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AN INJURY PROFILE OF PRACTICING DIAGNOSTIC MEDICAL SONOGRAPHERS IN ALBERTA

BY

© LOIS MARY W[illegible]DAL

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Science.

DEPARTMENT OF PHYSICAL THERAPY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **An Injury Profile Of Practicing Diagnostic Medical Sonographers In Alberta** submitted by **Lois Mary Wi lidal** in partial fulfillment of the requirements for the degree of **Master of Science.**

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ABSTRACT

The purpose of this descriptive study is to provide a profile of work-related injuries among practicing diagnostic medical sonographers. One hundred and fifty-six sonographers living in the province of Alberta were surveyed by mail. Ninety-six (61.5%) returned questionnaires were included in the study. Those sonographers with, and those without work-related symptoms were compared on the basis of personal and professional characteristics. Information was sought concerning the types of work-related symptoms, diagnoses received by physicians, consequences of injury (absenteeism, decreased ability to perform the work, workers' compensation, etc.), education received concerning work-related injury, and job satisfaction. Sonographers were asked to indicate their level of involvement in daily work activities and their perception of the contribution of their work activities to injury for sonographers in general.

Eighty-five respondents (88.5%) reported work-related symptoms. Significant differences in gender, age, height, weight and body mass index were found between groups of sonographers with, and those without work-related injuries. Significant relationships were also found between years since completion of training and shoulder/upper arm pain, and between activity level and neck pain.

The most common type of work-related symptom was interscapular pain. Other common symptoms included shoulder or upper arm, neck and low back pain. The most common diagnosis was tendinitis. Three clusters of symptoms emerged from the data. Neck and interscapular pain formed one cluster. Shoulder or upper arm pain, elbow pain, hand/wrist pain, clumsiness of the fingers and numbness or tingling formed the second cluster. The third cluster consisted of the symptoms of frontal headaches and visual disturbances. Significant relationships were found between the neck and interscapular pain cluster and sustained shoulder abduction, sustained twisting of the neck and trunk, repetitive twisting of the neck and trunk, and clerical activities.

Absenteeism, compensation, rehabilitation and lost productivity were consequences of work-related injury. Sonographers identified three major factors which they perceived could result in an increase in work-related injuries in sonographers over the next 3 to 5 years. These were increased workload/decreased staff, sustained posture/activity, and current equipment design.

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CHAPTER ONE: INTRODUCTION

PROBLEM STATEMENT

Due to the increased number and duration of sonograms and the types of activities performed by sonographers it appears that sonographers are at risk of developing work-related injuries. This is supported by the growing body of literature in the area of repetitive strain injuries (RSI).

As a result of musculoskeletal problems, the average worker loses nearly two days of work each year[32,40]. During the working years (18-65 years), musculoskeletal problems result in more disability than any other category of disorder[32,40,51]. According to the Bureau of Labor Statistics in the United States (1989), the number of reported cases of repetitive strain injuries has been increasing faster than any other occupational illness. Repetitive strain injuries accounted for 18 percent of all occupational illnesses in 1980 and accounted for 52 percent of all occupational illnesses in 1989[6]. Increased production rates[39], new technologies such as video display terminals[6], increased use of vibrating and pneumatic tools[39], improved record keeping by employers[6], increased employee/employer awareness of cumulative trauma disorders[6], reduced rate of worker turnover[58] and increased

numbers of women and older workers in the workforce[6] are some of the factors which may account for the increase in repetitive strain injuries. Although the true number of occupational repetitive strain injuries is unknown, it is widely recognized that costs of absenteeism, rehabilitation, and compensation due to work-related injuries are excessive[6,11,12,29,35,40,52]. In 1985 Burry et al[12] reported that "countless millions of dollars were spent annually in Australia due to occupational repetitive strain injury problems. In the United States one-third of workers' compensation costs are for cumulative trauma (repetitive strain injury) disorders[6]. Over one-half of the workers in the United States perform job activities with the potential to develop repetitive strain injury[58]. This is unlikely to differ greatly in Canada.

Diagnostic medical sonography is a relatively new profession, coming into existence in the early 1940's[20]. The advent of new technologies and the recognition of the diagnostic capabilities of ultrasound have resulted in an increased number and duration of sonograms performed each year[72]. Between 1987 and 1988 a total of 52,610 ultrasound examinations were performed in Canada[66]. Of this number, 7,925 examinations were carried out in Alberta[66]. The guidelines for diagnostic ultrasound facilities in

hospitals indicate that a sonographer can perform 8 cases/day for 220 days (excluding holidays) or 1760 cases each year[34].

Sonographers must carry out testing procedures in positions of prolonged standing or sitting. To obtain adequate test results these workers are required to lift and position patients before, during, and after the test procedures, as well as carry out other physically demanding tasks[20]. Much of the work involves repetitive activity. Craig[18] identified a number of health hazards associated with activities performed by sonographers. These hazards included increased risk of developing "carpal tunnel syndrome, muscle and joint damage, and latent possibilities of eye strain". Blurred vision, neck, back, shoulder and upper extremity pain are also reported to be common among sonographers.

OBJECTIVES OF THE STUDY

The primary objective of this study was to determine the profile of work-related injuries among sonographers. Specifically, the study was designed to elicit information about:

- the differences and similarities among personal and professional characteristics of those with, and

those without work-related injuries

- consequences of work-related injuries among sonographers
- possible risk factors which sonographers perceive may contribute to work-related injuries among their profession

RESEARCH QUESTIONS

The research questions of this study were:

1. Is work-related injury a common problem among sonographers? Is the occurrence rate comparable to other professions in the literature with similar job activities?

2. Are there differences in gender, age, height, weight, place of employment, training location, corrective lenses, frequency of exercise, current activity level, scanning hand, length of time since completion of training and full time versus part time employment between groups of sonographers with, or without work-related injury?

3. How do sonographers rate their overall job satisfaction? What is the relationship between job satisfaction and work-related symptoms?

4. What types of work-related injuries occur among diagnostic sonographers in Alberta and are they similar to the types of injuries reported among sonographers in the literature?

5. What factors are perceived by sonographers in Alberta to contribute to work-related injury among sonographers in general? Is there an association between level of involvement and contribution to injury for these factors?

6. Are there common clusters of work-related injury among diagnostic sonographers? Are these clusters related to the demographic information in any way?

7. What are the consequences of work-related injury among diagnostic sonographers? Are sonographers utilizing medications, workers' compensation, medical treatment, etc. to manage work-related problems?

8. Have sonographers received education concerning work-related symptoms and if so, what sources of education have been utilized?

9. What do sonographers perceive to be the most important factors that could result in an increase in injuries among diagnostic sonographers in the next 3-5 years?

OPERATIONAL DEFINITIONS

1. Work-related injury refers to any symptoms experienced by sonographers which they believe to be a result of their work activities. Work-related injury and work-related symptoms are used interchangeably.

2. Sonographers without work-related injury are those who have never experienced symptoms which are believed to be a result of their work activities.

3. Although controversy exists in the literature concerning terminology, the term repetitive strain injury (RSI) will be used to refer to all occupation-related musculoskeletal disorders.

ASSUMPTIONS AND LIMITATIONS

1. The study looked at one dimension of sonographer work life, injury and associated consequences. It did not take into consideration personal problems or other factors which may affect work life.

2. There is a diversity of technology in the field of

diagnostic ultrasound and this study did not address this.

3. A precise definition of work-related injury was not included in the questionnaire. There appeared to be some confusion about the term "injury". Some sonographers interpreted the term "work-related injury" to mean that they had to have experienced a specific accident while at work. The researcher was looking for any symptoms which were related to work activities. Therefore, the responses of those sonographers who responded "no" to having a work-related injury, but "yes" to having work-related symptoms were changed by the researcher. If symptoms were indicated, the researcher changed the negative response concerning work-related injury to a positive response or "yes".

4. Since this was a mail questionnaire the researcher was unable to check the responses given and to know for certain that the sonographers' perception was based on reality. There was no certainty that the questions were understood or interpreted as the researcher desired.

5. Representativeness of the sample was difficult to determine in the absence of a regulatory body which captures all numbers and data regarding sonographers.

Although all members and a number of non-members on the ADSA list were surveyed, the questionnaires may be biased by under reporting or non response of specific groups of sonographers. It is possible that sonographers without work-related symptoms did not wish to participate in the study due to lack of interest. It is also possible that those sonographers with work-related symptoms would be more likely to complete the questionnaire. Regardless, it was believed by the researcher that this sample was representative of the sonographer population in the province of Alberta.

6. There was a very low number of sonographers in the non-injury group. Therefore, there was not a strong group with which to compare the group with injuries.

CHAPTER TWO: LITERATURE REVIEW

WORK-RELATED INJURY

It has been recognized since the 18th Century that musculoskeletal problems are associated with some work activities. Ramazzini, an Italian physician, reported injuries in clerks and scribes, which he believed were due to repeated use of the hand, a constrained sitting position and excessive mental labor[48]. Names in medical history such as bricklayer's shoulder, carpenter's elbow, stitcher's wrist, telegrapher's cramp and cotton twister's thumb graphically indicate the extent of trade-related musculoskeletal disorders[58].

Descriptive labels such as "wear and tear" injuries, osteoarthroses, and degenerative joint diseases have been used to describe these musculoskeletal conditions[58]. More recently terms such as repetitive motion injury[58,62], cumulative trauma disorder[58,62], cervicobrachial disorder[58] and repetitive strain injury[58,62] have been used to describe work-related musculoskeletal impairments. For consistency the researcher will use the term repetitive strain injury (RSI) to refer to all occupation-related musculoskeletal disorders.

Although controversy exists over the terminology, in

most countries, RSI is recognized as a collective term for,

> conditions with recurrent or persistent pain, disability or loss of function in any part of the body, mainly in the limbs, and particularly in the upper limbs and neck. These conditions are usually associated with repetitive movement and/or fixed postures, and related to, or aggravated by, an occupational setting[61].

More recently in the literature, low back disorders resulting from static loading have been included as repetitive strain injuries[22,46].

Repetitive strain injuries occur most often in workers who perform highly repetitive work[50]. The work is usually simple and highly stylized with little variety in the tasks performed. The workload is reported to be continuously or intermittently high[61]. Due to repetitive strain and static postures as many as 70% of data entry operators are reported to experience upper extremity or low back problems[6]. Welders, carpenters and others whose occupations require the arms to be elevated for long periods have an increased incidence of shoulder problems[21].

FACTORS WHICH MAY CONTRIBUTE TO REPETITIVE STRAIN INJURY

A number of factors that may contribute to repetitive strain injury (RSI) or occupational overuse have been reported in the literature. Factors such as

repetition[6,12,24,29,35,37,39,42,61,62], force[6,11,37,39,42,61], direct pressure[37,45], constrained postures[11,12,28,39,45], vibration[24,29,37,39,45], cold temperature[24,37,39,45], poorly designed work stations[11,12,37,55] and tools[12,39], poor work practices[11,12] and personal factors such as age[32,29,55], gender[29,35,41,61], general health[11,12,29,37], job satisfaction[36,61] and emotional stress[11,12,36,48,55,61] are frequently cited.

Repetition refers to the number of repetitive motions that are performed per work day[6]. Repetitive movements involve dynamic muscular work and increase the mechanical loading of the muscles. With increased mechanical loading of the muscles, local fatigue of the muscles may develop[71]. Generally, the more repetitive the task, the more frequent and rapid the muscle contractions[58]. Tasks requiring higher rates of repetition require more muscular effort, and consequently, more recovery time than less repetitive tasks. Muscles develop less tension when contracting at a higher velocity than at a slower velocity for the same load. Therefore, tasks with high repetition rates can cause injury even when the required forces are low and believed to be safe[6]. Performance of repetitive work on a fairly continuous basis also results in static loading of the muscles which can result in discomfort and

reduced performance capabilities[14]. Sustained isometric contraction is often required of muscles which fix and support the moving part of the body. For example, when dynamic movement of the forearm and hand is performed, the muscles of the neck, shoulder and upper arm may contract isometrically to support and fix the arm in a position of function[11,55].

Force refers to the exertion used to do the job and is a critical factor contributing to RSI[62]. The greater the force, the greater the likelihood of developing repetitive strain injuries[24,73]. As muscular effort increases with increasing task load, circulation to the muscle decreases and more rapid muscle fatigue results. If the force requirements are high, recovery time can exceed the actual work time. If recovery time is inadequate, soft tissue injuries can occur[25,62,58]. When determining the amount of force that is tolerable, age, sex, body build, and general health need to be considered since they affect the amount of force acceptable[58].

Stress can be exerted on tendons and nerves by direct and continued contact with surfaces such as sharp edges of hand-held solid objects, or by leaning against objects[39,73]. Such actions cause the force to be

transmitted through the skin to the underlying tendons and nerves[6]. Mechanical stress can also be produced by repeated pounding with the hand.

Posture is a significant factor in the development of RSI. Sustaining undesirable postures for prolonged periods may result in a variety of musculoskeletal disorders[73]. Undesirable postures include those which are "fixed or constrained, overload the muscles and tendons, load the joints in an uneven or asymmetrical manner or involve a static load on the musculature"[6]. Prolonged postures may involve sitting, standing, kneeling or holding an extremity in an uncomfortable position. The majority of static posture problems appear to be related to the spine[29,46]. A greater incidence of low back and neck problems was reported in individuals whose work requires prolonged sitting[46] or driving[29]. Lumbar intradiscal pressure increases in the sitting posture and has been reported to exceed the loads generated by standing or lying[2].

Vibration results from use of hand-held power tools[29] or tools which cause whole body vibration[24]. Vibration may decrease circulation or cause microtrauma to the soft tissues[24,37]. White finger is a common example of a

vibration-induced repetitive strain injury[24,29]. Spinal structures appear to be very susceptible to the effects of vibration which occurs frequently in vehicles and powered equipment[29].

Cold and poorly designed work stations have also been identified as factors contributing to injuries. Cold results in physiological stiffness of the soft tissues, decreased circulation and decreased sensation, making the tissues more susceptible to injury[24,37]. Poorly designed work stations, tools or equipment place the worker at a mechanical disadvantage, thereby increasing the risk of developing RSI[12,37]. Factors such as the duration of work without rest[12,37], bonus and overtime incentives[12,37], lack of training[37] and failure of supervision contribute to RSI's[37].

Personal factors such as age[29], gender[29,31,35,41,61], general health[11.12,29,37], job satisfaction[6,36] and emotional stress may play a role in the development of RSI[11,12,48]. The body's resilience to wear and tear declines with age so susceptibility to RSI increases. As the body ages it recovers less quickly from the damage caused by repetitive movements[6]. Frymoyer reported that older workers were at greater risk for developing certain types of repetitive

strain injuries, particularly shoulder and low-back problems[29]. Females were more commonly affected than males[29,31,61] which was likely due to the tendency for females to be involved in more repetitive work than males, and to their lower degree of overall physical strength[61]. In a study of incidence and distribution of RSI in South Australia, Gun found injury frequency rates for the time period between 1985 and 1986 were higher in women than in men. The female-male incidence rate ratio was 1.86 and the frequency rate, which adjusts for the hours worked, was 2.5[31]. Since wide variation in female-male incidence rate ratios was found between different occupations and industries, these differences may be attributed to differences between work performed by male and female workers rather than biological differences[31].

An individual with problems outside the workplace or pressure within the work environment, may be more likely to develop symptoms than a relaxed person[12]. Ireland suggested that psychological stresses and overall job satisfaction may be of greater significance than mechanical factors[36]. In the study of incidence and distribution of RSI in South Australia (1980-81 to 1986-87), Gun (1990)[31] found low incidence rates in professional, technical and executive jobs where one may assume a high level of job

satisfaction. If emotional stresses are perceived to be high and job satisfaction is perceived to be low, the risk of work-related injury appeared greater[61]. Work may contribute to, or exacerbate, an existing health problem such as rheumatoid arthritis[6]. A worker who is recovering from illness or who is fatigued due to inadequate rest may be more at risk of developing RSI than a worker who is rested and healthy[39].

The greater the number of risk factors involved, the greater the likelihood of developing repetitive strain injuries[45]. If any of the factors are reduced, the overall risk of developing work-related injury is reduced[45].

WORK-RELATED INJURY AMONG SONOGRAPHERS

Sonographers perform prolonged sitting (Plate 2-1) or standing (Plate 2-2), lifting and positioning patients and other tasks which are physically demanding[20]. Sonographers are required to lift, stand and bend throughout the day, and work in darkened noisy environments. They are exposed to processing and cleaning chemicals, biohazardous materials and video monitors. For up to 90 minutes at one time with a transducer in the hand, a sonographer must apply pressure to keep the transducer in contact with the patient's body. The sonographer may keep the transducer

relatively still or may move it in repeated arcs over the area of the body being investigated. In order to support and fix the arm in a position to hold the transducer against the patient, static or sustained isometric contraction of the neck, back, shoulder and upper extremity is necessary[72]. The shoulder is held statically in an abducted position especially when scanning right-handed (Plate 2-3). Chaffin[14] indicated that greater than 30 degrees of abduction results in a rapid increase in fatigue rate of the medial portion of the deltoid muscle and thus, reduced physiological efficiency. To manipulate the transducer repetitive movements of the shoulder, forearm, wrist, hand and fingers are required[72]. Repetitive motion of the hand can lead to injury especially if tools must be grasped[35]. Johnson[39] indicated that poor tool design can stress the small muscles of the hand resulting in fatigue and inefficient use of energy for tool manipulation.

In a study by Vanderpool et al[72] of carpal tunnel syndrome and other musculoskeletal problems in cardiac sonographers, 86% reported symptoms of work-related musculoskeletal injuries. Sixty-three percent of those who completed the survey indicated that they had at least one or more symptoms of carpal tunnel syndrome.

Plate 2-1: Prolonged sitting postures may be required to perform sonograms.

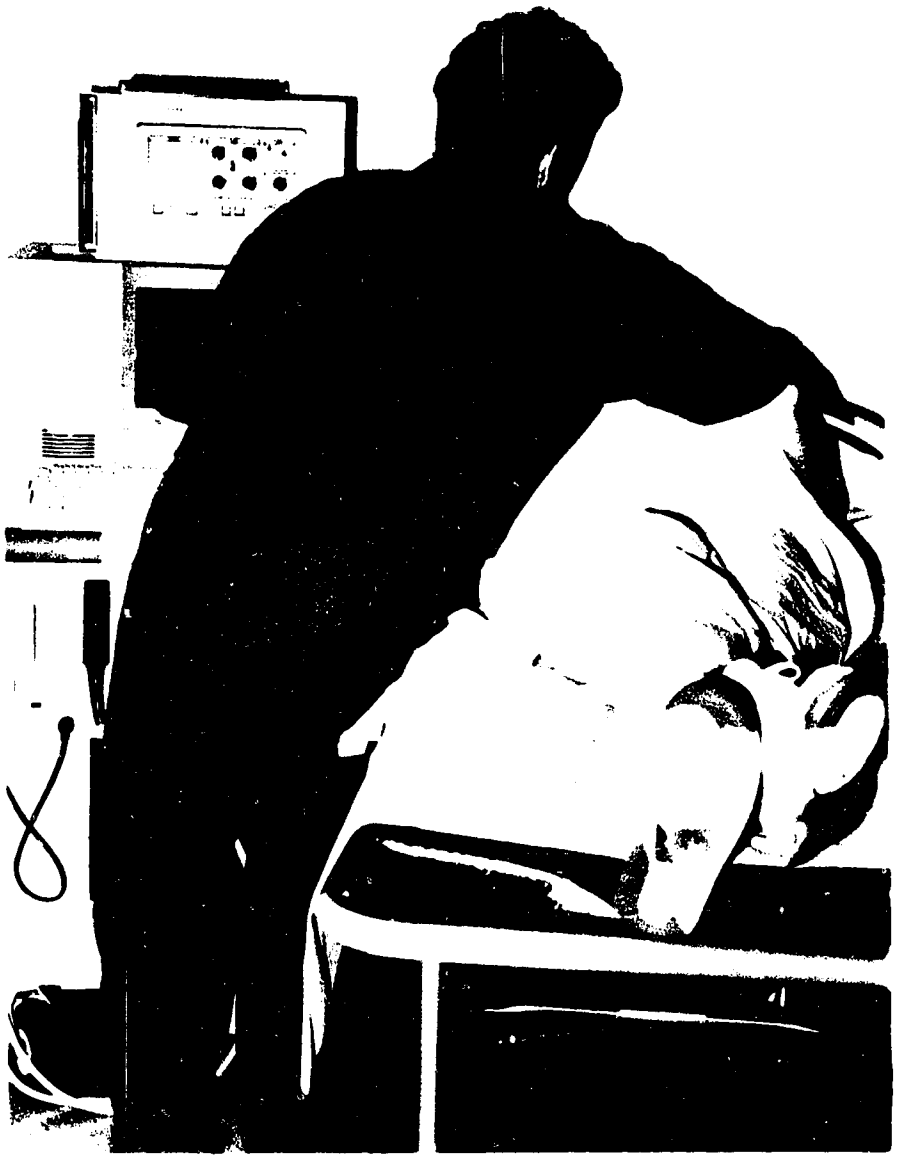

Plate 2-2: Prolonged standing postures may be required to perform sonograms.

Plate 2-3: Static shoulder abduction is required especially when scanning right-handed.

Seventeen percent of those who had work-related symptoms in the study by Vanderpool et al[72] indicated that they missed work due to injury. Thirty-one percent indicated that they had received treatment and 4% indicated that they received workers' compensation benefits.

Sonographers must observe images on a monitor and work in darkened environments for much of their work day. Visual disturbances such as eyestrain, eye irritation, blurred vision and difficulty focusing are reported by sonographers[19]. Improper lighting and glare appear to be the most common factors associated with visual disturbances reported by sonographers[19]. The occurrence of eyestrain associated with the use of visual display terminals is supported in the literature by Ong[55]. Formal studies of visual disturbances of sonographers are lacking in the literature. Two articles were found which reported visual disturbances among sonographers, and these were qualitative in nature.

SUMMARY

Work-related injuries appear to be common among workers and excessive costs of absenteeism, rehabilitation and compensation due to repetitive strain injuries are

reported. Many risk factors which contribute to repetitive strain are identified in the literature. Although little is reported in the literature concerning work-related injuries sustained by diagnostic medical sonographers, the repetitive nature of the tasks, constrained postures, prolonged sitting and standing and other physically demanding tasks suggest that sonographers are at risk of developing RSI. In the literature research has focused primarily on visual disturbances among sonographers in general, and work-related problems among cardiac sonographers. Only one formal study of work-related injury in diagnostic sonographers could be found in the literature. This study focused on carpal tunnel syndrome and other musculoskeletal problems in cardiac sonographers. Research concerning work-related injuries among sonographers is primarily qualitative. Quantitative research aimed at investigating work-related injury among sonographers is needed.

CHAPTER THREE: RESEARCH METHODS

STUDY PARTICIPANTS

Participants in this retrospective descriptive study were 96 practicing diagnostic sonographers: 83 (86.5%) females and 13 (13.5%) males. This was a convenience sample drawn from sources in Alberta. Members and non-members of the Alberta Diagnostic Sonographers Association (ADSA) were included in the study. The Alberta Diagnostic Sonographers Association was contacted for a roster of the membership. Permission was obtained to contact the members and the list of 155 members was received. A questionnaire was mailed to each member on the list. In an attempt to include non-members of ADSA, the managers of diagnostic imaging departments in all hospitals and major clinics in selected cities in Alberta were contacted. By telephone, these managers were requested to provide the names of all non-ADSA members. An additional 15 sonographers were identified and sent questionnaires as a result of the request. Initially a total of 170 questionnaires were sent.

A total of 96 questionnaires were returned and all were valid and included in the study. In follow-up telephone calls to those who had not returned the

questionnaire, it was identified that ten of the individuals on the ADSA list were not practicing, or were not sonographers. Those ten individuals were excluded from the study. An additional four students were also excluded since they had not completed their training. With the exclusion of these 14 individuals, 156 sonographers were eligible for participation in the study.

Initially the researcher estimated that there was a total population of 300 sonographers in Alberta. It appears that the initial estimate was high and that a more accurate estimate was 180. The discrepancy between estimates was due to the inclusion of non sonographers and non practicing sonographers on the ADSA list, and an apparent overestimation of the number of non ADSA members in Alberta. Initially the number of non-members was estimated to be approximately 150. Following conversations with the managers of the major hospitals and clinics in the major centers, it became apparent that the majority of practicing sonographers in Alberta were members of ADSA, and that the actual number of non-members appeared to be closer to 30.

Based on 156 sonographers eligible for participation in this study, a response rate of 61.5% was determined.

Three possible reasons for lack of response of some sonographers may be proposed. First of all, the time frame was not suitable for members on summer holidays. Secondly, those who did not have any work-related injury or symptoms may not have been interested in the study. Thirdly, nine of the individuals could not be reached in the follow-up phone calls due to incorrect telephone numbers. Some of these individuals may have moved, and those individuals who could not be reached may or may not have been sonographers.

DATA COLLECTION

Members and non-members of ADSA were initially contacted by mail and invited through an introductory letter (Appendix A) to participate in the study. The letter and the consent form (Appendix B) ensured anonymity and described the purpose of the study. The participants were given a one month time period in which to complete the questionnaire. A stamped self addressed envelope was included to facilitate the response rate and return of the questionnaire. Data collection started on July 20, 1994 and continued until August 20, 1994. Eighty-four questionnaires were returned within the given time period. On August 21, 1994 non-respondents were identified using the three-digit code number and contacted by a follow-up telephone call. They were encouraged to complete the

questionnaire and as a result, an additional 12 questionnaires were returned. Those who declined to participate (3.1%) or did not respond did not appear to differ from participants in any systematic way which would bias findings.

THE QUESTIONNAIRE

Data were collected using a standard questionnaire (Appendix C). The questionnaire was developed following interviews with 2 sonographers in Edmonton. These interviews were conducted to identify common problems experienced by sonographers, activities that sonographers performed during their work day, and to determine consistent meaningful terminology that could be used in the questionnaire. Each questionnaire was designed for self-administration and was identified only by an assigned code number to assure anonymity. The questionnaire was pre-tested for clarity, length and acceptability by 6 sonographers. The responses of these 6 individuals were included in the study. As a result of the respondents' comments the following modification was made:

1. Question 25. The original question stated: "For each of the following work-related activities below, circle the level of involvement in the activity during the course of a

typical work day (1=no involvement; 5=considerable involvement i.e. much of the day), and the degree to which you feel the activity contributes to work-related injury (1=no contribution to injury; 5=very high contribution to injury)". This question was changed to "For each of the following work-related activities below, circle your level of involvement in the activity during the course of a typical work day (1=no involvement; 5=considerable involvement i.e. much of the day), and the degree to which you feel the activity contributes to work-related injury for sonographers in general (1=no contribution to injury; 5=very high contribution to injury).

The questionnaire consisted of a series of 27 questions. Questions 1 to 16 and 23 to 27 were to be completed by all respondents. Those who had never had, or were not currently experiencing any work-related symptoms were asked to omit questions 17 to 22.

The first 14 questions dealt with demographic information: gender, age, height, weight, place of employment (hospital, private clinic or other), province or territory in which training occurred, use of corrective

lenses, frequency of exercise, present activity level compared to average activity level during the past 5 years, scan hand (right, left or both), length of time since completion of training, and full-time versus part-time hours of work.

Questions 15 and 16 identified work-related injury and specific symptoms which sonographers believed were a direct result of their work activities. Questions 17 to 22 concerned work-related symptoms and focused on: specific diagnosis by physicians, resolution of work-related symptoms and the single most important intervention that may have reduced or eliminated the work-related problem. Information about the consequences of work-related injury (absenteeism, decreased number of working hours, etc.), utilization of sick leave, unemployment insurance, vacation leave, etc. as a result of work-related symptoms, and changes made as a result of work-related injury was requested.

The remaining five questions covered a variety of topics. Questions 23 and 24 sought data about education received concerning work-related injury and the sources of education received if applicable. Question 25 sought

information concerning the level of involvement in activities that sonographers performed during the course of a typical work day, and the degree to which sonographers perceived each activity contributed to work-related injury for sonographers in general. In question 26 sonographers were asked to indicate the one response that best described their overall job satisfaction (from extremely dissatisfied to extremely satisfied). In the last question sonographers were asked to indicate their opinion concerning what they felt was the single most important factor that could result in an increase in work-related injuries in diagnostic sonographers over the next 3 to 5 years.

DATA ANALYSIS

The returned data were stored on the hard drive and a floppy disk. Accuracy of data entry was confirmed by the researcher by checking entered data on all questionnaires. Five errors of incorrect entry of data were discovered and corrected. An arbitrary decision was made by the researcher to randomly select ten questionnaires and check them for coding reliability as a further check of accuracy. No discrepancies were found between the entered data and

the selected questionnaires. The responses were analyzed using the SPSS for Windows release 6.1 program on an IBM clone DX computer.

Frequency distributions were calculated on each item of the questionnaire to determine the characteristics of the sample of sonographers. Descriptive statistics were computed to determine the demographic profile of the subjects. The statistics computed included means, medians, standard deviations, modes, maximum/minimum values, ranges and percentages.

Crosstabulations and Pearson's correlations of the first 14 questions (demographic information) with question 15 (work-related injury) and each variable of question 16 (specific work-related symptoms), question 17 (specific diagnosis by a physician) and question 18 (whether symptoms have resolved or not) were computed. Crosstabulations and correlations of each variable of question 25 (level of involvement in daily work activities and degree to which each activity contributed to work-related symptoms) with each variable of question 16 (work-related symptoms) and question 17 (specific diagnosis by a physician) were

performed to identify clusters. Pearson's Correlations between level of involvement and contribution to injury were also performed (question 25).

For the open-ended question, number 19, in which sonographers were asked to indicate the single most important intervention that reduced or eliminated their work-related problem, the researcher grouped these responses according to categories which emerged from the data. The categories which emerged included: surgery, exercise, adjust worksite/activity, orthotics, treatment, rest/relaxation, other and not applicable. Frequencies were determined for each category.

For the last question the researcher developed categories of responses concerning the single most important factor which could result in an increase in work-related injuries in diagnostic sonographers over the next 3 to 5 years. The categories which emerged from the data included: sustained posture/activity, lack of exercise, increased workload/decreased staff, lack of employee awareness, resistance of employer to change, poor body mechanics, job tasks, equipment, patient type/size and no knowledge/change. Frequencies were determined for each category.

Given the larger number of possible relationships explored in this study, it was useful to have a procedure for screening them to locate those requiring more specific interpretation. In this study correlations were used to screen for significant relationships, but crosstabulations were used for interpretation. Although this strategy produces a large experiment wise type I error, given the lack of previous research in the area, and the exploratory nature of the study, the greater concern was with type II error.

ETHICAL CONSIDERATIONS

This study received approval from the Student Projects Ethical Research Review Committee on May 20, 1994. Questionnaires were numbered and cross referenced and only the researcher and advisor had access to participants' names. Each participant read the letter and consent form which described the purpose of the study and guaranteed confidentiality and freedom to withdraw at any time. All participants signed the informed consent form prior to participation in the study.

CHAPTER FOUR: RESULTS

The results of this survey provided a descriptive profile of sonographers in Alberta. The sample consisted of 96 diagnostic medical sonographers: 83 (86.5%) females and 13 (13.5%) males. This sample was further divided into two subgroups: those with work-related symptoms and those without work-related symptoms.

STUDY GROUP DESCRIPTION

The occurrence rate of work-related symptoms

Eighty-five individuals (88.5%) reported that they either had experienced, or were experiencing work-related symptoms. Eleven sonographers (11.5%) indicated that they had never experienced work-related symptoms. The correlation between gender and work-related symptoms was .43* . The table from which this correlation and other correlations between work-related symptoms and demographic variables was extracted is found in Appendix D. In Table 4-1 the distribution of respondents by gender is presented. It shows that proportionally more women than men had

* Here and elsewhere the significance of correlations amongst ordinal and categorical variables was approximated using the test of significance for continuous variables. For sample sizes of about 100, this approximation can be shown to be accurate for probability levels as small as .01. In this chapter all correlations greater than .2 are significant at the .05 level.

experienced work-related symptoms.

Gender

Table 4-1. Distribution of respondents by gender

Variable	Respondents with work-related symptoms	Respondents without work-related symptoms	Total sample
Number of females	78	5	83
Number of males	7	6	13
Total number	85	11	96
Percent of females	94	6	86.5
Percent of males	54	46	13.5
Total percent	**88.5**	**11.5**	**100.00**

Age

The largest number of respondents (47.9%) was in the 35-44 year age range. Of the respondents with work-related symptoms, 45.5% were also in the 35-44 year age group. Only two individuals (2.1%) in this age group did not have work-related symptoms. There was a negative correlation between work-related symptoms and age (r=-.22). An age group profile for the two subgroups presented in Table 4-2 shows that sonographers with work-related symptoms were slightly younger than those without work-related symptoms.

Table 4-2: Age group profile of respondents

Age Group (yrs)	Respondents with work-related symptoms (n=85)		Respondents without work-related symptoms (n=11)		Total sample (n=96)	
	(#)	(%)	(#)	(%)	(#)	(%)
under 25	0	0.0	0	0.0	0	0.0
25-34	33	39.0	4	36.0	37	38.6
35-44	44	52.0	2	18.0	46	47.9
45-54	8	9.0	4	36.0	12	12.5
55-64	0	0.0	1	5.0	1	1.0
over 64	0	0.0	0	0.0	0	0.0

Height

There was a negative correlation between height and work-related symptoms (r=-.24). The height range with the largest percentage (43.8%) of sonographers was the 5'4" to 5'6" range. In this subgroup 95% had work-related symptoms and 5% did not. The height range with the lowest percentage (4.2%) of sonographers was the subgroup who were under 5'0" tall. In this subgroup 100% had work-related symptoms. The height profile of respondents presented in Table 4-3, shows that respondents without work-related symptoms were slightly taller than those with work-related symptoms.

Table 4-3: Height profile of respondents

Height (no shoes)	Respondents with work-related symptoms (n=85)		Respondents without work-related symptoms (n=11)		Total Sample (n=96)	
	(#)	(%)	(#)	(%)	(#)	(%)
under 5'0"	4	4.7	0	0.0	4	4.0
5'1"-5'3"	23	27.1	2	18.0	25	26.0
5'4"-5'6"	40	47.1	2	18.0	42	43.8
5'7"-5'9"	12	14.1	5	45.5	17	17.7
5'10"-6'0"	6	7.1	2	18.0	8	8.3

Weight

The weight profile for respondents is presented in Table 4-4. The weight range with the highest percentage of respondents (36.5%) was the weight range of 130 to 149 pounds. All 9 individuals in the 90-109 pound weight range reported work-related symptoms. The one individual in the 230 to 249 pound range did not report any work-related symptoms. The negative correlation between weight and work-related symptoms (r=-.34) suggests that people without work-related injuries were slightly heavier than those with work-related injuries.

Table 4-4: Weight profile of respondents

Weight (pounds)	Respondents with work-related symptoms (n=85)		Respondents without work-related symptoms (n=11)		Total Sample (n=96)	
	(#)	(%)	(#)	(%)	(#)	(%)
90-109	9	10.6	0	0.0	9	9.4
110-129	22	25.9	1	9.1	23	24.0
130-149	32	37.6	3	27.3	35	36.5
150-169	14	16.5	2	18.2	16	16.7
170-189	5	5.9	3	27.3	8	8.4
190-209	2	2.4	1	9.1	3	3.1
210-229	1	1.2	0	0.0	1	1.0
230-249	0	0.0	1	9.1	1	1.0

Body Mass Index (BMI)

An estimation of the body mass index (BMI) was computed. On the questionnaire respondents recorded their weight and height within a range for these variables. The midpoints of the height and weight ranges were chosen when computing the body mass index. A negative correlation between BMI and work-related symptoms was found (r=-.24). Due to small numbers in each category meaningful analysis was difficult to determine. The crosstabulation between

BMI and work-related symptoms is found in Appendix E.

Place of Employment

Fifty-five sonographers (57.3%) were employed in a hospital setting, and of these sonographers, 50 (91%) had work-related symptoms and 5 (9%) did not. Thirty-seven (38.5%) sonographers were employed in a private clinic. Of these sonographers, 31 (83.8%) had work-related symptoms and 6 (16.2%) did not. Three individuals worked in both a hospital setting and private clinic, and all three had complaints of work-related symptoms. One sonographer who worked in a mobile unit also had work-related symptoms.

Location of Training Program

The majority of sonographers (77%) were trained in the province of [redacted]. Of these individuals, 65 had work-related symptoms and 9 did not. A profile of training location of respondents is presented in Table 4-5.

Table 4-5: A training location profile of respondents

Province/ Territory	Number of Respondents with work-related symptoms (n=85)	Number of Respondents without work-related symptoms (n=11)	Total Sample (n=96) (#)	(%)
Alberta	65	9	74	77.1
B.C.	2	0	2	2.1
Manitoba	2	0	2	2.1
Ontario	7	0	7	7.3
Quebec	1	0	1	1.0
Sask	4	1	5	5.2
B.C.& AB	1	0	1	1.0
U.S.A.	2	1	3	3.1
England	1	0	1	1.0

Use of corrective lenses by respondents

Sixty-eight respondents (70.8%) wore corrective lenses. Fifty-nine (86.8%) of these respondents had work-related symptoms and 9 (13.2%) did not. Of the 28 (29.2%) respondents who did not wear corrective lenses, 26 (92.8%) had work-related symptoms and 2 (7.2%) did not. A profile of the types of corrective lenses worn by respondents is presented in Table 4-6.

Table 4-6: A profile of the types of corrective lenses worn by respondents

Type of lenses worn	Number of individuals	Percent of individuals
single vision	49	51
bifocals	6	6.3
trifocals	1	1.0
contacts	18	18.8
lineless bifocals	1	1.0

Fifty-nine (61.5%) sonographers indicated that they received their corrective lenses before commencing training as a sonographer. Nine (9.4%) individuals indicated that they received their corrective lenses after commencing training as a sonographer.

Exercise frequency

Table 4-7 shows the frequency of exercise profile of sonographers. The largest number of sonographers was found in the category of exercise 3-4 times per week (40 sonographers, 41.7%). The smallest number (2 individuals or 2.1%) was found in the category of exercise more than 8 times per week. Activity level did not significantly relate to experience of symptoms.

Table 4-7: Frequency of exercise profile of respondents

Exercise frequency	Respondents with work-related symptoms (n=85)		Respondents without work-related symptoms (n=11)		Total Sample (n=96)	
	(#)	(%)	(#)	(%)	(#)	(%)
never	9	10.6	1	9.0	10	10.4
1-2/wk	26	30.6	4	36.4	30	31.2
3-4/wk	37	43.5	3	27.2	40	41.7
5-6/wk	9	10.6	1	9.1	10	10.4
7-8/wk	4	4.7	0	0.0	4	4.2
over 8/wk	0	0.0	2	18.2	2	2.1

Comparison of present activity level to average activity level during the past 5 years

The majority of the respondents indicated that their activity level was the same (27.1%) or slightly less (28.1%) than their average activity level over the past 5 years. The comparison of present activity level to average activity level during the past 5 years is presented in Table 4-8.

Table 4-8: Comparison of present activity level to average activity level during the past 5 years.

Activity level	Respondents with work-related symptoms (#)	(%)	Respondents without work-related symptoms (#)	(%)	Total sample (#)	(%)
consid less	17	17.7	3	3.1	20	20.8
slightly less	24	25.0	3	3.2	27	28.1
same	24	25.0	2	2.1	26	27.1
slightly more	11	11.4	2	2.1	13	13.5
consid more	9	9.4	1	1.0	10	10.4
Total	85	88.5	11	11.5	96	100.0

Scan hand

The majority of respondents (88.5%) performed scanning with the right hand. Of these respondents, 76 (89.4%) reported work-related symptoms and 9 (10.6%) did not. Of the two individuals who scanned with their left hand, one had work-related symptoms and one did not have any symptoms. Eight of the 9 individuals who used both hands for scanning had work-related symptoms and one (11.1%) did not. This is consistent with the possibility that workers tried to relieve symptoms by changing the hand with which they scanned.

Length of time since completion of training

The length of time elapsed since completion of sonography training is presented in Table 4-9.

Table 4-9: Length of time since completion of training

Years since completion of training	Respondents with work-related symptoms (n=85)		Respondents without work-related symptoms (n=11)		Total sample (n=96)	
	(#)	(%)	(#)	(%)	(#)	(%)
under 5 years	18	21.2	4	36.4	22	22.9
5-9 years	31	36.5	1	9.1	32	33.3
10-14 years	29	34.1	4	36.4	33	34.4
15-19 years	7	8.2	0	0.0	7	7.3
20-24 years	0	0.0	2	18.2	2	2.1

Part-time and full-time years of employment

The average number of full-time years of employment was 6.6 with a standard deviation of 4.7. The mean for part-time years of employment was 1.5 with a standard deviation of 2.7. For those sonographers who worked part time, the mean number of hours of part-time employment was 21.8 hours.

Job satisfaction

The majority of respondents were either satisfied (47.9%) or extremely satisfied (37.5%) with their jobs. Job satisfaction is presented in Table 4-10.

Table 4-10: Job satisfaction of sonographers

Satisfaction rating	Respondents with work-related symptoms (#)	(%)	Respondents without work-related symptoms (#)	(%)	Total sample (#)	(%)
extremely dissatisfied	1	1.2	0	0.0	1	1.1
dissatisfied	7	8.2	0	0.0	7	7.4
no response	5	5.9	0	0.0	5	5.3
satisfied	43	50.6	3	30.0	46	47.9
extremely satisfied	29	34.1	7	70.0	36	37.9

note: missing cases = 1

The negative correlation found between work-related symptoms and job satisfaction (r=-.21) suggests that sonographers without work-related symptoms were slightly more satisfied than those with work-related symptoms.

WORK-RELATED SYMPTOMS

Eighty-five respondents (88.5%) reported work-related symptoms. Of those respondents who had work-related symptoms, the most common symptom was interscapular pain (pain between the shoulder blades). Forty-six respondents (54.1%) indicated that they had experienced this work-related symptom. Forty-five individuals (52.9%) reported shoulder or upper arm pain and forty-one individuals (48.2%) had neck pain. The work-related symptoms reported by sonographers are listed in Table 4-11.

Table 4-11: Work-related symptoms experienced by sonographers

Work-related symptom	Respondents with work-related symptom (n=85)	
	(#)	(%)
Pain between shoulder blades	46	54.1
Shoulder or upper arm pain	45	52.9
Neck Pain	41	48.2
Low back pain	32	37.6
Hand or wrist pain	32	37.6
Redness/dryness of eyes	29	34.1
Numbness or tingling of fingers	24	28.2
Elbow pain	20	23.5
Frontal headaches	16	18.8
Blurring of vision	11	12.9
Pulling of the eyes	10	11.8
Clumsiness of fingers	10	11.8
Other symptoms	6	7.0

Other symptoms reported by six sonographers included hip pain (1), knee pain (2), ankle pain (1), foot pain (1), right forearm pain (1), leg numbness (1) and occipital headaches (1).

Correlations between specific symptoms and demographic variables were analyzed and a positive correlation was found between activity level and presence of neck pain ($r=.38$). This suggests that those with lower activity levels as compared to the past 5 years had less problem with neck pain. The positive correlation between years

since completion of training and shoulder/upper arm pain (r=.31) suggests that those with a greater number of years since completion of training had more complaints of shoulder/upper arm pain. Several marginal correlations were found between a number of the demographic variables and specific work-related symptoms and these are found in Appendix F. These were considered to be of lesser importance and were not analyzed further.

MEDICAL DIAGNOSES BY PHYSICIANS

Of the 85 individuals who had work-related symptoms, 35 (41.2%) indicated that they had received a diagnosis by a physician. The most common diagnosis of work-related injury was tendinitis. Sixteen individuals in the group who reported a medical diagnosis by a physician responded that they had been diagnosed with tendinitis. Some individuals had multiple diagnoses. The diagnoses of work-related injuries are indicated in Table 4-12.

Table 4-12: Diagnoses of work-related injuries sustained by sonographers

Diagnosis	Respondents with diagnosis (n=35) (#)	(%)
tendinitis	16	45.7
epicondylitis	9	25.7
bursitis	9	25.7
other	9	25.7
ganglions	6	17.1
carpal tunnel syndrome	5	14.3
tenosynovitis	3	8.5

Other diagnoses given by physicians and reported by sonographers included: neck/back strain (4), plantar fasciitis (2), capsulitis right wrist (1), muscle spasm (1) and myositis of the shoulder (1). There are many potential relationships between specific work-related diagnoses and demographic variables, so it was decided to use correlations as a preliminary screen to select the most important. Eight significant correlations were found (Table 4-13). The variables involved for six of the significant correlations were examined more closely using crosstabulations. Although negative correlations were found between single lenses and tendinitis (r=-.21), and between single lenses and epicondylitis (r=-.21), these were not considered to be meaningful and no further analyses were performed. The complete table of

relationships between diagnoses and demographic variables is shown in Appendix G.

Table 4-13: Pearson's correlations comparing demographic variables with diagnoses

Demographic Variable	Diagnoses			
	Tendinitis	Bursitis	Ganglions	Epicondylitis
Age			.21	
Gender				
BMI	.25			
Scan hand			.34	
Av.yrs full time work	.27	.25		.21

The positive correlation between age and the diagnosis of ganglions (r=.21) suggests that younger sonographers were less frequently diagnosed with ganglions. Of the 6 sonographers who reported a diagnosis of ganglions, none were in the lower age range (25-34 years). Four respondents were in the 35-44 year age range, and 2 were in the 45-54 year age range. A positive correlation (r=.34) was also found between the scanning hand and the diagnosis of ganglions. The crosstabulation between diagnosis of ganglions and scanning hand is presented in Table 4-14.

Table 4-14: Crosstabulation between diagnosis of ganglions and scanning hand

Scanning hand	Respondents with diagnosis of ganglions (n=6) (#)	Respondents without diagnosis of ganglions (n=90) (#)
right	3	82
left	0	2
both	3	6

Although respondents were not questioned as to why they used both hands for scanning, the high percentage of respondents with ganglions who used both hands for scanning is consistent with the possibility that sonographers changed hands to relieve symptoms of ganglions.

A positive correlation was found between BMI and the diagnosis of tendinitis. However, interpretation of this result is questionable since the number of responses in each cell was low. Examination of the crosstabulation of BMI with tendinitis revealed that of the 16 individuals with tendinitis, 10 were above the upper limit of the healthy BMI range, and 1 was below.

Positive correlations were found between average

number of years of full time work and the diagnoses of tendinitis (r=.27), bursitis (r=.25) and epicondylitis (r=.21). Examination of the crosstabulations between these variables revealed that the numbers in each cell were too small to make any meaningful interpretation.

INTERVENTIONS WHICH HELPED REDUCE OR ELIMINATE WORK-RELATED SYMPTOMS

Of the 85 respondents with work-related symptoms, 24 (28.2%) individuals indicated that their work-related symptoms had resolved, 36 (42.4%) indicated that their symptoms had not resolved, and 25 (26%) did not respond. Responses to the single most important intervention which helped reduce or eliminate the work-related problem were grouped according to categories which emerged from the data. The interventions are reported in Table 4-15. Due to the large number of missing responses no further analysis was performed.

Table 4-15: Interventions that helped reduce or eliminate work-related symptoms among sonographers (n=85)

Intervention	Responses (#)	Percentage (%)
treatment	8	9.4
adjust worksite	7	8.2
surgery	2	2.4
orthotics	2	2.4
rest/relaxation	2	2.4
exercise	1	1.2
other	2	2.4

The two responses in the category of other were "instructor" and "unknown".

FACTORS WHICH CONTRIBUTE TO WORK-RELATED INJURY AMONG SONOGRAPHERS

Sonographers recorded the level of involvement (1=no involvement; 5=considerable involvement) and their perception of the degree of contribution to injury (1=no contribution to injury; 5=very high contribution to injury) for work-related activities specific to their profession. Examination of the mean scores revealed that the three activities with the highest level of involvement were gripping the transducer, applying sustained pressure with

the transducer, and sustained twisting of the neck and trunk. The top three activities which were perceived by sonographers to have the greatest contribution to injury were sustained shoulder abduction, sustained twisting of the neck and trunk, and applying sustained pressure with the transducer. In Table 4-16 the mean values for level of involvement and contribution to injury are presented.

Table 4-16: Mean scores for level of involvement and contribution of activity to injury

Activity	Level of Involvement (Score)	# of (Responses)	Contribution to Injury (Score)	# of (Responses)
Gripping transducer	4.702	94	3.386	88
Applying sustained pressure with transducer	3.777	94	3.924	92
Sustained twisting of neck and trunk	3.656	93	3.934	91
Sustained shoulder abduction	3.505	93	4.022	89
Repetitive twisting of neck and trunk to look from patient to monitor	3.484	91	3.591	88
Prolonged sitting	3.000	93	2.356	87
Prolonged standing	2.936	94	2.802	91
changing cassettes	2.872	94	2.132	91
lifting/assisting patients	2.670	94	3.185	92
clerical work	2.394	94	1.415	91
performing mobile studies	2.011	93	2.822	90
transporting equipment for mobile studies	1.957	94	2.600	90

CORRELATIONS OF LEVEL OF INVOLVEMENT AND CONTRIBUTION TO INJURY

The scores for level of involvement and contribution to injury were converted to Z scores in an effort to adjust for the possible differences in respondents' perceptions of an arbitrary level of involvement and contribution to injury. Pearson's correlations comparing the level of involvement in each activity with the degree to which sonographers believed the activity contributed to work-related symptoms in sonographers in general were computed. These correlations are presented in Table 4-17.

Table 4-17: Pearson's correlations comparing level of involvement and contribution to work-related injury in sonographers (Z scores)

Activity	Correlation	Sample Size
sustained twisting of neck and trunk	.5854	91
performing mobile studies	.5713	90
repetitive twisting of neck and trunk	.5327	87
transporting equipment for mobile studies	.4736	90
lifting/assisting patients	.4565	92
changing cassettes	.4516	91
sustained shoulder abduction	.4123	89
prolonged standing	.3649	91
applying sustained pressure with transducer	.2712	92
clerical work	.2649	91
prolonged sitting	.2524	87
gripping transducer	.2032	88

With the exception of gripping the transducer all correlations were significant at $p=\leq.05$. This suggests that as the level of involvement in the activity increases, the contribution to injury also increases. The top 3 activities in which the level of involvement and contribution to injury were most strongly correlated were sustained twisting of the neck and trunk, performing mobile studies and repetitive twisting of the neck and trunk.

CLUSTERS OF WORK-RELATED SYMPTOMS

In an effort to determine if some of the symptoms tended to be grouped together, the researcher examined the correlations and developed an "inside out" table (see Appendix H). The "inside out" table showed clusters of symptoms which were correlated with each other. Correlations greater than .3000 were included in the table. The correlations for work-related symptoms are found in Appendix I. From the "inside out" table, three distinct clusters were found. The symptoms of neck pain and shoulder blade (interscapular) pain were positively correlated (r=.48) and formed cluster 1. Many relationships were found between symptoms of shoulder and upper arm pain, elbow pain, hand and wrist pain, numbness or tingling, and clumsiness of the fingers, so they were grouped together to form cluster 2. Relationships were

found between the symptoms of frontal headaches, pulling sensation of the eyes, blurring of vision, and redness or dryness of the eyes, therefore, this group of symptoms formed cluster 3. Only those respondents that had all of the symptoms in a cluster were included within that cluster. Examinations of the clusters revealed that there were 31 out of 96 respondents with neck and interscapular pain in cluster 1. Cluster 2 contained 4 respondents who had all of the symptoms (shoulder or upper arm pain, elbow pain, hand or wrist pain, numbness or tingling, and clumsiness of the fingers). Only 1 respondent had frontal headaches, redness or dryness of the eyes, blurring of vision, and pulling sensation of the eyes. Therefore, no further analyses of cluster 3 were carried out.

Crosstabulations and correlations of clusters 1 and 2 with each of the demographic variables, level of involvement in activities, and contribution to injury were performed. No significant correlations were found between the demographic variables and cluster 1. A positive correlation of .23 was found between cluster 2 and BMI. This suggests that those respondents with all symptoms in cluster 2 have a higher body mass index. All 4 respondents in cluster 2 were outside the healthy range for BMI. Of these 4 individuals, 3 were above the upper healthy range

limit. No significant correlations were found between cluster 2 and levels of involvement or contribution to injury.

Significant relationships were found between cluster 1 and several of the levels of involvement and contribution to injury variables. These are presented in Table 4-18. Correlations between cluster 1 and level of involvement and contribution to injury are found in Appendix J. Correlations between cluster 2 and level of involvement and contribution to injury are found in Appendix K.

Table 4-18: Pearson's correlations between cluster 1 (neck and shoulder blade problems) and levels of involvement and contribution to injury

Work-related activity	Correlation	
	Level of involvement	Contribution to injury
sustained shoulder abduction	.2761	.2799
sustained twisting of neck and trunk	.3560	.3491
repetitive twisting of neck and trunk		.2364
clerical work	-.2203	

CONSEQUENCES OF WORK-RELATED INJURY

Sonographers were asked to indicate the number of days absent from work due to work-related injury (based on a 7 3/4 hour work day). Sixteen respondents (16.7%) reported that they had been absent from work due to work-related symptoms. Excluding two outliers (150 and 225 days), the average number of days of absence from work was 15.3 days. Nine respondents (9.4%) indicated that they had decreased their work hours as a consequence of their work-related injury. Fourteen sonographers (14.6%) reported that a consequence of their work-related injury was decreased ability to perform their regular job duties. Included in the category of other responses were: working and living with pain (4), frustration due to constant pain (1), decreased enjoyment of life (1), poor coping (1), taking medications (1) and the need for taking time to stretch (1).

Eighteen (21.2%) of the 85 respondents with work-related symptoms utilized sick leave, 1 utilized unemployment insurance, 10 took vacation leave, 1 utilized disability insurance and 11 received workers' compensation benefits. Thirty-seven respondents received treatment for work-related symptoms (physical therapy, chiropractic care,

massage, etc.) and 27 took medications. Two individuals resorted to regular exercise as a result of their work-related injury.

Eight (9.4%) of the 85 respondents with work-related symptoms indicated that they changed their job duties as a result of work-related injury. Four (4.7%) respondents changed lighting, 24 (28.2%) changed layout of their workstation and 8 (9.4) changed their equipment. Other changes which were made as a result of work-related injury included: change of technique (4), purchase of non-prescription glasses (1) and more frequent rest breaks (1).

EDUCATION CONCERNING WORK-RELATED INJURY

Sixty-eight (70.8%) respondents received education concerning work-related injury and 24 (25.0%) did not. The sources of education received by the 68 respondents are indicated in Table 4-19.

Table 4-19: Sources of education regarding work-related injury in sonographers (received by 68 respondents)

Source of education received by sonographers	Respondents who received education by source (n=68) (#)	(%)
physical therapists	41	60.3
sonographers	29	42.6
self study	28	41.2
instructors	12	17.6
ergonomists	12	17.6
physicians/specialists	11	16.2
occupational therapists	7	10.3
public health nurses	7	10.3
chiropractors	4	5.9
other	3	4.4

In the "other" category, three respondents indicated that they received education concerning work-related injuries from fitness instructors and public speakers at conferences.

FACTORS THAT COULD RESULT IN AN INCREASE IN WORK-RELATED SYMPTOMS OVER THE NEXT 3 to 5 YEARS

The responses to the single most important factor that could result in an increase in work-related injuries in diagnostic sonographers over the next 3 to 5 years were grouped according to categories which emerged from the data. The category with the greatest number of responses was increased workload/decreased staff (35 responses;

41.2%) followed by sustained posture/activity (21 responses; 24.7%) and equipment (10 responses; 11.8%). The factors which could result in an increase in work-related injuries among diagnostic sonographers are presented in Table 4-20.

Table 4-20: Factors which could result in an increase in work-related injuries in diagnostic sonographers over the next 3 to 5 years

Factor	Responses (#)	Percentage (%)
increased workload/decreased staff	35	41.2
sustained posture/activity	21	24.7
equipment	10	11.8
mental stress	4	4.7
no knowledge/no change of activity	3	3.5
job tasks	2	2.4
patient type or size	2	2.4
increased performance of portables	2	2.4
lack of exercise	2	2.4
poor body mechanics	2	2.4
employer	1	1.2
awareness of work-related injury	1	1.2
Total	**85**	**100.00**

Note: missing cases: 11 (11.5%)

CHAPTER FIVE: DISCUSSION

Although there is little scientific documentation concerning work-related injuries among diagnostic sonographers, the results of this survey demonstrate that a significant problem is perceived by sonographers in Alberta. The discussion of the results is somewhat limited by the scarcity of information in the literature concerning work-related injuries among diagnostic sonographers. In addition, few professions have work activities which are similar to those performed by sonographers that could be used for comparisons. Although some of the cells with correlations were small these will be discussed where appropriate. By reporting these findings it is anticipated that this will lay the foundation for further comparative purposes with future research studies.

STUDY GROUP DESCRIPTION

Ninety-six of 156 (61.5%) sonographers who were eligible to participate in this study returned a questionnaire. Since it is common to have returns of less than 40 to 50 percent for mail surveys, this response rate was considered to provide a satisfactory sample of sonographers in Alberta. Efforts were made to facilitate the return of the questionnaire, such as a stamped self-

addressed envelope and follow-up telephone calls. These efforts and the interest among sonographers concerning work-related injuries likely contributed to the fairly high response rate.

WORK-RELATED INJURIES AMONG DIAGNOSTIC SONOGRAPHERS

It is apparent that work-related injuries are a common problem among diagnostic medical sonographers. In this study 88.5% of respondents reported work-related injuries. This figure can be compared to that reported in the study of carpal tunnel syndrome in diagnostic sonographers by Vanderpool et al[72], in which 86% of sonographers had carpal tunnel and/or other work-related symptoms. Since video display units are utilized by sonographers in the performance of sonograms it seems reasonable to compare injury statistics of video display terminal users and sonographers. As reported to the Bureau of National Affairs (BNA)[6], the Communication Workers of America estimated that 30 to 60% of video display terminal operators experience repetitive strain injuries. The percentage of sonographers with work-related injuries is higher than that of video display operators as reported to BNA. The percentage of those with work-related injuries in this study is likely higher because of the additional activities performed by sonographers.

When examining differences between those sonographers with, and those without work-related injuries, significant differences were found concerning weight and gender. In the study of carpal tunnel syndrome and other musculoskeletal disorders in cardiac sonographers, Vanderpool et al[72] reported that 90 % of the females in the study had symptoms of carpal tunnel syndrome or other musculoskeletal problems compared to 75% of males. In this study a higher percentage of females had work-related symptoms (94%) than males (54%). Similar findings were reported by Hymovich and Lindholm[35] in the study of the Bunker-Ramo Corporation in which the ratio of injured employees was 7 females to 1 male. In this study the difference in the percentages of females compared to males with work-related injuries can not be explained by differences in work activities, since female and male sonographers perform the same work activities. A possible explanation for the higher percentage of injuries in females is the relatively lower general physical strength of females compared to males as reported by Sikorski[61].

Examination of the data concerning weight and work-related symptoms revealed that there is a higher percentage of sonographers in this study that had work-related symptoms in the lower weight ranges. One hundred percent

of sonographers in the 90 to 109 pound weight range had work-related injuries. When examining the data concerning height and work-related symptoms, it appears that higher percentages of respondents had work-related symptoms in the shorter height categories. Sonography systems are heavy (450-550 pounds) and relatively unadjustable for height variation. The higher percentages of respondents with work-related symptoms in lower weight and height categories may reflect the limitations of the current equipment. Body mass index (BMI) was computed and a significant difference was found. The body mass index uses height and weight to suggest whether you are in a healthy range or have an increased likelihood of developing health problems due to being over or underweight. According to the guidelines for BMI, scores of less than 20 or greater than 25 may be associated with health problems for some people. All individuals in this study with a body mass index below 20 were experiencing work-related symptoms, which supports the BMI guidelines. The findings for a BMI of greater than 25 are less clear. This may be due to the low number of responses in each category which makes interpretation of results questionable.

There was a significant relationship between age and work-related symptoms. Higher percentages of respondents

with work-related injuries were found in the lower age groups (25-44 years) which is contrary to what one might expect. Sonography is a relatively new profession so there is not an abundance of sonographers over the age of 40. It is possible that older sonographers who had work-related symptoms may have left the profession to seek physically less stressful work, or may have retired.

Examination of the data concerning the remaining demographic variables did not reveal any significant relationships. Therefore, further analyses and interpretation of results were not performed.

JOB SATISFACTION

The majority of sonographers were either satisfied or extremely satisfied with their jobs. All sonographers who indicated extreme dissatisfaction, dissatisfaction or no response concerning job satisfaction had work-related symptoms. These findings were supported by Sikorski[61] who reported that the risk of work-related injury appears greater if emotional stresses are high and job satisfaction

is low. Caution should be exercised in interpreting the results since one does not know whether the dissatisfaction was present before the onset of work-related symptoms or if it occurred as a result of work-related symptoms. Although the relationship between job satisfaction and resolution of symptoms was not significant, it is interesting to note that the work-related symptoms had not resolved among 10 of the 11 sonographers who indicated extreme dissatisfaction, dissatisfaction or no response concerning job satisfaction.

TYPES OF WORK-RELATED INJURIES AMONG DIAGNOSTIC SONOGRAPHERS

The most common symptom reported by respondents was interscapular pain, followed by shoulder or upper arm pain, neck pain and low back pain. Although the same number of respondents had hand or wrist pain as compared to low back pain, fewer respondents indicated symptoms of carpal tunnel syndrome overall (hand or wrist pain, numbness or tingling of the fingers, and clumsiness of fingers). These results are similar to those in the study of carpal tunnel syndrome and other musculoskeletal problems in cardiac sonographers[72]. Vanderpool et al[72] reported that although 63% of respondents indicated that they had symptoms of carpal tunnel syndrome, a greater percentage (80%)

indicated that they had work-related back and neck injuries. Vanderpool et al[72] proposed the following explanation for the larger percentage of back and neck injuries relative to carpal tunnel syndrome. Since 80% to 90% of the population experiences back pain at some time during their lives it is reasonable that cardiac sonographers would display more back and neck symptoms than symptoms of carpal tunnel syndrome.

Although not as prevalent as other symptoms, visual problems were reported among diagnostic sonographers. This supports the findings of Craig[18,19] who reported visual problems such as eyestrain, eye irritation, blurred vision, eye fatigue and itching and burning of the eyes among sonographers. The finding of visual problems is supported by Ong[55] who indicated that eyestrain is associated with the use of video display terminals. Visual problems among sonographers may be compounded by working in a dark environment for much of the work day.

When correlations between specific symptoms and demographic variables were examined, positive correlations were found between activity level and neck pain, and between years since completion of training and shoulder or upper arm pain. It appears that those respondents who were

less active at the time of the study as compared to their activity level of the previous 5 years, had fewer complaints of neck pain. Caution must be exercised in interpreting this data since one is not aware of the types of activities in which the respondents were involved. Many activities such as aerobics, racket sports, and jogging may aggravate neck problems. Sonographers may have had neck problems and therefore, decreased their involvement in activities which would aggravate their symptoms.

The prevalence of shoulder or upper arm pain increased as the number of years since completion of training increased. One might expect to see this relationship. Performance of repetitive work on a fairly continuous basis results in static loading of the muscles which fix and support the moving part of the body[11,14,55]. To perform dynamic movement of the forearm and hand, the muscles of the neck, shoulder and upper arm contract to support and fix the arm in a position of function. Over time this can result in discomfort and reduced performance capabilities[14].

MEDICAL DIAGNOSES BY PHYSICIANS

Tendinitis was the most common medical diagnosis of work-related injury. Although 41.7% of the total sample of sonographers reported one or more symptoms of carpal tunnel syndrome, few (5.2% of total sample) were actually diagnosed as having carpal tunnel syndrome. These findings reflect those of Vanderpool et al[72] who reported that a total of 63% of respondents had experienced symptoms of carpal tunnel syndrome at some time during their careers, but only 3% had been diagnosed with carpal tunnel syndrome.

The positive correlation between age and the diagnosis of ganglions was not unexpected. As the body ages it recovers less quickly from the damage caused by repetitive movement[6]. Therefore, one may expect to see more injuries in older workers due to repetitive movement, as compared to younger workers. Of the 6 individuals with a diagnosis of ganglions, 3 used both hands for scanning. With the large percentage (50%) of those with a diagnosis of ganglions who scanned with both hands, it would not be unreasonable to suspect that the sonographers changed scanning hands to relieve the symptoms of ganglions. Caution must be exercised in interpretation of these results.

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APPENDIX A

INTRODUCTORY LETTER

Department of Physical Therapy
Faculty of Rehabilitation Medicine
2-50 Corbett Hall
University of Alberta
Edmonton, Alberta
T6G 2G4

July 20, 1994

Dear _____,

I am conducting a study designed to investigate the occurrence of work-related injuries among diagnostic medical sonographers. If you are currently working as a sonographer, it would be appreciated if you would participate in this project.

Enclosed is a consent form and questionnaire. The questionnaire asks questions concerning your personal and professional characteristics, current work details, current or previous work-related symptoms or injuries, and any consequences of work-related injuries. The questionnaire will take approximately 5-10 minutes of your time. The information you provide may help identify the occurrence and consequences of work-related injuries among sonographers, and identify areas for future study.

All information given will be kept confidential. Access to information will be limited to the principal investigator and academic supervisors. There are no known risks involved with this type of investigation.

Please complete the consent form and questionnaire and return them to me by August 20, 1994. A stamped addressed envelope is included for your convenience. If you have any questions regarding this study, please contact me at 459-2848.

Thank you for considering this request.

Sincerely,

Lois Wihlidal
Master's of Science Candidate,

Academic Supervisor: Shrawan Kumar, PhD., Phone: 492-5983

APPENDIX B

CONSENT FORM

INFORMED CONSENT FOR DIAGNOSTIC SONOGRAPHERS

Title: An injury profile of practicing diagnostic sonographers in Alberta

Investigator: Lois Wihlidal, Rehabilitation Medicine
Graduate Student in Physical Therapy
459-2848

Advisor: Dr. Shrawan Kumar
Faculty of Rehabilitation Medicine U of A
492-5979

Purpose: The purpose of this study is to investigate the occurrence and consequences of work-related injuries in diagnostic medical sonographers. You will be requested to complete a brief questionnaire which will ask questions concerning your personal and professional characteristics, current work details, current or previous work-related symptoms or injuries, and any consequences of work-related injuries. It will take approximately 5-10 minutes of your time.

Consent:

I, _____, agree to participate in the above named project.

I understand that my participation in this project is voluntary. I may refuse to answer any questions I so choose. I may withdraw from this study at any time without consequences to myself.

I understand that all the information that will be obtained in this study will be treated confidentially. My name will not appear on any of the data sheets, and any information that is published or presented at conferences will not refer to me by name. All questionnaires and data sheets will be destroyed once the final report is completed.

The research may not benefit me directly, but the information obtained will be used to help further research concerning work-related injuries in diagnostic sonographers.

Any questions that I had about the project have been answered to my satisfaction. I understand that I am free to ask the principal investigator any questions I may have.

_____ _____

Signature of Participant Date

_____ _____

Signature of Investigator Date

APPENDIX C

QUESTIONNAIRE

Please check (✓) only one box in **each** section as appropriate unless otherwise indicated.

1. SEX	CODE	✓
MALE	01	
FEMALE	02	

2. AGE (IN YEARS)	CODE	✓
UNDER 25	01	
25-34	02	
35-44	03	
45-54	04	
55-64	05	
OVER 64	06	

3. HEIGHT (NO SHOES)	CODE	✓
UNDER 5'0"	01	
5'1" - 5'3"	02	
5'4" - 5'6"	03	
5'7" - 5'9"	04	
5'10" - 6'0"	05	
6'1" - 6'3"	06	
6'4" - 6'6"	07	
OVER 6'6"	08	

4. WEIGHT (IN POUNDS)	CODE	✓
UNDER 90 lbs	01	
90 - 109	02	
110 - 129	03	
130 -149	04	
150 -169	05	
170 -189	06	
190 -209	07	
210 -229	08	
230 - 249	09	
250 - 269	10	
OVER 269	11	

5. PLACE OF EMPLOYMENT	CODE	✓
Hospital	01	
Private Clinic	02	
Other (Specify) _____	03	

6. PROVINCE/TERRITORY IN WHICH YOU TRAINED	CODE	✓
Alberta	01	
British Columbia	02	
Manitoba	03	
New Brunswick	04	
Newfoundland/Labrador	05	
N.W.T	06	
Nova Scotia	07	
Ontario	08	
P.E.I.	09	
Quebec	10	
Saskatchewan	11	
Yukon	12	
Other (specify) _____	13	

7. Indicate (✓) if you wear corrective lenses (contacts, glasses, etc.)	CODE	✓
YES	1	
NO	2	
If no, go to question 10		

8. Indicate (✓) type of lenses worn	CODE	✓
Single vision	01	
Bifocals	02	
Trifocals	03	
Contacts	04	
Lineless Bifocals	05	

9. Indicate (✓) when you received your **first** lenses.	CODE	✓
Before training/working as a sonographer	01	
After starting training/ work as a sonographer	02	

10. On average, indicate (✓) the number of times per week that you exercise **continuously** at a moderate pace for at least 20 minutes (walking, cycling, swimming, etc.)	CODE	✓
NEVER	01	
1 or 2 times/week	02	
3 or 4 times/week	03	
5 or 6 times/week	04	
7 or 8 times/week	05	
more than 8 times/week	06	

11. Choose the **one** response that best compares your present activity level to your average activity level during the past 5 years.	CODE	✓
I presently exercise:		
considerably less often	01	
slightly less often	02	
the same number of times/wk	03	
slightly more often	04	
considerably more often	05	

The following statements/questions are related to your work as a sonographer.

12. Indicate (✓) which and you scan	CODE	✓
RIGHT	01	
LEFT	02	
BOTH	03	

13. Indicate (✓) how long ago you completed training	CODE	✓
less than 5 years ago	01	
5 - 9 years ago	02	
10 - 14 years ago	03	
15 - 19 years ago	04	
20 -24 years ago	05	
more than 24 years ago	06	

14. Since graduation/completion of training, based on earned annual hours (eg. based on 7 3/4 hour day with 2022.75 hrs equal to one year of service), identify the following:

a. Number of years of active full time service _____

b. Number of years of active part-time service _____

(Specify average part time hours/week)

_____

15. Have you ever had, or do you currently have, a **work-related injury?**	CODE	✓
YES	01	
NO	02	

16. Indicate (✓) if you ever had, or are currently experiencing any of the following symptoms **that you believe are a direct result of your work activities** (Check as many as apply to you)	CODE	✓
neck pain	01	
frontal headaches	02	
pain between shoulder blades	03	
shoulder or upper arm pain	04	
elbow pain	05	
hand or wrist pain	06	
numbness or tingling of fingers	07	
clumsiness of fingers	08	
low back pain	09	
pulling sensation of the eyes	10	
blurring of vision	11	
redness/dryness of eyes	12	
other (specify) _____ _____ _____	13	

If you have never had, or are not experiencing any work-related symptoms go to question 23

17. Indicate (✓) if you have ever been diagnosed by a doctor as having any of the following problems (Check as many as apply to you)	CODE	✓
carpal tunnel syndrome	01	
tendinitis	02	
tenosynovitis	03	
epicondylitis (tennis or golfer's elbow)	04	
bursitis	05	
ganglions	06	
other (specify) _____ _____ _____	07	

18. Indicate (✓) if your problem has resolved	CODE	✓
YES	01	
NO	02	

19. If your problem has resolved, what in your opinion is the **single** most important intervention that has reduced or eliminated your work-related problem?

_____

_____

_____

20. Indicate (✓) any consequences of your **work-related injury**	CODE	✓
Absenteeism from work Indicate the **total** number of days absent from work based on a 7 3/4 hr da since the onset of you **work-related injury** _____	01	
Decreased number of working hours	02	
Decreased ability to perform regular job duties	03	
Other _____ _____ _____	04	

21. As a result of your **work-related injury** indicate (✓) if you have utilized any of of the following. (Check as many as apply).	CODE	✓
sick leave	01	
unemployment insurance	02	
vacation leave	03	
disability insurance	04	
workers compensation	05	
treatment (physiotherapy, chiropractic, etc.)	06	
medications	07	
other (specify) _____ _____ _____	08	

22. As a result of your **work-related injury**, indicate (✓) if you have had to change any of the following	CODE	✓
Job duties	01	
Equipment	02	
Layout of work station	03	
Lighting	04	
Other (specify) _____ _____ _____	05	

23. Indicate (✓) if you have received education concerning work-related injury (types of injury, causes, prevention)	CODE	✓
YES	01	
NO	02	

24.If yes, indicate (✓) the source(s) of the education you have received concerning work-related injuries	CODE	✓
instructors during training	01	
physical therapists	02	
occupational therapists	03	
public health nurses	04	
physicians/specialists	05	
chiropractors	06	
sonographers	07	
ergonomists	08	
self study	09	
other (specify) _____ _____	10	

25 For each of the following work-related activities below, circle **your** level of involvement in the activity during the course of a typical work day (1 = no involvement, 5 = considerable involvement ie. much of the day), and the degree to which you feel the activity contributes to work-related injury **for sonographers in general** (1 = no contribution to injury; 5 = very high contribution to injury for sonographers in general)

ACTIVITY	LEVEL OF INVOLVEMENT 1=no involvement during day 5=considerable involvement	CONTRIBUTION TO INJURY 1=no contribution to injury 5=very high contribution
a. gripping transducer	1 2 3 4 5	1 2 3 4 5
b. applying sustained pressure with transducer	1 2 3 4 5	1 2 3 4 5
c. sustained shoulder abduction (ex. scanning apical 4 chamber with arm at approx. 90 degrees)	1 2 3 4 5	1 2 3 4 5
d. prolonged sitting	1 2 3 4 5	1 2 3 4 5
e. prolonged standing	1 2 3 4 5	1 2 3 4 5
f. performing on-line measurement	1 2 3 4 5	1 2 3 4 5
g. performing off-line measurement	1 2 3 4 5	1 2 3 4 5
h. sustained twisting of neck and trunk	1 2 3 4 5	1 2 3 4 5
i. repetitive twisting of neck and trunk to look from patient to monitor	1 2 3 4 5	1 2 3 4 5
j. lifting/assisting patients	1 2 3 4 5	1 2 3 4 5
k. transporting equipment for mobile studies	1 2 3 4 5	1 2 3 4 5
l. performing mobile studies	1 2 3 4 5	1 2 3 4 5
m. clerical work	1 2 3 4 5	1 2 3 4 5
n. changing cassettes	1 2 3 4 5	1 2 3 4 5
o. Other (specify) _____	1 2 3 4 5	1 2 3 4 5
_____	1 2 3 4 5	1 2 3 4 5
_____	1 2 3 4 5	1 2 3 4 5

26. Indicate (✓) the **ONE** response that **BEST** describes your **overall** job satisfaction	CODE	✓
extremely dissatisfied	01	
dissatisfied	02	
no response	03	
satisfied	04	
extremely satisfied	05	

27. What in your opinion is the **single** most important factor that could result in an **increase** in work-related injuries in diagnostic sonographers over the next 3-5 years?

_____

_____

_____

THANK YOU FOR YOUR RESPONSES!

YOUR TIME IS SINCERELY APPRECIATED

PLEASE RETURN BY:_____

APPENDIX D

CORRELATIONS BETWEEN WORK-RELATED SYMPTOMS AND DEMOGRAPHIC VARIABLES

Correlations between demographic variables and work-related symptoms

Demographic Variable	Correlation Coefficient with work-related symptoms
Age	-.2155 (p=.035)
Gender	.4311 (p=.000)
BMI	-.2409 (p=.018)
Weight	-.3392 (p=.001)
Height	-.2364 (p=.020)
Employment	-.0242 (p=.815)
Province	-.0210 (p=.839)
Lenses (yes/no)	.0869 (p=.400)
Bifocal lenses	.2096 (p=.040)
Contact lenses	.0548 (p=.596)
Lineless bifocals	.1450 (p=.159)
Single lenses	-.0530 (p=.608)
Trifocal lenses	.0757 (p=.463)
First lenses	.0894 (p=.386)
Exercise frequency	-.1233 (p=.231)
Activity level	.0291 (p=.778)
Scan hand	-.0390 (p=.706)
Yrs since completion of training	-.0822 (p=.426)
Av. full time yrs	-.1250 (p=.227)
Av. part time yrs	.1793 (p=.081)
Av. part time hrs	-.2246 (p=.029)

APPENDIX E

CROSSTABULATIONS OF BMI AND WORK-RELATED SYMPTOMS

Crosstabulations of BMI and work-related symptoms

	Work-related symptoms		
Count	yes	no	Row Total
BMI	1.00	2.00	# %
16.68	3		3 3.1
18.28	2		2 2.1
18.33	5		5 5.2
19.57	1		1 1.0
19.57	1		1 1.0
20.01	12	1	13 13.5
21.33	4	1	5 5.2
21.99	6		6 6.3
22.36	3		3 3.1
23.35	17	1	18 18.8
23.48	2		2 2.1
24.38	5	1	6 6.3
25.16	1	2	3 3.1
25.66	10	1	11 11.5
26.68	4		4 4.2
27.43	1	1	2 2.1
27.95	1		1 1.0
29.33	2	1	3 3.1
30.02	2		2 2.1
30.47		1	1 1.0
33.35	1		1 1.0
35.23	1		1 1.0
36.57		1	1 1.0
36.69	1		1 1.0
Total	85 (88.5%)	11 (11.5%)	96 (100%)

APPENDIX F

CORRELATIONS BETWEEN DEMOGRAPHIC VARIABLES AND SPECIFIC SYMPTOMS

Correlations between demographic variables and specific symptoms page 1

Demographic Variable		Symptoms		
	Neck Pain (corr) (sig)	Frontal Headache (corr) (sig)	Shoulder blade pain (corr) (sig)	Shoulder/ upper arm (corr) (sig)
Age	-.1251 .225	.0729 .481	-.1180 .252	.0825 .424
Gender	.0955 .355	.0953 .356	.1968 .055	.1277 .215
Height	.2175 .033	-.0289 .780	.0431 .677	-.0216 .835
Weight	.0024 .981	-.0726 .482	.0571 .581	.0741 .473
BMI	-.0988 .338	-.0580 .574	.0728 .481	.1129 .273
Employment	.0778 .451	-.1239 .229	-.0924 .371	-.0771 .455
Province	.1440 .162	.0876 .396	-.1115 .279	-.0102 .921
Lenses	.0019 .985	-.0410 .692	-.0650 .529	-.2354 .021
Contacts	-.0083 .936	.0136 .895	.0063 .951	-.1125 .275
Lineless bifocals	.0209 .840	-.0296 .775	-.0414 .689	-.2058 .044
Single lenses	-.0977 .343	-.1448 .159	-.2146 .036	-.2922 .004
Trifocals	.0209 .840	-.0296 .775	-.0414 .689	-.2500 .014
Bifocals	.0998 .333	.0170 .870	.0554 .592	-.2019 .049
First lenses	.0527 .610	-.0260 .801	-.0267 .796	-.2440 .017
Exercise frequency	.1018 .324	.0883 .392	-.0107 .918	-.1545 .133
Activity level	.3820 .000	.0826 .424	.1729 .092	.1839 .073
Scan hand	.0517 .617	.0314 .761	-.0205 .843	-.0132 .899
yrs since training	.0597 .563	.0526 .611	.0888 .390	.3102 .002
av. full time yrs	.0701 .500	.0986 .342	.2032 .048	.2681 .009
av. part time yrs	.0300 .772	.0243 .814	-.1555 .130	.1089 .291
av. part time hours	.0403 .698	-.0011 .991	.1399 .176	-.0607 .559

Correlations between demographic variables and specific symptoms page 2

Demographic Variable		Symptoms		
	Elbow pain (corr) (sig)	Hand/wrist pain (corr) (sig)	Numbness/ Tingling (corr) (sig)	Clumsiness of fingers (corr) (sig)
Age	.1018 .324	.0209 .839	-.0428 .679	.0192 .853
Gender	.2030 .047	.0215 .835	.0879 .395	.1350 .190
Height	-.0795 .441	-.0228 .825	.0248 .810	.1409 .171
Weight	-.0167 .872	.0328 .751	.0670 .517	.1282 .213
BMI	.0269 .795	.0515 .618	.0585 .572	.0838 .417
Employment	-.1137 .270	-.1632 .112	-.0711 .491	-.2015 .049
Province	-.0878 .395	-.1005 .330	.0077 .940	.0558 .589
Lenses	-.1035 .316	-.0648 .530	.0529 .609	.0063 .952
Contacts	.0344 .740	-.0108 .917	.0527 .610	.0478 .644
Lineless bifocals	-.0883 .392	-.0468 .651	.0637 .538	.0135 .896
Single lenses	-.1661 .106	-.1018 .324	.0346 .738	-.0319 .758
Trifocals	-.0883 .392	-.0468 .651	.0637 .538	.0135 .896
Bifocals	-.1206 .242	-.0536 .604	.0219 .832	-.0181 .861
First lenses	-.0728 .481	-.0905 .381	.0201 .846	.0087 .933
Exercise frequency	-.0871 .399	-.1745 .089	-.1709 .096	.1521 .139
Activity level	.1463 .155	.0949 .358	-.0097 .925	.2621 .010
Scan hand	-.0936 .364	.0869 .400	-.1621 .115	-.1197 .246
yrs since training	.0933 .366	.2421 .017	.0556 .591	.0270 .794
av. full time yrs	.0915 .378	.2356 .022	.0698 .502	.1003 .334
av. part time yrs	.0067 .949	.0424 .681	.0667 .519	-.1364 .185
av. part time hours	.0111 .915	.0136 .896	-.0533 .608	.1035 .318

Correlations between demographic variables and specific symptoms
page 3

Demographic Variable		Symptoms		
	Low back pain (corr) (sig)	Pulleyes (corr) (sig)	Red/Dry eyes (corr) (sig)	Blurring of vision (corr) (sig)
Age	-.0419 .685	-.1263 .220	-.2597 .011	-.0170 .870
Gender	.0861 .404	-.0644 .533	.1278 .215	.0468 .651
Height	-.0228 .825	-.0000 1.00	.0234 .821	.1013 .326
Weight	.0328 .751	-.0744 .471	-.1132 .272	-.0493 .633
BMI	.0562 .587	-.1057 .305	-.1346 .191	-.1055 .306
Employment	-.0653 .527	.0504 .626	.0503 .627	-.0725 .483
Province	.0019 .985	.0031 .976	.1690 .100	-.0548 .596
Lenses	-.0648 .530	.0063 .952	-.0728 .481	-.0869 .400
Contacts	-.0431 .677	-.0021 .984	-.1333 .195	-.0548 .596
Lineless bifocals	-.0468 .651	.0135 .896	-.0555 .591	-.0757 .463
Single lenses	-.1018 .324	.0466 .652	-.0694 .502	-.1730 .092
Trifocals	-.0936 .364	.0135 .896	-.0555 .591	-.0757 .463
Bifocals	-.0134 .897	-.0181 .861	-.0267 .796	-.0310 .764
First lenses	-.0411 .691	.0468 .651	-.0414 .689	.0202 .845
Exercise frequency	-.0698 .499	.0552 .593	.0613 .553	.0923 .371
Activity level	.0949 .358	-.0950 .357	-.0681 .509	.1817 .077
Scan hand	.0496 .631	-.0048 .963	-.1544 .133	-.1262 .220
yrs since training	.1286 .212	.0270 .794	-.0085 .935	.0150 .884
av. full time yrs	.1508 .145	.0309 .766	-.0664 .522	.0113 .914
av. part time yrs	-.0873 .398	.0138 .894	.1053 .307	.0668 .518
av. part time hours	.0854 .410	-.0531 .609	-.1939 .060	-.0316 .761

APPENDIX G

CORRELATIONS BETWEEN DIAGNOSES AND DEMOGRAPHIC VARIABLES

Correlations between demographic variables and diagnoses.
page 1

Demographic Variable	Diagnosis: Carpal Tunnel (corr) (sig)	Tendinitis (corr) (sig)	Tenosyno-vitis (corr) (sig)	Bursitis (corr) (sig)
Age	.0132 .898	.1921 .061	-.0239 .817	.0587 .570
Gender	-.0442 .669	.0136 .895	.0711 .491	-.0816 .429
Height	-.0484 .639	-.0577 .576	-.0000 1.00	.0738 .475
Weight	.0533 .606	.1764 .086	.1653 .108	.1368 .184
BMI	.0791 .444	.2476 .015	.1894 .065	.1165 .258
Employment	-.1039 .314	-.1239 .229	-.1326 .198	-.0792 .443
Province	-.0280 .786	-.1860 .070	-.0863 .403	.0296 .774
Lenses	.1590 .122	-.1640 .110	-.1153 .263	.0295 .776
Single lenses	.1130 .273	-.2092 .041	-.1616 .116	-.0013 .990
Bifocals	.1583 .124	-.1866 .069	-.0749 .468	-.0041 .969
Trifocals	.1582 .124	-.1480 .150	-.1070 .300	.0355 .731
Contacts	.1698 .098	-.0681 .510	-.0273 .791	.1077 .296
Lineless bifocals	.1582 .124	-.1480 .150	-.1070 .300	.0355 .731
First lenses	.1369 .184	-.1821 .076	-.1358 .187	.0362 .726
Exercise frequency	-.1175 .254	.0618 .550	-.0106 .918	-.0190 .854
Activity level	-.0464 .653	.1951 .057	.0512 .620	.0054 .958
Scan hand	-.0823 .426	.0314 .761	-.0630 .542	.0075 .942
yrs since training	.0186 .858	.1675 .103	.0634 .539	.1870 .068
av. full time yrs	.0488 .638	.2663 .009	.0273 .793	.2459 .016
av. part time yrs	.0912 .377	-.1809 .078	-.1015 .325	-.0375 .717
av. part time hours	-.0571 .582	.1437 .165	.1182 .254	.0611 .556

Correlations between demographic variables and diagnoses page 2

Demographic Variable	Diagnosis: Epicondylitis (corr) (sig)	Diagnosis: Ganglions (corr) (sig)
Age	.0587 .570	.2103 .040
Gender	.1273 .217	-.0236 .820
Height	-.0369 .721	-.1333 .195
Weight	.1368 .184	-.0180 .862
BMI	.1806 .078	.0595 .565
Employment	-.1848 .072	.0636 .538
Province	-.1545 .133	-.1240 .229
Lenses	-.1278 .215	-.0710 .492
Single lenses	-.2070 .043	-.0836 .418
Bifocals	-.0691 .503	-.0294 .776
Trifocals	-.1159 .261	-.0627 .544
Contacts	.0033 .975	-.0393 .704
Lineless bifocals	-.1169 .261	-.0627 .544
First lenses	-.1235 .231	-.0030 .977
Exercise frequency	-.0868 .401	.0255 .805
Activity level	.0054 .958	.1430 .165
Scan hand	-.0527 .610	.3443 .001
yrs since training	.1503 .144	.0912 .377
av. full time yrs	.2055 .046	.0391 .707
av. part time yrs	-.0440 .670	.1384 .179
av. part time hours	.0902 .385	-.0177 .864

APPENDIX H

INSIDE OUT TABLE USED TO DETERMINE CLUSTERS OF WORK-RELATED SYMPTOMS

Inside out table used to determine clusters of work-related symptoms

Corr.	1 Neck Pain	2 Frontal Headache	3 Pain between shoulder blades	4 Shoulder or Upper Arm Pain	5 Elbow Pain	6 Hand/ Wrist Pain	7 Numbness or Tingling	8 Clumsiness of fingers	9 Low back pain	10 Pulling of Eyes	11 Blurring of Vision	12 Red Dry Eyes
.5												
.4	3		1				6,8	5,7				
.3		11		6	6,8	4,5,7		11		11,12	2,8,10	10
.2												

APPENDIX I

CORRELATIONS BETWEEN WORK-RELATED SYMPTOMS

Correlations between work-related symptoms
page 1

Symptom	Neck Pain (corr) (sig)	Frontal Headache (corr) (sig)	Pain between Shoulder blades (corr) (sig)	Shoulder or Upper Arm Pain (corr) (sig)
Neck Pain	1.000	.1789 .081	.4786 .000	.2862 .005
Frontal Headaches	.1789 .081	1.000	.0746 .470	.0840 .416
Pain between shoulder blades	.4786 .000	.0746 .470	1.000	.2272 .026
Shoulder or Upper Arm Pain	.2862 .005	.0840 .416	.2272 .026	1.000
Elbow Pain	.2312 .023	.2524 .013	.0727 .481	.2891 .004
Hand/Wrist Pain	.2382 .019	.1581 .124	.2064 .044	.3985 .000
Numbness/ Tingling	.1337 .194	.1936 .059	.0722 .484	.2772 .006
Clumsiness of fingers	.2571 .011	.2135 .037	.2190 .032	.2947 .004
Low back pain	.2382 .019	.2174 .033	.2064 .044	.2214 .030
pulling of the eyes	.0503 .627	-.0610 .555	-.0540 .601	.0897 .385
blurring of vision	.2183 .033	.3656 .000	.1787 .082	.1208 .241
red or dry eyes	.2116 .038	.1319 .200	.0501 .628	-.0270 .794

Correlations between work-related symptoms
page 2

Symptom	Elbow Pain (corr) (sig)	Hand/Wrist Pain (corr) (sig)	Numbness or Tingling (corr) (sig)	Clumsiness of fingers (corr) (sig)
Neck Pain	.2312 .023	.2382 .019	.1337 .194	.2571 .011
Frontal Headaches	.2524 .013	.1581 .124	.1936 .059	.2135 .037
Pain between shoulder blades	.0727 .481	.2064 .044	.0722 .484	.2190 .032
Shoulder or Upper Arm Pain	.2891 .004	.3985 .000	.2772 .006	.2947 .004
Elbow Pain	1.000	.3446 .001	.2369 .020	.4128 .000
Hand/Wrist Pain	.3446 .001	1.000	.4593 .000	.2652 .009
Numbness/ Tingling	.2369 .020	.4593 .000	1.000	.4331 .000
Clumsiness of fingers	.4128 .000	.2652 .009	.4331 .000	1.000
Low back pain	.1270 .218	.2500 .014	.2041 .046	.2652 .009
pulling of the eyes	.0770 .456	.2652 .009	.2756 .007	.1070 .300
blurring of vision	.0570 .581	.0925 .370	.1699 .098	.3056 .002
red or dry eyes	-.1141 .269	.0160 .877	.1965 .055	.0727 .481

Correlations between work-related symptoms
page 3

Symptom	Low back pain (corr) (sig)	Pulling of eyes (corr) (sig)	Blurring of vision (corr) (sig)	Red or Dry Eyes (corr) (sig)
Neck Pa[illegible]	.2382 .019	.0503 .627	.2183 .033	.2116 .038
Fronta Headac[illegible]	.2174 .033	-.0610 .555	.3656 .000	.1319 .200
Pain bet shoulder blades	[illegible]4 .044	-.0540 .601	.1787 .082	.0501 .628
Shoulder c Upper Arm Pain	2214 .030	.0897 .385	.1208 .24[illegible]	-.0270 .794
Elbow Pain	.1270 .218	.0770 .456	.0570 .581	-.1141 .269
Hand/Wrist Pain	.2500 .014	.2652 .009	.0925 .370	.0160 .877
Numbness/ Tingling	.2041 .046	.2756 .007	.1699 .098	.1965 .055
Clumsiness of fingers	.2652 .009	.1070 .300	.3056 .002	.0727 .481
Low back pain	1.000	.1206 .242	.0925 .370	.0642 .535
pulling of the eyes	.1206 .242	1.000	.3056 .002	.3698 .000
blurring of vision	.0925 .370	.3056 .002	1.000	.2619 .010
red or dry eyes	.0642 .535	.3698 .000	.2619 .010	1.000

APPENDIX J

CORRELATIONS BETWEEN CLUSTER 1 AND LEVEL OF INVOLVEMENT AND CONTRIBUTION TO INJURY

Correlations between Cluster 1* and level of involvement and contribution to injury

Activity	Level of Involvement	Contribution to Injury
gripping transducer	.0062 .953	.0478 .658
applying sustained pressure with transducer	.1585 .127	.1672 .111
sustained shoulder abduction	.2761 .007	.2799 .008
prolonged sitting	.0528 .615	.0900 .407
prolonged standing	-.0940 .368	.0336 .752
sustained twisting of neck and trunk	.3560 .000	.3491 .001
repetitive twisting of neck and trunk	.1180 .265	.2364 .027
lifting/assisting patients	.0044 .966	-.0117 .912
transporting equipment for mobile studies	.1399 .179	-.0404 .705
performing mobile studies	.1551 .138	.0215 .841
clerical work	-.2203 .033	.1094 .302
changing cassettes	-.0541 .604	.1307 .217

* Cluster 1 consists of the symptoms of neck pain and interscapular pain

APPENDIX K

CORRELATIONS BETWEEN CLUSTER 2 AND LEVEL OF INVOLVEMENT AND CONTRIBUTION TO INJURY

Correlations between cluster 2* and level of involvement and contribution to injury

Activity	Level of Involvement	Contribution to Injury
gripping transducer	.0729 .485	.1979 .064
applying sustained pressure with transducer	.0416 .690	.0540 .609
sustained shoulder abduction	.1664 .111	.1544 .149
prolonged sitting	-.0409 .697	-.0592 .586
prolonged standing	.0093 .929	-.0076 .943
sustained twisting of neck and trunk	.1009 .336	.0101 .925
repetitive twisting of neck and trunk	.0027 .980	-.0489 .651
lifting/assisting patients	.1531 .141	-.0274 .795
transporting equipment for mobile studies	.0076 .942	-.0860 .420
performing mobile studies	-.0434 .680	-.1407 .186
clerical work	-.0721 .490	-.1130 .286
changing cassettes	-.0464 .657	-.0224 .833

* Cluster 2 consists of the symptoms of shoulder or upper arm pain, elbow pain, hand or wrist pain, clumsiness of fingers, and numbness or tingling