abduction angle and elbow discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = 0.04$ . This value gives the appearance of a weak relationship between

variables. The significance probability was .98, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 12: No significant relationship existed between wrist ulnar deviation angle and wrist/hand discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .20$ . This value indicates a weak relationship between the variables. The reported significance probability was .25, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis (see Table 7).

Hypothesis 13: No significant relationship existed between wrist extension angle and wrist/hand discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = -.19$ . This value gives the appearance of a weak negative relationship between variables. The reported significance probability was .28, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis (see Table 7).

Hypothesis 14: No significant relationship existed between a combination of wrist ulnar deviation angle with wrist extension angle and wrist/hand discomfort. A Spearman rank-order correlation addressed the relationship between these variables resulting in  $r_s = -.12$ . This value gives the appearance of a weak negative relationship between

variables. The significance probability was .51, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis. These results are in Table 7.

Hypothesis 15: No significant relationship existed between trunk angle and upper back discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = -.07$ . This value indicates a very weak negative relationship between the variables. The reported significance probability was .71, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis (see Table 7).

Hypothesis 16: No significant relationship existed between trunk angle and lower back discomfort. A Spearman rank-order correlation addressed the relationship between rank scores on these variables producing a  $r_s = .05$ . This value gives the appearance of a very weak relationship between variables. The reported significance probability was .79, which exceeds the  $p < .05$ . Statistical results failed to support rejection of the null hypothesis (see Table 7).

#### Discussion

Posture has been found to be a primary risk factor in the development of musculoskeletal discomfort and injury (Aaras et al., 1988; Boussenna et al., 1982; Corlett et al., 1986; Grandjean, 1988; Pascarelli & Quilter, 1994). The results of this study are contrary to previous research. Two earlier events occurred in this study population that may

have produced a positive or negative effect on the study population and a negative effect on this study. The first event that may have had an impact on the study population was attendance, by some subjects 18 months earlier, in an ergonomic awareness training program presented by the occupational health clinic. The awareness program consisted of a presentation describing the types of musculoskeletal injuries that occur in the office environment, symptoms of injuries, treatment alternatives, liability issues, and a brief explanation of ergonomic principles that have been shown to be effective in reducing injuries and discomfort. This was accomplished during a 45 minute lecture utilizing visual media.

Secondly, 12 months prior to this study, some subjects had their work site evaluated and corrective measures undertaken to reduce existing and potential injury risk factors. The work site evaluation consisted of identifying nonneutral postures, poor worker/equipment interface, tasking methods, and work process flow. All risk factors identified were corrected upon completion of the work site evaluation. These events may have influenced the outcomes of this study. This possibility is supported by the differences in prevalence of discomfort reported during last 12 months and last 7 days by VDT workers in Table 3. The findings of no significant differences between discomfort levels and postural angles in Table 7 also support this possibility. In the event nonneutral postural angles are not the source of discomfort, other factors not measured in

this study need to be examined. This can be seen clearly in the high prevalence of low back discomfort at 55.9% (see Table 3), while greater than two standard deviations (95%) of the sample population had neutral postures that are not predictors of discomfort (see Table 4).

Accepting that awareness training and work site interventions were effective in reducing the nonneutral postures and discomfort levels, other risk factors may be responsible for the observed discomfort present in the study population. Along with nonneutral posture, static loading, (i.e., maintaining fixed posture over time), number of musculoskeletal repetitions, amount of force, work/rest ratio, lack of task variety, and physical mobility are physical predictors of potential injury and discomfort. These physical risk factors can produce injury and discomfort independently or as the result of combinations of risk factors. Further examination of the impact of the health education and health promotion programs on worker discomfort is warranted.

Additional areas that must be considered are the attitude, work place climate, and level of job dissatisfaction in the workers. These factors can influence the reporting of discomfort by individuals and the group as a whole. The department from which the subjects in this study belong, are in the middle of a reduction and/or reassignment of approximately one-third of the workers. For many of these individuals, this is a stressful time. The level of physical discomfort reported may have been

influenced as a result of this situation and confounded the relationship between nonneutral postures and worker discomfort.

## CHAPTER V

### SUMMARY, CONCLUSION, AND RECOMMENDATIONS

#### Summary

This study attempted to determine if a significant relationship existed between postural angles and discomfort in VDT workers. This investigation also examined the relationships between age, tenure, height, and weight with postural angles. In addition, differences in postural angles were examined between gender.

The final subject population consisted of 34 VDT workers employed at the finance and accounting division at Fort McCoy, Wisconsin. Subject participation in the study required involvement in two data collection processes. The first process involved the measurement of postural angles while the worker performed routine tasks. This was viewed as a critical element of the study by the researcher requiring patience, attention, and cooperation of the worker and researcher. The second process involved the completion of the Standardized Nordic Questionnaire by the VDT worker to obtain demographic and discomfort data.

Statistical analyses of 16 hypotheses were completed using the following statistical procedures: Forward stepwise regression analysis. Nonparametric tests include the Mann-Whitney U-test and Spearman rank-order correlation. All hypotheses were tested at the .05 level of significance.

The following results were obtained from the study:

1. There was no significant relationship between age, tenure, height, and weight with postural angles.
2. There was no significant relationship between gender and postural angles.
3. There was no significant relationship between neck flexion angle and neck discomfort.
4. There was no significant relationship between cervicobrachial angle and neck discomfort.
5. There was no significant relationship between a combination of neck flexion angle with cervicobrachial angle and neck discomfort.
6. There was no significant relationship between shoulder flexion angle and shoulder discomfort.
7. There was no significant relationship between shoulder abduction angle and shoulder discomfort.
8. There was no significant relationship between a combination of shoulder flexion angle with shoulder abduction angle and shoulder discomfort.
9. There was no significant relationship between shoulder flexion angle and elbow discomfort.
10. There was no significant relationship between shoulder abduction angle and elbow discomfort.
11. There was no significant relationship between a combination of shoulder flexion angle with shoulder abduction angle and elbow discomfort.
12. There was no significant relationship between wrist ulnar deviation angle and wrist/hand discomfort.

13. There was no significant relationship between wrist extension angle and wrist/hand discomfort.
14. There was no significant relationship between a combination of wrist ulnar deviation angle with wrist extension angle and wrist/hand discomfort.
15. There was no significant relationship between trunk angle and upper back discomfort.
16. There was no significant relationship between trunk angle and lower back discomfort.

#### Conclusions

Results indicated that postural angles were not a predictor of discomfort in the VDT worker population in this study. Posture is one of six generic categories of risk factors known to produce musculoskeletal discomfort and injury. The occurrence of discomfort can result from the presence of an individual risk factor or a combination of risk factors. The high prevalence rates of discomfort found in the study subjects indicate that other risk factors not included in this study are present in the work place.

The discomfort questionnaire was found to be a valuable instrument for the collection of worker discomfort. Data collected were meaningful and useful in the identification of individuals and anatomical body areas experiencing discomfort. The ease in completing the questionnaire reported by subjects contributed to the acceptability of the instrument.

Many of the VDT workers in this study have had an ergonomic awareness training session. This training took

place approximately 18 months prior to this study. In addition, many subjects had their work site evaluated and corrective measures undertaken to reduce existing and potential injury risk factors. Individuals were counseled in using correct posture, varying work tasks, and changing their work process. These preventive actions may be responsible for the lack of postural angle differences between VDT workers with discomfort and with no discomfort.

#### Study Recommendations

The following recommendations for expanded health education, health promotion, and disease/injury prevention are presented.

1. Perform additional studies on the current subject population to identify risk factors related to the prevalence of existing discomfort.
2. Perform pretest and posttest assessments on work populations to determine impact of training and intervention programs.
3. Evaluate repetition frequencies, work:rest ratio, lack of mobility, equipment use, and work process of VDT workers.
4. Replicate this study using a larger population of VDT workers performing identical tasks to determine if lack of significance could be attributed to tasking differences.
5. Conduct studies with other employers having similar employee populations. Geographic location, size of

employee population, management style, and work environment could impact on the results.

6. Evaluate other sampling methods for collecting data from the sample population. Multiple matrix sampling provides for sampling larger populations with fewer survey items. Advantages to the multiple matrix method include less data collection time, people, and expense.
7. Encourage all employers to become active participants in health education, health promotion, and disease/injury prevention programs for the identification, treatment, and prevention of musculoskeletal and all other injuries in the work place.
8. Encourage all workers to become involved in health issues, practice healthy lifestyles, and utilize disease/injury prevention behaviors.

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APPENDIX A

WORKER DISCOMFORT INVENTORY INSTRUMENT

Subject \_\_\_\_\_

Address \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Location \_\_\_\_\_

Date of Survey

\_\_\_\_/\_\_\_\_/\_\_\_\_  
year/month/day

Sex

1 Female 2 Male  
(Circle one Number)

Year of Birth

19\_\_\_\_

How many years and months have you been  
doing your present type of work?

\_\_\_\_ years \_\_\_\_ months

Your employment status is?

\_\_\_\_ full-time \_\_\_\_ part-time

On average how many hours a week  
do you work?

\_\_\_\_ hours a week

How much do you weigh?

\_\_\_\_ lbs

What is your height?

\_\_\_\_ ft \_\_\_\_ inches

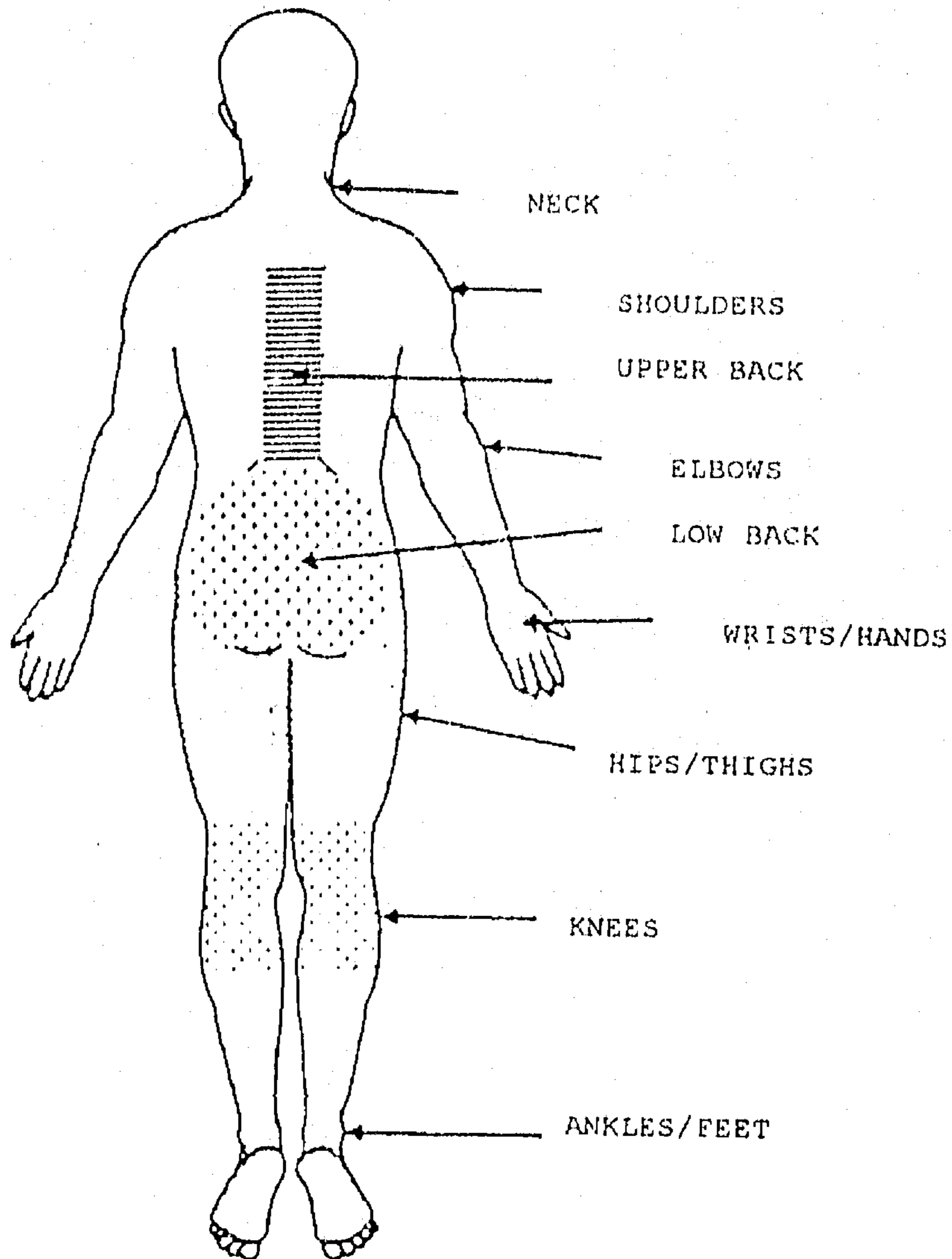
Are you right or left handed?

1 Right 2 Left  
(Circle one Number)

Comments:

How to answer the questionnaire:

Please answer placing a circle around the appropriate number - one circle for each question. You may be in doubt as to how to answer, but please do your best anyway. Please answer every question, even if you have never had trouble in any part of your body.



In this picture you can see the approximate position of the parts of the body referred to in the questionnaire. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which location you have or have had your trouble (if any).

## Trouble with the locomotive organs

To be answered by those who  
have had trouble

Have you at any time during the last  
12 months had trouble (ache, pain,  
discomfort) in:

Have you at any time  
during the last 12  
months been prevented  
from doing your  
normal work (at home  
or away from home) be-  
cause of the trouble?

Have you had trouble  
at any time during  
the last 7 days?

### Neck

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

### Shoulders

1 No 2 Yes in the right shoulder  
3 Yes in my left shoulder  
4 Yes in both shoulders

1 No 2 Yes

1 No 2 Yes

### Elbows

1 No 2 Yes in the right elbow  
3 Yes in my left elbow  
4 Yes in both elbows

1 No 2 Yes

1 No 2 Yes

### Wrist/Hands

1 No 2 Yes in the right wrist/hand  
3 Yes in my left wrist/hand  
4 Yes in both wrists/hands

1 No 2 Yes

1 No 2 Yes

### Upper Back

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

### Low Back

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

### One or both Hips/Thighs

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

### One or both Knees

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

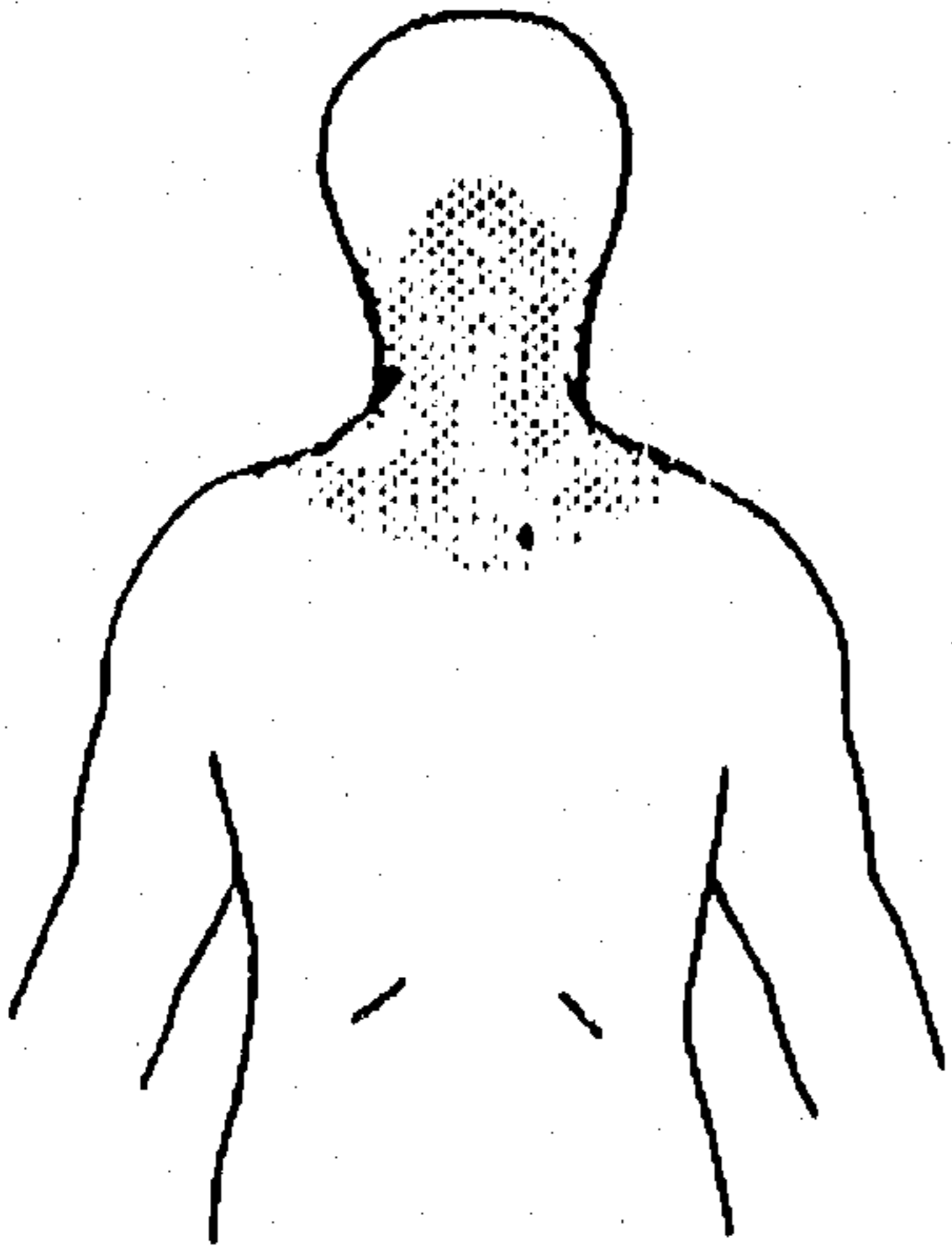
### One or both Ankles/Feet

1 No 2 Yes

1 No 2 Yes

1 No 2 Yes

## Neck



How to answer the questionnaire: In this picture you can see the appropriate position of the part of the body referred to in the questionnaire. By neck trouble is meant ache, pain or discomfort in the shaded area. Please concentrate on this area, ignoring any trouble you may have in adjacent parts of the body. There is a separate questionnaire for shoulder trouble.

Please answer by putting a circle around the appropriate number - one circle for each question. You may be in doubt as to how to answer, but please do your best anyway.

1. Have you ever had neck trouble (ache, pain or discomfort)?

1 No      2 Yes

If you answered No to question 1, do not answer questions 2 - 8.

2. Have you ever been hospitalized because of neck neck trouble?

1 No      2 Yes

3. Have you ever had to change jobs or duties because of neck trouble?

1 No      2 Yes

4. What is the total length of time that you have had neck trouble during the last 12 months?

1 0 days  
2 1 - 7 days  
3 8 - 30 days  
4 More than 30 days  
5 Every day

If you answered 0 days to question 4, do not answer questions 5 - 8.

5. Has neck trouble caused you to reduce your activity during the last 12 months.

a. Work activity (at home or away from home)?

1 No      2 Yes

b. Leisure activity?

1 No      2 Yes

6. What is the total length of time that trouble has prevented you from doing your normal work (at home or away from home) during the last 12 months?

1 0 days  
2 1 - 3 days  
3 8 - 30 days  
4 More than 30 days

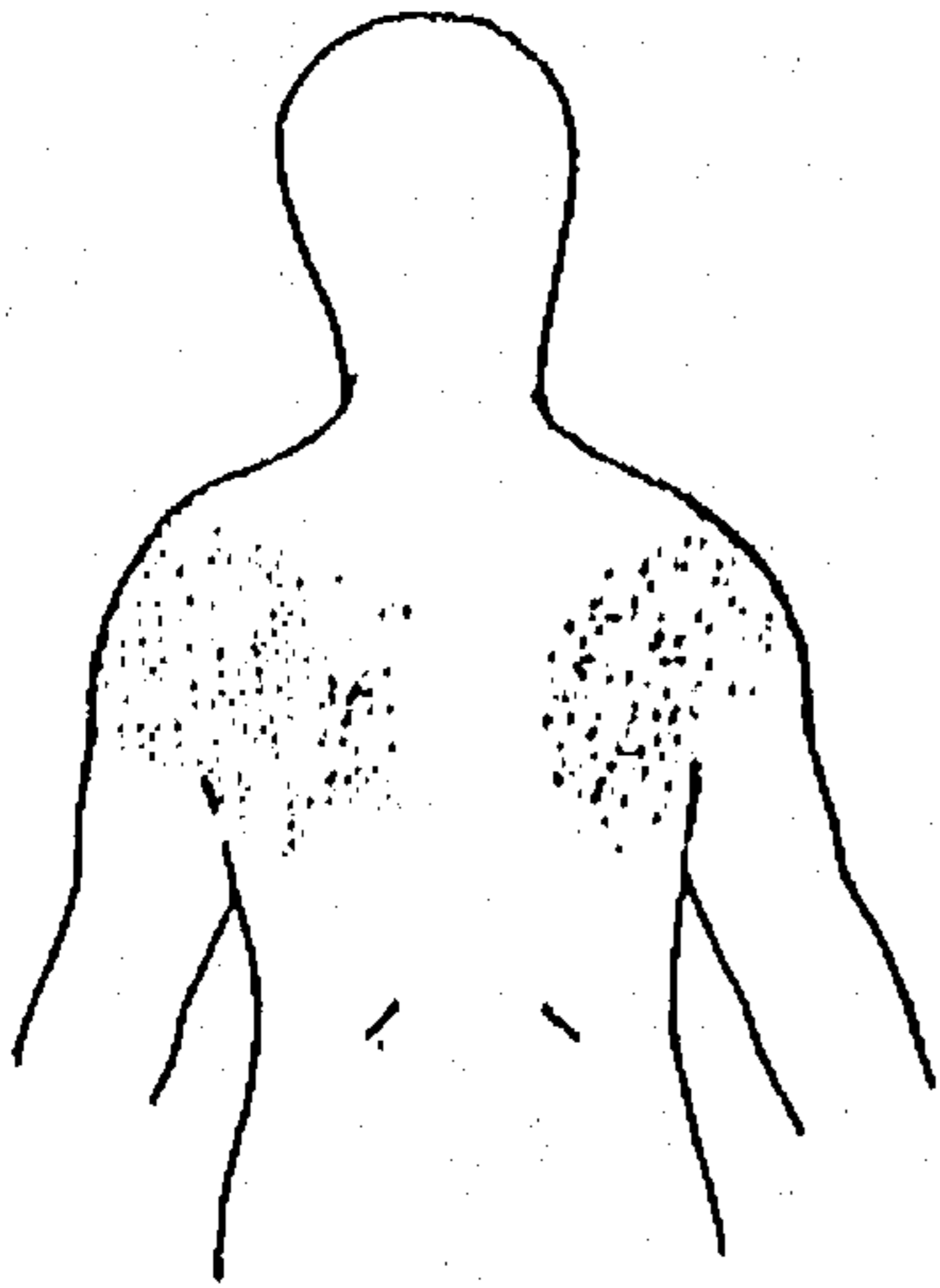
7. Have you been seen by a doctor, physio-therapist, chiropractor or other such person because of neck trouble during the last 12 months?

1 No      2 Yes

8. Have you had neck trouble at any time during the last 7 days?

1 No      2 Yes

## Shoulders



How to answer the questionnaire: In this picture you can see the appropriate position of the part of the body referred to in the questionnaire. By shoulder trouble is meant pain or discomfort in the shaded area. Please concentrate on this area, ignoring any trouble you may have in adjacent parts of the body. There is a separate questionnaire for neck trouble.

Please answer by putting a circle around the appropriate number - one circle for each question. You may be in doubt as to how to answer, but please do your best anyway.

1. Have you ever had shoulder trouble (ache, pain or discomfort)?

1 No      2 Yes

If you answered No to question 1, do not answer questions 2 - 8.

2. Have you ever been hospitalized because of shoulder trouble?

1 No      2 Yes

3. Have you ever had to change jobs or duties because of shoulder trouble?

1 No      2 Yes

4. What is the total length of time that you have had shoulder trouble during the last 12 months?

1 0 days  
2 1 - 7 days  
3 8 - 30 days  
4 More than 30 days  
5 Every day

If you answered 0 days to question 4, do not answer questions 5 - 8.

5. Has shoulder trouble caused you to reduce your activity during the last 12 months.

a. Work activity (at home or away from home)?

1 No      2 Yes

b. Leisure activity?

1 No      2 Yes

6. What is the total length of time that trouble has prevented you from doing your normal work (at home or away from home) during the last 12 months?

1 0 days  
2 1 - 3 days  
3 8 - 30 days  
4 More than 30 days

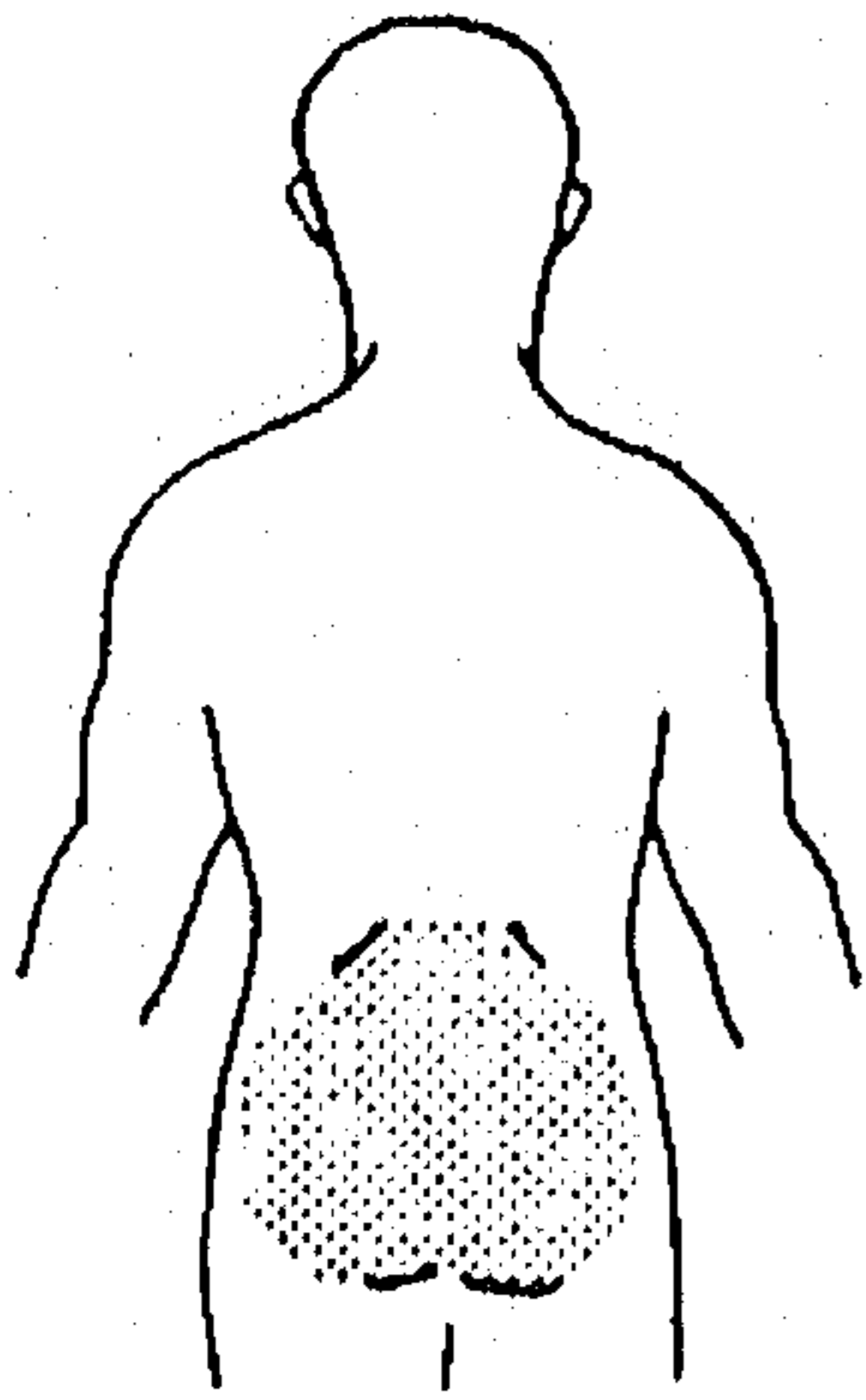
7. Have you been seen by a doctor, physio-therapist, chiropractor or other such person because of shoulder trouble during the last 12 months?

1 No      2 Yes

8. Have you had shoulder trouble at any time during the last 7 days?

1 No      2 Yes

## Low back



How to answer the questionnaire: In this picture you can see the appropriate position of the part of the body referred to in the questionnaire. By low back trouble is meant ache, pain or discomfort in the shaded area. Please concentrate on this area, ignoring any trouble you may have in adjacent parts of the body.

Please answer by putting a circle around the appropriate number - one circle for each question. You may be in doubt as to how to answer, but please do your best anyway.

1. Have you ever had low back trouble (ache, pain or discomfort)?

1 No      2 Yes

If you answered No to question 1, do not answer questions 2 - 8.

2. Have you ever been hospitalized because of low back low back trouble?

1 No      2 Yes

3. Have you ever had to change jobs or duties because of low back trouble?

1 No      2 Yes

4. What is the total length of time that you have had low back trouble during the last 12 months?

1 0 days  
2 1 - 7 days  
3 8 - 30 days  
4 More than 30 days  
5 Every day

If you answered 0 days to question 4, do not answer questions 5 - 8.

5. Has low back trouble caused you to reduce your activity during the last 12 months.

a. Work activity (at home or away from home)?

1 No      2 Yes

b. Leisure activity?

1 No      2 Yes

6. What is the total length of time that trouble has prevented you from doing your normal work (at home or away from home) during the last 12 months?

1 0 days  
2 1 - 3 days  
3 8 - 30 days  
4 More than 30 days

7. Have you been seen by a doctor, physio-therapist, chiropractor or other such person because of low back trouble during the last 12 months?

1 No      2 Yes

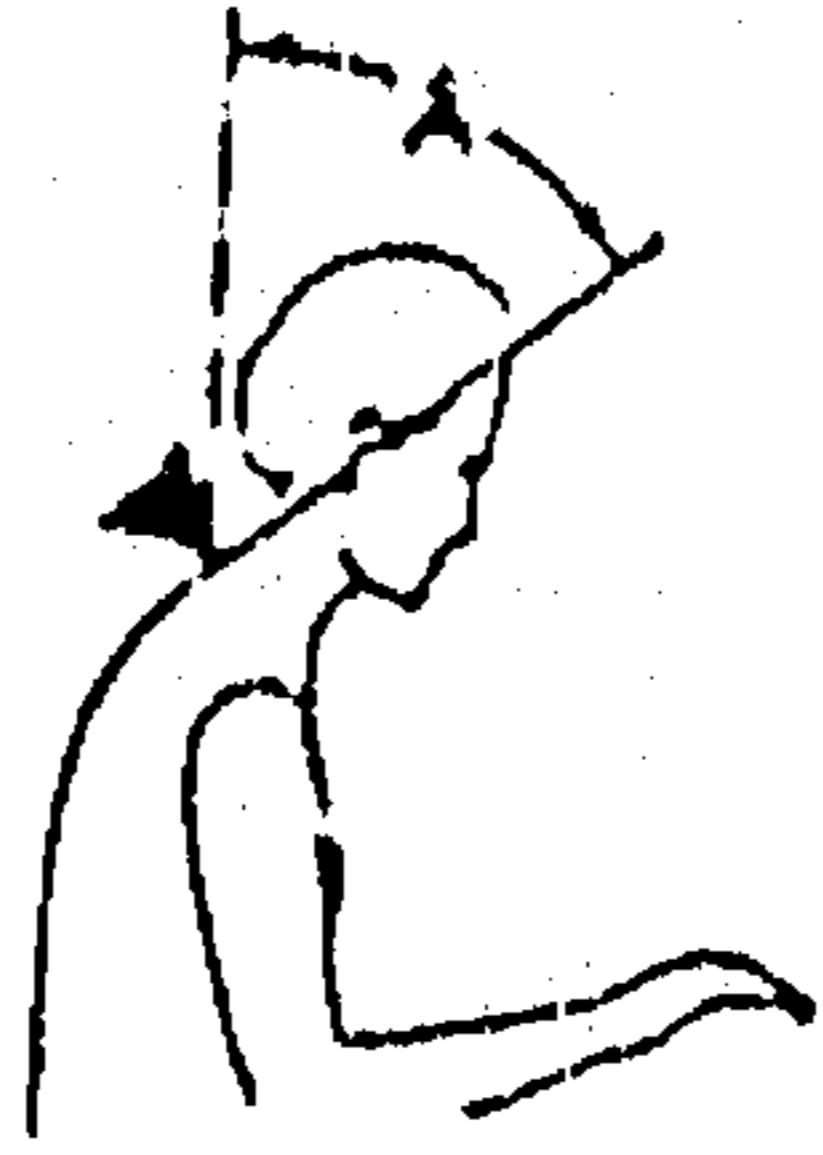
8. Have you had low back trouble at any time during the last 7 days?

1 No      2 Yes

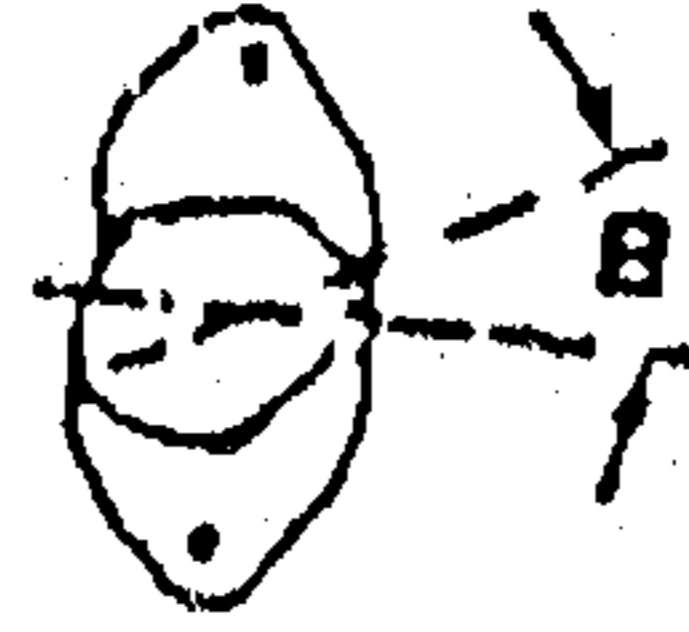
APPENDIX B

NONNEUTRAL POSTURE INVENTORY INSTRUMENT

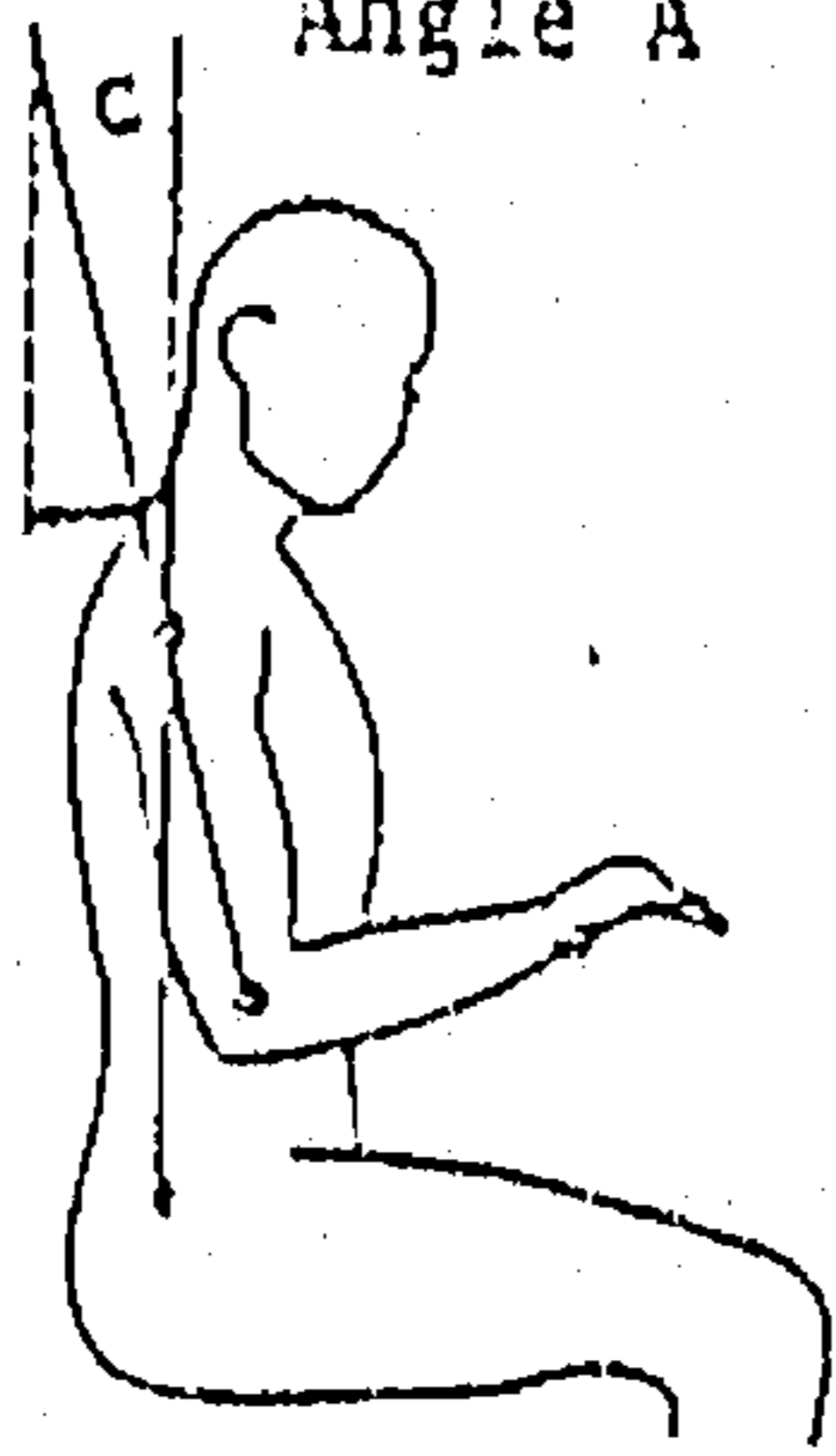
Nonneutral Posture Measurements



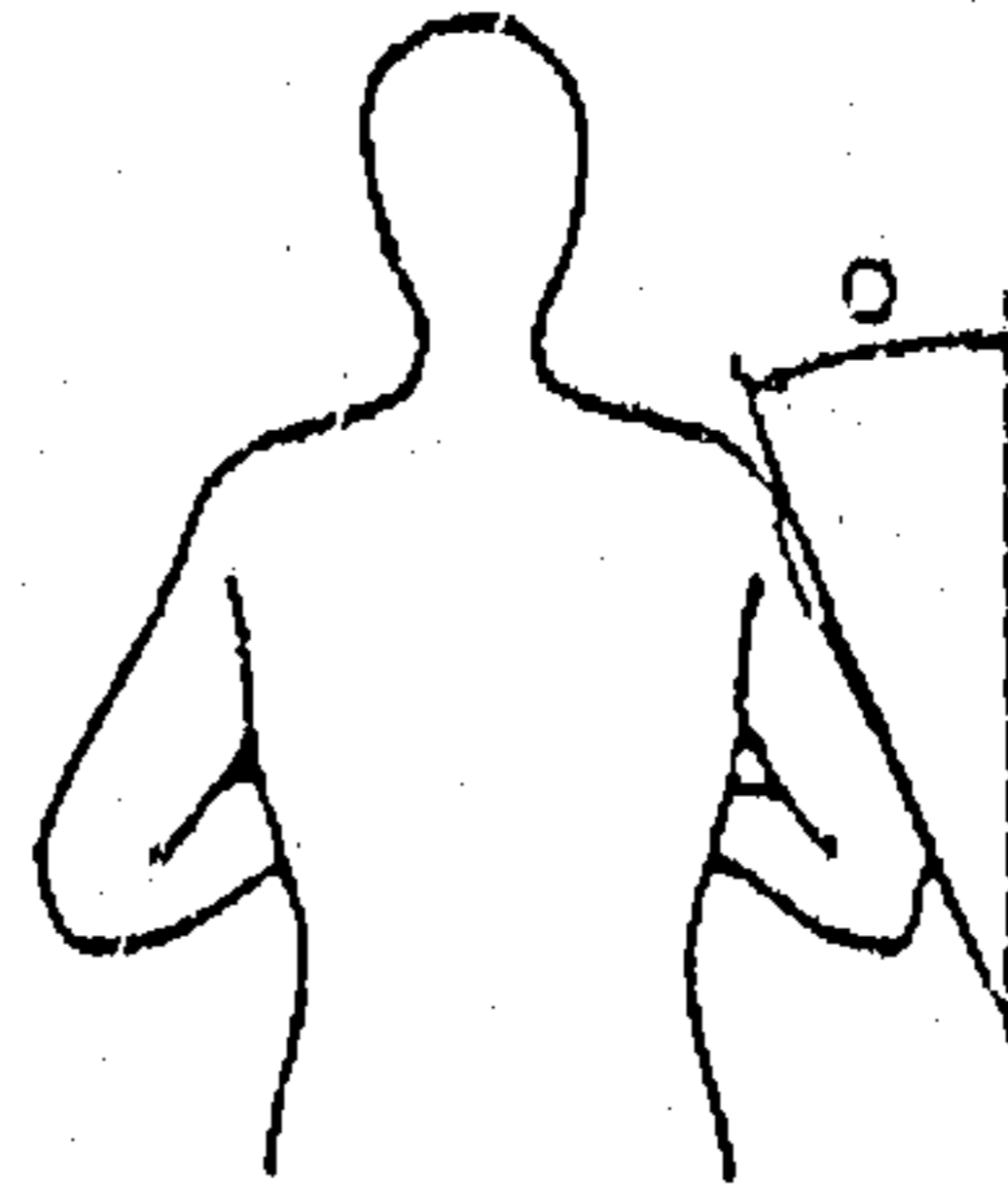
Angle A



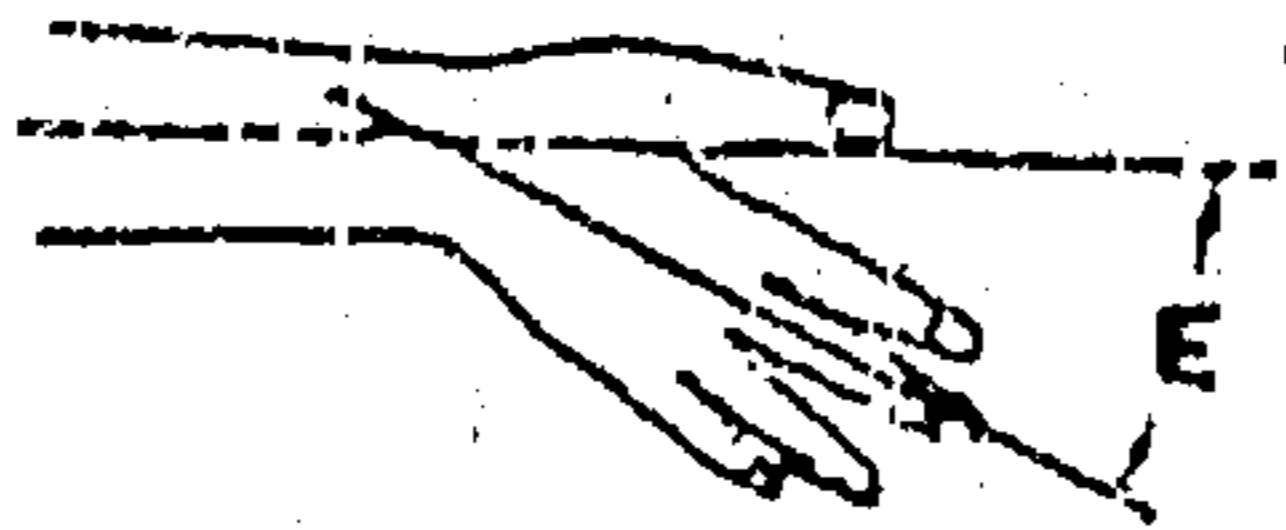
Angle B



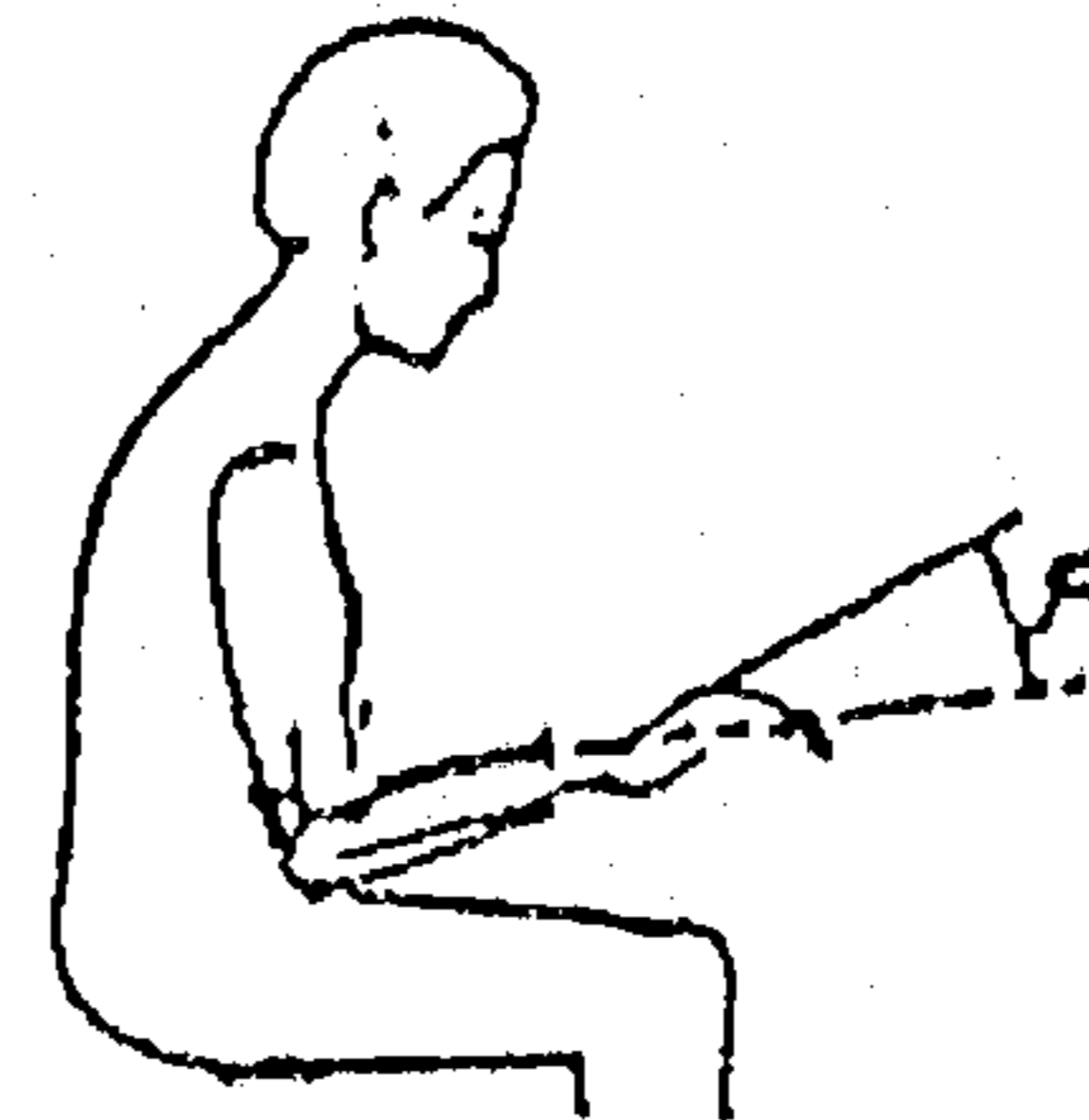
Angle C



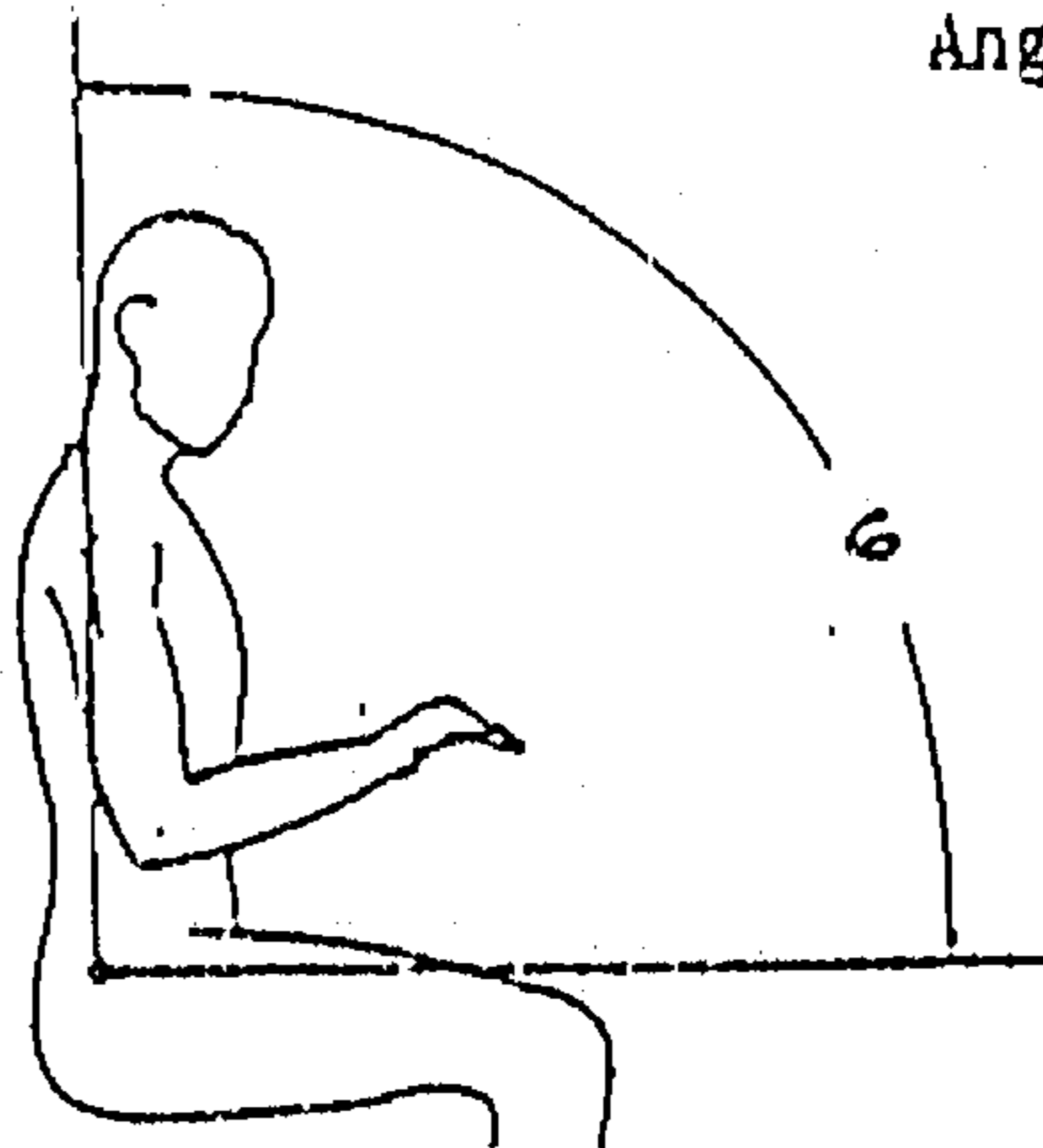
Angle D



Angle E



Angle F



Angle G