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HISTORICAL RESEARCH REPORT

Research Report TM/99/04
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WORLD HEALTH ORGANISATION
COLLABORATING CENTRE
FOR OCCUPATIONAL HEALTH

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Two linked studies were undertaken to examine a wide variety of factors which may be associated with symptoms of upper limb disorders in keyboard operators, including characteristics of the work, workplace, posture, and psychological stresses.

In Phase 1, almost 4,500 questionnaires were given to keyboard users working for a number of public and private organisations. Almost 80% of these were returned completed. Of the respondents, 55% had experienced symptoms of upper limb disorders at some time, and 49% reported experiencing symptoms in the last three months. Fourteen percent had asked for advice about their symptoms from a health professional (e.g. a doctor or physiotherapist).

In Phase 2, a sample of 295 of these cases with symptoms were compared with 154 controls without symptoms. For each of these, a detailed examination of the workplace was conducted by an ergonomist, who applied a standard interview, administered questionnaires, and observed work practices. Although there were differences between the upper limb syndrome groups, female gender and increased age were often significantly associated with risk of being a case. Analyses of almost 100 variables showed a number of work-related factors also to be significant. Both the number of hours per week spent using a keyboard and the length of time spent at the keyboard without a break were particularly strongly associated with case status. Large numbers of the factors that were associated with symptoms of ULDs could be related to psychosocial stresses in the work environment.

A number of the associations identified are supportive of the provisions of the Health and Safety (Display Screen Equipment) Regulations 1992, which came into force during the course of this research.

This report is one of a series from the Institute of Occupational Medicine (IOM). Lists of these reports and of other IOM publications are available from our Scientific Information Officer.

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EXECUTIVE SUMMARY

Discomfort in the wrists and arms was reported over 300 years ago as an occupational hazard for office workers. In the last ten years or so there has been an increase in awareness of those using computer keyboards particularly experiencing these symptoms. Many different factors have been blamed for this, including the intensive nature of computer keyboard work; the postures adopted by those working at computer keyboards; the design of the keyboard itself; etc. This study was conducted to examine a wide variety of factors which may be associated with these problems, including characteristics of the workplace, the postures adopted by those using the keyboards, and the mental stresses and pressures acting upon keyboard users.

The work was conducted in two phases. In Phase 1, a questionnaire was specially developed (the ULSQ) to collect information about symptoms (aches, pains, swellings etc.) of upper limb problems. Almost 4,500 of these questionnaires were given to keyboard users working for a number of organisations in both the public and private sector. The questionnaires were given to those who used a computer for at least an hour a day; some who completed the questionnaire worked almost full-time at a keyboard. Some undertook data entry work, others such as computer programmers and managers, had more latitude in the way they used the computer.

Almost 80% of these questionnaires were returned completed. The results showed that almost 55% of those who filled in a questionnaire had experienced symptoms of upper limb disorders at some time and nearly a half (49%) reported experiencing symptoms in the last three months. Fourteen percent of the total had asked for advice about their symptoms from a health professional (e.g. a doctor or physiotherapist). Few directly comparable studies have been reported elsewhere. However, the rates of symptoms reported here are lower than those reported for a group of newspaper workers in the USA, who also indicated a much higher rate of seeking medical advice.

Groups of symptoms were used to classify subjects into six 'syndrome groups' suggesting particular types or locations of disorder. These were: 'Trigger Digit'; 'Nerve Entrapment'; 'Tendon disorders'; 'Epicondylitis'; 'Shoulder Disorders'; and general 'Forearm Pain'. Of the 1924 people who reported symptoms, 939 could be classified as being in at least one of these syndrome groups, the rest having single symptoms or groups of symptoms which did not fit into these categories.

In Phase 2 of the study a sample of 295 people from these 939 took part in a case-control comparison study as 'cases', together with 154 of the 1579 subjects who reported no symptoms ('controls'). For each of these, a detailed examination of their workplace was conducted by an ergonomist who interviewed the individual, asked them to complete standard questionnaires and observed them working.

The information collected was used to compare cases and controls for each of the six syndrome groups together with a seventh category of 'Any Syndrome' which included all cases regardless of the nature of their symptoms. Almost 100 variables were examined for their association with upper limb symptoms. Variables considered concerned: gender and age; duration of keyboard usage and other 'risky' activities; information about the job; information about the work equipment; the physical environment and factors outside work; personal information; general body postures; hand and wrist postures; and psychosocial factors.

It was found that those who were cases (the 'Any Syndrome' group) were older and more likely to be female than the controls. The same pattern with age and gender was seen amongst the cases in the Nerve Entrapment and Shoulder Disorders groups. However, in other groups of cases the pattern was slightly different with females being more likely to be cases in the Tendon Disorders and Forearm Pain groups but there being no association with age; older people being more likely to be cases in the Epicondylitis group but there being no association with gender; and no difference concerning age and gender between cases and controls in the Trigger Digit group.

In considering other variables, as would be expected, accidental injuries effecting the upper limbs or suffering from an established medical conditions (such as arthritis) accounted for some cases. However, in each of the syndrome groups, the number of hours per week spent using a keyboard and the length of time spent at the keyboard without a break were significantly associated with experiencing upper limb symptoms, with those experiencing symptoms spending more hours per week at the keyboard, and working more hours before a break. Other factors which were significantly related to *all* syndrome groups were: experiencing difficulties reading text on the documents or screen; having a specified rate at which to key; having a footrest; and being disturbed by environmental factors in the office (draughts, extremes of temperature, etc). Other factors which were associated with *most* of the syndrome groups were: the number of hours spent in 'risky' sports or hobbies (racket or club sports, knitting, home computing etc); experiencing frustrating problems with the computer programs; not being able to choose when to have a break from the keyboard; the chair not having armrests; experiencing problems with the chair; using a document holder; having a keyboard which did not tilt; having a screen which produced flicker; being exposed to hand-arm vibration; and reporting dissatisfaction with the physical environment.

Analyses of working postures from direct observation of general posture or electronic recording of wrist angles were rarely found to be significant. It was considered that those experiencing symptoms which were related to particular postures were likely to have changed their posture since the time of completing the questionnaire. Furthermore, it was only possible to obtain a 'snap shot' measure of postures, which could also have been modified due to observer presence.

It can be seen that a large number of the factors which were associated with symptoms of ULDs concerned psychosocial stresses (frustrating problems with computer programs; dissatisfaction with the physical environment; disturbance by environmental factors such as draughts; experiencing difficulties reading text; control over breaks) and work pressure (specified keying rate).

It can be reasoned that some of the factors which were found to be significant may be related to the type of work that operators are undertaking, and may indicate high number of hours spent at the keyboard. For example those who have a document holder are more likely to be those who undertake intensive data or text entry. Using a chair which does not have armrests is also a likely indicator of intensity of work (the typical 'typists chair'). It could also be argued that those who have a footrest are more likely to undertake intensive keyboard work, and to have been given 'accessories' whether they are required or not. Conversely it could be argued that those who are experiencing symptoms of ULDs may be given accessories to help alleviate the condition. Experiencing general problems with the chair was also associated with experiencing discomfort, possibly indicating a causal relationship (although those with discomfort may exhibit a greater tendency to complain about the chair).

Factors about the equipment which were associated with symptoms of ULDs included having a keyboard which did not tilt and having a screen which produced noticeable flicker (both possibly indicating older equipment).

Obvious causal relationships can be seen with some of the risk factors, for example, it is well recognised that exposure to hand-arm vibration is linked with the development of some ULDs. Exposure to other risks outside work (e.g. sports and hobbies which require repetitive movements, awkward postures or application of force through the arms/hands) can also be seen as causing ULDs. It is also likely that the number of hours per week spent using a keyboard and the length of time spent at the keyboard without a break are causal factors in the development of ULDs.

Further analysis of these factors in conjunction with one another in order to determine their relative importance showed that the factor most significantly associated with symptoms of ULDs was the number of hours per week spent at the keyboard. This was highly correlated with the length of time spent at the keyboard without a break. For the 'Any Syndrome' group, other factors which remained significant when all were considered together were related to work pressure (having a specified keying rate; emphasis on efficiency and getting the job done) and stress (experiencing frustrating problems with the programs; experiencing difficulties reading text on screen or documents); work equipment (flicker on the screen; experiencing problems with the chair; use of footrest; hand-held telephone when keying); and time spent in 'risky' sports and hobbies.

Studies of this nature, known as case-control studies, do not identify causal relationships. They only reveal links or associations between work factors and symptoms, which may have some other explanation. A number of the associations identified are supportive of the provisions of the Health and Safety (Display Screen Equipment) Regulations 1992 which came into force during the course of this research. For example, provisions for regular breaks and the replacement of older (non-adjustable) computer equipment, both of which are required by the Regulations, should have a beneficial effect. It is important, however, that the new equipment and furniture provided is used correctly. Adequate implementation of the requirements for information and training should rectify this and help to reduce ULD symptoms among keyboard users. It should not be concluded from this study that provision of footrests will cause ULDs.

In summary, this study identified a number of work, equipment and psychological factors associated with ULDs among keyboard users. The relative significance of these factors was considered. The factors most strongly associated with symptoms of ULDs among keyboard users were found to be spending a high number of hours per week keying and spending long periods at the keyboard without a break.

CONTENTS

1. INTRODUCTION

Work-related Upper Limb Disorders (ULDs) are not a new phenomenon. Reviews on the topic are seldom complete without reference to Bernadino Ramazzini, 'the father of occupational medicine', with his comments on 'certain violent and irregular motions and unnatural postures of the body' (Ramazzini, 1700 cited in Wright, 1940). In more recent history, Hunter wrote of traumatic tenosynovitis, describing it as a frequent cause of incapacity in various occupations. Amongst the hop pickers, rope braiders, linoleum fitters, etc. mentioned were occupations such as typists and comptometer workers. Elsewhere, under the banner 'Occupational Cramps', reference was made to an extensive list of occupations experiencing these, including telegraphists, typists, comptometer workers and pianists. The author commented that most of these occupations (fifty are listed) 'involve rapid, repetitive movements of short range, either by one or by both hands .... [The movements] .... necessitate a high degree of precision and coordination'..... 'There may be an associated anxiety on the part of the individual to get the work done in time and up to standard. Symptoms may appear after physical or psychological events which lower the patient's normal level of efficiency'. .... 'The causative factors are no doubt multiple and both physical and psychological in nature' (Hunter, 1957).

Despite these early writings, until relatively recently ULDs have largely been regarded as the province of the industrial worker, although Telegraphists Cramp was listed as a specific example in the notes on diagnosis published in relation to cramp of the hand or forearm as a Prescribed Industrial Disease (DHSS, 1991). Thus the guidance note MS10 (HSE, 1977) and its predecessor (D of E, 1972) make no reference to typing or similar tasks in relation to tenosynovitis. Authoritative texts on the subject, such as that prepared by NIOSH (Putz-Anderson, 1988) or the HSE (1990), make little reference to keyboard work. Similarly, guidance and recommendations published by the HSE on the introduction and use of VDUs (HSE, 1983) made virtually no reference to this issue, apart from a brief comment on bodily fatigue.

However, in the late 1980s reports were emerging in the scientific literature, particularly from Australia (eg. Hopkins, 1990) and the non-scientific press (including union publications eg. GMBATU, 1986), that the increasing use of computer terminals, in particular the use of computer keyboards, was giving rise to a dramatic increase in the level of complaints relating to musculoskeletal disorders of the upper limb amongst office workers.

In 1987, Raffles and his colleagues added a new chapter in revising 'Diseases of Occupations' by Hunter. This chapter, 'Repeated movements and repeated trauma' referred to 'Repetition Strain Injury (RSI)', occurring in 'almost epidemic proportions' in Australia and New Zealand in certain occupational groups including keyboard operators. It reflected a growing concern, albeit not one supported by strong epidemiological evidence, that keyboard work could cause ULDs (Raffles *et al* 1987).

In 1995, English *et al* reported the results of previous IOM work which demonstrated that 'secretary/temps' were significantly over-represented amongst female cases reporting ULDs with an indication that a composite job group of 'keyboard operators' (including the former group) were also over-represented.

This present project was conceived against this background of concern. Although there were clear indications, from a variety of sources, of an association between keyboard work and a number of ULDs, there was little evidence which stood up to the rigours of epidemiological investigation regarding which work factors contributed to this association, and therefore what remedial measures would be most effective at alleviating the risks of illness.

This lack of good quality epidemiological evidence was referred to in the UK by the committee which reviewed all new evidence concerning work related upper limb disorders (not just keyboard-related work) on behalf of the Industrial Injuries Advisory Council (IIAC, 1992).

The growing recognition of the apparent link between keyboard work and ULDs has been paralleled by growth in the extensive body of scientific literature published on the topic (eg. Bammer and Blignault, 1987). However, as recently as 1995, Hagberg *et al* reported that despite the increasingly widespread recognition of the multifactorial nature of work-related musculoskeletal disorders, with varying levels of attention to individual, psychosocial and physical factors that may contribute to the development or prevention of these disorders, the various factors had not been studied simultaneously with equal rigour in any scientific investigation. The purpose of this study was to address this issue and to study workplace, postural, psychosocial and personal factors simultaneously to determine their relative importance in the development of ULDs amongst keyboard workers.

During the period covered by this research, the Health and Safety (Display Screen Equipment) Regulations 1992 were published and came into force. These Regulations were produced as part of a European Community drive towards improving health and safety at work. Upper limb pains and discomfort were identified as one of the main risks to health which the implementation of these Regulations was intended to reduce. Amongst other requirements, these Regulations laid down minimum requirements for display screen equipment (DSE) workstations. As a result, the later stages (Phase 2) of this research were conducted against a changing background where some employers had made extensive changes to the provision of equipment and furniture, some were in the process of change and others had made little or no change. The possibility of such change was recognised and accommodated as much as possible in the design of Phase 2.

2. AIMS AND OUTLINE WORK PROGRAMME

2.1 AIMS

The general aim of the research was to conduct an epidemiological and ergonomic study of keyboard operators with the intention of identifying factors that were associated with risks of ULDs. A second general aim was, on the basis of the findings, to advise on ergonomically viable modifications to work or working practices which would be expected to result in a reduction of the risk of ULDs.

Within these general aims, the specific objectives of the work were:

1. To identify 'cases' of ULDs (those reporting characteristic symptoms) in selected groups of keyboard operators from several industry sectors covering a range of modes of keyboard usage;

2. To classify these 'cases' according to symptoms relevant to clinical diagnoses;

3. To identify specific workplace, postural, psychosocial and personal factors associated with 'case' status;

4. To identify the relative importance of these factors;

5. To make recommendations as to how the identified factors may be modified in practice to reduce the risk of individuals developing the symptoms associated with ULDs.

2.2 OUTLINE WORK PROGRAMME

To achieve these aims, the work reported in this study was undertaken in two distinct phases. Phase 1 was a cross-sectional study, carried out primarily to identify keyboard workers reporting symptoms of ULDs. A variety of types of keyboard users were identified and a representative sample was sought. Using a self-administered questionnaire, information was collected on symptoms affecting the different parts of the upper limbs (hands, wrists, forearms, elbows and shoulders). The results were used to identify six 'syndrome groups' of subjects reporting certain patterns of symptoms

Phase 2 was a case-control study, using cases drawn from the identified syndrome groups and controls who had not reported any symptoms. Possible factors associated with the development of ULDs were identified from previous research and these were used to develop a survey package. This package consisted of an interview, observations, postural measurements and questionnaires concerning psychosocial factors.

The results from Phase 2 were analysed to identify those factors which showed a statistical association with case status and to indicate the relative importance of these factors. Finally, drawing from these findings, recommendations were produced in relation to the design of work and workplaces to reduce the influence of these risk factors and hopefully, through this, to reduce the risk of individuals developing symptoms of ULDs through working at a keyboard. This report is structured with Chapter 3 outlining the methods used in Phase 1 of the research (the cross-sectional study), with the findings of this being presented in Chapter 4. Chapter 5 presents the methods used in Phase 2 of the research (the case-control study), along with the selection of cases and controls. Techniques used to ensure reliability of the methods used are also presented in this chapter, along with the statistical approaches used in the analysis. The results of the case-control study are presented in two chapters: 6 and 7. Chapter 6 presents the findings by each risk factor, indicating their significance in association with symptoms of ULDs (with six syndrome groups being considered, as well as a composite group composed of all those who experienced one of the named syndrome groups). Chapter 7 presents the results of the regressions for the seven different syndrome groups for groups of variables, and then for all significant variables simultaneously. The findings of both the cross-sectional study and the case-control study are discussed in Chapter 8. Based on the findings of the study, recommendations for the prevention of symptoms of ULDs are presented in Chapter 9. The conclusions of the study are outlined in Chapter 10.

3. PHASE 1: SURVEY OF UPPER LIMB SYMPTOMS : METHODS

3.1 DEVELOPMENT OF UPPER LIMB SYMPTOMS QUESTIONNAIRE (ULSQ)

The first aim of the research, as stated above (Section 2.1), was to identify those individuals reporting symptoms of upper limb disorders amongst groups of keyboard operators. The primary purpose of this was to establish a population of those with or without symptoms from which a sample could be drawn for a subsequent case-control study. This part of the research was not therefore conceived primarily as a formal cross-sectional study of incidence. A central element of the preparation for this upper limb symptoms survey was the development of a self-administered questionnaire for use in the survey. A study team was assembled from IOM staff to develop this questionnaire. This team included physicians, ergonomists, statisticians and epidemiologists

The Upper Limb Symptoms Questionnaire (ULSQ) asked about symptoms (pain, discomfort, tingling, numbness, loss of strength, etc.) which the respondent may have experienced in their upper limbs. It was developed to identify the characteristic symptoms of clinically defined upper limb disorders including De Quervain's disease, carpal tunnel syndrome, tenosynovitis, tennis (and golfers') elbow, together with shoulder disorders (see Appendix 1). The list only included symptoms and made no attempt to encourage self-diagnosis of clinical signs. It was not expected that the questionnaire would diagnose specific conditions reliably, but would identify symptoms broadly similar to those which could be produced by these conditions.

The questions asked whether the subject had ever had these symptoms present for more than one day, since our interest was in recurrent or chronic ill-health, and whether the symptoms were present within the last 3 months or previously, in order to identify whether the symptoms were current or past. Symptoms were identified separately in left and right arms. Diagrams were provided within the questionnaire to illustrate the extent of the regions represented by hands, wrists, forearms, elbows and shoulders.

Two supplementary questions attempted to obtain some measure of severity of symptoms, by asking whether these interfered with normal work and whether the individual had consulted a doctor or other health professional about them. Additionally, the individual was asked whether they associated any symptoms with a specific accident or injury.

The questionnaire also obtained occupational information, whether the individual had received any touch typing or data entry training, how long they had been working in their current job, and whether the way in which they did their job had changed in the last 3 months (and whether any of these changes had been as a result of symptoms). Information was also obtained on the longest time on a typical day that they used a keyboard without a break, the kind of keyboard work they undertook, and personal information such as age and gender.

Final refinement of the questionnaire was conducted with the assistance of two consultant orthopaedic surgeons (see acknowledgements) who commented on the appropriateness of the questions and whether or not there was a need to include any further symptoms of clinical relevance.

Finally, 20 keyboard users amongst IOM staff, followed by a further 70 from a local company, were asked to complete the questionnaire. A sample of each group was subsequently interviewed to ascertain any difficulties they had experienced in understanding, interpreting or otherwise completing the questionnaire. As a result of this, minor changes to the wording of instructions were introduced, but not to the questions themselves.

The final version of the questionnaire is included as Appendix 2.

3.2 RECRUITMENT OF PARTICIPATING COMPANIES AND INDIVIDUALS

3.2.1 Recruitment of Companies

An important element of the symptoms survey was clearly the need to recruit an extensive number of companies and organisations to provide access to individual keyboard users. It was not planned to examine the relative incidence of problems in companies of different sizes or in different geographical locations. However, it was considered desirable not to recruit subjects only from large office complexes or to favour particular parts of the UK. Companies of various sizes were included into the study by a combination of recruitment from the private sector and from government departments which had some sites with only a few staff, such as M.A.F.F. and HM Customs and Excise. Smaller sites tended to be selected for sampling on the basis of proximity to other participating sites to allow cost-effective distribution and collection of questionnaires. Similarly, where participating government departments had a number of potentially suitable sites, locations were chosen which were considered not to be well-represented geographically amongst other participants. The Civil Service Occupational Health Service and the Loss Prevention Council assisted in the identification of suitable companies for study.

Recruitment of companies was conducted solely on the basis of willingness to participate. Although the proposed study was publicised through a Loss Prevention Council newsletter only one small company was recruited through this channel. Otherwise, personal contacts of those involved in the study in some way were the primary avenues for recruitment. No attempt was made to obtain a sample representative of UK businesses as it was not a purpose of the study to conduct a formal prevalence study. One occupational group where very active efforts were made to recruit companies was that of journalists. At the time of the study, journalists were a self-reported high-risk group. However, no newspaper company agreed to participate.

Previous experience had indicated that the manner of keyboard use, such as the intensive high frequency use by word processor operators or the more 'conversational' or creative use of computer programmers (or others composing text straight onto the screen) might have a significant influence on the incidence of upper limb symptoms. It was therefore decided to collect some basic information regarding type and pattern of keyboard use from amongst the potential sample population prior to selecting subjects.

Consequently a form was constructed to elicit this information *via* nominated representatives of the companies involved. A copy of this form and an accompanying explanatory note is shown in Appendix 3. It identifies the three patterns of keyboard usage: 'Text or data entry'; 'Form filling'; and 'Conversational mode'. These were defined as:

(a) TEXT OR DATA ENTRY: Taking a set of numbers or a piece of text

	(written or recorded) and keying it into a computer eg. Wordprocessing, audio typing, data entry.
(b) FORM FILLING:	Obtaining spoken information and entering it directly into a computer following a standard procedure eg. Insurance quotes, travel bookings.
(c) CONVERSATIONAL MODE:	Obtaining or handling information already on a computer by means of operating system commands, menu selection or other techniques eg. Database interrogation, typing sequences of operating system commands.

Whilst recognising that these categories were not necessarily mutually exclusive and therefore not always particularly distinct it was considered useful to have an awareness of the general pattern of keyboard usage in the potential sample population before deciding on a sampling strategy. It was also considered important not to restrict the survey to those who almost exclusively worked at keyboards.

Feedback from nominated officials in participating companies indicated that classifying employees in this way was not always straightforward. Some organisations had relatively rigid structures and job descriptions and it was fairly straightforward to complete the matrix on the form as directed. In other instances, particularly in those organisations undergoing radical change, the distinctions were far less clear. Nevertheless, it was apparent from the collated returns that, across the sample group of companies and government departments, a reasonable distribution of types and patterns of keyboard use was available and that normal random sampling should ensure adequate representation.

3.2.2 Recruitment of Subjects

Following on from this exercise, participating companies were asked to provide lists of keyboard users available for sampling. In the case of some multi-site organisations (particularly government departments) the request was limited to information for a sample of sites. Most companies and organisations acceded to this request. However, two organisations (one private, one government) elected to deviate from this procedure. One (private) company restricted the selection of staff to 100 predominantly intensive keyboard users (clerical and secretarial staff). It appeared that these lists were derived from specific departments within the organisation. One government department provided a list of names of keyboard users to participate in the study despite our request that, in order to maintain consistency across organisations, we wished to sample potential recruits ourselves. Careful examination of the responses of this subgroup did not reveal any differences from the rest of the sample and therefore this sub-sample, representing approximately 10% of the final total sample, was retained in the study.

Discussions were held between IOM project staff and company representatives to agree a sampling frequency. This was necessary to ensure a balance between obtaining a reasonable proportion of staff and minimising any disruption to work activities caused by questionnaire distribution and completion. A total in excess of 4,000 subjects was potentially available from the private sector. Across the five participating government departments the total number of staff was potentially much greater (in excess of 10,000). However, selection of Government Departments to provide a reasonable spread of locations and size reduced this number to approximately 4,000. It was anticipated that a total of approximately 50% of these would be invited to participate in the cross-sectional study by completing a questionnaire. At smaller locations, or where the list of potential participants had already been restricted (see above) all keyboard users listed were invited to participate. Where more general lists had been provided a sample proportion ranging from 25% to 100% was agreed. Lists of names were produced by IOM Data Processing staff using a random sampling protocol which was not known to ergonomics staff who would be conducting the questionnaire distribution.

3.3 DISTRIBUTION AND COLLECTION OF ULSQ

To obtain the highest possible response rate, a system of direct distribution and collection of questionnaires was adopted. The basic procedure followed is described below. However, in some instances, either for practical reasons or at the request of the participating company, this procedure had to be modified. The main deviations from the procedure are also noted below.

Prior to ULSQ distribution an explanatory leaflet was distributed to those selected (see Appendix 2). Subsequently, as explained in the note, an ergonomist visited them to hand over the questionnaire for completion, returning either later the same day or the following day to collect the completed questionnaire. The ergonomists checked completed questionnaires as they collected them. They were instructed to answer any general questions but to take care not to make any statements which might influence the manner in which the questionnaire was completed. Where a selected subject was no longer available (eg. moved or changed jobs) a replacement was drawn from the sample. For those temporarily unavailable, a reply-paid envelope was left with the questionnaire for it to be completed and returned subsequently. Some small sites were visited where they were close to other, larger sites. However, where this was not practical, postal distribution was used.

Some deviations occurred from this procedure. For example, at several sites the questionnaires were collected together by a local representative before the ergonomist returned. This well-intentioned kindness meant that it was not possible to check on missing entries.

At other sites, the company requested that a company representative conducted the distribution and collection of questionnaires using the list of names which were provided to them by the IOM. In such cases, envelopes were supplied for individuals to seal their questionnaire in to help preserve confidentiality.

3.4 PROCESSING OF ULSQ

Each site was given a code identifying both the organisation and the office. Each questionnaire was given a unique serial code to allow identification. The completed questionnaires were collated by IOM ergonomists and forwarded for data processing as a batch of data for a site. The progress of each batch was monitored through data entry, data validation and on to analysis confirming that the expected number of records were carried forward. For some batches the key-entry to computer was carried out within the IOM, the remainder were entered by a commercial bureau.

After key-entry, validation checks were applied to the data using Fortran programs. These checked both that individual responses corresponded to the protocol set of permitted values, and that responses were consistent. Suspect data was checked against manuscript records, with assistance from IOM ergonomists if required. A note was made on the manuscript of any data where it was decided that the computer entry should differ from the manuscript (eg. setting it to 'missing data' if an incorrect route was taken through the logic). The validated files were used in the statistical analysis.

The data collected during Phase 1 of the project was organised and stored on the IOM's PRIME 2850 computer system. The system is governed by Standard Operating Procedures dealing with modification and access to the data (integrity protection), and backups of the data (security against loss). After completion of the study, the data was archived according to standard procedures.

4. PHASE 1 : RESULTS

4.1 RESPONSE RATES

The ULSQ was distributed to keyboard workers at 61 sites throughout mainland Britain during late 1992 and early 1993. Five sectors of the Civil Service and six private companies were represented. A total of 4424 questionnaires were withdrawn from stock for distribution. Although enquiries were made it was not possible to confirm that all questionnaires despatched for distribution by management had been at least offered to the designated participant. A total of 3569 questionnaires were returned, representing a response rate of 81%. Of these, 3503 yielded useable data on symptoms with fewer than 2% returning the questionnaire without making any entries (62). Of these void questionnaires, 41 were from one site. Altogether 2453 questionnaires were returned with respondents names on, which meant they could be contacted to take part in the Case-Control Study (Phase 2). Amongst the different sites, response rates varied from 40% of those issued, up to 100%. Of the 61 sites, 20 yielded a response rate of over 90% with a further 16 over 80%. Twelve gave at least 70% response with only 13 worse than this. Only two sites provided less than a 50% response rate.

There is a tendency to assume, with a questionnaire of this nature, that those who feel they have something to report are more likely to respond. The very high response rate obtained tends to suggest that any such effect was limited although it clearly cannot be discounted. Similarly, it may be argued that companies who felt that they had 'something to hide' or were worried about what they might 'stir up' would be reluctant to agree to participate. As organisations were not recruited in any formal, systematic way, information on non-participation was not routinely collected.

4.2 TABULATION OF RESULTS

The incidence of upper limb symptoms is presented here only in general terms. Thus, four categories of subject are defined: (i) an asymptomatic group consisting of subjects who gave a negative response to all of the 60 unconditional questions on upper limb symptoms; (ii) a group of subjects with positive responses, but only to symptoms occurring 'before the last three months'; (iii) a group with symptoms occurring 'within the last three months', but who had not sought professional medical advice about these recent symptoms; and (iv) the remainder, consisting of subjects with recent symptoms, who had sought medical advice about those symptoms. In tables, these sub-groups are referred to as 'asymptomatic', 'old symptoms', 'recent mild symptoms', and 'recent severe symptoms' respectively. It will be noticed that groups (iii) and (iv) may (and in fact do) contain subjects with symptoms which occurred three or more months before they completed the questionnaire, as well as within that period. However, the terms 'mild' and 'severe' refer only to their recent symptoms.

4.2.1 Industry Sector

The largest number of completed questionnaires (624) was returned by one of the participating Civil Service organisations, the smallest (30) by one of the private companies. In all, 2280 (65%) of the 3503 usable questionnaires were from Civil Service organisations (Table 4.1).

Prevalences of recent severe symptoms among the 11 organisations varied from 6% to 17%, the overall prevalence being 14% (Table 4.1).

4.2.2 Age and Gender

Of the 3503 completed questionnaires, 2001 were from females and 1477 from males (25 subjects did not enter M/F on the form). Seventeen percent of females and 11% of males reported recent severe symptoms (Table 4.2). Seventy-eight percent of the study group of 3503 subjects were under 45 years old. The prevalence of recent symptoms (mild or severe) did not vary markedly with age, but the proportion of those with severe symptoms tended to increase with age (Table 4.3).

4.2.3 Other Factors

Twenty percent of 1895 subjects with symptoms (old or recent) associated their symptoms with a specific accident or injury. Of the 496 subjects whose symptoms were recent and severe, 40% associated their symptoms with an accident (Table 4.4).

5. PHASE 2 : CASE-CONTROL STUDY : METHODS

5.1 FACTORS IDENTIFIED AS POTENTIALLY RELEVANT TO THE DEVELOPMENT OF ULDs

5.1.1 Introduction

The World Health Organisation expert committee described 'work-related' diseases as multifactorial, where the work environment and the performance of work contribute significantly, but as two of a number of factors, to the causation of disease:

'... they [work-related diseases] may be partially caused by adverse working conditions; they may be aggravated, accelerated or exacerbated by workplace exposures; and they may impair working capacity. It is also important to remember that personal characteristics, other environmental and socio-cultural factors usually play a role as risk factors for these diseases' (WHO, 1985).

Many different factors have been suggested as being causally related to the occurrence of ULDs, either industrially- or keyboard-related. In many instances such suggestions are based on nothing more tangible than anecdotal evidence. However, it is widely recognised that ULDs have a multifactorial aetiology related to posture, movement and force, work equipment, environment and organisation, activities outside work and the social climate of the workplace as well as personal factors. Following the comments of Hagberg *et al* (1995) reported earlier, regarding the need for simultaneous scientific appraisal of a wide array of potential risk factors, it was important for the current research to include factors that had been shown in previous research to be linked with ULDs so that the significance of all implicated factors could be assessed. The factors that have been identified from previous research as being important risk factors in the development of ULDs are outlined below.

5.1.2 Gender

Previous research has shown that gender is significant in the development of ULDs, with more women developing the problem than men (eg. Knave *et al* 1985; Dimberg *et al* 1989; English *et al* 1995). There has been considerable debate as to whether this reflects the tendency for more women to be in so-called high risk jobs or some innate increased biological susceptibility. However, Hagberg *et al* (1995) reported, after reviewing the literature, that there was no evidence of increase female susceptibility to work related carpal tunnel syndrome after controlling for exposure (eg. Silverstein, 1985). Neck-shoulder pain is more commonly reported among females than males, both among the general population and among industrial workers (Hagberg and Wegman, 1987). Because of the apparent complexity of the relationship between gender and risk, particularly the various theories regarding explanatory mechanisms, gender should be examined carefully in establishing any association with ULDs.

5.1.3 Age

There is conflicting evidence as to whether age is associated with the development of ULDs. Some studies have shown that there is an increased prevalence of ULDs with age (eg. English *et al* 1995; Dimberg *et al* 1989). Hagberg *et al* (1990) reported that the outcome of non-specified musculoskeletal pain (finger-ache and tingling in the hands at night) was related to increased age even after controlling for duration and level of exposure. However, Jeyaratnam *et al* (1989) observed that older operators (40+ years) did not report as many musculoskeletal problems as their younger colleagues and this supported the findings of Sauter (1984) that older workers did not appear to have any more musculoskeletal complaints than their younger colleagues.

As with gender, the conflict regarding the influence of age suggests that its role should be examined carefully and not simply adjusted for in any analysis.

5.1.4 Force

The force required to depress the keys on the keyboard has been suggested as a contributory factor to ULDs (Eckles, 1994), although others have implicated the force-displacement relationship (Armstrong *et al* 1994). Some keyboards require more force than others to operate, and in particular, traditional typewriters require the operator to depress the keys relatively hard and require greater travel. It was therefore important to make a distinction between the length of time that the subject had spent working with a VDU keyboard and the time spent working with a manual typewriter. High keying force was observed by Pascarelli and Kella (1993) in a group of keyboard operators suffering from ULDs. These operators were defined by the researchers as 'clackers' because of the characteristic sound produced.

As well as any force applied by the hand, forces acting on the hand or arm have also been identified as of concern. The question of the influence of external pressure on the wrist, due to resting the wrists, is an interesting example of the complexities surrounding keyboard-related ULDs. Theoretically, it could be hypothesised that compressing the wrist by resting it on a hard surface could promote congestion and irritation in the carpal tunnel (giving rise to Carpal Tunnel Syndrome). Some authors (eg. Ballard, 1993) and other authorities (such as the National Safety Council of Australia; NSCA, undated) have counselled against resting the wrists whilst typing. In contrast, others have positively encouraged this, even developing keyboard designs incorporating a rest area (eg. Nakaseko *et al* 1985). Dainoff (1982) referred to an increased level of complaints amongst keyboard users who were seldom able to rest their hands or forearms at all. Others, such as Hünting *et al* (1981) distinguish differing needs for different patterns of keyboard use. It is possible that 'inability to rest arms' has been interpreted as a need to rest arms whereas it may be indicative of lack of time to rest (or of a more general lack of space) (Hünting *et al* 1981). It is also difficult to separate out the impact of resting the wrists whilst typing, from the wrist extension (dorsiflexion) which will inevitably accompany it with most keyboards (see below, Section 5.1.5).

5.1.5 Movements and Postures

It is widely accepted that movement and posture are both extremely important in the development of ULDs (eg. Putz-Anderson, 1988). Posture is affected by many factors, including the type of work that is being undertaken; the furniture and equipment; and how these are positioned. Adjustability of furniture, particularly chairs, and the provision of suitable additional equipment such as footrests if required, are important to ensure that the operator can obtain a suitable, comfortable posture. As a proportion of symptoms of ULDs can be related to referred pain arising from neck disorders (Stock, 1991), upper body posture can also be implicated.

Wrist postures away from the neutral line have been associated with ULDs. As well as the forearm rotation required to place the hands flat onto any conventional keyboard (Nakaseko *et al* 1985), ulnar deviation (eg. Kroemer, 1972) and wrist extension (dorsiflexion) are frequently referred to as factors. Wrist flexion is seldom identified as a feature although it may be a corollary to elbow angles less than 90° which have been cited as associated with increased risk (Ryan and Bampton, 1988). These authors also identified 'forward arm flexion' (shoulder flexion) as a factor, suggesting that a smaller angle of flexion was a feature of ULD cases. This is interesting in that it runs counter to the conventional wisdom that the upper arm should be hanging straight down in a relaxed, neutral position (eg. Arndt, 1983). Hünting *et al* (1981) identified shoulder abduction (movement of the upper arm away from the body) as a significant factor in ULDs. As stated, upper body posture, particularly the neck, can be important. Ong *et al* (1981) described the commonly observed forward inclination and sideways rotation of the neck (normally to the left to view documents or the display screen) as being associated with an increased incidence of symptoms amongst data-entry operators.

Hünting *et al* (1981) found that the incidence of physical impairments to the hands, arms, shoulders and neck was increased when there was insufficient space to rest the forearms and hands; when the lateral deviation of the hands operating the keyboards was great; and when there was pronounced inclination or turning of the head. Other specific postures observed among keyboard operators who have reported ULDs have been noted by Pascarelli and Kella (1993). Among these recorded were: 'alienated thumb' where one thumb is held in extreme extension and abduction (this was linked with high incidence of De Quervain's syndrome); hyperextended little finger in order to reach more extreme keys (eg. function keys) without moving the hand - some subjects with this practice experienced weakened muscles in the flexor digiti minimi (the muscle that controls little finger flexion); and joint hypermobility, which was observed among many of their subjects, was suggested as a risk factor in the development of ULDs. The study also defined different keyboard techniques observed among keyboard users: 'the leaner' with the wrist resting on the desk top and the fingers curled to the keyboard; 'the pointer' i.e. those who only used the index and middle fingers of both hands when keying (also known as a 'hunt and peck' typist); and the 'clacker' as described above. The study also postulated that the use of a mouse can lead to upper limb problems due to the awkward postures that are often observed when using the mouse, and the finely controlled movements and forces required to activate the mouse buttons.

Many papers have addressed the incidence of ULDs, or at least musculoskeletal discomfort, through the characteristics of the equipment or furniture, or other features of the working environment which might influence the primary (postural) factors described above. For example, Grandjean (1984b) referred to an increase in musculoskeletal symptoms if the desk surface was too low or if the keyboard height above the desk was too great. In another paper the same author described musculoskeletal problems due to sitting in one place for long periods and insufficient leg room (Grandjean, 1984a). Many authors, including Arndt (1983), have described the characteristic posture of the copy typist with the neck flexed and rotated, and noted that this posture is related to equipment and furniture, in this instance the need to read documents which are lying flat on the desk. The increasingly widespread use of document holders has reduced or removed this particular postural problem.

One of the problems which arises from concentrating on physical attributes of the workplace in this manner is that the compensatory postural changes (and consequently the potential outcome in terms of symptoms) will vary between individuals. Thus, when a desk surface is too high, some users may compensate by elevating their shoulders whilst others might abduct the upper arms (move them out sideways from the body) leading them to flex the wrists sideways (ulnar deviation) to compensate in addressing the keyboard. Still others might sit forwards on their chair in order to 'perch' on the edge and, through this, achieve a taller sitting height. Some may adopt a combination of these postures.

In addition to the confusions which can arise because of different outcomes, some authors believe that concentrating on physical attributes of the workplace is misleading. Oxenburgh (1985) for example found no difference in workstation design between those with and without upper limb symptoms. Many organisations have corporate furniture which is consistent across all staff.

5.1.6 Psychosocial Aspects of Work

Several studies have been conducted looking at the psychosocial work factors and musculoskeletal disease. These studies were reviewed by Bongers *et al* (1993) in order to establish if there is a positive association between these factors and musculoskeletal disease. The findings suggest that high perceived work load and time pressures are related to musculoskeletal symptoms. They also suggest that low control of the job and lack of social support by colleagues are positively associated with musculoskeletal disease.

The social environment at work has been measured in a number of ways by different authors. One widely used tool is the Work Environment Scale (Moos and Insel, 1974). This is a standardised job stress scale which measures various factors of the work place against a population standard. This has been used by previous researchers (eg Smith *et al* 1980; Sauter *et al* 1983; Ryan and Bampton, 1988; Hopkins, 1990) and showed that job task demands interacted with VDU use to produce an increased stress level and heightened health complaints in VDU operators. Ryan and Bampton (1988) found that there were significant differences on the WES scores between cases with upper limb symptoms and controls. Cases scored higher for supervisor support and work pressure and lower for peer cohesion, autonomy and clarity of their job.

Some authors have suggested that psychosocial factors may induce a risk of developing ULDs through influencing muscle tension. As well as being influenced by physical factors such as constrained or static postures, psychological or psychosocial factors such as visual strain, stress, frustration, job dissatisfation and mental load can also induce a higher level of muscle tension.

5.1.7 Keying Rates

High keying rates have been linked with postural immobility (Laville, 1980) which can lead to muscle tension. If the operator has a specified keying rate or target output they have to meet they will be more likely to suffer increased muscle tension, be less likely to take micro breaks to alter their posture and are therefore more likely to suffer ULDs. Smith *et al* (1992) reported that electronic performance monitoring had an adverse effect on keyboard operators' mental health by increasing anxiety, depression, job boredom, health complaints and fatigue. The implication from these studies is that it is the imposition of a high required keying rate rather than an intrinsically fast typing speed *per se*, which is associated with ULDs.

5.1.8 Type of Work

The type of keyboard work that is undertaken has also been implicated in the development of ULDs. For example, a study by Hünting *et al* (1981) showed that data entry VDU operators had an increased prevalence of daily reported discomfort over VDU typists. Sauter *et al* (1983) also found that data entry VDU operators reported more hand-arm problems than other VDU users, and this was not related to the amount of time spent using VDUs. Coe *et al* (1980) found that more muscular discomfort in arms, neck and shoulders was reported by data input operators than by those working in a conversational mode.

5.1.9 Previous or Second Jobs

Jobs which involve repetitive movements, twisting or applying force (eg. light assembly work) with the arms or hands will increase the risk of developing ULDs (Putz-Anderson, 1988).

5.1.10 Sports and Hobbies

Some sports and hobbies involve static postures or repetitive movements (eg. playing a musical instrument and knitting), application of force with the hand or arm (eg. racket and club sports, some DIY or woodwork), and transmission of vibration into the hand (eg. cycling). All of these may increase the risk of developing ULDs. In addition, there may be an effect of keyboard use at home through home computing or playing computer games. Swanton (1986) reported that subjects whose symptoms required medical assessment and time off work mostly undertook handcraft activities (art, crochet, knitting, sewing, tapestry, piano) in their leisure time, while the controls who did not report pain or time off work spent their leisure time mostly in sporting activities (aerobics, athletics, cycling, fishing, swimming, squash, tennis). Hand-wrist tendonitis and De Quervain's tendinitis have been assocated with tennis, racquetball, squash and badminton (Osterman *et al* 1988).

5.1.11 Vibration

Vibration has also been strongly linked to the development of certain ULDs and is well established as a causative factor in the development of Carpal Tunnel Syndrome (Wieslander *et al* 1989). In fact Carpal Tunnel Syndrome is now recognised by the DSS as a prescribed industrial disease when occurring in association with exposure to hand arm vibration. Vibration exposure is unlikely to be a factor in keyboard work but may be related to a hobby or to a previous or second job.

5.1.12 Eyesight

There is evidence of increased eye strain among keyboard users (eg. Bergqvist *et al* 1989; Maeda *et al* 1980). Eyesight problems may affect the posture of the operator. Short sighted operators (myopics) may have to lean forwards to see the text on the VDU screen or documents clearly. Although operators with eyesight problems may wear corrective eye wear, these may still result in awkward or static postures. For example, glasses that are prescribed for reading and not for VDU use may not allow the operator to focus comfortably at the greater viewing distance required to read text on the screen. With bifocals only a small portion of the spectacle may provide clear vision at a given distance and therefore operators will have to maintain a fixed posture to view the screen (usually with the head tilted backwards) (Arndt, 1983). Sauter *et al* (1983) reported that the use of corrective eyewear was an important predictor of musculoskeletal disturbances.

5.1.13 Work Environment Factors

A study by Ryan and Bampton (1988) showed that significantly more cases (with musculoskeletal disorders) had high scores on the visual glare index of discomfort than controls. Exposure to noise has also been shown to be a strong correlate of psychological well-being (Klitzman and Stellman, 1989), and this may contribute to the development of ULDs. In addition, high noise levels have also been suggested as having an detrimental affect on static muscle loading (Kjellberg *et al* 1991) which may contribute to ULDs. Other factors in the environment may add to the stress at work, for example smells and draughts can have a distracting and disturbing effect.

5.1.14 Training in Workstation Layout

In a study by Ryan and Bampton (1988) significantly fewer cases (i.e. those with upper limb symptoms) had been shown how to adjust their chair than had controls. Green and Briggs (1989a) also identified that there was a perceived need for training and/or information in the correct adjustment of workstation equipment among keyboard operators.

Other authors have sought to extend the training beyond the adjustment of the workstation, contending that the manner of use is also important. Pascarelli and Kella (1993) for example described four different typing styles which reflected different gross postures together with differing hand styles. These were: the leaner; the pointer; the lounger; and the clacker. Others (eg. Dulmage, 1991) have advocated new typing techniques as part of the process of reducing injury.

5.1.15 Educational Level

Some studies have shown that educational level is related to the development of ULDs. For example Houtman *et al* (1994) reported increased incidence of musculoskeletal discomfort among those with higher educational levels. Ghiringhelli (1980) also suggested that more discomfort (includes musculoskeletal, headaches, nausea and dizziness and eyesight problems) is felt by keyboard operators who have the highest professional expectations (i.e. those who have studied for more than 5 years). However, this was not supported by Knave *et al* (1985) who reported no difference in terms of musculoskeletal discomfort between keyboard operators of different educational levels. Various theories have been put forward to account for the effects of level of education where these have been observed, some suggesting that willingness to tolerate discomfort at work may be reduced whilst others regard them as indicative of differences in the nature of the jobs performed or of the degree of application to that job, creating external or internal psychosocial pressures.

5.1.16 Hours of Work

Stellman and Klitzman (1987) found that full time VDU operators reported significantly more musculoskeletal symptoms than did the part time VDU operators. Oxenburgh *et al* (1985) also reported a difference in the time spent at the keyboard between cases (with upper limb symptoms) and controls, with the likelihood of injury rising rapidly after more than 5 hours of work at the VDU per day. However, Dimberg *et al* (1989) reported significantly more cervicobrachial symptoms among part time workers in an automobile assembly plant than among full time workers.

5.1.17 Specific Medical Conditions

Some medical conditions have also been linked to the development of ULDs. These have been identified in previous research, and include: rheumatoid arthritis (Chamberlain and Corbett 1970); obesity (Falck and Aarnio 1983; Green and Briggs 1989b; Dimberg *et al* 1989); thyroid disorders (Weislander *et al* 1989); diabetes (McCann and Davis, 1978); menopause (Chatterjee, 1987); and general physical ill-health (Bongers *et al* 1993; Pascarelli and Kella, 1993). Pregnancy and the period immediately following childbirth have also been linked to the development of upper limb disorders, specifically carpal tunnel syndrome (Voit *et al* 1983).

5.1.18 Smoking

Dimberg *et al* (1989) reported significantly more cervicobrachial symptoms among smokers than non-smokers, although no link was found by Knave *et al* (1985) between musculoskeletal discomfort and smoking. However, smoking has been linked to an increased risk of developing traumatic vasospastic disease (Ekenvall and Lindblad, 1989) such as Vibration White Finger. Hagberg *et al* (1995) concluded that it was likely smoking was related to neck-shoulder disorders and carpal tunnel syndrome. Smoking was an important determinant for both tingling in the hands at night and wrist ache in a study of manual workers (Hagberg *et al* 1990).

5.1.19 Accident or Injury

Another risk factor in the development of ULDs is experiencing a specific trauma to the upper limb (Chatterjee, 1987). It was important to determine if the symptoms presented were related to a previous accident or injury which may have caused or aggravated the symptoms.

5.2 CONTENT OF THE MEASUREMENT AND OBSERVATION PACKAGE

5.2.1 Introduction

For the case-control study it was necessary to develop a survey methodology which would provide for the systematic scientific appraisal of a wide range of the factors which various researchers have implicated in the aetiology of keyboard-related upper limb disorders.

This methodology was subject to a variety of sometimes conflicting constraints and limitations. Firstly, the studies were to be conducted in workplaces with subjects carrying out their normal work. Therefore the methods used had to be as unintrusive and non-invasive as possible to ensure cooperation both of the individuals invited to participate and of their employers. In particular, impact on work had to be kept to a minimum both for the above reason and to avoid artefacts being created by modifying normal work routines and procedures. The total time for which any individual would be studied was obviously an important element of this. Accessibility to subjects and the logistics (and cost) of the survey would clearly be enhanced by keeping the time per subject as short as possible. However, the desire for coverage of potential factors to be as comprehensive as possible tended to conflict with this, creating a demand for an extensive period of examination. In summary, the survey procedure had to be as short as possible with minimal intrusion into normal working activities whilst, at the same time, being as complete and comprehensive as possible and capable of being applied consistently by a variety of researchers.

Case-control studies of this type are always subject to the limitation that the study of potential causative factors or, more correctly, of associations between exposure to potential risk factors and case-control status, always takes place after the disease or health effect being studied has developed. This can cause problems in gathering information reliably about potential risk factors. Given the scale of the cross-sectional survey there was also an intervening period between questionnaire administration (and therefore the period to which symptoms referred) and the case-control study. Anticipating that there would be some delay, the methods developed and the subsequent data analysis and interpretation, were designed to be as robust as possible (ie. the factor being examined was unlikely to have changed significantly in the intervening period) or to allow some degree of check on the responses received, as to the direction or extent of any change.

In asking questions of subjects it was recognised that some of the questions would be easier for the subject to answer reliably than others. For example, some of the factors of interest were unlikely to have changed in the intervening period (eg. the level of education, whether they had received typing training at the time of completing the ULSQ). There would also be some questions that could be answered accurately because they were personal to the subject (eg. whether they wore glasses at the time of completing the ULSQ, how long they had worked with keyboards). However, other questions were likely to be harder for the subject to answer, (eg. the adjustments that were available on their chair at the time of completing the ULSQ, and how many hours a week they spent at the keyboard at that time) although it could be argued that those experiencing discomfort would be more likely to recall such factors than those with no discomfort. All of these issues had to be taken into account in developing the wide ranging package of questions and observations necessary to measure the identified factors of interest in the workplace. Different tools were appropriate to obtain different pieces of information. The package consisted of a structured interview, an observation period of keyboard activity and the Work Environment Scale (WES) and its supplementary questionnaire. The package was carefully constructed so that there was a balance, of structured interview, a practical period and two self completed questionnaires. It was felt that this structure would allow the subject to become involved with the research, and the longer questioning periods would be broken up with a practical period. The initial structured interview allowed the subject to become familiar with the observer, and consequently it was hoped, feel relaxed and act naturally during the observation period.

5.2.2 Structured Interview

A structured interview was developed in which a number of factual details were obtained concerning the work, equipment and furniture and what it had been like at the time of completing the ULSQ. The interview was divided into five sections concerning: a) the subject's job; b) the work equipment; c) the physical environment; d) activities outside of work that may contribute to the development of upper limb problems; and e) personal details. In order to involve the subject in the research the interview was structured with the questions that were thought to be easiest to answer and least personal asked first. The final section of the interview covered more personal questions. The structured interview was followed by questions about what had changed at the work situation since the time of completing the ULSQ, including furniture, equipment and organisational changes. These were administered directly following the structured interview and still in an interview mode. The detailed contents of the structured interview were:

(a) Job

The questions concerning their job at the time the ULSQ was completed included how many years experience the subjects had of working with any keyboard, and with a VDU keyboard; how the information that they keyed was presented to them (visually, audibly); whether there were any factors that may have forced them to adopt an awkward posture at the keyboard (eg. not being able to read the text on the documents or the screen clearly, using another input device, not having sufficient space); any problems with the software; the ability to take a break from keyboard work; any particularly busy periods of the year involving more keyboard work than usual; if they had received any typing training; their keying rate (if known); if there had been a specified keying rate; and the amount of time they spent in a typical week at the keyboard and undertaking other 'risky' activities at work. Risky activities were defined as those involving repetitive movements or application of force, for example large quantities of stapling or hole punching.

(b) Work equipment

The questions concerning the work equipment covered details of the chair, desk, keyboard and screen and use of a document holder and footrest. The work equipment that was being used at the time of the case-control study was compared with the work equipment that had been used at the time of filling in the ULSQ so that the possible reliability of the observed postures could be estimated.

(c) Physical environment

The questions concerning the physical environment covered whether the subject had been disturbed by the levels of background noise, lighting and or any other environmental factors (including draughts, extremes of temperature, smells etc.).

(d) Other activities

The questions concerning the activities outside of work that could contribute to the development of upper limb problems covered: previous jobs that involved repetitive movements, twisting or applying force with the arms or hands; other paid or voluntary jobs done at the time of completing the ULSQ; participation in any sports and hobbies that might contribute to the development of upper limb problems (including racquet or club sports, knitting/needlework, DIY/woodwork and gardening); and if the subject had been exposed to hand/arm vibration.

(e) Personal details

The questions concerning personal details covered: whether the subject had worn glasses or contact lenses while working at the VDU at the time of filling in the ULSQ; if they smoked cigarettes at that time; their employment status (full or part time, permanent or temporary contract); their level of qualification; height; any medical conditions that might affect upper limb problems; and if applicable, whether they were pregnant at that time. The final questions concerned whether the subject had ever had an accident or injury involving their shoulders, arms, wrists or hands, and if they associated any discomfort at the time of filling in the ULSQ with any particular activity (work or social).

Following the structured interview a short series of questions was asked that concerned what had changed in the office and the job since the time of filling in the ULSQ. These questions covered: changes in job description; working methods; amount of keyboard and mouse use; relocation or office changes; new additional equipment; new programs; new manager; VDU workstation layout training; and any other changes.

Most questions were assigned a categorical answer eg. 'yes' / 'no' or 'always' / 'sometimes' / 'never'. Where a question was not relevant to a subject and where appropriate, a 'not applicable' category was assigned.

5.2.3 Electrogoniometers

One aim of the research was to obtain more information on what postures and movements were likely to contribute to the development of ULDs. Detailed information can be obtained on joint position using electrogoniometers. Electrogoniometers have been used in research and medicine with little intrusion to the subject (Palmer *et al* 1985; Parsons and Thompson, 1990). They are small and light and do not restrict the normal range of movements. They allow a high sampling rate and accurate measurements of joint deviations (in degrees), and a detailed picture of joint position with time can be developed.

Prior to the observed keyboard activity, goniometers were placed over both wrist joints. The measures from the goniometers included deviation in two planes for both hands: flexion / extension, and radial / ulnar deviation. For each of these measures the results were summarised in terms of the median angle, the standard deviation of the posture from this median, (as a measure of the variability of the posture) and the extreme postures adopted: i.e. 1st percentile and 99th percentile deviations from the neutral posture.

5.2.4 Observations

Postures and movements made during keyboard work that could not be measured were observed and recorded. In particular, the following observations of the arm postures were made as they were considered to be significant in the development of ULDs: shoulder elevation, upper arm abduction, upper arm flexion / extension, forearm elevation, frequent flexion of the forearm, frequent pronation / supination of the hand, and whether the forearms or wrists were rested while keying. Hand movement observations included any stretching of the fingers while keying, if any fingers were used more frequently than others, the subject's typing style, and whether they had a tendency to be a leaner (i.e. rests their wrists while keying) or a clacker (i.e. use high force while keying). In addition, neck posture and movement, trunk posture and movement, and lower limb posture were recorded.

Obviously postures are not constant, and there was concern that the postures observed might not reflect the postures that were adopted at the time of completing the ULSQ. In addition, postures vary throughout the day, and so any observed could only represent a snapshot.

Observations were also made concerning the work that was undertaken during the observation period: what type of work was being undertaken, how the information that was keyed was presented to the subject; what (if any) additional input devices were used during the observations; and the percentage of time during the observation period that each hand spent keying, using an input device or undertaking another activity. These observations were intended to be used to interpret the postures observed.

Finally, the interaction of the subject with the equipment that they used was observed: whether they used the backrest of the chair; whether there were any space restrictions on their thighs, knees or feet; what the most frequently viewed item at the workstation was, and whether this was positioned directly in front of the subject, whether the documents and screen were at a suitable viewing distance; and if the screen was at a suitable height. All of these factors may affect the posture that the subject adopts at the keyboard and again were recorded to interpret the observed postures.

The observations concerning the furniture and equipment included details of the chair that were likely to affect posture (armrests, seat height adjustment, backrest height and angle adjustment, amount of support the backrest provided and whether the chair was on castors). Questions concerning the work surface included if it was height adjustable, if there was sufficient space for all the equipment, a measure of work surface height and thickness. Observations were also made concerning the presence of a footrest, a desk lamp and a document holder and if they were suitably positioned. The keyboard thickness was measured and factors concerning the keyboard were observed, including the style of keyboard, whether the keyboard was detachable from the screen, adjustable in tilt, recessed into the workstation, provided with wrist support and whether the subject had sufficient space to rest their wrists in front of the keyboard. Questions concerning the screen included if it could be tilted, swivelled, adjusted for height, if the contrast level could be controlled, and whether any part of the text on the screen was obstructed due to reflections of light on it. In addition, factors concerning the general environment (large amounts of noise, heat or draughts in the vicinity) were noted. Finally, a sketch was made of the workstation layout in relation to lights and other operators.

5.2.5 Psychosocial Aspects of Work

The literature review had indicated that the psychosocial aspect of work was significant in the development of ULDs. It was therefore decided to administer a standard package recognised for measuring such factors in the workplace. The Work Environment Scale (WES) (Moos and Insel, 1974) was selected as it has been used in similar studies of assessment of ULDs, (eg. Hopkins, 1990) and was simple to administer as a self-administered questionnaire. The WES is comprised of a series of 90 questions that fall into 10 subscales (9 questions for each subscale). The 10 subscales cover the following topics: Involvement; peer cohesion;

supervisor support; autonomy; task orientation; work pressure; clarity; control; innovation; and physical comfort. These are defined as follows:

Involvement	the extent to which employees are concerned about and committed to their jobs
Peer cohesion	the extent to which employees are friendly and supportive of one another.
Supervisor support	the extent to which management is supportive of employees and encourages employees to be supportive of one another.
Autonomy	the extent to which employees are encouraged to be self sufficient and to make their own decisions.
Task orientation	the degree of emphasis on good planning, efficiency and getting the job done.
Work pressure	the degree to which the pressure of work and time urgency dominate the job milieu.
Clarity	the extent to which employees know what to expect in their daily routine and how explicitly rules and policies are communicated.
Control	the extent to which management uses rules and pressures to keep employees under control.
Innovation	the degree of emphasis on variety, change and new approaches.
Physical comfort	the extent to which the physical surroundings contribute to a pleasant work environment.

The WES measures psychosocial factors at work and therefore an individual's responses are likely to change over time as the work environment changes, although it has been shown to be reasonably stable in a stable environment. It could not be used to directly measure the psychosocial aspects of work at the time of completing the ULSQ. Indeed, it could only tell us the psychosocial response of the subject to the work environment now. Therefore it was necessary to develop a series of questions that would give some indication of the subject's attitude to the work environment at the time of completing the ULSQ. Ten questions, one for each element of the WES, were developed to measure this. Questions were worded so that the subject responded by saying they now felt more, less or the same of a factor as they did at the time of completing the ULSQ.

5.2.6 Observer Training

As the package was to be administered by several different observers within the research team, it was standardised, to allow questions and procedures to be administered in the same way on each occasion.

In order to ensure that all observers conducted the interviews, completed the observations and fitted the goniometers in a sufficiently standardised way a training session was undertaken for all observers. In this the techniques were described and practised. Practice observations were undertaken using video material. During the course of the field work one observer joined the team. This observer was trained by the experienced observers, and shadowed several interview sessions prior to undertaking any herself.

5.2.7 Summary

Altogether, almost 100 factors which could be associated with upper limb symptoms were measured in the survey. These were grouped into 9 logical groups, as shown below.

1. *Age and gender*

i age
ii gender

2. *Duration of keyboard usage and other 'risky' activities*

i Number of years experience with keyboards (typewriters and VDUs)
ii Number of years experience with VDUs
iii Hours per week in 'risky' office activities (stapling, filing, photocopying etc.)
iv Number of hours per week spent keying
v Longest spell at the keyboard without a break
vi Number of hours per week spent in 'risky' sports and hobbies (e.g. racket and club sports, playing a musical instrument, home computing, knitting, DIY, gardening and cycling)

3. *Information about the job*

i How the information typed was presented (audible or visual means)
ii If visual means, whether a document holder was used
iii If audible means, whether a hand-held telephone was used
iv Use of mouse or other input device
v Experiencing difficulties reading text on the documents or on the screen
vi Experiencing frustrations with the programs
vii Being able to take a break from the keyboard
viii Particularly busy periods at work
ix Having received typing training
x Having a specified rate of keying

4. *Information about the work equipment*

i Chair having seat height adjustment
ii Chair having backrest height adjustment
iii Chair backrest angle adjustment
iv Chair providing upper back support (in addition to lower back support)
v Chair having armrests
vi Armrests being height adjustable
vii Chair having castors
viii Experiencing any problems with the chair
ix Having a footrest
x Using a document holder
xi Having sufficient space to write at the workstation
xii Height adjustable desk
xiii Keyboard detachable
xiv Keyboard tiltable
xv Keyboard recessed into workstation
xvi Wrist supports provided at the keyboard
xvii Sufficient space in front of the keyboard to rest the wrists when not keying
xviii Noticeable screen flicker
xix Screen swivel
xx Screen tiltable
xxi Sufficient contrast on the screen
xxii Screen height adjustable

5. *The physical environment and factors outside work*

i Disturbed by noise at work
ii Disturbed by lighting at work (glare etc.)
iii Disturbed by other environmental factors at work (temperature, draughts, smells etc.)
iv Previous job involving repetitive hand/arm movement
v Second job involving repetitive hand/arm movements
vi Exposed to hand/arm vibration in work or non-work activities

6. *Personal information*

i Wearing glasses or contact lenses
ii Smoking cigarettes
iii Employment status (permanent or temporary)
iv Full or part-time work
v Highest educational qualification
vi Rheumatoid or osteo-arthritis
vii Other conditions effecting ULDs (diabetes, gout, gall bladder problems, thyroid disorders, high blood pressure, kidney disease, menopause, obesity)
viii Pregnancy
ix Accident relating to ULDs

7. *General body postures*

i Shoulder elevation (left and right)
ii Upper arm abduction (left and right)
iii Upper arm flexion/extension (left and right)
iv Regular elbow flexion (left and right)
v Regular forearm pronation/supination (left and right)
vi Forearm inclination (upwards, horizontal, downwards from elbow to wrists) (left and right)
vii Undue stretching of the digits (left and right)
viii Some fingers used more frequently when keying
ix Typing style (touch typist or hunt and peck)
x Tendency to be a leaner (resting the wrists while keying)
xi Tendency to be a 'clacker' (forceful keying)
xiii Trunk inclination
xiv Trunk lean
xv Trunk twist
xvi Thighs adequately supported on chair

8. *Psychosocial factors (WES)*

i Involvement
ii Peer Cohesion
iii Supervisory Support
iv Autonomy
v Task orientation
vi Work pressure
vii Clarity
viii Control
ix Innovation
x Physical comfort

9. *Hand and wrist posture*

i Right hand Ulnar/Radial deviation
- Median
- Standard deviation
- Extreme ulnar deviation
- Extreme radial deviation

ii Left hand Ulnar/Radial deviation
- Median
- Standard deviation
- Extreme ulnar deviation
- Extreme radial deviation

iii Right hand Flexion/Extension
- Median
- Standard deviation
- Extreme flexion
- Extreme extension

iv Left hand Flexion/extension
- Median
- Standard deviation
- Extreme flexion
- Extreme extension

5.3 PILOT STUDY

The package of structured interview, observations and measurements was piloted both in-house and in one of the sites that had agreed to participate. Three pilot interviews and observations were conducted in-house and two were conducted at the participating site. It had been planned to pilot the package on 10 subjects at this site, but although 20 subjects were asked to participate only two agreed due to a lack of management support. This site was also used later in the survey and it was found to be the least co-operative of all the sites.

Following the pilot study minor changes were made to the package. Some questions were added to the package; for example, a question was added concerning the activities of the hands during the observation period, so that the goniometer results would be more meaningful. Some additional categories were added to some questions. For example, in the question asking about how the information was presented to the subject, a category for no information presentation (eg. composing text) was added.

Some questions were simplified so that the information was collected in a more concise way. Some questions were also removed as they were found to be impracticable or difficult for the subject to answer. For example, it had been planned to include a measure of the force that had to be applied to the keys to activate them. This was tried using small weights placed on the keyboard, but was found to be unworkable.

In general subjects did not have difficulty answering the questions as they were phrased, nor in remembering the situation as it had been at the time of completing the ULSQ. Attaching the goniometers was found to be acceptable to subjects.

5.4 SELECTION AND RECRUITMENT OF SUBJECTS

5.4.1 Definition of Cases and Controls

The cross-sectional survey, conducted as Phase 1, identified 1924 people who had reported symptoms and would therefore serve as potential cases for Phase 2, the case-control study. The data from the cross-sectional survey was examined in detail and various frameworks for case definition were considered. Eventually, a definition based on 'syndrome groups' was derived which categorised individuals according to patterns of symptoms typical of one or more clinically-defined disorders.

A symptom (for example, 'numbness, tingling, or pins and needles in the hands' - See ULSQ Section A, Item 1 Appendix 2) was indicated for a particular subject if he or she responded 'yes' to one or more of the four sub-items making up the whole item. Symptoms were **recent** or **past** according to whether the subject experienced the symptom within, or before, the three months prior to administration of the ULSQ. Note that a symptom could be both recent **and** past, but only if the two 'yes' responses referred to the same side of the body. If they referred to different sides, then two symptoms were indicated, one recent, one past.

The need was to choose cardinal symptoms, which singly or in combination, were reasonably sensitive and specific for the type of syndrome in question. It was not expected that the questionnaire syndromes would correspond exactly with what a clinician would diagnose, but, it was intended, would identify the presenting symptom complexes which were typical of common clinical diagnoses. In some cases the typical presenting symptoms of two or more diagnoses were so similar that we considered it impractical to distinguish between them, even though they represented disease at widely separated anatomical sites, eg. we did not try to distinguish between the symptoms in the hands caused by nerve entrapment at the wrist (carpal tunnel syndrome), elbow (ulnar neuritis), or shoulder/neck (thoracic outlet syndrome), even though a clinical examination would in many cases enable these separate diagnoses. Similarly, we did not attempt to distinguish between forearm tenosynovitis and De Quervain's tenovaginitis, nor between the various diseases which can cause pain and limitation of movement of the shoulder. The questions relating to trigger finger or thumb asked directly about the characteristic movements in these conditions. The questions on carpal tunnel syndrome, ulnar neuritis and thoracic outlet syndrome asked about numbness, tingling or pins and needles in the hands, and weakness of the grip and aches or pains in the hands. We additionally asked whether these symptoms woke the person at night, but eventually did not make this a requirement for syndrome definition, since it probably would have excluded some genuine cases. We attempted to identify forearm tenosynovitis and De Quervain's tenovaginitis by asking about aches and pains in the forearms, with either swelling of the forearm or crackling sensations in the forearm (representing the crepitus associated with rubbing of a tendon in its sheath). We asked about tennis or golfer's elbow (epicondylitis), by enquiring about aches or pains in the elbows and whether they got worse when gripping or making a fist. We did not attempt to distinguish between these two diseases because of the linguistic difficulty of differentiating for layman between medial and lateral sides of the elbow. We attempted to identify shoulder problems such as frozen shoulder, rotator cuff tendinitis or tear, and osteo-arthritis of the acromio-clavicular joint by asking about limitation of the range of movement, and aches or pains in the shoulders.

Although information relevant to ganglia had also been collected, we did not include this as a syndrome group since we considered the effect to be principally cosmetic and not disabling.

Finally, a classification of 'forearm pain' was developed. This was intended to represent those cases who displayed at least this symptom but who did not display other related symptoms characteristic of specific diagnoses such as forearm tenosynovitis.

Summary Table 5.1 lists the six syndrome groups eventually devised, together with the main clinical disorders subsumed within each group, the cardinal symptoms used to identify them and the ULSQ questions from which they were derived.

Summary Table 5.1 Definition of syndrome groups

Syndrome Group	Syndromes	Symptoms
Any Syndrome	Any of the below	As defined below
Trigger Digit	Trigger finger Trigger thumb	Yes to: 'Have you had difficulty straightening one or more fingers or thumbs - which then suddenly jerk straight on more than one day in or before the last 3 months?
Nerve Entrapment	Carpal tunnel syndrome Ulnar neuritis Thoracic outlet syndrome	Yes to: 'Have you had any numbness, tingling or pins and needles in your hands on more than one day in or before the last 3 months?' And 'Has your grip been weak on more than one day in or before the last 3 months?' And 'Have you had any aches or pains in your hands on more than one day in or before the last 3 months?'
Tendon Disorders	De Quervain's disease Tenosynovitis	Yes to: 'Have you had any aches and pains in your forearms on more than one day in or before the last 3 months?' And either: 'Have you had any swellings on your forearms in or before the last 3 months?' Or: 'Have you, when moving your hands, noticed a crackling sensation in your forearm on more than one day in or before the last 3 months?'
Epicondylitis	Tennis elbow Golfer's elbow	Yes to: 'Have you had any aches and pains in your elbows on more than one day in or before the last 3 months?' And 'Does this ache or pain in your elbow(s) get worse when you grip something or make a fist with your hand?'
Shoulder disorders	Frozen shoulder Rotator cuff tendinitis Osteoarthritis of acromio-clavicular joint	Yes to: 'Has the range of movement of either of your shoulders been limited on more than one day in or before the last 3 months?' And 'Have you had any aches and pains in your shoulders on more than one day in or before the last 3 months?'
Forearm pain	Forearm pain	Yes to: 'Have you had any aches and pains in your forearms on more than one day in or before the last 3 months?'

In total, there were 939 subjects in one or more of the six syndrome groups. The smallest group was the 'Tendon Disorders' syndrome group, with 84 subjects, the largest was the 'Shoulder Disorders' syndrome group, with 512. A substantial number of the subjects in each group also fell into other syndrome groups. For example, of 168 subjects in the 'Epicondylitis' group, 124 fell into at least one other group; of 512 subjects in the 'Shoulder Disorders' group, 234 were in other groups. (All subjects in the Tendon Disorders group fell into the forearm pain group, but this was a matter of definition). Excluding the Tendon Disorders subjects, 574 (67% of 855) were in a single syndrome group only. These 939 subjects were therefore selected as potential cases in accordance with the definitions established above. The remainder (985) had patterns of symptoms which did not fall into these 'syndrome group' categories and were not therefore considered further.

Potential cases were categorized according to **purity**, **severity**, and **newness**, as follows. Cases belonging to only one syndrome group were designated pure. Severe cases were those who had sought advice from a health professional regarding symptoms at the anatomical site implicated in their syndrome. For example, potential cases with symptoms of Nerve Entrapment were regarded as severe (for that syndrome group) if they responded 'yes' to Question A9. Finally, new cases were subjects whose symptoms contributing to their syndrome had all occurred within the three months prior to administration of the ULSQ and not before. A potential case with more than one syndrome could be new with respect to a subgroup of these. Table 5.2 gives the numbers of potential cases in each syndrome group by severity, purity and newness.

This shows that the Epicondylitis syndrome group has the largest proportion of severe cases (41.7%) with Forearm Pain the least (25.5%). The data show a two-way grouping to some extent with similar proportions amongst the Forearm Pain and Trigger Digit syndrome groups and little spread between the proportions in the other four groups.

No cases reported solely those symptoms which classified them as a Tendon Disorders syndrome group case whilst Shoulder Disorders syndrome group cases tended to be the most pure with 54.3% only classified in that group. Finally, the Trigger Digit syndrome group had the highest proportion of new case members whilst those reporting Nerve Entrapment syndrome group symptoms tended to have had the symptoms for some time.

Although the effects of some proposed risk factors are mediated locally eg. poor wrist posture, others may be expected to have a more general effect. For example, it has been suggested that psychosocial stress has a general effect on muscle tone and therefore may be expected to have a more general effect on upper limb symptoms. To examine this possibility a seventh syndrome group, called 'Any Syndrome', was therefore included as a classification. This was a combination of all six syndrome groups described above.

The group of potential controls was taken to be those subjects who had not responded 'yes' to any of the unconditional questions on upper limb symptoms. Of the 1580 subjects in this group, 66 had left one or more questions blank. After excluding these, 1514 potential controls remained.

The combined distribution, by age and gender, of all 2453 potential cases and controls (939 cases and 1514 controls) is given in Table 5.3. The remaining 1050 subjects who completed the questionnaire were not defined as either cases or controls as their responses did not fall into any of the defined categories. For all six case groups, females outnumber males quite markedly (the syndrome group with the most equitable gender distribution is the Trigger Digit group with 74 males and 125 females), whereas male and female controls are roughly equinumerous. A comparison of the age distributions of the case groups with that of the control group shows that, generally, there appears to be a tendency for cases to be somewhat older, and that this trend is more marked for females.

These results can be compared with those reported earlier, prior to the classification into syndrome groups (Tables 4.2 and 4.3) which showed females most likely to report recent severe symptoms and for the proportion of asymptomatic individuals to remain fairly constant.

5.4.2 Selection of Cases and Controls for Ergonomic Evaluation

From the point of view of statistical power, it was desirable to select for study as many cases and controls as possible. Against this had to be balanced the costs, logistics and time required to survey the chosen study group. Regardless of the final numbers, the form of the analysis was known, namely, seven case-control analyses, each involving a descriptive phase and a modelling phase, the latter to be carried out by multiple logistic regression. As a rough guide, some simple power calculations were carried out for the simplest possible case-control design, where the exposure factor was at two levels only. Noting that the number of Tendon Disorders cases could not exceed 84, probabilities were calculated assuming 80 cases and 160 controls. Results of these calculations are shown in Table 5.4.

For proportions of the control group exposed to the risk factor of between 10% and 70%, the probability of detecting an odds ratio of 3 is reasonably high (at least 87%). The chance of detecting only a doubling of risk is (of course) less, but is still moderately good (about 70%) if the proportion of controls exposed lies between 30% and 50%. When the risk factor is common amongst controls (90%), it is unlikely that even a trebling of the odds ratio would be detected.

The power calculations suggested that, if groups of 80 cases and 160 controls were chosen, there would be a reasonably good chance of detecting strong associations (odds ratios of at least 3) between the probability of disease and potential risk factors which were neither very rare nor very widespread among the controls.

As mentioned previously, Table 5.3 shows higher proportions of females among potential cases than among controls. The greatest disparity was with the Nerve Entrapment syndrome group, in which 74% of 236 potential cases were female, whereas only 52% of 1486 potential controls were female. These percentages would be approximately reproduced in simple random samples of cases and controls, and the question arose whether or not this particular gender distribution would result in the most efficient estimates of the effects of risk factors adjusted for gender, or whether some form of stratified sampling would be preferable.

A limited investigation of possible gains in the precision of estimated effects which could be achieved using some form of stratified sampling by gender was conducted. It was felt that to attempt to control the relative proportions of males and females sampled from the six syndrome groups would not be practical because of the large overlap between the groups. An alteration to the gender distribution within one of the groups, caused by non-response, might cause an alteration in one or more of the overlapping groups. The focus was therefore on the possible benefits of increasing the proportion of females in the control group, to resemble those in the case groups. Calculations were carried out for the Nerve Entrapment comparison, assuming a risk factor with an odds ratio of 3 in both males and females, and exposure 'prevalences' of 10%, 20%, up to 90% in both male and female controls. A first order approximation to the standard error of the log odds ratio between cases and controls was calculated.

On average, a random sample of 80 Carpal Tunnel cases would yield 20 males and 60 females. Standard errors of log odds ratios were obtained for (i) a random sample of 160 controls (76 males and 84 females) and (ii) a stratified sample of controls (40 males and 120 females). For males, the estimated standard error under stratified sampling was between 4% and 15% greater than that obtained under random sampling. For females, standard errors were reduced by between 3% and 9%. (These ranges cover the 81 possible combinations of exposure prevalences in male and female controls). It was judged that the improvement for females was so small as to be of no practical benefit. In any case, it was offset by the larger loss of precision for males.

On the basis of this limited investigation, the decision was taken not to stratify the sampling of controls by gender, age, or type of keyboard work. For the latter variable, stratification was inappropriate for an additional reason unconnected with statistical power. It was possible that many factors of interest to the study would be correlated with this variable, and hence, alteration of its distribution within controls would introduce unknown biases into the estimated effects of the correlated risk factors.

It was decided to aim, as far as possible, for approximately equal numbers of severe and non-severe cases from each syndrome group. Compared to severe cases, it was less likely that non-severe cases would have changed their way of working at the keyboard for reasons related to symptoms, during the period between administration of the ULSQ and the ergonomic studies. Consequently, postural and dynamic measurements made during the ergonomic survey were, for mild cases, probably a more reliable indication of what the measurements would have been at the time of the symptoms questionnaire, had they been obtained. Inclusion of these subjects would therefore tend to reduce the effect of a potential bias caused by cases compensating for their disability by altering their work habits. A further constraint on the sampling of cases was the preferential inclusion of pure and new cases.

The sampling procedure was as follows. Six overlapping lists of potential cases were prepared, one for each syndrome group. Subjects on the lists were ordered by severity (severe first), purity (pure first), and newness (new first), and then randomized within this ordering. A new list containing all potential cases was then created by selecting from the lists in the following order: the first severe Tendon Disorders group case, the first mild case; the first severe Epicondylitis group case, the first mild case; the first severe Trigger Digit group case, the first mild case; and so on, finishing this first selection with the first mild Shoulder Disorders group case. This sequence was then repeated, taking the second severe and second mild case from each of the six lists; repeated again taking the third severe and third mild case from each list; and so on, finishing when all the lists were exhausted. If at any stage during the procedure, a choice could not be made - for example, when all severe cases from the Tendon Disorders syndrome group had been selected - the next selection in order would be made, in this instance, a non-severe Tendon Disorders group case. Once the new list had been created, all records were removed for any subject who had not provided his or her name on the symptoms questionnaire and therefore could not be contacted. A subject could appear on more than one case list, but in the definitive list they appeared only once, i.e. each case was associated with one particular syndrome or selection out of the six, namely the syndrome list from which he or she was first selected.

The resulting list provided the definitive randomized list of potential cases for the case-control study. Initially the first 480 subjects in this list (80 subjects in 6 syndrome groups) formed the chosen study group of cases.

Sampling of controls was straightforward. A randomized list of all potential controls was prepared, and subjects who had not provided their name on the symptoms questionnaire were removed from the list. This yielded the definitive randomized list of potential controls for the case-control study. The first 160 subjects on this list formed the chosen study group of controls. The two definitive randomized lists of cases and controls were used to provide replacements in the event of chosen subjects being unavailable for ergonomic survey.

5.4.3 Selection of Sites

The distribution of subjects selected in this way between different sites was examined. In order to keep down costs of the visits, in general only those sites where at least eight subjects had been selected were included in the Phase 2 visits. However, in some of the case groups (particularly Tendon Disorders) there were few identified cases from the total number of respondents. It was therefore important to involve as many of these as possible in the research. The sites where these staff were identified were not discarded from the research.

Following this selection of sites, the cases and controls who had been selected were reviewed in the light of the sites that were to be visited. Additional subjects were identified from the sites that would be visited, to replace those that had been discarded from the smaller sites. In doing this the balance of cases from different groups and controls was maintained.

The make-up/representativeness of the sample is discussed in Chapter 6.1.

5.5 MAIN SURVEY

5.5.1 Contacting the Companies

A list of the names of all subjects in an organisation who had completed the ULSQ originally was sent to the contacts in participating companies and they were asked to identify all those who still worked at the company. Any subjects who had initially been identified for the research but were no longer available were replaced by others, in terms of their case status. As far as possible the same cases status was sought at each site. These subjects were then written to individually explaining the project, what the research would involve and asking them if they would be willing to participate. They were informed of the proposed dates for the visit and asked if they would be available at that time.

The contact at each site was asked to distribute these letters and to encourage their staff to participate. Subjects were asked to respond by completing a form and returning it to the IOM in a reply paid envelope. If a subject was unwilling or unable to participate they were asked to give a reason for this.

Two definitive randomized lists of cases and controls were used to provide replacements in the event of subjects being unavailable for ergonomic survey. To replace a case who had a particular 'syndrome of selection', the next available case with the same 'syndrome of selection' was chosen. To replace controls, the next available control on the randomized list of controls was chosen. The lists of subjects were held by an IOM data scientist who was not involved directly in the field work. Subjects were identified by an eight digit code which gave no indication of their case/control status. The observers who were involved directly with the field work did not know the case/control status of subjects.

To further boost the response rate, the trade unions who were represented at the organisation were contacted and informed of the research. They were asked to encourage their members to participate.

Each line manager was asked for their permission for the subject to be released for the survey. Line managers were also asked to encourage their staff to participate in the research.

5.5.2 Method of Administering the Package

Introduction

At the start of the session the observer introduced himself/herself to the subject and explained the background to the research and what the session would involve. Subjects were assured of confidentiality and any questions they had were answered.

Structured interview

The package started with a structured interview in which the subjects were asked a series of questions concerning their work, work equipment and personal factors at the time of completing the ULSQ. This took approximately 20 minutes to complete.

Depending on the nature of the organisation, these interviews were either conducted at the subject's desk or in a quiet room. Since most of the questions were factual in content, most subjects did not experience concerns over confidentiality or embarrassment in answering these questions. For the more sensitive questions (level of education, medical conditions, pregnancy), if the subject was in an open plan office, they were shown the questions and asked to mark their response on the sheet.

Keyboard activity

Following this, the goniometers (Penny and Giles, M110) were attached across the subject's wrists using double sided medical tape and micropore tape. The goniometer data logger (DL1001) was programmed to sample radial and ulnar deviation, flexion and extension angles at a rate of 1000 records per minute. This allowed a sampling period of 16 minutes. The goniometers were calibrated to each subject prior to data collection by asking them to stand with their arms hanging down relaxed at their sides. The data logging was commenced and subjects were asked to undertake their normal keyboard work. If appropriate they could answer the telephone or deal with colleagues' enquiries, as they would in their normal work.

During the time that the subjects were undertaking their keyboard work observations were made concerning the equipment and the subject's posture. The postural observations were commenced approximately five minutes after the subject had started keying, so that they had some time to relax and behave naturally.

During the observation period two to three minutes of finger and upper limb postures and movements were collected on video.

Completing the observations usually took 10-15 minutes.

When the observations, video and electrogoniometer data had been collected, subjects were told that they could stop keying at a convenient point. The data logger was stopped (if the memory was not already full) and the leads disconnected. The electrogoniometers were removed from the subject by the observer.

Work Environment Scale (WES)

Following the observations, subjects were asked to complete two questionnaires concerning the work environment. The first questionnaire was the WES. The statement sheet and the answer sheet were shown to the subject and the method of marking their responses explained. It was emphasised that it was their current feelings that were of interest, and their own feelings rather than the feeling of the work group. Any questions they had concerning the questionnaire were answered. Once they had completed that questionnaire they were asked to complete the retrospective questionnaire. They were asked to answer in terms of now feeling the same, feeling more or feeling less of a WES factor than they did at the time of completing the ULSQ.

The data stored on the data logger was transferred onto a computer, the electrogoniometers cleaned and the completed questionnaires were checked to ensure there was no missing data.

Feedback

Once the package had been completed each subject was given some feedback concerning the layout of their workstation. The total time spent with each subject was approximately 1 hour 30 minutes.

The survey package is shown in Appendix 4.

5.6 RELIABILITY

5.6.1 Validation of ULSQ

The symptoms reported in the ULSQ during the cross-sectional survey were used to classify subjects into symptom groups intended to suggest the likely types of clinical diagnosis. As part of the case-control study, efforts were made to examine the relationship of these classifications with clinical diagnoses. Several approaches were investigated in order to achieve this.

The first entailed a proposal to arrange for a clinical interview of a sample of selected cases specifically for the purpose of the study. A group of individuals were to be randomly selected from the list of cases and invited to undergo such an interview. However, following discussions with staff at a number of the participating organisations, it became apparent that companies were reluctant to release staff further from their work. The survey package took about 1 hour 30 minutes to complete and, although subjects were able to continue working during some of this period, the opinion was expressed that any further intrusion was unacceptable. Consideration was given to inviting participation by individual subjects outside normal working hours but the logistics of providing an interview venue, or of visiting homes, rendered this alternative unworkable. It was therefore with reluctance that this approach was not pursued any further.

As a second approach, the feasibility was investigated of arranging for patients not connected with the study but attending out-patients clinics for treatment concerning ULDs to complete the questionnaire. A senior consultant orthopaedic surgeon at a major hospital in the South of Scotland agreed to participate in this exercise. He was provided with a list of the principle diagnoses for each symptom group and requested to invite each of his patients presenting with one or more of these diagnoses to complete an ULSQ. This had been slightly amended to remove the occupationally-related questions concerning keyboard use etc. Patients agreeing to do so were to be issued with a letter giving details of the study and were asked to complete the questionnaire and return it in the prepaid envelope. The consultant indicated his diagnosis on a label attached to the ULSQ. Unfortunately, individuals proved to be most reluctant to participate and, over a six month period, only four completed questionnaires were received. Requests to involve other consultants at the same hospital did not result in any further success.

As the poor response became apparent, consideration was given to extending the exercise to another hospital centre. However, although local consultant surgeons expressed a willingness to participate it became apparent that because of the delay already experienced, time constraints in clearing the local hospital ethical committee meant that insufficient time would be available to recruit further patients before the data collection phase had to be concluded.

Of the four patients who returned questionnaires, three had symptoms which were positive for syndrome groups as defined in the research and these agreed with the diagnosis the consultant made. Of these three, two had additional responses which were positive for more than one syndrome group. However, the consultant had only indicated one diagnosis on the form. The fourth patient had responses that were positive for two syndrome groups, but had been diagnosed as having a different condition.

During the case-control study structured interview, a few cases had volunteered information about specific diagnoses they had received (from GPs or other medical practitioners) although they were not directly asked for this information. This was normally recorded by the interviewer as 'additional information'. When the poor response from other sources became apparent, this information was examined retrospectively to provide some check on the derived classifications given the difficulties with the alternative procedures. Twenty seven subjects reported a medical diagnosis of whom seventeen had a relevant specific clinical diagnosis. The others generally reported less specific diagnoses such as nerve damage or other disorders (eg. Raynaud's disease). Of the seventeen, twelve reported a diagnosis which was directly consistent with that of their syndrome group. It must be emphasised that the interviewer was not initially aware of the case-control status of the subject (although this frequently became apparent during the interview) and was certainly not aware of their syndrome group classification, this comparison being made retrospecively. This agreement (70%) is consistent with the small group of out-patients (75%).

5.6.2 Reliability of Data Collected in Measurement and Observation Package

It was important to determine the reliability and reproducibility of the collected data. It was therefore necessary to identify the factors in the research that could be subject to unreliability, and to measure and monitor these.

There were four ways in which the reliability of the data collected may be compromised. These were:

1. Poor subject memory;

2. Differences in recorded observations between different observers (inter-observer reliability) and differences in an observer over time (intra-observer reliability);

3. Changes in posture due to new furniture/working practices etc.;

4. Differences (inter- and intra-observer) in fitting the goniometer to the subject.

These issues affect different parts of the data collection package and are discussed below.

1. Poor subject memory

Due to the time lapse between the time of completing the ULSQ and the time of interviewing it was possible that some subjects would have difficulty remembering what their job and work equipment were like at the time of completing the ULSQ. The Sections of the package that would be affected by this were the structured interview questions on the changes in workplace conditions and the retrospective questions concerning the WES. All subjects who were vague in their responses or who had difficulty remembering the situation at the time of completing the ULSQ were noted and their influence on the results considered.

There were very few subjects who reported being unable to remember the details of the workplace. Although many had moved offices, they could remember clearly the work situation at the time of interest. In addition, there were a number of triggers that subjects were able to use (such as events in their personal life) that enabled them to identify the time accurately.

2. Differences in inter- and intra-observer reliability

The questions that were asked during the structured interview were all written out and asked in the same way by all observers. This was done to reduce inter-observer questioning differences.

The observations that were made were more subjective and reliability would be compromised if different observers categorised factors differently. The observations concerned the posture and activities of the subject and the workplace. Six ergonomists were involved in the ergonomics study and the data collection took place over a 10 month period. In order to determine how reliable the observers were, inter- and intra-observer reliability were measured as follows.

(2a) Inter-observer reliability

Inter-observer reliability was assessed during the field work. One observer conducted an interview with a subject as usual. During the observation part of the session, a second observer also completed an observation sheet of the postures that were observed. This meant that there were 2 sets of observations for these subjects. The observations made by the observer who had conducted the interview were recorded in the main data set, while the second observer's observations were used to compare with these and determine the reliability.

In total 27 repeat measures were taken, with each of the 4 main observers observing with each other twice. In addition, a fifth observer observed with one of the main observers on three occasions.

In considering the reliability of the data, only the factors that would be included in the analysis were examined. The reliability of these factors is outlined in Table 5.5 for inter-observer reliability. The results are a score out of 27 for the number of times the observers agreed in their observations.

The results show that for all the postures, observers agreed on 74% of occasions or more. This is a relatively high degree of agreement between observers and can be considered to indicate reliable postural observations.

An estimation of the amount of time during the recording period that the hand was keying also gives a relatively high degree of agreement between observers (74% for both hands). This information was used to interpret the goniometer results.

Observation of the typing style gave good reliability (93%) and stretching of inter-digital skin when keying was also reliable (81%). The least reliable observation was whether the subject was classified as being a 'clacker' i.e. using undue force when keying. This was the most subjective observation as there was no standard 'undue amount of force' with which to compare it. Due to the high level of subjectivity with this variable, the lower level of agreement (52%) is perhaps not surprising.

(2b) Comparison of intra-observer reliability

In order to assess the intra-observer reliability it was necessary to standardise the observation material so that comparisons could be made of changes in observation over time. At three stages during the period that the field work was being undertaken all the members of the field work team observed two standard pieces of video of keyboard users. The video was recorded at the IOM and was of two styles of keyboard use - a text entry task and a conversational task. This was so that both a relatively static posture and a more dynamic posture could be observed. The video material was played to the observers on three occasions and each observer completed an observation sheet based on the video material. These observations were undertaken at the start, middle and end of the field work period. Each observer completed the postural observations while observing the video material. With these observations it was possible to compare intra-observer reliability.

Due to changes in staff, although there were 6 observers who spent time in the field, complete (3 exposure) intra observer reliability checks were not obtained for 2 of these observers.

However, the 4 observers who were included in all 3 reliability checks observed 94% of the subjects (436 of the 462 subjects) examined during the ergonomic survey.

The results of the intra observer reliability test are shown in Table 5.6. The level of agreement is shown as a score out of 8 (4 observers and 2 pieces of video material). Agreement was only positive if the same response had been recorded by an observer on all three occasions. The number represents the number of observers who were consistent in their responses across all three observation periods.

From this it can be seen that in general there were high levels of consistency within operators over time. The factors that were least consistent were whether the wrist was higher than the elbow when typing, and whether the interdigital skin was stretched when typing. This may be to do with the video material which made it difficult to determine the arm position accurately.

3. *Changes in posture due to new furniture/working practices etc.*

Posture will obviously be affected by the furniture and equipment that is used. If all the furniture and equipment the subject was using at the time of completing the ULSQ have changed then it is not possible to say with any confidence that the observed posture ('now') was the same as the posture at the time of completing the ULSQ ('then'). The extent to which any alteration in furniture or equipment affects the posture will depend on the degree of difference between the furniture 'then' and 'now'. For example if the chair 'then' and the chair 'now' are identical or very similar, it could be inferred that the postures should largely be the same. However, if the chair 'now' does not have armrests while the chair 'then' did have, the posture may have altered considerably. If none of the furniture or equipment has changed it is more likely that the posture 'now' is very similar to the posture 'then'.

It is difficult to quantify what changes in furniture will affect what aspect of the posture and to what extent. Much thought was given to the furniture changes that would affect posture.

To address this, a number of questions were included in the package to identify where work equipment, furniture, work practices etc. had changed between the time of completing the ULSQ and the observations. The questions were used to develop an indicator of how similar it could be assumed the upper limb posture is 'now' compared to 'then'. These indicators were used to stratify responses into those which could be considered reliable and those which could be viewed as unreliable due to these postural or furniture changes. For example, the upper arm abduction variable observed during the field work was considered to be an unreliable indicator of this posture when the ULSQ was administered if the chair had changed and neither chair had adjustable armrests; or if the new desk had a different thickness; or if the job had changed; or the method of information presentation; or the amount of keying; or the use of the mouse; or if deliberate changes had been made to their sitting position; or they had received any training in workstation layout.

4. *Reliability of goniometer measurements*

The goniometers measured the position of the hand relative to the forearm. Prior to the start of each data collection the goniometers were calibrated while attached to the subjects. Therefore any differences between observers when attaching the goniometers (eg. placing them slightly differently on the forearm) should not affect the readings. However, to check this some repeat goniometer data readings were taken for five randomly selected subjects. This involved a second 15 minute collection period on a different day. A comparison was made between the mean angles and standard deviation of these readings.

A brief, informed analysis was conducted on the goniometer measures. This suggests that there is a moderate degree of reliability between goniometer measures obtained on different occasions (agreement within 5° occurred for between 33% and 75% of measures).

When considering these goniometer results it is important to remember that any differences may be due to different activities that the subjects were undertaking in the course of their work. It was not possible to limit operators' movements during the goniometer collection; they were able to answer the telephone, and discuss work with colleagues during this time. Therefore, there may have been a different amount of time spent keying during the observation periods. These differences in work activity may have more effect on the readings than differences due to different observers collecting the data.

5.7 DATA PROCESSING

The questionnaires and observation forms from each subject surveyed at a site were collated by the ergonomists and forwarded for data processing as a batch of data for a site. The progress of any batch was monitored from receipt by the IOM's Computing Section through data entry, data validation, and on to the analysis. Checks were applied at each stage to confirm that the expected number of records were carried forward.

Data were keyed from the forms using the KE-III package on a PC. This provided checks on the validity of individual fields to ensure that responses matched criteria developed by the ergonomists (who were familiar with the observations or measurements concerned and the circumstances in which they were generated). Suspect data (eg. coded as 'missing') were checked against manuscript records, with assistance from the ergonomists when required.

5.8 STRATEGY OF ANALYSIS AND STATISTICAL METHODS

5.8.1 Case-control Design and Overall Approach to the Statistical Analysis

The basis of this study is the use of a case-control design (Schlesselman 1982). Cases for each syndrome were identified using strictly defined criteria (Section 5.4.1), along with a group of control subjects who had no symptoms for the six syndrome groups: Trigger Digit, Nerve Entrapment, Tendon Disorders, Epicondylitis, Shoulder Disorders, and Forearm Pain. Having identified these subjects as either cases or controls the analysis of a case-control design is a comparison of the factors or characteristics of subjects in case and control groups. An excess of a characteristic in the cases of a syndrome group then suggests an association with that syndrome group. The number of variables obtained from the different instruments (the ULSQ from Phase 1, the Structured Interview and Goniometer measurements from Phase 2), was large and so a structured approach was necessary to reduce the number of possible comparisons, while at the same time maintaining a thorough analysis of all possible factors. This structured approach, which was informed by ergonomic and medical knowledge, as well as by statistical considerations, consisted of the following stages:

Prioritising variables for comparison of cases and controls

1. Descriptive analysis and screening of variables for inclusion in logistic regression models;

2. Analysis of relationship between the syndromes and age and gender;

3. Analysis of groups of variables in regression analyses for each syndrome;

4. Analysis of significant variables from the previous step to give a final model for each syndrome

Each of these steps are described in turn below.

5.8.2 Prioritising Variables for Comparison of Cases and Controls

Each variable derived from the fieldwork package was assigned a priority based on its perceived relative importance in terms of developing upper limb disorders based on medical and ergonomic knowledge. This produced a scale from one to five, with priority one being the most important. For example, the number of hours keying per week was designated a priority one variable as intensity of work is considered a risk factor, while having a temporary or permanent job was assigned priority five as there is little indication that this is an important risk factor. Some questions which were not prioritised but which may be related to syndrome status were also considered at this initial stage.

5.8.3 Screening Variables for Inclusion in the Regression Analyses of Upper Limb Disorders

As a large number of variables were collected for the study, it was important to screen out those which either are poorly related to being a syndrome case or are not sensible to link with the syndromes in a scientific sense. Hence this stage involved a combination of ergonomic and medical input as to the relevance of inclusion, along with the consideration of statistical significance.

For each of the seven syndrome groups (including Any Syndrome) the frequency in cases were compared to the frequency in controls for each level of all categorical variables. For continuous variables such as the hours of keying per week, means were compared between cases and controls and if any skewness was found log transformed variables were compared between cases and controls. The same set of 154 controls who had no syndromes present were used in all comparisons with the different sets of cases.

In assessing a large number of variables for differences, a common strategy is to adopt a p-value for statistical tests which is divided by k, the number of tests, as the nominal significance level to assess statistical differences. However, if this was strictly adhered to, very few if any variables would be left for analysis. Also it is important to include variables in the regression analysis which although showing weak significance may be of scientific importance and may become more significant on adjusting for confounders.

In consequence, in order to be included in the analysis, the following criteria had to be fulfilled:

(1) For a variable, not Priority 1, which has no known specific relation to syndromes identified from the published scientific literature, it had to show a significant difference between cases and controls at least at the 5% level for at least two syndromes.

or

(2) For a variable for which a mechanism linking it to a syndrome could be postulated, (although not sufficiently established for Priority 1 status), it had to show a difference between cases and controls which was significant at least at the 10% level for any syndrome.

or

(3) All variables which had been assigned Priority 1 based on ergonomic principles would be included in the regression analysis irrespective of the statistical significance.

These variables were identified by a team of ergonomists as being those where a proposed causative link or other form of association had been proposed in the scientific literature or where an a priori link could be hypothesised on the basis of the literature.

The above is a highly conservative approach and would include many weakly significant variables but would be unlikely to miss important relationships at this early stage in the analysis. In the multiple regression analyses many of these apparent differences would become non-significant on adjusting for confounders.

Implications of reliability indicators on statistical analysis

Factors derived from the Structured Interview were assumed to be relatively reliable, in the sense that similar responses would have been achieved if the structured interview had been administered at the same time as the ULSQ. Where equipment had changed in the intervening period, information at the time the field work was administered was also recorded and used in the analyses. Detailed descriptions of the treatment of reliability were considered in Section 5.6.2 and only a brief description of its relevance to the screening of variables for inclusion in the regression analyses is included here.

When considering the gross postural variables it was important to take into account changes in furniture, equipment, environment, or working practices between the time of completing the ULSQ and the observations being undertaken. For the gross postural variables a number of reliability indicators were constructed to indicate whether changes in the workstation had occurred between the ULSQ administration and the interview. Tabulations of responses and syndrome status were repeated for 16 variables stratified by the relevant indicator. Tests on the frequencies displayed in these tables were attempted as described above.

There was also a retrospective investigation into the WES variables to see if the environment had changed since the ULSQ had been completed. These questions recorded whether the WES scores were greater, the same or less than they were when the ULSQ was completed. These were used as indicators to see if suggested links between WES scores and syndromes differed according to recent changes in environment. These indicators were intended as a guide to the interpretation of any WES score and syndrome associations.

There was also indicators for reliability of the goniometer variables which related to changes in the work environment. Tests were repeated on subgroups which were indicated as reliable and unreliable. In addition, the percentage of time spent keying during the observation period needed to be considered. This was split into five categories: ≤20%, 21%-40%, 41%-60%, 61%-80% and >80%; and the assessment of the goniometer variables was considered separately for these levels of activity.

5.8.4 Relationship Between the Syndromes and Age and Gender

Initially, before considering other explanatory variables the relationships between age and gender and each syndrome were explored. Logistic regression analyses were carried out with only age in the model, only gender, then age and gender and finally age, gender and the age-gender interaction. For the two variable model the order of entry of age and gender was also considered.

5.8.5 Strategy for the Regression Analyses of the Syndromes

Next, in order to consider a large number of variables in the regression analyses a structured approach was necessary. In this study, there were already some natural groupings or clusters of variables. In the Structured Interview these are Sections: A (The Job); B (Work Equipment); C (Physical Environment); D (Other Activities); and E (Personal details); the Postural observations; psychosocial data obtained from the WES scales; and the goniometer readings.

Initially, variables included for regression as selected using the screening criteria described above were assessed within each cluster or group. For example, the goniometer data were assessed in a forward stepwise regression procedure. The selection of variables can be controlled using the options in the logistic regression program within the statistical package BMDP (Dixon 1990). The relationship between the variables in each cluster and what could be described as the 'core' variables (age and gender) were explored by carrying out the above procedure with and without adjustment for the core model. The implications of any age and/or gender association was discussed with the ergonomists at this stage. The results of this procedure was a core model plus a subset of goniometer variables chosen by the stepwise procedure. This procedure was repeated for each of the clusters of variables as described above.

5.8.6 Final Regression Modelling for Each Syndrome

Secondly, the variables which were selected as significant in the stepwise procedure for each group were combined simultaneously in a stepwise procedure to give a final model.

Finally, as a check on the above, a stepwise procedure was carried out on all the variables selected by the screening procedure and this model compared to the final model obtained from the modelling of clusters of variables, to show up possible unexpected confounding which might be missed on the first level analysis of variables. The above was repeated for each syndrome.

5.8.7 Statistical Methods

The initial screening of variables as described in Section 5.7.3 involved comparing all variables in cases and controls. The frequencies of categorical variables such as gender (male/female) in cases and controls were compared using chi-squared tests. Differences between cases and controls for continuous variables such as number of years of keyboard use were assessed using t-tests. Where a continuous variable was skewed, the non-parametric equivalent test was used; the Mann-Whitney test. The level of 5% was taken to indicate statistical significance in all tests. All statistical analyses were carried out using the statistical software BMDP (Dixon 1990).

The regression analyses used in the analysis strategy described from Section 5.7.4 onwards used the method of logistic regression. Logistic modelling is a common statistical technique used to analyse differences between cases and controls, while adjusting for other confounding variables and so allowing the assessment of the independence of relationships with each syndrome (Collett, 1991). Logistic regression models the probability of being a case through the log odds in relation to the variables derived from the fieldwork. This is expressed in terms of the odds of being a case; if 10 males are cases of a syndrome compared to 30 males who are not, the odds of being a case for males is 0.33. The comparison of odds for two groups is often expressed in terms of the odds ratio. For example, if the odds of being a case in males is 0.33 and in females is 0.66, then the odds ratio is 0.66/0.33 = 2 for females relative to males. Note that an odds ratio of one indicates no difference between two groups. Many of the variables were coded Yes/No and so many results are expressed as odds ratios for two groups, along with a 95% confidence interval. For those categorical variables with more than two responses, dummy variables were constructed to give odds ratios for a particular response relative to a reference category. For example, the three responses to the question of how visual information was presented were 'flat on the desk', 'on a document holder' or 'other'. In this case, two dummy variables representing the odds ratios of use of a document holder relative to flat on a desk and the other category relative to flat on the desk were used, the former being the main comparison of interest. The results for continuous variables were expressed in terms of odds ratios for a one standard deviation increase in the variable. All logistic modelling was carried out using the BMDP statistical software (Dixon, 1990).

6. PHASE 2 : RESULTS – DESCRIPTIVE

This chapter details the associations between risk factors (as measured in the study, see Chapter 5.5) and syndrome groups. The risk factors are considered in logical groups, as they were obtained in the survey package: age and gender; duration of keyboard usage; information about the job; information about the work equipment; the physical environment and factors outside work; personal information; general body postures; psychosocial factors (WES); and hand and wrist postures. Each group of factors is considered for its association with the seven syndrome groups. It is important to recognise that a study of this type (retrospective) can only identify associations between risk factors and symptoms; significant associations do not indicate a causal relationship, although consideration of the significant factors can indicate whether the association is likely to be causal or resulting from the syndrome. The implications of the findings are discussed further in Chapter 8.

6.1 REPRESENTATIVENESS OF SAMPLE

Altogether, 449 subjects took part in the case-control study which was conducted from late 1994 to early 1995. Of these, 178 were male and 271 female. In total, 295 were cases, and 154 controls. Of those who were cases, 65 were classified in the Trigger Digit syndrome group, 75 in the Nerve Entrapment syndrome group, 38 in the Tendon Disorders syndrome group, 57 in the Epicondylitis syndrome group, 155 in the Shoulder Disorders syndrome group and 132 in the Forearm Pain syndrome group. Note that all those in the Tendon Disorders syndrome group were also in the Forearm Pain syndrome group due to the way these syndrome groups were defined. Some cases had more than one syndrome group. A full breakdown of the participants in the study described by age, cases-control status and gender is shown in Table 6.1.

The total number of non-participants was 470 (287 cases and 183 controls). Many of the non-participants (48%) were those who no longer worked for the company. This is discussed further in Chapter 8.2.3.

It is important to consider the potential biases which could arise from differential participation among the syndrome groups. The reasons for non-participation from those invited were numerous, ranging from subjects not being available due to sickness or holiday absence, to subjects who were embarrassed or refused to take part. The first non-participants were of course those who did not complete the first questionnaire. The case-control selection process described in Section 4.1 identified a possible 2453 subjects, excluding the anonymous respondents, others who had not fully completed the questionnaire, or those whose symptoms did not coincide with any of the syndrome group categories. Of those initially selected to take part in Phase 2, the largest group of non-participants (48%), were subjects who had left the organisation, had retired or had been relocated within their organisation. The two next largest groups of non-participants were those who now scarcely used a keyboard, if at all and therefore did not wish to participate; and those who were on holiday, on sick leave or maternity leave at the time of conducting the survey. The non-participation rate varied from 26% to 36% across the syndrome groups suggesting no real imbalance in non-participation between groups. The non-participation rate in controls was much lower at 12% compared to the syndrome groups. As stated, approximately 50% of the reasons for non-participation were due to individuals having left, retired or relocated in the organisation. There was some variation between groups for non-participation for this reason with a high of 59% of Trigger Digit cases to a low of 40% of Forearm Pain cases but there was general similarity across syndrome groups. There was a slight excess of non-participating cases in the Nerve Entrapment syndrome group for those who did not consider themselves to be sufficiently keyboard users to participate. Considering other reasons for non-participation, low numbers meant that it was difficult to assess any association with syndrome group status.

To check that this non-participation or other sampling parameters had not created any bias in the case-control sample, comparisons were conducted between those actually sampled and the potential cases and controls using data from Phase 1.

The distributions by severity, purity and newness were very similar in the sampled cases compared to the potential cases. There were slightly fewer new sampled cases of Epicondylitis (19%) compared to potential cases (25%), and slightly fewer pure sampled cases of Shoulder Disorders (49%) compared to potential cases (54%), but these differences were not large.

The equal sampling of severe and mild cases ensured that all the severe cases were selected but, as there were fewer severe cases compared to the mild group in the potential cases, the resulting distribution is weighted towards the mild cases. One exception where equality was almost realised was with the Epicondylitis syndrome group with 46% of cases defined as severe. Overall, the range of proportions of severe cases varied from 25% to 46%.

Although there were some differences in the age and gender distribution between cases and potential cases, these were not consistent between different syndrome groups. There were no indications, for example, of a general loss of older potential cases (eg. through retirement) or of any bias in participation related to gender.

6.2 RELATIONSHIPS BETWEEN UPPER LIMB SYNDROME GROUPS AND AGE AND GENDER

The total number of cases was 295 and the total number of controls was 154 in the study sample. Table 6.1 shows the number and percentage of cases and controls in the age groups: 15-24; 25-34; 35-44; 45-54; and 55 and over for males and females separately. The data are also categorised into the six defined syndrome groups, as well as the Any Syndrome group (all six syndrome groups combined).

6.2.1 Age

Comparing the age distribution for controls with the distributions found for the Any Syndrome group shows a similar distribution for males, but a higher proportion of females aged 45 and over in the cases compared to female controls. Within the syndrome groups, this is even more marked with higher proportions of older females for the Nerve Entrapment, Epicondylitis and Shoulder Disorders syndrome groups compared to female controls (Table 6.1).

6.2.2 Gender

Considering the gender distribution overall suggests a greater proportion of females as cases in the Any Syndrome group compared to controls. This is also true for the individual syndrome groups with the Nerve Entrapment syndrome group (83%), Tendon Disorders syndrome group

(79%) and Forearm Pain syndrome group (74%) having particularly high proportions of female cases compared to controls (51%).

6.3 DESCRIPTION OF CONTINUOUS VARIABLES FROM THE STRUCTURED INTERVIEW

There were a small number of continuous variables derived from questions in the structured interview. These were:

- number of years experience with a keyboard
- number of years working with VDUs
- number of hours in 'risky' office activities (e.g. filing, photocopying, etc)
- number of hours per week spent keying
- number of hours per week spent in 'risky' sports or hobbies (including racket or club sports, playing a musical instrument, computing, knitting, DIY, gardening and cycling)

For the purposes of analysis, logarithmic transformations were used for the number of years experience at the keyboard and the number of hours per week of risky sports or hobbies as these variables were positively skewed.

Comparisons between cases and controls were carried out using t-tests and results for variables which fulfilled the criteria described in Section 5.8.3 are included in Table 6.2.

6.3.1 Length of experience with keyboards

The number of years experience with keyboard use was significantly related to cases in the Nerve Entrapment and Epicondylitis syndrome groups. No other comparisons of this factor reached statistical significance, although mean values for cases were greater than controls for all syndrome groups.

6.3.2 Length of experience with VDUs

The number of years of experience working with VDUs was not significantly related to being a case of any of the syndrome groups.

6.3.3 Hours per week keying

Cases for all syndrome groups showed greater number of hours per week spent keying compared to controls, especially for cases in the Trigger Digit, Tendon Disorders and Nerve Entrapment syndrome groups. All differences for this variable were highly significant at the 0.1% level.

6.3.4 Hours per week in 'risky' office activities

The number of hours spent per week in 'risky' office activities was not significantly related to being a case of any syndrome group.

6.3.5 Hours per week in 'risky' sports/hobbies

Only two syndrome groups, the Nerve Entrapment and Tendon Disorders syndrome groups, showed no significant relationship with the number of hours per week of risky sports or hobbies. All other syndrome groups had significantly higher mean values for this variable in cases compared to controls (Table 6.2). Male and female cases in the Any Syndrome group had greater time in risky sports or hobbies than same gender controls. The average number of hours of risky sports or hobbies was higher for control males than for case females. There was also increasing numbers of hours spent in such activities with age.

Consequently, the following three variables: the number of years experience with keyboards; the number of hours keying per week; and the number of hours in risky sports or hobbies were considered in the regression analyses. The results of the tests of association with syndrome groups are summarised below in Summary Table 6A.

Summary Table 6A Summary of significant tests of association for continuous variables from Structured Interview with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-condylitis	Shoulder Disorders	Fore-arm Pain
No. years experience with keyboard (higher)	x	x	5	x	5	x	x
No. hours keying per week (higher)	5	5	5	5	5	5	5
No. hrs/week risky sports or hobbies (higher)	5	5	x	x	5	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
All variables shown are priority 1

Completely non-significant variables are not shown and direction associated with being a case shown in brackets.

6.4 DESCRIPTION OF RESPONSES TO QUESTIONS FROM SECTION A (THE JOB) OF THE STRUCTURED INTERVIEW

From this section of the structured interview, nine variables gave significant differences between cases and controls according to the criteria described in Section 5.8.3. These are presented in Tables 6.3 to 6.9 with the number and proportion of responses in cases and controls for each syndrome group. For this and the following four Sections (6.5-6.8), Chi-squared statistics were calculated for each table and compared to appropriate probability tables to assess statistical significance. For variables with Yes/No responses these represent tests of the differences in percentages of Yes responses (or No responses) in cases compared to controls. For variables with more than two responses, these are tests of association and inspection of the percentages in the tables will indicate which differences in percentages have contributed most to the significance of the test.

6.4.1 Information presentation

The way in which information was presented was important, with visual and audible means combined being more prevalent in cases of every syndrome group. This failed to reach statistical significance for the Tendon Disorders syndrome group (Table 6.6) and was only significant at the 10% level for the Trigger Digit syndrome group (Table 6.4). Two further questions were asked following this question to ascertain what specific visual or audible means were used in presenting information. A large majority used visual means and for these individuals use of a document holder tended to be higher in cases compared to controls. These differences were significant for all syndrome groups except for Shoulder Disorders. The use of audible means *via* a hand held telephone was associated with cases from the Any Syndrome and Forearm Pain syndrome groups but was only significant at the 10% level.

6.4.2 Other work factors

Of the other variables from this Section, 'having difficulties reading from text or screen', 'the ability to take breaks', and 'having a specified rate of keying' were all significantly related to being a case of every syndrome group. Use of a mouse showed no significant association with any of the syndrome groups but was included in the regression selection as it was considered to be a Priority 1 variable. Frustrating problems with software was significantly related to all syndrome groups except for the Nerve Entrapment and Tendon Disorders syndrome groups. 'Having particularly busy periods of work' was only significantly related to the Shoulder Disorders syndrome group (Table 6.8). The results of significance tests for each syndrome group are summarised in Summary Table 6B.

6.4.3 Non-significant variables

Those variables from Section A which did not show any significant associations with any of the syndrome groups were 'more frequent use of keyboard and VDU, electronic or manual typewriter'; and 'the frequency of particularly busy periods'. These were not therefore considered in the regression analyses. 'Having sufficient space to write' was weakly significant but was not included in the regression model as the association was weak and the theoretical linkage to ULDs indirect.

Table Summary 6B Summary of significant tests of association for variables from Section A with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-condylitis	Shoulder Disorders	Fore-arm Pain
How info. presented (Visual & Audible)	5	10	5	x	5	5	5
Visual means (Doc. holder)	5	5	5	5	5	x	5
Audible means (Hand held tele.)	10	x	x	x	x	x	10
Difficulties reading text (Yes)	5	5	5	5	5	5	5
Frustrations with programs (Yes)	5	5	x	x	5	5	5
Able to take breaks (No)	5	5	5	5	5	10	5
Busy periods (Yes)	x	x	x	x	x	5	x
Specified rate of keying (Yes)	5	5	5	5	5	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
Priority 1 variables are in bold and the responses associated with being a case are in brackets.

Completely non-significant variables are not shown.

6.5 DESCRIPTION OF RESPONSES TO QUESTIONS FROM SECTION B (WORK EQUIPMENT) OF THE STRUCTURED INTERVIEW

There were eleven variables concerning work equipment which fulfilled the criteria outlined in Section 5.8.3 and are presented as the number and percentage for each response in cases and controls in Tables 6.10 to 6.16. As described in the methods (Section 5.2.1) these variables took into account changes in equipment between administration of the ULSQ and all variables refer to equipment at the time the ULSQ was completed.

6.5.1 Chair

Of the chair variables, 'having any problems with the chair' and 'having a footrest' were significantly associated with all syndrome groups. Considering aspects of the chair in more detail, 'not having armrests' was significantly associated with being a case of every syndrome group except for the Shoulder Disorders group. On the other hand, 'having seat height adjustment' was only significantly related to the Shoulder Disorders syndrome group at the 10% level (Table 6.15). 'Not having a backrest angle adjustment' was also significantly related to most syndrome groups, the exceptions being the Tendon Disorders, Epicondylitis and Shoulder Disorders syndrome groups. 'Having no support for the upper back' was associated with the Tendon Disorders, Epicondylitis and Forearm Pain syndrome groups, although the former two were only significant at the 10% level.

6.5.2 Footrest

Having a footrest was significantly associated with all syndrome groups.

6.5.3 Document holder

'Use of a document holder' was significantly associated with every syndrome group except the Shoulder Disorders group.

6.5.4 Keyboard

Some aspects of the keyboard were also found to be important. 'Not having a detachable keyboard' was significantly associated only with the Epicondylitis syndrome group, while 'not having a tiltable keyboard' was significantly associated with all syndrome groups except the Tendon Disorders syndrome group.

6.5.5 Screen

Similarly, 'having previous screen flicker' was associated with all syndrome groups except the Tendon Disorders group at a high level of significance. 'Not having the facility to swivel the screen' was also associated with most syndrome groups except for the Nerve Entrapment syndrome group.

The results of significance tests for each syndrome group are shown in Summary Table 6C.

Summary Table 6C Summary of significant tests of association for variables from Section B with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-Condylitis	Shoulder Disorders	Fore-arm Pain
Chair: armrests (No)	5	5	5	5	5	x	5
Chair: seat ht. adjustment (No)	x	x	x	x	x	10	x
Chair: backrest angle adjustment (No)	10	5	5	x	x	x	5
Chair: support upper back (No)	10	x	x	10	10	x	5
Any problems with chair (Yes)	5	5	5	10	5	5	5
Footrest (Yes)	5	5	5	5	5	5	5
Use document holder (Yes)	5	5	5	5	5	x	5
Detachable keyboard (No)	x	x	x	x	5	x	10
Tiltable keyboard (No)	5	5	5	x	5	5	5
Screen flicker (Yes)	5	5	5	x	5	5	5
Screen swivel (No)	10	10	x	10	10	5	x

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
Priority 1 variables are in bold and the responses associated with being a case are in brackets.

Completely non-significant variables are not shown.

6.5.6 Non-significant variables

Variables which did not show any significant associations with any of the syndrome groups and so are not included in the regression analyses were: 'having the ability to adjust the height of armrests'; 'having the ability to adjust the height of the backrest'; 'having castors on the chair'; 'whether they worked at the same desk doing keyboard work'; 'whether the desk was used by more than one person'; 'whether the height of the desk could be adjusted' and if so, 'whether respondent was able to adjust the height'; 'whether the keyboard was recessed into the workstation'; 'whether the respondent had wrist support at the keyboard'; 'whether there was sufficient space in front of the keyboard to rest the wrist when not keying'; 'whether the screen provided sufficient contrast'; and 'whether the previous screen was tiltable and height adjustable'.

6.6 DESCRIPTION OF RESPONSES TO QUESTION FROM SECTION C (THE PHYSICAL ENVIRONMENT) AND SECTION D (OTHER ACTIVITIES) OF THE STRUCTURED INTERVIEW

There were three environmental factors which fulfilled the criteria outlined in Section 5.8.3 and are presented as the number and percentage for each response in cases and controls in Tables 6.17 to 6.23.

6.6.1 Physical environment

'A disturbing level of noise' was significantly associated with only the Nerve Entrapment and Tendon Disorders syndrome groups. 'Having disturbance from the lighting' was associated with the Shoulder Disorders syndrome group but this was only at the 10% level. This variable was therefore not included in the regression analyses, having only one weakly significant association. However, the strongest association with all syndrome groups was 'other environmental factors', including temperatures, draughts, smells or seasonal changes.

6.6.2 Other activities

Exposure to risk factors from previous jobs or other activities outside the workplace were important to consider in this study. These questions were given priority one status for the regression analysis. 'Having a previous job that involved repetitive movements' was not significantly associated with any of the syndrome groups. In addition, 'having a job outside their present job involving repetitive movements' did not show any strong associations; only the Forearm Pain group at the 10% level suggested a weak association. On the other hand, 'exposure to vibration in work or non-work activities' was strongly associated with all syndrome groups except for the Tendon Disorders syndrome group. The results of the significance tests are given in Summary Table 6D.

Summary Table 6D Summary of significant tests of association for variables from Sections C and D with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-Condylitis	Shoulder Disorders	Fore-arm Pain
Level noise disturbing (Always)	x	x	5	5	x	x	x
Lighting disturbing (Always)	x	x	x	x	x	10	x
Other environmental factors (Yes)	5	5	5	5	5	5	5
Second job repetitive movements (Yes)	x	x	x	x	x	x	10
Exposed to vibration (Yes)	5	5	5	x	5	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
Priority 1 variables are in bold and the responses associated with being a case are in brackets.

Completely non-significant variables are not shown.

6.7 DESCRIPTION OF RESPONSES TO QUESTIONS FROM SECTION E (PERSONAL DETAILS) OF THE STRUCTURED INTERVIEW AND RESPONSES FROM THE ULSQ

Four variables from the personal details Section were found to be related to syndrome groups (Tables 6.24 to 6.30).

6.7.1 Personal details

Wearing some form of glasses or contact lenses was related to three syndrome groups; Nerve Entrapment, Epicondylitis and Forearm Pain at the 5% level. In particular, wearing either bifocals or glasses specifically for VDU work (VDU glasses) was significantly associated with the Epicondylitis and Shoulder Disorders syndrome groups at the 5% level. Smoking cigarettes was significantly associated with all syndrome groups except for the Tendon Disorders group but this may be due to the small numbers in this group. In general, the permanency of employment was not related to any particular syndrome group despite permanent employment approaching statistical significance for Forearm Pain syndrome group. Also, educational level was not significantly related to any of the syndrome groups and so was not considered for the regression analysis.

6.7.2 Illnesses

The questions concerning arthritis (rheumatoid arthritis and osteo-arthritis), were combined to indicate the presence of any type of arthritis and this was significantly related to being a case of Epicondylitis, Shoulder Disorders and Forearm Pain syndrome groups. The questions concerning other types of illness (such as diabetes, thyroid disorders, high blood pressure, obesity, etc.) were also combined to indicate the presence of other relevant medical problems but did not show any significant differences between cases and controls, mainly because of low numbers of responses for these problems, even when combined.

6.7.3 Pregnancy

The responses to the question on pregnancy, 'Were you pregnant at that time?', had to be adjusted to make all men 'not applicable' and all women 'no' or 'yes' even if they felt they were not at risk of becoming pregnant. Since there were only five pregnant women in the study, this variable became a surrogate for the male/female gender variable. The variable was intended to be used to compare pregnant women to other women, but since 60%, (3 of 5), of pregnant women were cases, and 71% of other women were cases, there was little power to detect associations.

6.7.4 Previous injury

When the ULSQ was completed, respondents who had symptoms were asked whether they could relate these to an accident or injury. The positive responses were significantly associated with all the syndrome groups but this comparison is not meaningful as controls could not have given a positive response to this question. However, this information was useful in the regression analysis, in that, regressions were carried out both including and excluding those who related their symptoms to an accident and the results compared.

6.7.5 Length at keyboard without break

Other information concerning the frequency of working was also obtained from the ULSQ. The longest spell at the keyboard without a break was found to be strongly related to all syndrome groups. In addition, there was a linear trend with longer spells being more strongly associated with each syndrome group compared to shorter spells.

The results of the significance tests of association are shown in Summary Table 6E. Variables not included for the regression analyses were the permanency of employment, an indicator for pregnancy, other medical problems, whether their job was full-time or part-time and highest educational qualification.

Summary Table 6E Summary of significant tests of association for variables from Section E and the ULSQ with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-Condylitis	Shoulder Disorders	Fore-arm Pain
Wear glasses or contacts (Yes)	x	x	5	x	5	x	5
Type of eyewear (Bifocals, VDU glasses)	x	x	x	10	5	5	x
Smoke cigarettes (Yes)	x	5	5	x	5	10	5
Rheum. or osteo arthritis (Yes)	x	x	x	10	5	5	5
Accident related to symptoms (Yes)	5	5	5	5	5	5	5
Longest spell at keyboard without a break (positive trend)	5	5	5	5	5	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
Priority 1 variables are in bold and the responses associated with being a case are in brackets.

Completely non-significant variables are not shown.

6.8 DESCRIPTION OF RESPONSES TO THE GROSS POSTURAL VARIABLES OF THE STRUCTURED INTERVIEW

There were 15 postural variables which were found to have differences of response frequency according to the criteria described in Section 5.8.3. The numbers of responses and percentages are presented in Tables 6.31 to 6.37 for cases of each syndrome group compared to controls.

Two variables showed significant associations for four syndrome groups; these were the typing style and a tendency for forceful typing (clacker). In terms of typing style, the proportion of cases who touch type while looking at the text/screen was much greater than the proportion of controls. It is of course possible that people who have the largest amount of keying in their jobs are those who have adopted this typing style, rather than the style being directly related to syndrome groups. This variable was significant at the 1% level for four syndrome groups: Nerve Entrapment, Tendon Disorders, Epicondylitis and Forearm Pain. The tendency to be a clacker also refers to keying, with a much greater proportion of cases having a forceful keying style than controls. There was a difference in response to this question significant at the 10% level for the Any Syndrome group and at the 5% level for the Nerve Entrapment, Shoulder Disorders and Forearm Pain syndrome groups.

Among other variables with differences in response significant at the 5% level for one syndrome group were a higher proportion of cases of Trigger Digit related to shoulder elevation. One finger used more frequently than others was associated with a reduction in odds of being a case in the Epicondylitis syndrome group. Variables with differences only significant at the 10% level included arm abduction, trunk twisted while keying, upper arm flexed, neutral or extended, and undue stretching of digits.

Seven variables were constructed to indicate whether changes in the workstation had occurred between the questionnaire and the structured interview. These variables were used to suggest responses which could be viewed as unreliable due to these postural or furniture changes. Tabulations of responses and syndrome group status were repeated for the 15 variables conditioning on the relevant flag. Tests on the frequencies displayed in these tables were attempted as described above. However, there were often so few responses flagged as reliable that tests were invalid or impossible to complete. This suggests that results with the gross postural variables should be treated with caution. When there were sufficient numbers of reliable and unreliable cases and controls there was little effect on results. The overall results are given in Summary Table 6F.

Summary Table 6F Summary of significant tests of association for Gross postural variables with each syndrome group and significance level

	Any Syndrome	**Trigger Digit**	**Nerve Entrapment**	**Tendon Disorders**	**Epi-condylitis**	**Shoulder Disorders**	**Fore-arm Pain**
L Shoulder elevated (Yes)	x	5	x	x	x	x	x
L arm abducted (Yes)	x	x	x	10	x	x	x
Trunk twisted (Yes)	x	x	x	x	x	10	x
R upper arm flexion (Extended)	x	x	x	10	x	x	x
Undue stretching digits (Yes)	x	x	x	10	x	x	x
Use some fingers more frequently (No)	x	x	x	x	5	x	x
Typing style (touch typist)	x	x	5	5	5	x	5
Tendency to be a clacker (Yes)	10	x	5	x	x	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
Priority 1 variables are in bold and the responses associated with being a case are in brackets. Completely non-significant variables are not shown.

Variables which did not show any significant associations with the syndrome groups or were not Priority 1 variables and therefore not included in the regression analyses were: whether the trunk was inclined while keying; whether the trunk was twisted to the left or to the right, whether the operator leaned to one side; whether the operator was perched on the seat; whether the feet were dangling unsupported; whether there was a dominant keying hand and if so, which hand; whether the hand movements were mirrored; and how often support for the upper and lower back was used.

6.9 DESCRIPTION OF WORK ENVIRONMENT SCALE (WES) VARIABLES

There were 10 Work Environment Scale variables described in Section 5.2.5. For each variable a table was constructed of the continuous response by case or control status overall and for each of the seven syndrome groups. Tests on the mean responses in the cells of each table were completed to examine the differences between the responses of the cases and controls (Tables 6.38 to 6.44).

There were only 7 variables which were found to have differences of response frequency large enough to be significant at least at the 10% level (Summary Table 6G).

There was also a retrospective investigation into the WES variables to see if the psychosocial environment had changed since the original ULSQ had been completed. These questions considered whether the present levels for the ten dimensions of the WES were more, the same or less than before. These were used as flags to see if suggested links between WES scores and syndrome groups differed according to recent changes in environment. These flags were intended to be used as a guide to the interpretation of any WES score and syndrome group associations.

The three variables that did not have significant differences between cases and controls for any of the syndrome groups were scores for Autonomy, Clarity and Control. The variables of Involvement, Supervisory Support and Work Pressure had differences between cases and controls only significant at the 10% level. Differences between WES score values significant at the 5% level were found for the variables Peer Cohesion, Task Orientation, Innovation and Physical Comfort with lower levels in the cases compared to controls. Cases and controls for all of the syndrome groups except Epicondylitis had significant differences in WES score values for the Physical Comfort variable.

It should also be noted that cases tended to have lower mean WES scores for all syndrome groups and all variables except for Work Pressure and Control for the Tendon Disorders, Epicondylitis and Shoulder Disorders syndrome groups. All significant differences between responses had case WES values significantly lower than control WES values. Examination of the full questions suggests that lower WES values for variables other than Work Pressure and Control indicate a less positive perception of the work environment. Higher values given to these two indicate greater time pressure to meet deadlines and greater management control and so a less positive perception of the work environment.

The variable Involvement, had differences significant at the 10% level for the Any Syndrome and Shoulder Disorders groups. The variable Peer Cohesion, had differences significant at the

5% level for the Tendon and Shoulder Disorders groups and at the 10% level for the Any Syndrome group. Supervisory Support had significant differences at the 10% level for the Any Syndrome, Tendon and Shoulder Disorders groups. There were differences in Task Orientation, significant at the 5% level for the Any Syndrome group and Epicondylitis and, at the 10% level, for the Trigger Digit group. Work Pressure only had differences significant at the 10% level for Trigger Digit. The Innovation score had differences significant at the 5% level for the Any Syndrome and Shoulder Disorders syndrome groups and also at the 10% level for the Epicondylitis group. As mentioned above, Physical Comfort had significant differences at the 5% level for almost all of the syndrome groups.

The retrospective investigation flags were then considered. Each flag was linked to a unique variable and indicated whether their attitudes to their environment had become more extreme, less extreme or stayed the same. Tabulations of the mean WES scores were completed for the ten variables as before. Significant differences in the mean values in many tables indicated that people with the lowest WES scores felt that these were now lower than before and those with the highest WES values now felt that these were higher values than before. In other words, individuals are at more extreme positions on the scales than before. For example, those who now have high physical comfort feel that the level of comfort is now higher than it was at the time of completing the ULSQ. Similarly, those with low physical comfort feel it is worse than before. These differences in mean WES values between responses to the change in environment question were often far greater than the differences in WES values between cases and controls. The results of the significance tests are given in Summary Table 6G and all WES variables were considered in the regression analysis as they were all assigned Priority 1 status.

Summary Table 6G Summary of significant tests of association of WES variables with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-Condylitis	Shoulder Disorders	Fore-arm Pain
Involvement (Lower)	10	x	x	x	x	10	x
Peer cohesion (Lower)	10	x	x	5	x	5	x
Supervisory support (Lower)	10	x	x	10	x	10	x
Task orientation (Lower)	5	10	x	x	5	x	x
Work pressure (Lower)	x	10	x	x	x	x	x
Innovation (Lower)	5	x	x	x	10	5	x
Physical comfort (Lower)	5	5	5	10	x	5	5

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
All variables shown are priority 1 and direction associated with being a case shown in brackets.

Completely non-significant variables are not shown.

6.10 DESCRIPTION OF GONIOMETER VARIABLES

There were 16 goniometer variables which are presented in Tables 6.45 to 6.51 in terms of the mean and standard deviations. These variables represent the flexion and extension (up and down) movements of the wrist and the radio-ulnar (side to side) movements of the wrist. These were measured in terms of the angle of the movement and each of these movements were measured over a period of 15 minutes. In order to summarise these, four statistics have been calculated; the median representing the average position of the hand relative to the wrist, the standard deviation representing the spread of movements, and the 1st and 99th percentiles representing the extremes of movements. This gives a total of two wrists by two directions of movement (flexion/extension; radial/ulnar deviation) by four summary measures equal to sixteen variables. Although some of these variables may be correlated, they each represent different aspects of movement of the wrist. For each variable a t-test was carried out on the mean measurements of the cases and controls to see if there was any significant difference between them. A non-parametric statistic was also calculated to be used in situations where the distribution of measurements was clearly not normal. Natural logs were taken of the variables corresponding to standard deviations of measurements since these were highly skewed.

Any changes to the furniture, equipment and environment between the time of completing the ULSQ and the structured interview are likely to affect the goniometer measurements. As with the gross postural variables a binary flag was constructed indicating whether furniture and equipment changes had occurred ('unreliable') or not ('reliable'). Tests were repeated on subgroups which were flagged as reliable and unreliable.

In all the description which follows, in the interests of brevity, each of the sixteen variables are indicated by variable names where RH and LH refer to right hand and left hand respectively, FE refers to flexion and extension, RU refers to radio-ulnar movement, extreme values refer to the first and 99th percentiles. Throughout the tables, positive angles indicate flexion, negative angles extension. Similarly, radial deviation is indicated by negative values, ulnar deviation positive.

Of these 16 variables only 7 showed significant differences between the cases and controls for any of the syndrome groups (without considering reliability). For the variable right hand flexion-extension (RHFE) median cases had significantly larger positive values than controls for the Tendon Disorders syndrome group (indicated by a difference of approximately 5^{o}) and the Epicondylitis group, at the 5% level and the Nerve Entrapment group at the 10% level, indicating that the average positional angle for cases tends to be more flexed compared to controls. Cases in the Tendon Disorders group had larger values of right hand extreme flexion than controls that were significantly different at the 10% level. Values of right hand extreme extension were of significantly (10%) larger magnitude in cases than controls for the Any Syndrome and Shoulder Disorders groups. Values of log transformed RHFE standard deviation were positive and significantly larger at the 5% level in cases than controls for the Tendon Disorders syndrome group. In other words, the spread of positions for the right hand tends to be greater for cases compared to controls. The left hand radio-ulnar (LHRU) median had significantly larger values in cases than controls for the Tendon Disorders and Epicondylitis syndrome groups at the 10% and 5% levels respectively. Cases in the Tendon Disorders syndrome group had significantly larger values of left hand extreme radial deviation than controls at the 10% level. Values of left hand extreme ulnar deviation were of significantly (10%) larger magnitude in cases than controls for the Shoulder Disorders group.

When only the 'reliable' data was considered then only four variables had significant differences in the values found for cases and controls and almost all of these were at the 5% level. The variables were RHFE median, RH extreme extension, LH extreme extension and LH extreme ulnar deviation. The first had significantly larger values for Tendon Disorder cases than controls. The others had negative and significantly larger values for the Any Syndrome group, Shoulder Disorders and Forearm Pain syndrome group cases than the controls. In addition, values of LH extreme extension were also larger for the Epicondylitis syndrome group. Values of RH extreme extension were smaller in cases than controls for the Trigger Digit syndrome group which is in contrast to the differences found for other syndrome groups with this variable.

Investigation of the unreliable data showed that variables RHFE median, RHRU median, RH extreme radial deviation, LHRU median and LH extreme radial deviation had differences between values found for cases and controls which were predominantly significant at the 10% level. The differences in values of RHRU median only related to the Any Syndrome group. Only variable LHRU median had significant differences for the Epicondylitis syndrome group and all other differences were between controls and cases in the Trigger Digit, Nerve

Entrapment and Tendon Disorder syndrome groups. In general, the reliability indicators did not suggest that this altered the differences found between cases and controls. The results of the significance tests are given in Summary Table 6H and, as all goniometer variables were assigned priority one status, all variables were considered for the regression analysis.

Summary Table 6H Summary of significant tests of association of Goniometer variables with each syndrome group and significance level

	Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-Condylitis	Shoulder Disorders	Fore-arm Pain
RHFE Median	x	x	10	5	5	x	x
RH extreme Flexion	x	x	x	10	x	x	x
RH extreme Extension	10	x	x	x	x	10	x
RHFE standard deviation	x	x	x	5	x	x	x
LHRU Median	x	x	x	10	5	x	x
LH extreme radial deviation	x	x	x	10	x	x	x
LH extreme ulnar deviation	x	x	x	x	x	10	x

RHFE - Flexion and extension of the right hand
LHRU - Radio-ulnar movement of the left hand

5 = factors significant at the 5% level
10 = factors significant at the 10% level
x = non-significant factors
All variables shown are priority 1 and positive values of all variables are associated with being a case, except for the 1st percentile where negative values are associated with being a case.

Completely non-significant variables are not shown.

6.11 SUMMARY OF RESULTS FROM INITIAL STATISTICAL ANALYSES

Summary Table 6I shows all risk factors for which at least one statistically significant comparison between cases and controls (at least at the 5% level) was obtained for at least one syndrome group.

Summary Table 6I Summary of significant tests of association (≤ 5%) of all variables with each syndrome group

Risk Factors	Any Synd.	Trigger Digit	Nerve Entra-pment	Tend'n Disord	Epico-ndylitis	Shoul-der Disord	Fore-arm Pain
Gender (female)	✓	-	✓	✓	-	✓	✓
Age (increasing)	✓	-	✓	-	✓	✓	-
No. years experience with keyboard	-	-	✓	-	✓	-	-
No. hours keying per week	✓	✓	✓	✓	✓	✓	✓
No. hrs/wk in 'risky' sports + hobbies	✓	✓	-	-	✓	✓	✓
How info presented (visual + audible)	✓	-	✓	-	✓	✓	✓
Visual means (document holder)	✓	✓	✓	✓	✓	-	✓
Difficulties reading text (yes)	✓	✓	✓	✓	✓	✓	✓
Frustrations with programs (yes)	✓	✓	-	-	✓	✓	✓
Able to take breaks (no)	✓	✓	✓	✓	✓	-	✓
Busy periods (yes)	-	-	-	-	-	✓	-
Specified rate of keying (yes)	✓	✓	✓	✓	✓	✓	✓
Chair: armrests (no)	✓	✓	✓	✓	✓	-	✓
Chair: backrest angle adjustment (no)	-	✓	✓	-	-	-	✓
Chair: upper back support (no)	-	-	-	-	-	-	✓
Any problems with chair? (yes)	✓	✓	✓	-	✓	✓	✓
Footrest (yes)	✓	✓	✓	✓	✓	✓	✓
Use document holder (yes)	✓	✓	✓	✓	✓	-	✓
Detachable keyboard (no)	-	-	-	-	✓	-	-
Tiltable keyboard (no)	✓	✓	✓	-	✓	✓	✓
Screen flicker (yes)	✓	✓	✓	-	✓	✓	✓
Screen swivel (no)	-	-	-	-	-	✓	-
Noise level disturbing (always)	-	-	✓	✓	-	-	-
Other env. factors disturb (yes)	✓	✓	✓	✓	✓	✓	✓
Exposed to vibration (yes)	✓	✓	✓	-	✓	✓	✓
Wear glasses or contacts (yes)	-	-	✓	-	✓	-	✓

Risk Factors	Any Synd.	Trigger Digit	Nerve Entra-pment	Tend'n Disord	Epico-ndylitis	Shoul-der Disord	Fore-arm Pain
Eyewear type (bifocals, VDU glasses)	-	-	-	-	✓	✓	-
Smoke cigarettes (yes)	-	✓	✓	-	✓	-	✓
Rheumatoid or osteo-arthritis (yes)	-	-	-	-	✓	✓	✓
Accident related to symptoms (yes)	✓	✓	✓	✓	✓	✓	✓
Longest spell at k.b. without break (+ve)	✓	✓	✓	✓	✓	✓	✓
Left shoulder elevated (yes)	-	✓	-	-	-	-	-
Use some fingers more frequently (no)	-	-	-	-	✓	-	-
Typing style (touch typist)	-	-	✓	✓	✓	-	✓
Tendency to be a 'clacker' (yes)	-	-	✓	-	-	✓	✓
WES - Peer Cohesion (lower)	-	-	-	✓	-	✓	-
WES - Task Orientation (lower)	✓	-	-	-	✓	-	-
WES - Innovation (lower)	✓	-	-	-	-	✓	-
WES - Physical Comfort (lower)	✓	✓	✓	-	-	✓	✓
Goni - RH Flex/Extension median	-	-	-	✓	✓	-	-
Goni - RH Flex/Extension Stand. Dev.	-	-	-	✓	-	-	-
Goni - LH Rad/Ulnar deviation median	-	-	-	-	✓	-	-

7. PHASE 2: RESULTS OF REGRESSIONS OF SYNDROME GROUP STATUS WITH AGE AND GENDER AND DIFFERENT GROUPS OF EXPLANATORY VARIABLES

Prior to the stepwise regressions with each group of variables as explanatory variables, the relationships between age and gender and the syndrome groups were assessed. These are described first, followed by the results of stepwise regressions undertaken for each of the groups of variables relating to the ULSQ, The Job, Work Equipment, Physical Environment, Other Activities, Personal Details, Posture, Goniometer measures and WES scales, as described in Section 5.8.5.

7.1 RELATIONSHIP BETWEEN SYNDROME GROUPS AND AGE AND GENDER

Each of the syndrome groups was analysed using logistic regression modelling in which the probability of being defined as a case of a syndrome group is related to age and gender. The results of these analyses have been expressed in terms of odds ratios and their 95% confidence intervals which are obtained by taking the exponential of the regression coefficients. The odds ratio expresses the odds of being a case in one group relative to another. If the odds ratio for gender is 2, this suggests that females are twice as likely to be cases as males. For age the odds ratio expresses the increase or decrease in odds due to a ten year increase in age.

7.1.1 Any Syndrome group

Being a case in at least one syndrome group was strongly associated with being female, with 71% of females being cases compared to 58% of males being cases. In the regression modelling this difference was highly statistically significant (Table 7.1) and remained significant on adjusting for age. There was an indication of a trend with increasing probability of being a case with age, although this was only just significant at the 5% level. On adjusting for gender, this trend changed to significance at the 10% level. There was some slight indication of a stronger age effect in women but this difference failed to reach statistical significance. The order of entry of age and gender to the regression model did not have any noticeable effect, as indicated by the interaction term.

7.1.2 Trigger Digit syndrome group

No significant association was noted between Trigger Digit syndrome group and age or gender. In women there were 33% who were cases in this group compared to 26% in men but this difference failed to reach statistical significance (Table 7.2).

7.1.3 Nerve Entrapment syndrome group

There was a significant linear trend of increasing probability of being a case in the Nerve Entrapment syndrome group with age and this difference remained significant on adjusting for gender. There was a marked difference in prevalence of this syndrome group in women (44%) compared to in men (15%). This difference was highly statistically significant and remained significant on adjusting for age (Table 7.3). There was no significant interaction between age and gender for this syndrome group.

7.1.4 Tendon Disorders syndrome group

There was a weak association of this syndrome group with age which did not reach statistical significance. As with the Nerve Entrapment syndrome group there was a large difference in prevalence between women (28%) and men (10%). This difference was statistically significant and remained so on adjusting for age (Table 7.4).

7.1.5 Epicondylitis syndrome group

There was a significant increase in probability of this syndrome group with increasing age and this trend remained significant on adjusting for male-female differences. The prevalence of this group of syndromes was higher amongst women at 31% compared to men at 23% but this difference failed to reach statistical significance (Table 7.5).

7.1.6 Shoulder Disorders syndrome group

There was increasing prevalence of Shoulder Disorders with age and this trend was statistically significant. This result was robust to adjustment for male-female differences (Table 7.6). As in other syndrome groups the prevalence of cases was higher in women (57%) compared to men (41%) and this difference was statistically significant (Table 7.6) and largely unaffected on adjusting for age.

7.1.7 Forearm Pain syndrome group

There was some indication of a weak age effect with increasing probability of being a case with age although not reaching statistical significance at the 5% level. As with other syndrome groups, women were more likely to be cases (55%) compared to men (31%). This difference was statistically significant and remained so after adjusting for age (Table 7.7).

Based on these regression results it was proposed that:

1. Where age and gender were significantly related to the syndrome group at least at the 10% level, analyses would be carried out with these variables forced into the model.

2. Where only one variable showed a significant relationship to the syndrome group, analyses would be carried out with this variable forced into the model.

3. Where neither age nor gender showed a significant relationship to a syndrome group both would be treated on an equal footing with every other variable in the stepwise regression procedure.

Hence, using the above, the following syndrome groups were found to be associated with age and gender and the appropriate adjustments were carried out before the stepwise regression procedure was carried out for each syndrome group as indicated below:

Any Syndrome	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epi-condylitis	Shoulder Disorders	Forearm Pain
Age	-	Age	-	Age	Age	-
Gender	-	Gender	Gender	-	Gender	Gender

7.2 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM THE ULSQ

The first of the clusters of variables to be considered consisted of the variables from the ULSQ. The models constructed during the stepwise procedures for each syndrome group are displayed in tables. Given in each table, for each variable, are the odds ratio and its 95% confidence interval at each step. The p-values of the chi-squared test for improvement on entry of each variable compared to the previous model are also given at each step. Adjusted p-values, calculated on the entry of further variables, refer to t-tests of the regression coefficient divided by its standard error.

Four variables relating to type and frequency of keyboard use were collected at the same time as the administration of the ULSQ. These were:

- the type of keyboard work involved (text or data entry, form filling or conversational mode)
- frequency of keyboard use (less than once a week; 1 to 2 days per week; and 3 or more days per week
- the time spent at the keyboard in a typical day (less than 2 hrs; 2-4 hrs; 4-6 hrs; and 6 or more hrs)
- the longest spell at the keyboard without a break (less than 30 mins; 30-60 mins; 1-2 hrs; more than 2 hrs).

For those who worked less than 3 days per week at the keyboard a dummy category was created for the latter two variables in the regression analyses and, as these are not of primary interest, odds ratios for these categories are not included in the tables. Only 37 subjects worked less than 3 days per week at the keyboard.

Initially, all of the above variables were significantly related to all syndrome groups. The results of the stepwise regressions using the above variables were also identical for all syndrome groups (Tables 7.8 to 7.14), in that the longest spell at the keyboard was significantly related to syndrome group status at the first step. Once this variable entered the models no other variable was significant, suggesting that the longest spell without a break is the most important factor among these keyboard use variables. In addition, a trend was apparent with increasing odds of each syndrome group with increasing length of spell without a break. Although this was significant for all syndrome groups the trend was most marked for the Nerve Entrapment syndrome group with an odds ratio of 6.5 for those having to work for more than 2 hours without breaks compared to those who could have breaks after less than 30 minutes (Table 7.10).

7.3 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM SECTION A (THE JOB) OF THE STRUCTURED INTERVIEW

After initial screening of the variables from Section A of the Structured Interview the following variables satisfied the criteria for inclusion in the regression analyses as described in Section 5.8.3:

- the number of hours per week spent keying
- the number of years working at keyboards (included as a log transformed variable)
- the way in which information for typing was presented (off the top of the head, visually, audibly, or both)
- if this was visually, whether documents were placed flat on the desk, on a document holder or by other means
- if this was audibly, whether from hand held telephone, direct, recording machine, telephone headset or in some other way
- difficulties reading text on documents or screen
- use of a mouse
- frustrating problems with programs
- whether breaks could be taken
- whether there were particularly busy periods
- whether there was a specified rate for keying

The results are described below for each syndrome group.

7.3.1 Any Syndrome group – Section A variables (The Job)

As older age and female gender were related to being a case in the Any Syndrome group, these two variables were forced into the model initially before the stepwise regression proceeded. The results are shown in Table 7.15 in terms of the odds ratio for being a case and the 95% confidence interval along with the p-value on entry to the model. At step zero, females were approximately 50% more likely to be a case than males, while an increase of ten years in age suggests a 20% increase in odds of being a case. At step 1, after adjustment for age and gender, the number of hours per week keying was highly significant with an odds ratio of 1.59 per ten hours increase. This increment is approximately equal to one standard deviation from the distribution of hours keying. It is noticeable that on entry of this variable gender was no longer significant and remained so in all subsequent steps meaning that females tended to have greater number of hours keying per week compared to males. On the other hand, age became more significant as other variables entered the model.

The second variable to enter was an indicator for those experiencing difficulties with programs with roughly a doubling of odds if this was the case. Similarly, difficulties reading text from documents or on screen was also associated with a doubling of odds of being a case in the Any Syndrome group.

Following this, having a specified rate for keying was significant overall, but this was mainly due to the subgroup who had jobs for which this question was not relevant. Having information presented audibly *via* a hand held telephone was significantly related to increased odds of being a case. In general, the odds ratios did not alter greatly on addition of new variables at each step, suggesting that these variables have independent associations with being a case.

7.3.2 Trigger Digit syndrome group – Section A (The Job)

Only one variable entered on the implementation of the stepwise procedure for this syndrome group. Increased hours of keying per week was significantly associated with increased odds of being a case in the Trigger Digit syndrome group. As age and gender were not significantly related to this syndrome group, they were not considered in the regression model (Table 7.16).

7.3.3 Nerve Entrapment syndrome group – Section A (The Job)

Both older age and being female were significantly associated with this syndrome group and so were entered first before the stepwise procedure began (Table 7.17). Females were almost four time more likely than males to be a case, while an increase in age of ten years was associated with an increase of odds of 42% for the Nerve Entrapment syndrome group.

As with the Any Syndrome group, the number of hours per week entered the model first with an odds ratio close to two for a ten hour increase. It was noticeable that on entry of this variable that the odds ratio for gender dropped to about three but still remained statistically significant. Hence, although gender had some effect on hours spent keying, both gender and the number of hours keying had significant associations with the Nerve Entrapment syndrome group, independently of each other.

Having a specified rate for keying entered next which, although giving overall significance, the specific comparison of those who had a specified rate to those who did not just failed to reach statistical significance. The next two variables to enter, having frustrating problems with programs and having difficulties reading text were associated with an approximate doubling of odds. Finally, for those with information presented audibly, using a hand held telephone was associated with being a case but just failed to reach statistical significance, although the variable overall was significant.

7.3.4 Tendon Disorders syndrome group – Section A variables (The Job)

As described earlier (Section 7.1.4) age was not significantly related to this syndrome group. Women were three times more likely than men to be a case in the Tendon Disorders syndrome group. After adjustment for gender, the number of hours keying per week was significantly related to being a case. The specified rate of keying variable was significant next, but this was mainly due to the category of individuals to whom this question was not applicable. Finally, having difficulties reading text was significantly associated with being a case of this syndrome group (Table 7.18).

7.3.5 Epicondylitis syndrome group – Section A variables (The Job)

For this syndrome group age was associated with an increase in odds of 70% per ten years, while gender was not significantly related to this syndrome group (Table 7.19). Unlike other syndrome groups, having difficulties reading text entered the regression model first with a highly significant increase in odds of about five. The number of hours per week keying entered next, which reduced the odds ratio for difficulties with reading but this still remained highly statistically significant. Those who were presented with information audibly *via* a hand held telephone were also associated with being a case in this syndrome group. Finally, those who had frustrating problems with programs were about three times more likely to be a case in the Epicondylitis syndrome group.

7.3.6 Shoulder Disorders syndrome group – Section A variables (The Job)

Older age was highly significantly related to being a case in the Shoulder Disorders syndrome group, while being female was also associated with this syndrome group (Table 7.20). The first variable to enter in the stepwise procedure was having problems with programs with an odds ratio of about two. Having a specified rate of keying was also significantly related to being a case with an increase of about 5 in the odds relative to those who had no specified rate. On entry of this variable, being female was no longer significantly related to being a case in the Shoulder Disorders syndrome group. Having information conveyed *via* a hand held telephone was related to being a case. Next, having difficulties reading text entered the model. Finally, the variable indicating how visual information was presented was just significant overall, but having a document holder compared to those reading documents flat on the desk just failed to reach statistical significance. The number of hours per week keying was not significantly related to this syndrome group, unlike many of the other syndrome groups.

7.3.7 Forearm Pain syndrome group – Section A (The Job)

Cases in the Forearm Pain group were significantly more likely to be female than male, while age was not significantly related to this syndrome group (Table 7.21). The first variable to enter was the number of hours per week keying with an odds ratio of 1.66 per ten years increase. On addition of this variable, gender became less significant although still just significant at the 5% level. The next variable to enter was having difficulties reading text which was significantly associated with a doubling of odds relative to those who had no difficulties. The ability to take breaks reduced by 60% the odds of being a case in the Forearm Pain syndrome group. The last variable to enter was having difficulties with programs.

7.4 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM SECTION B (WORK EQUIPMENT) OF THE STRUCTURED INTERVIEW

Section B contained questions on work equipment and all were categorical in nature, that is, most were Yes/No responses for the presence of a piece of equipment as described in Section 5.2.2. Information was obtained for current equipment if this had not changed and also for equipment used at the time of administration of the ULSQ if these had changed. For the purposes of the regression analyses all variables used refer to equipment <u>at the time</u> the ULSQ was completed.

The following variables met the criteria for selection (Section 5.8.3):

- any problems with the chair
- whether the chair had armrests
- whether seat height could be adjusted
- availability of backrest angle adjustment
- support for upper back

- possession of a foot rest
- possession of a document holder
- having a detachable keyboard
- a tiltable keyboard
- ability to swivel the screen
- screen flicker

7.4.1 Any Syndrome group – Section B variables (Work Equipment)

After adjustment for age and gender, the presence of previous screen flicker was strongly associated with being a case in the Any Syndrome group with an odds ratio of about four (Table 7.22). Following this, any problem with the chair was significant with those with a problem being twice as likely to be a case in the Any Syndrome group. On entry of this variable, age became more significant (initially it was only significant at the 10% level), suggesting an association between age and having problems with the chair. At the next step, possession of a document holder was significantly associated with being a case, with an odds ratio of about three. Possession of a footrest was also significantly associated with being a case while having support for the upper back was also significant with a 44% reduction in odds.

7.4.2 Trigger Digit syndrome group – Section B variables (Work Equipment)

Having any problem with the chair was strongly associated with membership of the Trigger Digit syndrome group with an odds ratio of around four (Table 7.23). Secondly, possession of a document holder entered the model, with those having a holder six times more likely to be a case compared to those without. Next, previous screen flicker was significantly associated with being a case, also with an odds ratio of about six. Possession of a footrest entered next followed by backrest angle adjustment; the latter significantly associated with a reduction in odds of 56% for the Trigger Digit syndrome group.

7.4.3 Nerve Entrapment syndrome group – Section B variables (Work Equipment)

The first variable to enter the stepwise regression was again having problems with the chair, with those having problems three times more likely to be a case in the Nerve Entrapment syndrome group (Table 7.24). This was followed by possession of a document holder, and screen flicker, both of which were associated with being a case. Having a backrest angle adjustment entered next, and was associated with a reduction in odds. Possession of a footrest was significantly associated with being a case, while the last variable to enter, support for the upper back, was significantly associated with a reduction in the odds. The odds ratios did not change greatly at each step indicating that these variables had independent associations with membership of the Nerve Entrapment syndrome group.

7.4.4 Tendon Disorders syndrome group - Section B variables (Work Equipment)

After adjusting for gender, having a document holder entered the model with those possessing a holder almost five times more likely to be a case. Following this, one more variable entered the model, having support for the upper back was significantly related to a reduction in odds of 72% of being a case in the Tendon Disorders syndrome group (Table 7.25).

7.4.5 Epicondylitis syndrome group - Section B variables (Work Equipment)

After adjustment for age, having problems with the chair was the first variable to enter the model followed by possession of a document holder (Table 7.26). Following this, having had flicker on the screen was significantly associated with this syndrome group with an odds ratio of five. Next, those who had a detachable keyboard were 88% less likely to be a case and finally support for the upper back was also significantly associated with a reduction in odds of being a case.

7.4.6 Shoulder Disorders syndrome group - Section B variables (Work Equipment)

After adjustment for age and gender, screen flicker was significantly associated with being a case in the Shoulder Disorders syndrome group (Table 7.27). This variable entered first, followed by having problems with the chair, which had tended to be the first variable selected for other syndrome groups. Following this, possession of a footrest was significantly associated with a doubling of the odds of being a case. Finally, the ability to swivel the screen was associated with a 48% reduction in odds for membership of the Shoulder Disorders syndrome group.

7.4.7 Forearm Pain syndrome group - Section B variables (Work Equipment)

As with most of the syndrome groups, having problems with the chair was strongly related to being a case of this syndrome group with an approximate doubling of the odds (Table 7.28). Possession of a document holder entered secondly, with an odds ratio of about three. Next, having support for the upper back was significantly associated with a reduction of 54% in odds, followed by possession of a footrest which was significantly associated with increased odds. Finally, having the ability to adjust the backrest angle was significantly associated with a reduction in odds of 42%.

7.5 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM SECTION C (PHYSICAL ENVIRONMENT) OF THE STRUCTURED INTERVIEW

The variables which satisfied the inclusion conditions for the stepwise regressions were:

- the level of disturbance due to noise in the office
- the presence of other environmental factors (such as temperature, draughts and excluding lighting) which caused disturbance.

The regression tables for these variables are presented in Tables 7.29 to 7.35.

The indicator of other environmental factors such as temperature and draughts was significantly related to being a case in the Any Syndrome group with an approximate doubling of odds compared to those not disturbed. This variable was also significant for the Trigger Digit, Epicondylitis, Shoulder Disorders and Forearm Pain syndrome groups.

Only the Tendon Disorders and Nerve Entrapment syndrome groups showed a relationship with noise disturbance. Those who indicated always being disturbed by noise were significantly more likely to be cases than those who were never disturbed by noise (Tables 7.31 to 7.32).

7.6 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM SECTION D (OTHER ACTIVITIES) OF THE STRUCTURED INTERVIEW

The variables which satisfied the inclusion conditions were:

- having a previous job with repetitive movement
- having a second job with repetitive movement
- the number of hours of risky sports/activities
- having previous work or non-work exposure to vibration.

A log transformation of the number of hours of risky sports was carried out before entry in the stepwise procedure because of the positive skewness of the distribution.

The regression models selected by runs of this procedure are given in Tables 7.36 to 7.42 for each syndrome group. The p-values given are the p-values prior to entry into the model.

No significant relationships with other jobs with repetitive movement either in a previous job or in a current second job were found with any of the syndrome groups.

7.6.1 Any Syndrome group – Section D variables (Other Activities)

Having at least one syndrome group was strongly associated with being female with females twice as likely to have a syndrome group as males. After allowing for gender differences cases were related to greater hours of risky activities and past or present exposure to vibration. The regression procedure revealed no significant relationship with age, after having adjusted for the number of hours of risky sports or hobbies.

7.6.2 Trigger Digit syndrome group – Section D variables (Other Activities)

There was a strong association between hours of risky activities and being a case in the Trigger Digit syndrome group which was significant at the 5% level (Table 7.37).

7.6.3 Nerve Entrapment syndrome group – Section D variables (Other Activities)

Allowing for the differences due to age and gender, exposure to vibration was highly significantly related to the Nerve Entrapment syndrome group (Table 7.38).

7.6.4 Tendon Disorders syndrome group – Section D variables (Other Activities)

For the Tendon Disorders syndrome group, once the differences between males and females were taken into account, the relationship between increased hours of risky activities and being a case was significant at the 5% level (Table 7.39).

7.6.5 Epicondylitis syndrome group – Section D variables (Other Activities)

Table 7.40 shows a strong relationship between case status in the Epicondylitis syndrome group and exposure to vibration. There was also a weaker relationship between being a case and greater hours of risky activities, significant at the 10% level, which is not included in Table 7.40.

7.6.6 Shoulder Disorders syndrome group – Section D variables (Other Activities)

There was a strong relationship between hours of risky activities and being a case in the Shoulder Disorders syndrome group which was significant regardless of the presence of other variables (Table 7.41). Females were 2.3 times more likely to be cases and there was a strong association between increasing age and cases. The relationship between being a case and exposure to vibration was just not significant at the 5% level after age and gender were included.

7.6.7 Forearm Pain syndrome group – Section D variables (Other Activities)

There was a strong relationship between hours of risky activities and being a case in the Forearm Pain syndrome group, after adjusting for gender. In addition, exposure to vibration was significantly related to this syndrome group. Females were 4 times more likely to be cases than males.

7.7 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS FOR VARIABLES FROM SECTION E (PERSONAL DETAILS) OF THE STRUCTURED INTERVIEW

There were four variables which were significant and suitable for inclusion in the modelling procedure. These were:

- wearing glasses or contact lenses for VDU work
- if worn, were these contact lenses, glasses, bifocals or VDU glasses
- smoking cigarettes
- presence of any type of arthritis

7.7.1 Any Syndrome group – Section E variables (Personal Details)

Being a case in the Any Syndrome group was associated with being female, smoking cigarettes or having arthritis. There was also a relationship between increasing age and being a case, but this was only significant at the 10% level, after adjusting for other variables. After the inclusion of age in the model, the relationship with arthritis was just significant at the 5% level (Table 7.43), as these two variables were correlated.

7.7.2 Trigger Digit syndrome group – Section E variables (Personal Details)

Cases in the Trigger Digit syndrome group were associated with smoking cigarettes and the presence of arthritis (Table 7.44). It should be noted that only 7 of the cases and controls for this syndrome group had arthritis and hence the very wide confidence interval for the odds ratio.

7.7.3 Nerve Entrapment syndrome group – Section E variables (Personal Details)

Both increasing age and being female were strongly associated with being a case in the Nerve Entrapment syndrome group. Smoking cigarettes or wearing glasses or contact lenses were related to being a case, but this relationship was only significant at the 10% level once age and gender had been taken into account. Therefore it did not enter the model in the stepwise procedure and no table is presented for the Nerve Entrapment syndrome group.

7.7.4 Tendon Disorders syndrome group – Section E variables (Personal Details)

Both smoking cigarettes and the presence of arthritis were associated with being a case in the Tendon Disorders syndrome group. However these links were only significant at the 10% level once the relationship with gender had been taken into consideration and so are not presented here.

7.7.5 Epicondylitis syndrome group – Section E variables (Personal Details)

The final model for cases in the Epicondylitis syndrome group included the presence of arthritis and smoking cigarettes. Once the relationship between increasing age and being a case had been taken into account, there was no significant link with wearing glasses or contact lenses. Eye strength decreases with age so the eye wear variable was probably acting as a surrogate for age (Table 7.45).

7.7.6 Shoulder Disorders syndrome group – Section E variables (Personal Details)

Both increasing age and being female were strongly associated with being a case in the Shoulder Disorders syndrome group and were selected for inclusion in the model. The presence of arthritis was also related to being a case. Smoking cigarettes was related to being a case, but this relationship became non significant once age and gender had been taken into account (Table 7.46).

7.7.7 Forearm Pain syndrome group – Section E variables (Personal Details)

As with many other syndrome groups, females were more likely to be cases in the Forearm Pain syndrome group. After adjusting for gender, the presence of arthritis was related to being a Forearm Pain case, but only at the 10% level.

7.8 RESULTS OF REGRESSION ON SYNDROME GROUP STATUS WITH THE GROSS POSTURAL VARIABLES AS EXPLANATORY VARIABLES

A number of variables satisfied the criteria outlined in Section 8.8.3 in relation to postural observations:

- touch typing while looking at the screen
- touch typing while looking at the keyboard
- a hunt and peck style
- tendency to be a clacker (forceful keying)
- having the trunk twisted while keying
- having the shoulder elevated while keying.

In the stepwise regression procedure a number of variables were significant at the 10% level for all syndrome groups. However, only two syndrome groups showed significant results at the 5% level; the Epicondylitis and the Shoulder Disorders syndrome groups.

7.8.1 Epicondylitis syndrome group – Section F variables (Gross Posture)

After adjusting for age, those who touch typed while looking at the screen were significantly more likely to be cases in the Epicondylitis syndrome group compared to touch typists who look at the keyboard and those who hunt and peck. This is likely to be an indicator for experienced high intensity keyboard workers who would tend to be touch typists (Table 7.47). Having the right shoulder elevated was also significantly related to being a case of this syndrome group, after adjustment for typing style.

7.8.2 Shoulder Disorders group – Section F variables (Gross Posture)

After adjustment for age and gender, having the trunk twisted was significantly related to a reduced odds of being a case in the Shoulder Disorders syndrome group. A tendency to be a clacker was also significantly related to this syndrome group with approximately a doubling of the odds (Table 7.48).

7.9 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS WITH WES VARIABLES AS EXPLANATORY VARIABLES

The WES variables consisted of scores relating to attitudes to different aspects of the work environment. There were ten of these variables relating to perception of:

- involvement
- peer cohesion
- supervisory support
- autonomy
- task orientation
- work pressure
- clarity
- control
- innovation
- physical comfort.

Low values of most of these variables suggested that the perceived standard was low. For instance a low numerical value of physical comfort indicated generally uncomfortable furniture and an unpleasant office environment.

Ratings of the work environment at the time of the original symptoms questionnaire (ULSQ) would have been the most useful information. However, variables were available which indicated whether perception values had stayed the same, decreased or increased between the original symptoms questionnaire and the application of the field package. The models found by the stepwise procedure using only the WES variables were tested to see if the introduction of any interaction term which took account of this change in rating would give additional distinction between cases and controls. None of these interaction terms were found to be significant. This would suggest that there was no great difference in distinguishing cases and controls of a syndrome group between individuals whose ratings had remained at a particular value, fallen to that value or risen to that value in the intervening period.

7.9.1 Any Syndrome group – Section G variables (WES)

Being a case in the Any Syndrome group was strongly independently related to perception of task orientation and physical comfort. The odds of 0.73 for task orientation suggested that, after adjusting for age and gender, individuals with about one standard deviation (15 units) lower values of task orientation ('emphasis on hard work') were more likely to be cases (Table 7.49). In addition, those who gave a low value of physical comfort were more likely to be cases. An increase of 15 units was used for these scales as this corresponded to approximately one standard deviation for all of these scores.

7.9.2 Trigger Digit syndrome group – Section G variables (WES)

Being a case in the Trigger Digit syndrome group was related to having lower values of physical comfort and lower values of work pressure (Table 7.50). There was a significant interaction term indicating a non-additive effect of change in values of these two variables. The increase in chance of being a case with lower values of physical comfort was much smaller with higher values of work pressure and similarly the increase in chance with lower values of work pressure was much smaller with higher values of physical comfort. Therefore if both of these values were low then the chance of being a case was higher than their additive effects.

7.9.3 Nerve Entrapment syndrome group – Section G variables (WES)

Being a case in the Nerve Entrapment syndrome group was very strongly related to being female with females 4.5 times more likely to be cases as males. There was also an age effect with older individuals having an increased chance of being cases. In addition, lower values of physical comfort were associated with suffering from this syndrome group (Table 7.51).

7.9.4 Tendon Disorders syndrome group – Section G variables (WES)

The model for the Tendon Disorders group showed that females were 3.8 times more likely to be cases. Also related to being a case were lower values of peer cohesion, i.e. poor support and friendliness from colleagues (Table 7.52).

7.9.5 Epicondylitis syndrome group – Section G variables (WES)

Epicondylitis cases were more common in older workers and there was no significant gender relationship. Workers with lower perceived task orientation ('emphasis on hard work') had greater chance of being cases (Table 7.53).

7.9.6 Shoulder Disorders syndrome group – Section G variables (WES)

Shoulder Disorders cases were more common in older workers and there was a significant gender relationship. Workers with lower values of physical comfort had a greater chance of being cases. There was also a weak relationship between lower perceived emphasis on hard work and cases, which was only significant at the 10% level and therefore did not enter the model in the stepwise procedure (Table 7.54).

7.9.7 Forearm Pain syndrome group – Section G variables (WES)

There was a strong relationship between being female and being a case in the Forearm Pain syndrome group with females 2.7 times more likely to be cases. There was also a significant link between lower values of physical comfort and cases (Table 7.55).

The correlations of the WES variables with each other were examined and were, in several cases, higher than would be desirable in this type of regression modelling procedure. A multivariate method of Principal Components Analysis (PCA) was used to provide a smaller number of alternative variables. These were used in the modelling procedure to attempt to explain more of the differences between cases and controls than could be explained using the larger number of original WES variables. However, when this was carried out some of the groupings of variables were not easily interpretable and in any case, did not give any more information than contained in the individual variables and so this procedure was not used in the regression analyses.

7.10 RESULTS OF REGRESSIONS ON SYNDROME GROUP STATUS WITH GONIOMETER MEASUREMENTS AS EXPLANATORY VARIABLES

The goniometer variables consisted of measurements of movement of the subject's wrists during a short period at the keyboard. For flexion and extension of the wrist a negative reading on the goniometer indicated flexion which meant that the hand was at an angle to the wrist and below a line extending beyond the forearm and in its direction. Radial and ulnar deviation was movement in the horizonal plane with radial towards the thumb and ulnar away from it. For the right hand radial deviation was positive and for the left hand ulnar deviation was positive. The variables which were analysed for each hand and in each of the two planes of movement were the median reading, the 1st and 99th percentiles and the standard deviation. The median was a measure of the most usual wrist position and the standard deviation was a measure of the range of movements of the wrist for an individual during the observation period. The 1st and 99th percentiles were chosen to give a measure of extreme positive and negative wrist positions during the period.

The median and standard deviation variable values were easy to interpret, however the percentiles were not as simple. A low value of the 1st percentile of the flexion/extension reading indicated a more negative, i.e. extreme, position. This would suggest a hand position at a large vertical angle to the forearm and below the line extending from the forearm. A high value of the 99th percentile of the flexion/extension indicated more positive, i.e. more extreme, vertical angle of the hand to the forearm and position above the line extending from the forearm.

Only one syndrome group showed significant associations with any of the goniometer variables. There was a strong relationship between cases in the Tendon Disorders syndrome group and being female. Once this had been taken into account, the other significant relationships with cases were higher values of RH flexion/extension median, RH flexion/extension standard deviation and lower values of LH flexion/extension 99th percentile (the latter was only significant at the 10% level). No interactions were found between gender and any of these variables. As can be seen from Table 7.56, only the first of these variables entered into the logistic regression. No interactions were found with the reliability flag for the goniometer variables, indicating that the relationship of these variables with the Tendon Disorders syndrome group did not differ in subjects where furniture changes had occurred since completing the ULSQ compared to subjects who indicated no furniture change.

It was noted that the amount of time spent keying varied greatly between individuals and also between left and right hands for the same individual. An additional pair of indicators were used to give an indication of the amount of time spent keying for each hand. The percentage of time spent keying and in other interactive activities (such as mouse use) was summed to give the percentage of time spent in computer interaction for each hand during the goniometer recording period.

These answers were not available for the first 44 individuals surveyed. Estimates of the answers which would have been obtained for each individual were made using video recordings of 2-3 minutes of the goniometer measurement period. The estimates were judged to within bands of 20% so that they formed a five point scale: less than 20%, 21-40%, 41-60%, 61-80% and more than 81% of time spent in data entry. The answers given for the rest of the individuals were similarly classified so that a total of 442 individuals had five point information available on the use of each hand for data entry. This new information was stored as 'entry left' and 'entry right' and was made available to the modelling procedure. There were small numbers of individuals with small percentages of time entering data with the right hand so the less than 20% and 20-40% bands were pooled for entry right.

It was clear that mean values of some of the goniometer variables were different for the 5 different levels of entry left or right. The strongest trends were an increase in mean RH flexion/extension 1st percentile and decrease in mean LH flexion/extension standard deviation with increasing entry right and increase in mean LH flexion/extension 1st percentile with increasing entry left. Neither entry right nor entry left were selected as main effects in the modelling procedure. No interactions of either term with any of the relevant goniometer variables were found for the Tendon Disorders syndrome group.

The modelling was repeated with one variable forced into the model as well as the age and gender variables which had previously been selected. The goniometer variables which had been in the model for the Tendon Disorders syndrome group were still significant after taking account of the effects of gender and entry right or gender and entry left.

The variables entry left and entry right had a correlation coefficient of 0.53. This would suggest that it would not be sensible to force both these terms into a model since they give very similar information. The goniometer variables also had quite high correlation coefficients and so the models obtained should be viewed with some caution.

7.11 RESULTS OF REGRESSIONS USING ALL SIGNIFICANT VARIABLES FROM GROUPS SIMULTANEOUSLY

Following the stepwise regressions for each group of variables separately, those variables which entered the model at the 5% level were considered in a stepwise procedure together. This gave a final model for each of the syndrome groups.

7.11.1 Any Syndrome Group

The variables which were found to be significantly related to being a case in the Any Syndrome group from each of the group regressions were:

Section A

- presentation of audible information (hand held telephone)
- experiencing difficulty reading text on screen or documents
- frustrating problems with programs
- specified rate for keying
- number of hours keying per week

Section B

- having problems with the chair
- support for the upper back on chair
- having a footrest
- use of a document holder
- previous screen flicker

Section C

- Other environmental factors (temperature, draughts, etc.)

Section D

- Number of hours risky sports or hobbies (log transformed)

Section E

- Cigarette smoking
- rheumatoid or osteo-arthritis;

ULSQ

- longest spell at the keyboard without a break

Gross Postures

none

WES scales

- task orientation
- physical comfort

Goniometer

none

Considering all significant variables from the group analyses in relation to being a case in the Any Syndrome group simultaneously, and adjusting for age and gender, the first variable to enter was the number of hours per week spent keying with an odds ratio of 1.83 (95% C.I. = 1.43, 2.33) for a 10 hour increase. This relationship is illustrated in Figure 7.1. This implies a reduction in odds of 45% (95% C.I. = 30%, 57%) for a 10 hour decrease in keying hours per week. This variable was related to many other variables under consideration. Of these, it was noticeable that the significance of the longest spell at the keyboard without a break was reduced from $p < 0.0001$ to $p = 0.01$ and became non-significant in subsequent steps. Having a high number of hours of keying per week is related to having longer spells at the keyboard without a break (Table 7.57), that is, both are measures of intensity of working.

In addition, gender was no longer significant at the 5% level on addition of the number of hours keying per week. Females were more likely to have longer hours keying with a mean of 18.3 hours (SD = 11.4) per week compared to a mean of 13.4 hours (SD = 8.7) per week in males. The difference between cases and controls in the number of hours was greater in females compared to males but the interaction term did not reach statistical significance ($p = 0.09$).

The second variable to enter was screen flicker which was associated with being a case. This was more likely to be a marker for low status jobs and poor equipment rather than a causal effect. Having frustrating problems with programs and difficulties reading text from the screen entered next. A high number of hours spent on risky sports or hobbies was associated with being a case in the Any Syndrome group and, adjusting for this factor, the variables related to keying behaviour and equipment still remained highly significant. A low level of task orientation was associated with being a case, followed by cigarette smoking, having a specified rate of keying, having any problems with the chair, having a footrest and having audible information presented *via* a hand held telephone. It is likely that having a footrest does not cause symptoms but may be a result of symptoms or alternatively it may be a marker for an intensive mode of working. The results are given in Summary Table 7A.

When having any problem with the chair was excluded from the stepwise procedure, support for the upper back replaced it and was significantly associated with a reduction in odds of being a case. Thus, the variable 'any problems with the chair' may mask the more specific problem, which for the Any Syndrome group, was support for the upper back.

When those subjects who were identified as relating their symptoms to an accident or injury were excluded from the analysis, effectively reducing the number of cases and hence reducing the power of statistical tests, the order in which variables entered the model was very similar with minor differences. One exception was the number of hours spent on risky sports or hobbies which was only significant at the 10% level when these subjects were excluded. This suggests that the relationships between keying behaviour, equipment and psychosocial factors and being a case in the Any Syndrome group were robust.

In addition, the stepwise regressions were repeated separately for those defined as having non-severe symptoms and those with severe symptoms. As roughly one third were defined as having severe symptoms the power to detect associations would be reduced. Despite this, in order of entry, experiencing difficulties reading text, longest spell at the keyboard, arthritis, the number of hours of risky sports/hobbies, physical comfort and smoking entered the model for those with severe symptoms. The number of hours keying was not as significant ($p = 0.01$) for this subset as with the full sample, and was replaced in the regression model by the longest spell at the keyboard. It is likely that those having severe symptoms would not be able to key for long hours and hence the reduction in significance of this variable. In the non-severe subset, the results were very similar to those for the total sample. However, age was no longer significant as this subset would tend to be younger, while the number of hours keying was more significant. The number of hours in risky sports/hobbies, although still significant in the non-severe subset entered the model later at step 8 in the stepwise procedure.

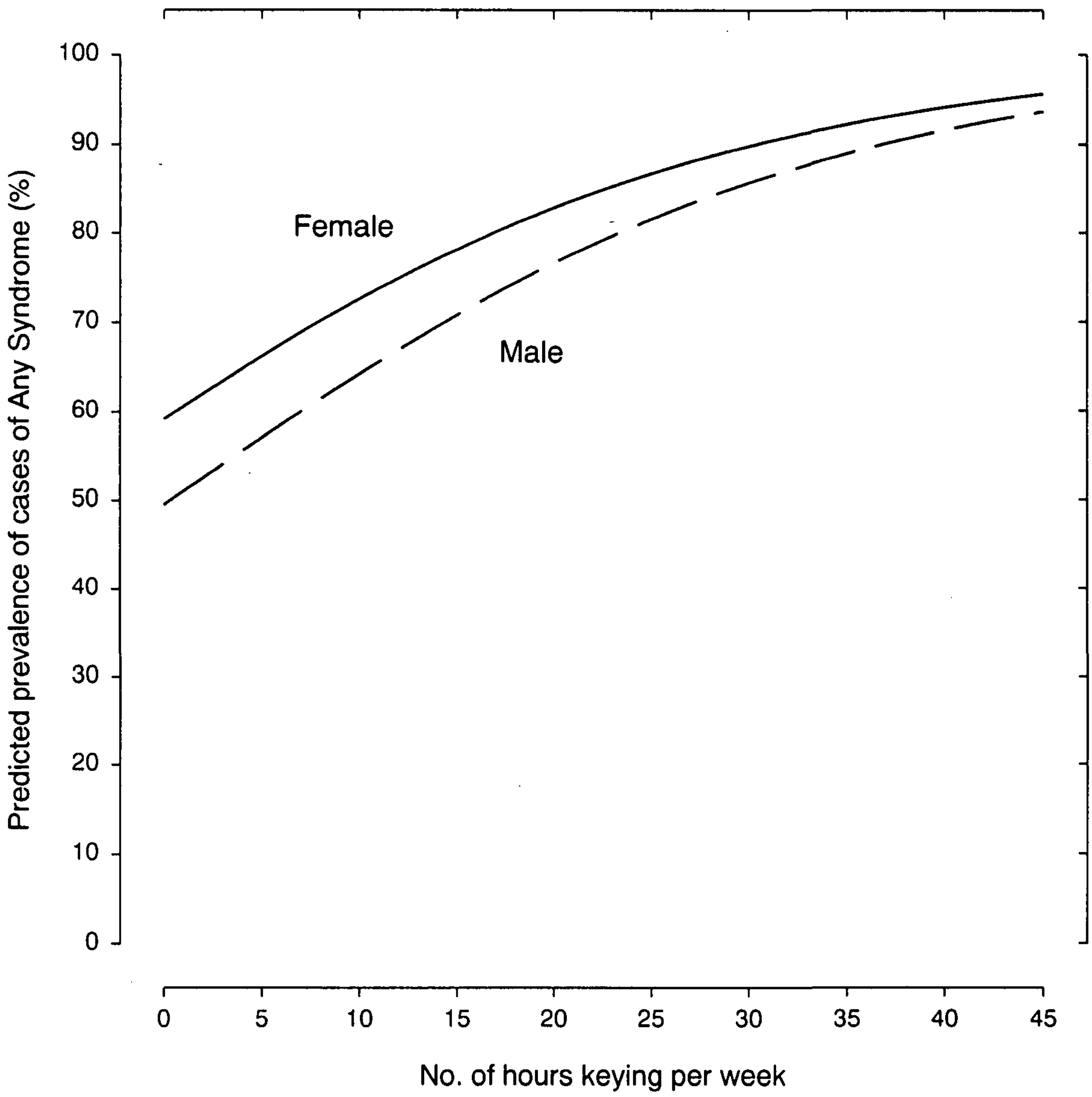

Figure 7.1
Relationship between length of time spent keying per week and prevalence of Any Syndrome

Summary Table 7A Order of entry in stepwise regression on case status in the Any Syndrome group adjusted for age and gender; Odds ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Age (+ 10 years)	1.42 (1.10, 1.84)	Forced in
0	Gender (Female)	1.60 (0.89, 2.86)	Forced in
1	No. hrs/week keying (+ 10 hrs)	2.01 (1.45, 2.80)	1
2	Previous screen flicker (Yes vs No)	4.16 (1.82, 9.50)	3
	(Not applicable vs No)	1.10 (0.57, 2.12)	
3	Frustrating problems with progs (Yes vs No)	2.08 (1.22, 3.56)	2
4	Experience diffs reading text (Yes vs No)	2.03 (1.11, 3.70)	4
5	No. hrs/week risky sports or hobbies (+ 1 log scale)	1.50 (1.14, 1.96)	10
6	Task orientation score (+ 15 units)	0.70 (0.53, 0.91)	5
7	Smoke cigarettes	3.10 (1.52, 6.30)	7
8	Specified rate of keying (Yes vs No)	1.39 (0.43, 4.51)	6
	(Not applicable vs No)	4.80 (1.63, 14.1)	
9	Problems with chair (Yes vs No)	2.09 (1.20, 3.63)	8
10	Having a footrest (Yes vs No)	2.26 (1.23, 4.17)	11
11	Audible presentation (Hand held telephone*)	5.43 (1.32, 22.4)	
	(Telephone headset*)	1.08 (0.19, 6.13)	
	(Other*)	1.30 (0.44, 3.82)	9

*Comparison group consists of those who received audible information direct or from a recording machine.

7.11.2 Trigger Digit Syndrome Group

The variables which were found to be significantly related to membership of the Trigger Digit syndrome group from each of the group regressions were:

Section A
- The number of hours keying per week

Section B
- having problems with the chair
- backrest angle adjustment on chair
- having a footrest
- use of a document holder
- screen flicker

Section C
- Other environmental factors (temperature, draughts, etc.)

Section D
- Number of hours risky sports or hobbies (log transformed)

Section E
- Cigarette smoking
- rheumatoid or osteo-arthritis

ULSQ
- longest spell at the keyboard without a break

Gross Postures
none

WES scales
- work pressure
- physical comfort

Goniometer
none.

A high number of hours per week keying was also highly significantly related to the Trigger Digit syndrome group as with the Any Syndrome group. In a similar pattern to the Any Syndrome group the relationship between the longest spell at the keyboard without a break and the Trigger Digit syndrome group became non-significant when the hours keying per week was taken into account. In addition, there was a significant gender interaction with the number of hours keying per week ($p = 0.004$). When this was added to the model, gender became significant despite showing a non-significant relationship with the Trigger Digit syndrome group on univariate analysis. Table 7.58 shows that the difference in the number of hours keying between cases and controls is greater in males compared to females. Females generally have higher keying intensity than males even in the controls and hence the rise to values associated with being a case (mean = 22 hours/week) is shorter in females.

Next, smoking cigarettes was again related to being a case. Following this, the number of hours spent in risky sports and hobbies was strongly related to this syndrome group, as was screen flicker. Having a low level of physical comfort was associated with this syndrome group. Problems with the chair was significantly related to this syndrome group as was having a document holder. These variables remained significant as later variables were entered suggesting independent relationships with the Trigger Digit syndrome group.

On excluding those who associated their symptoms with an accident or injury, the procedure gave a similar order of entry of variables. As with the procedure with the Any Syndrome group the number of hours in risky sports or hobbies became non-significant at the 5% level but was selected at the 10% level. These significant findings are given in Summary Table 7B.

Summary Table 7B Order of entry in stepwise regression on the Trigger Digit syndrome group (adjusted for gender) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
1	No. hrs/week keying (+ 10 hrs)	49.5 (5.91, 414)	1
2	Gender (Female)	23.0 (2.46, 214)	Forced in
3	Gender by number hours keying interaction	0.17 (0.05, 0.53)	Forced in
4	Smoke cigarettes (Yes vs No)	5.93 (2.03, 17.3)	3
5	No. hrs/week risky sports or hobbies (+ 1 log scale)	2.02 (1.26, 3.26)	7
6	Previous screen flicker (Yes vs No)	5.41 (1.56, 18.7)	2
	(Not applicable vs No)	1.31 (0.42, 4.07)	
7	Physical comfort score (+ 15 units)	0.69 (0.46, 1.03)	6
8	Problems with chair (Yes vs No)	2.89 (1.13, 7.38)	4
9	Having a document holder (Yes vs no)	4.84 (1.12, 20.9)	5

7.11.3 Nerve Entrapment Syndrome Group

The variables which were found to be significantly related to membership of the Nerve Entrapment syndrome group from each of the group regressions were:

Section A

- presentation of audible information (telephone hand held)
- experiencing difficulty reading text on screen or documents
- frustrating problems with programs
- specified rate for keying
- number of hours keying per week

Section B
- Having problems with the chair
- backrest angle adjustment on chair
- having a footrest
- use of a document holder
- screen flicker

Section C
- level of office noise disturbing

Section D
- work or non-work exposure to vibration of the hands

Section E
none

ULSQ
- longest spell at the keyboard without a break

Gross Postures
none

WES scales
none

Goniometer
none

After adjusting for age and gender, the first variable to enter was the longest spell spent at the keyboard without a break, with longer spells more strongly associated with being a case in the Nerve Entrapment syndrome group compared to shorter spells. There was a significant gender interaction with this variable showing a strong trend in females while in males there was less of a clearcut trend which was based on lower numbers (Table 7.59). The odds ratios for females suggest a two-fold increase in the risk of being a case if the longest spell without a break is 1-2 hours and an increase of eight times if this is more than two hours. The large values for males and very wide confidence intervals suggest that these estimates are unreliable for males (Table 7.59). This was the only syndrome group which showed a stronger association with the time at the keyboard without a break compared to the number of hours keying, suggesting that the frequency of breaks is more important than the length of working for cases in the Nerve Entrapment syndrome group.

Summary Table 7C Order of entry in stepwise regression on the Nerve Entrapment syndrome group (adjusted for age and gender) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Age (+ 10 years)	1.75 (1.17, 2.61)	Forced in
0	Gender (Female)	40.8 (5.73, 291)	Forced in
1	Longest spell at keyboard without a break relative to < 30 mins		1
	30 - 60 mins	34.9 (3.73, 326)	
	1 - 2 hrs	25.2 (1.25, 505)	
	> 2 hrs	13.3 (0.45, 395)	
2	Gender x longest spell at keyboard interaction relative to < 30 mins		Forced in
	30 - 60 mins	0.01 (0.001, 0.19)	
	1 - 2 hrs	0.06 (0.002, 1.47)	
	> 2 hrs	0.27 (0.0002,0.41)	
3	Having a specified rate of keying (Yes vs No)	2.84 (0.69, 11.7)	2
	(Not applicable vs No)	14.3 (2.54, 79.9)	
4	Office noise disturbing (Sometimes vs. Never)	0.61 (0.25, 1.50)	3
	(Always vs Never)	3.50 (1.13, 10.9)	
5	Physical comfort score (+ 15 units)	0.71 (0.51, 0.99)	4

Following this, having a specified rate of keying entered the model. Always being disturbed by office noise compared to those who were never disturbed was significantly related to being a case in the Nerve Entrapment syndrome group. Low physical comfort from the WES scale was also significantly associated with this syndrome group. No other variables entered at the 5% level.

On excluding those who had an accident or injury related to being a case, the results were virtually unchanged and are given in Summary Table 7C.

7.11.4 Tendon Disorders Syndrome Group

The variables which were found to be significantly related to the Tendon Disorders syndrome group from each of the group regressions are listed below were:

Section A

- experiencing difficulty reading text or screen
- specified rate for keying
- number of hours keying per week

Section B

- support for the upper back on chair
- use of a document holder

Section C

- level of office noise disturbing

Section D

- number of hours per week in risky sports or hobbies (log transformed)

Section E

none

ULSQ

- longest spell at the keyboard without a break

Gross Postures

none

WES scales

- peer cohesion

Goniometer

- Right hand flexion-extension (median, standard deviation)
- left hand flexion-extension (99th percentile).

After adjusting for gender, the first variable to enter was the number of hours keying per week (odds ratio = 2.37) with longer hours more strongly associated with being a case in the Tendon Disorders syndrome group compared to shorter hours. This implies a reduction in odds of 58% (95% C.I. = 31%, 74%) for a 10 hour decrease in keying per week. There was no significant gender interaction with this variable. All of the goniometer variables became non-significant on adjusting for this variable except for the standard deviation of the right hand flexion-extension movements.

Following this, having a specified rate of keying was entered followed by experiencing difficulties reading text from the screen or documents. Next, one of the goniometer variables entered with high values of the standard deviation for the right hand flexion-extension associated with being a case in the Tendon Disorders syndrome group. This implies a wide spread or range of flexion-extension movements (that is, up and down) is associated with this syndrome group, independently of the number of hours keying. Finally, low peer cohesion, which is an indicator of poor support and friendliness from work colleagues, was associated with being a case in the Tendon Disorders syndrome group.

On excluding those who had an accident or injury related to being a case, the results were identical and are given in Summary Table 7D.

Summary Table 7D Order of entry in stepwise regression on cases in the Tendon Disorders syndrome group (adjusted for gender) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Gender (Female)	2.29 (0.62, 8.43)	Forced in
1	Number hours keying per week (+ 10 hrs)	2.51 (1.35, 4.65)	1
2	Having a specified rate for keying (Yes vs No)	1.57 (0.24, 10.5)	Not selected
	(Not applicable vs No)	9.82 (2.07, 46.6)	
3	Experiencing difficulty reading text (Yes vs No)	4.78 (1.44, 15.9)	2
4	R hand flexion-extension standard deviation (+ 5 degrees)	1.94 (1.10, 3.41)	3
5	Peer cohesion (+ 15 units)	0.62 (0.38, 1.02)	4

7.11.5 Epicondylitis Syndrome Group

The variables which were found to be significantly related to membership of the Epicondylitis syndrome group from each of the group regressions were:

Section A
- presentation of audible information (hand held telephone)
- experiencing difficulty reading text or screen
- frustrating problems with programs
- number of hours keying per week;

Section B
- having problems with the chair
- support for the upper back on chair
- use of a document holder
- having a detachable keyboard

Section C
- other environmental factors (temperature, draughts, etc.)

Section D

- number of hours per week on risky sports or hobbies (log transformed)
- work or non-work exposure to vibration of the hands

Section E

- cigarette smoking
- rheumatoid or osteo-arthritis

ULSQ

- longest spell at the keyboard without a break

Gross Postures

- right shoulder elevated
- touch typing looking at screen vs touch typing looking at keyboard
- hunt and peck style

WES scales

- task orientation

Goniometer

none

After adjusting for age, the first variable to enter was experiencing difficulty reading text which was associated with this syndrome group. This was followed by the number of hours per week keying. There were no significant gender interactions with either of these variables. The two gross postural variables relating to typing style and shoulder elevation became non-significant once difficulties with reading and the number of hours keying were taken into account. Following this, audible information presented *via* a hand held telephone was related to being a case in the Epicondylitis syndrome group. Next, having problems with the chair entered the regression model followed by cigarette smoking. Having a diagnosis of rheumatoid or osteo-arthritis was associated with this syndrome group despite the low numbers. A high number of hours involved in risky sports or hobbies was significantly associated with membership of the Epicondylitis syndrome group after adjusting for all other variables in the model.

On excluding those who had an accident, the order of entry showed a number of important exceptions. Having a diagnosis of arthritis entered earlier and so became slightly more important. The number of hours in risky sports or hobbies did not enter at all as might be expected. Having the right shoulder elevated now entered the model as did low task orientation associated with being a case. Having information *via* hand held telephone was also no longer selected suggesting a relationship between this variable and having symptoms related to an accident or injury. The results are given in Summary Table 7E.

Summary Table 7E Order of entry in stepwise regression on cases in the Epicondylitis syndrome group (adjusted for age) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Age (+ 10 yrs)	1.63 (0.99, 2.69)	Forced in
1	Experience difficulties reading text (Yes vs No)	7.13 (2.71, 18.7)	2
2	Number hours keying per week (+ 10 hrs)	2.40 (1.37, 4.22)	1
3	Audible information (Hand held telephone*)	10.5 (1.35, 82.4)	Not selected
	(Telephone headset*)	0.08 (0.003,2.72)	
	(Other*)	0.47 (0.11, 1.92)	
4	Having problems with the chair (Yes vs No)	3.55 (1.33, 9.50)	3
5	Smoke cigarettes (Yes vs No)	4.56 (1.31, 103)	7
6	Rheumatoid or osteo-arthritis	11.8 (1.35, 103)	4
7	Number hours in risky sports or hobbies (+ 1 log scale)	1.60 (1.00, 2.55)	Not selected
Not selected	Right shoulder elevated	-	5
Not selected	Low task orientation	-	6

*Comparison group consists of those who received audible information direct or from recording machine

7.11.6 Shoulder Disorders Syndrome Group

The variables which were found to be significantly related to being a case in the Shoulder Disorders syndrome group from each of the group regressions were:

Section A

- presentation of visual information (document holder)
- experiencing difficulty reading text or screen
- frustrating problems with programs
- having a specified rate of keying

Section B

- having problems with the chair
- having a footrest
- screen flicker
- ability to swivel screen

Section C

- other environmental factors (temperature, draughts, etc.)

Section D

- number of hours per week on risky sports or hobbies (log transformed)

Section E

- rheumatoid or osteo-arthritis

ULSQ

- longest spell at the keyboard without a break

Gross Postures

- trunk twisted while keying
- tendency to be a clacker

WES scales

- physical comfort

Goniometer

none

After adjusting for age and gender, the first variable to enter was screen flicker. This was followed by having problems with the chair and diagnosis of arthritis. The tendency to be a clacker was associated with being a case. A high number of hours of risky sports or hobbies was also associated with this syndrome group. Having a footrest entered next followed by low levels of physical comfort and having a specified rate of keying.

On excluding those who had an accident the order of entry was similar. The number of hours in risky sports or hobbies entered the model later and so was less important. A number of variables now became significant. Having the trunk twisted while keying and experiencing difficulties reading text were associated with a higher probability of being a case. Having a footrest and low physical comfort became non-significant on excluding those who related their symptoms to an accident. The results are given in Summary Table 7F.

Summary Table 7F Order of entry in stepwise regression on the Shoulder Disorders syndrome group (adjusted for age and gender) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Age (+ 10 yrs)	1.27 (0.96, 1.68)	Forced in
0	Gender (Female)	2.30 (1.21, 4.37)	Forced in
1	Screen flicker (Yes vs No)	5.91 (2.22, 12.1)	1
	(Not applicable vs No)	1.26 (0.58, 2.76)	
2	Problems with the chair (Yes vs No)	2.85 (1.55, 5.25)	2
3	Rheumatoid or osteo-arthritis (Yes vs No)	6.79 (1.68, 27.5)	4
4	Tendency to be a clacker (Yes vs No)	2.28 (1.19, 4.37)	3
5	Number hours in risky sports or hobbies (+ 1 log scale)	1.45 (1.08, 1.96)	8
6	Having a footrest (Yes vs No)	2.28 (1.17, 4.43)	Not selected
7	Physical comfort (+ 15 units)	0.73 (0.57, 0.93)	Not selected
8	Having a specified rate of keying (Yes vs No)	2.90 (0.83, 10.2)	7
	(Not applicable vs No)	3.30 (1.17, 9.31)	
Not selected	Experienced difficulties reading text	-	6
Not selected	Trunk twisted while keying	-	5

7.11.7 Forearm Pain Syndrome Group

The variables which were found to be significantly related to case status in the Forearm Pain syndrome group from each of the group regressions were:

Section A

- experiencing difficulty reading text or screen
- frustrating problems with programs
- ability to take breaks
- number of hours keying per week

Section B

- having problems with the chair
- having backrest angle adjustment
- having support for the upper back
- having a footrest
- use of a document holder

Section C

- other environmental factors (temperature, draughts, etc.)

Section D

- number of hours per week on risky sports or hobbies (log transformed)
- work or non-work exposure to vibration of the hands

Section E

- rheumatoid or osteo-arthritis

ULSQ

- longest spell at the keyboard without a break

Gross Postures

none

WES scales

- physical comfort

Goniometer

none

After adjusting for gender, the first variable to enter was the number of hours keying per week with a high number of hours associated with being a case in the Forearm Pain syndrome group. This was followed by experiencing difficulties reading text. A high number of hours of risky sports or hobbies was also associated with this syndrome group. Low levels of physical comfort scored on the WES scale entered next. Having a diagnosis of arthritis was associated with this syndrome group and having backrest angle adjustment on the chair reduced the odds of being a case.

On excluding those who had an accident the order of entry changed with the number of hours in risky sports or hobbies no longer significant. Other environmental factors became significant as did having frustrating problems with programs. Physical comfort, a diagnosis of arthritis and having a backrest angle adjustment were no longer significant suggesting that these factors may be associated with relating symptoms to an accident or injury. The results of the stepwise regression are given in Summary Table 7G.

Summary Table 7G Order of entry in stepwise regression for the Forearm Pain syndrome group (adjusted for gender) and Odds Ratio (and 95% C.I.) for final model.

Step	Factor associated with being a case	Odds Ratio (95% C.I.)	Order of entry on excluding those who had an accident
0	Gender (Female)	2.48 (1.30, 4.75)	Forced in
1	Number hours keying per week (+ 10 hrs)	1.73 (1.28, 2.35)	1
2	Experiencing difficulties reading text (Yes vs No)	2.23 (1.16, 4.30)	4
3	Number of hours risky sports or hobbies (+ 1 log scale)	1.47 (1.08, 2.00)	Not selected
4	Physical comfort (+ 15 units)	0.75 (0.58, 0.96)	Not selected
5	Diagnosis of arthritis (Yes vs No)	4.15 (0.96, 18.1)	Not selected
6	Backrest angle adjustment (Yes vs No)	0.55 (0.30, 1.00)	Not selected
Not selected	Frustrating problems with programs	-	2
Not selected	Other environmental factors	-	3
Not selected	Trunk twisted while keying	-	5

7.11.8 Summary

Most of the variables which were significantly related to syndrome status when analysed by group remained significant when adjusting for variables from the other groups suggesting many independent relationships between these variables and syndrome status.

The most striking was the number of hours spent keying per week which was highly significantly related to most syndromes and was generally the first variable to enter the models. A linear dose-response relationship suggested that causality was likely. Reporting bias was unlikely as this variable showed consistency with other variables which indicated intensity of work, notably the longest spell spent at the keyboard without a break. Approximately two thirds of the sample had non-severe symptoms, so reporting bias is less likely in this group, and the severe group still showed a significant relationship with hours keying when analysed separately, although the longest spell at the keyboard replaced it in the regression model.

The longest spell spent at the keyboard without a break was more important in the Nerve Entrapment syndrome group compared to the number of hours keying, but this was the only syndrome group for which this was so.

Females were significantly more likely to be cases in every syndrome group except for Epicondylitis. A linear trend with the longest spell spent at the keyboard without a break was more apparent for females in the Nerve Entrapment syndrome group compared to males. The increase in number of hours keying for males was greater in cases in the Trigger Digit syndrome group, mainly due to the low mean keying hours for male controls.

Significant increases in the odds of syndrome group with age were seen with the Any Syndrome, Nerve Entrapment, Epicondylitis and Shoulder Disorders syndrome groups.

Even allowing for the influence of gender and age, many variables relating to work environment and equipment were associated with syndrome status, such as possession of a document holder, and a footrest, both potentially indicators of intensive work patterns. Experiencing any problems with the chair was also strongly associated with syndrome status, along with, and independently of, lack of support for the upper back and inability to adjust the angle of the backrest.

The number of hours spent in risky sports/hobbies and suffering from arthritis were significantly associated with syndrome status, especially in those with severe symptoms.

Despite the unreliability of the physical measurements, wide spread movement of the right wrist in flexion and extension was independently associated with being a case in the Tendon Disorders syndrome group.

Of the psychosocial measurements poor physical comfort was generally significantly associated with syndrome status.

8. DISCUSSION

8.1 SYMPTOMS STUDY (PHASE 1)

With a symptoms survey of the scale undertaken in Phase 1 of this research there will inevitably be a tendency to regard it as a formal cross-sectional survey and to draw inferences from it in relation to the incidence of symptoms across the wider population of keyboard users. However, there were distinct limitations to the pattern of recruitment of companies which suggest that such tendencies should be resisted. Primary amongst the limitations was the fact that management of many companies were concerned about what might be 'stirred-up' by the circulation of such a questionnaire or, on some occasions, were embroiled in high-profile debate with staff over ULDs, possibly including legal action. This undoubtedly had an influence on the willingness of companies to participate. During the recruitment period, certain sectors had a very high profile with regard to the occurrence of ULDs amongst those employed in that sector. Possibly the most notable of these was the publishing sector, particularly those producing national daily papers. Strenuous efforts were made to recruit representatives from this sector with no success.

In order to ensure the survey covered a wide range of activities and sizes of organisations the recruitment also included the public sector departments (civil service). Although concerns about ULDs had a fairly high profile amongst some of these, we were nevertheless generally very successful in recruiting within this sector. Not all were the vast organisations which is a commonly held picture of the civil service. Small groups of staff, for example at outstations, were recruited to supplement a number of small companies participating from amongst the private sector. A range of types and sizes of organisations were therefore recruited to the study.

To ensure the ULSQ was given to a representative sample of keyboard users, recruitment of individuals from within an organisation was, wherever possible, done by random sampling. However, because we were beholden to the participating companies for their continued involvement, a reasonable degree of flexibility was required. Thus several companies restricted sampling to Sections of their workforce (i.e. particular departments or, in the case of large organisations, particular geographical sites). However, these restrictions were not extended to encompass only particular individuals. There was one exception to this, in that one public sector organisation carried out its own recruitment, providing a list of those who had agreed to participate. It was not possible to ascertain what proportion of the workforce had been approached or the manner in which that approach was made. However, examination of the data from this organisation (code 05; Table 4.1) shows that the relative proportion of respondents in the four categories of symptoms (none, old, new and severe) did not suggest that the sampling was unduly biased.

Even allowing for the uncertainties as to whether all issued questionnaires were offered to individuals for completion, the response rate of 81% (98% of these completed) was highly satisfactory. Personal administration appears to be a very successful mode of questionnaire distribution. This high response extended to where the distribution was conducted by a company representative. For example, at one location where we were specifically requested to allow local staff to distribute the questionnaires, 96% of the 125 issued questionnaires were returned completed.

Although not formally established as a cross-sectional survey it is interesting to note a broad degree of consistency of symptom reporting across the eleven participating organisations (some of which involved multiple sites). Generally speaking, just over 50% of participants reported symptoms of some form (45% asymptomatic) with an average of 14% reporting what were classified as recent (within the last three months) severe symptoms (warranting professional advice) a statement taken to indicate a degree of severity.

There are few comparable published studies to relate these results to. Hodgson *et al* (1993) reported on the results of a trailer questionnaire on self-reported work-related illness in England and Wales, conducted as part of the 1990 Labour Force Survey. Comparisons between studies are difficult because of the different manner of reporting; the different nature of the questions asked; etc. However, summing all musculoskeletal conditions of the upper limb gives a prevalence in excess of 120,000 making it one of the highest categories of ill-health. Separation of specific occupational groups is problematic as the manner in which disorders were subdivided often separated 'RSI' from other upper limb disorders in the analysis. For clerical workers, musculoskeletal disorders of the upper limb and neck, combined with 'RSI' of the upper limb, had a total 12-month prevalence of 38 per 10,000, averaged across males and females.

This is clearly considerably lower than the levels indicated in the present study, even when compared against the reports of recent severe symptoms (probably the most realistic comparison). In contrast, Bernard *et al* (1996) reported the results of a cross-sectional study of work-related musculoskeletal disorders amongst newspaper employees using VDTs. A total of 973 respondents (93%) completed a self-administered questionnaire on musculoskeletal symptoms of the upper extremities. Over 83% of these reported symptoms of some sort, although only 41% met the authors' criteria for categorisation as a case. Although neck symptoms predominated (26%), at least amongst those defined as cases, the level of reporting clearly exceeds that found in this present study (55% any symptoms, 49% in last three months) (neck symptoms were not included in the present study). Similarly, amongst the cases 'at least one third' had seen a health care provider, which may be compared with the 14% in our sample ('recent severe symptoms'). One of the case criteria imposed by Bernard *et al* was to exclude those who attributed their symptoms to an acute injury. If a similar exclusion is applied to our data then the proportion reporting recent symptoms falls to 39%, very similar to the 41% reported by Bernard *et al.* It seems therefore that, although the proportion of respondents reporting symptoms in the present study seems high, it does not appear to be particularly different to that reported by Bernard *et al.* However, the criteria of seeking advice seems directly comparable with the study of Bernard *et al*; in which case the consultation rate in the present study of less than one half that reported by Bernard *et al* suggest fewer serious problems.

As those in the present study were at work, their symptoms could not have been sufficiently severe to prevent them from working on the day the questionnaire was issued. No further information was collected regarding time off, need to make changes to work, or any other potential indicator of severity. Those who were absent from work or had to leave their jobs due to ULDs will have been excluded from the case-control study due to their unavailability to participate.

8.2 CASE CONTROL STUDY (PHASE 2): INTRODUCTION

A considerable number of studies have been undertaken that consider the effect of keyboard work on the development of ULDs. Although many of these studies have identified and addressed many of the factors that relate to the development of ULDs, few have taken a holistic approach by including a large proportion of significant risk factors in an investigation, in order to identify those that are most significant. This was the approach adopted in this study, and means that the study is valuable in identifying all the factors that are associated with symptoms of ULDs, and their relative importance. The results of this study show many significant associations between risk factors and ULD symptoms, classified into syndrome groups.

Retrospective assessment of exposure to occupational hazards is fraught with difficulties and, particularly in relation to an issue of such size and complexity as that addressed by the present study, will inevitably have shortcomings. Approaches to minimise the impact of such deficiencies have been, and will continue to be a topic of extensive discussion amongst international epidemiologists (eg. Guillemin [ed], 1996).

In discussing the significance of the findings from the current study it is therefore important to examine also how much credence can be placed on them. The first Section of this discussion therefore addresses the question 'how reliable are these results?' It examines the design of the study; the representativeness of the sample (including possible sources of bias); the methods adopted for data collection; and the reliability of the results collected.

Finally, the significance of the results are discussed, firstly from the viewpoint of the different risk factors (Section 8.8) and secondly, grouping risk factors according to the syndrome group classification (Section 8.9).

In interpreting the results it is important to consider the relationship between the risk factors and the syndrome groups. The selection process for cases was of those who were experiencing discomfort at the time of completing the ULSQ. The survey then focussed on work and non-work factors at the time of completing this ULSQ. Since the period of interest was when the cases were already suffering from the upper limb symptoms, it is not possible to say whether these risk factors actually caused the syndromes, although associations between risk factors and syndrome groups can be described. Consideration is given in the discussion as to the plausibility of associations between risk factors and syndrome groups. For example, it is possible that if an operator develops an upper limb disorder, they will change their working practice or work equipment in order to reduce the discomfort and this may effect the variable of interest.

One difficulty with so many variables is that many of the factors recorded are not necessarily primary variables (directly affecting ULDs), reflecting instead an association with some underlying or related factor. This can create some interesting anomalies. For example, use of a document holder was included as it is widely considered that poor upper body posture arising from reading documents on the horizontal surface of the desk contributes to the occurrence of some upper limb problems. Paradoxically, use of a document holder was significantly positively associated with some syndrome groups. As it is unlikely that this is a causal relationship, it could be interpreted as indicating that those with problems obtained document holders in an attempt to alleviate their symptoms. However, it was apparent from the study that those with document holders are more likely to undertake intensive keyboard work and therefore type at higher rates, for longer periods, with fewer breaks; in short they are more likely to be exposed to many work-related risk factors. These anomalies and apparent contradictions are discussed in the relevant Sections below.

The practical implications of the findings for the prevention of symptoms of work-related ULDs are discussed in Chapter 9.

8.3 APPROPRIATENESS OF THE CASE-CONTROL STUDY DESIGN

The design of the study incorporated seven case-control comparisons. As with any design, case-control studies have advantages and disadvantages. The 'gold standard' epidemiological design is the prospective cohort design which allows analysis of the incidence of syndrome groups in relation to risk factors measured at the start of follow-up. In order to achieve large enough numbers of subject in each syndrome group a large population would have to be followed up over a long period of time and so the cost is prohibitive.

The design used in this study gives seven case-control comparisons by using a single control population and seven defined syndrome groups. In a prospective study, risk is measured directly, while in a case-control design the odds ratio as a measure of association is calculated, which means that the temporal order of symptom development and risk factor is more difficult to determine. It is therefore not possible to say that a factor caused a symptom, rather that there is an association between the factor and the symptom. To our knowledge, longitudinal studies which provide support for causal processes linking stressors to development of ULDs are unavailable. In addition, in this study most factors were measured some time after information on symptoms were collected and so the reliability, in the sense of change over time of factors, is an important consideration, which is discussed later (Section 8.5).

8.4 REPRESENTATIVENESS OF THE SAMPLE

It was important to ensure that there was as little bias as possible in the selection of case-control study participants from the available population. This section discusses the steps that were taken to ensure the representativeness of the sample.

8.4.1 Non-Participation

There are two potential ways that bias could occur in this study through the selection process into and out of professions: selection of 'healthy workers' into the work population (healthy enough to work when employed); and a loss from the work population of those employees who leave jobs due to health problems they have developed over time. These biases may lead to under estimation of the magnitude of the associations between work and disease.

As discussed previously (Section 8.1) the high response rate to the original questionnaire indicates that any distortion of the initial sample would have been limited. Nevertheless, it must be acknowledged that individuals absent from work due to chronic ill-health, including possibly some with ULDs, would not have completed the initial ULSQ and would not therefore have been available for selection as a case in Phase 2. This provides further support for the need for caution referred to above (Section 8.1), in seeking to interpret the Phase 1 results as a prevalence study. In terms of distributions of age, gender and symptoms complexes, the subjects selected for Phase 2 were representative of their parent population from the cross-sectional survey, and this provides no indication that they might have been unrepresentative in terms of their relationships between risk factors and health.

However, the loss of potential cases from the study population for health reasons could be particularly problematic for the present study because of the time interval between ULSQ administration and the survey.

The total number of non-participants was 470 (287 cases and 183 controls), while the total number of participants was 449 (295 cases and 154 controls). Many of these non-participants no longer worked in the company (48%) and therefore were not invited to participate.

It can be seen that 51% of those cases and 46% of those controls invited to take part in Phase 2 did so, suggesting that there was little difference between those with and without upper limb symptoms in terms of their willingness and availability to participate. This indicates that little bias was introduced into the sample in this way.

Comparing for each syndrome group, the percentages of participants and non-participants indicates that very similar numbers were obtained for each group. The biggest difference was in the Tendon Disorders syndrome group where 45.2% of those with this syndrome participated and 25.0% did not. A difference was also seen for the Forearm Pain syndrome group where 34.7% participated and 25.5% did not participate. These small differences are unlikely to introduce bias into the sample. The results suggest that there was no real imbalance between syndrome groups in their non-participation rates.

In considering the reasons for non-participation, it is clear that most reasons (79%) are apparently unrelated to the study (eg. the subject had left, retired or relocated in the organisation). It is possible that among those who had left the company or retired, some had done so due to suffering from an ULD. Due to the confidential nature of reasons for leaving a company, it was not possible to determine if the reasons were related to ULDs. However, there was no evidence of more cases having left the company than controls, and this suggests that little or no bias was introduced to the sample in this way.

A small number of reasons (13%) for non-participation are a direct response to the study (eg. not interested; too busy). Eight percent of subjects did not give a reason for non-participation. The non-participation rate due to unwillingness was low, which suggests that the majority of subjects who still worked at a company and were invited to participate did so.

The distribution of reasons for non-participation across syndrome groups and controls was considered to determine if there was a prevalence of subjects in a syndrome group not participating for a particular reason. The results showed that the reasons for non-participation are similar across all syndrome groups. There were slightly more cases who did not participate due to holiday, sick leave, maternity leave or being unavailable on the set day than controls. The only one of these reasons that could be related to ULDs is sickness absence, if caused by a ULD. However, due to confidentiality of sickness records, it was not possible to determine if sickness absence was related to ULDs. However, the differences between cases and controls being unavailable for these reasons is small, and unlikely to introduce any significant bias to the sample.

Slightly more controls than cases gave their reason for non-participation as not being interested in the research, suggesting that those with upper limb problems were motivated to assist in research to address the issue, although the numbers involved in this were small.

In summary, it therefore appears that the subjects who participated in the field work were representative of the subjects who completed the ULSQ, who had stayed in the company, were still using the keyboard and who were available at the time of the field work.

8.4.2 Selection of subjects

Of the 3,503 subjects who completed the ULSQ, 939 had responses that defined them as being in a syndrome group (see Section 5.4.1); 1514 had responses that defined them as being a control (i.e. experiencing no upper limb discomfort); while the remainder had symptoms that did not result in them being defined as being in either a syndrome group or as being a control.

For the case-control study comparisons were made between work factors of those with and without ULDs. Cases who had a syndrome that was 'severe', 'pure' and 'new' would provide the best comparisons with the controls.

As outlined in the results (Section 6.1), the distribution of the sampled cases by severity, purity and newness was very similar to the potential cases, indicating that the sampled cases were in effect a random sample of the potential cases. Although strict criteria had been developed for the sampling procedure so that comprehensive analysis could take place, this was difficult to achieve in reality. This was with three main reasons:

1. The high non-participation rate meant that many of the targeted subjects were not always available, as discussed above;

2. Subjects could be in more than one syndrome group - for example they may have developed symptoms for the Nerve Entrapment syndrome group which were 'new' and 'severe' while also having symptoms of Shoulder Disorders that were 'not new' and 'not severe'. The analysis was conducted with subjects being present in all relevant syndrome groups. (Note: it was not possible to select only 'pure' cases as there were insufficient);

3. Some sites were impractical to visit due to the low number of subjects there, and therefore some potential subjects were excluded in this way.

These factors had a effect on the distribution of cases in terms of their severity, purity and newness, which is discussed below.

In terms of severity, most potential subjects did not have severe syndromes at the time of completing the ULSQ (ranging from 25.5% for severe Forearm Pain cases to 41.7% for severe Epicondylitis). It had been planned to obtain equal numbers of cases with severe and non-severe syndromes so that comparisons could be made between the two groups. It had been thought that the cases who had severe syndromes would alter their working habits in order to compensate for their symptoms. However, for the reasons outlined above, this balance could not be achieved and as a result it was not possible to undertake detailed analysis comparing the severe with the non-severe cases.

As stated earlier however, the balance of severe and non-severe cases was towards the non-severe. Although this can be seen as a disadvantage it does have some benefits in relation to the question of the association between working practices and symptoms. As those with very severe symptoms would be more likely to be handicapped in their work, this would increase the likelihood that what was observed in Phase 2 was as a consequence of their symptoms. The predominance of cases with mild symptoms can therefore be seen as strengthening the suggestion that any associations identified are indicative of a causal relationship between work factors and upper limb discomfort. This issue will be discussed further in relation to the analysis of results (see Section 8.8).

Most potential subjects in a syndrome group were not pure, i.e. they had fell into more than one syndrome group. This is reflected in the sampled subjects where subjects are in more than one syndrome group.

In terms of the newness, most potential subjects did not have new syndromes (developed within previous 3 months) at the time of completing the ULSQ (ranging from 16.5% for new Nerve Entrapment to 33.5% for new Trigger Digit cases). The aim in selecting new cases was to help in identifing the work situation that may have given rise to the discomfort. If a subject had recently developed a problem, it was thought that inferences could be made about the factors concerning the work at that time in relation to the development of these problems. However, due to the low numbers of subjects who had new syndromes, most sampled cases were not new. This means that less emphasis can be placed on assumptions that the work situation observed was that which had lead to these problems, although if these subjects have been in stable jobs within the organisation, undertaking the same work for some time and therefore having less opportunity for change, then this is less of a problem.

It can be concluded that despite the recruitment difficulties, the sample seen were in effect a representative random sample from the potential sample of subjects. Although this means that some comparisons could not be made (such as comparing the work situation of new and not new cases), the sample seen were a good representation of the potential sample.

8.5 RELIABILITY OF SURVEY METHODS

The strength of the relationships found may be altered due to methodological problems such as recall bias and alterations over time. These will be discussed in the way that they relate to the different survey methods.

8.5.1 Reliability of ULSQ

Several attempts were made to establish the extent to which clusters of symptoms reported on the ULSQ reflected the symptoms experienced by those who had been given a clinical diagnosis of a specific disorder (see Section 5.6.1). None were entirely successful in that the amount of information which could be obtained was limited. Collectively however, they do appear to support the suggestion that the symptoms reported are at least indicative of specific clinically defined disorders. Seventy to seventy five percent of the small data set obtained did show a direct agreement between the syndrome group classification allocated from the ULSQ responses and the reported clinical diagnosis. In most instances the source of the reported diagnosis was not known but was most likely to be that of a GP. It is widely recognised that there are discrepancies in the diagnosis of specific disorders by different medical practitioners. Extensive experience in reviewing medical case histories produced for legal purposes has shown at least one of the present authors (RAG) how disparate some such diagnoses can be. In other instances, the different practitioners place varying reliance on specific signs, symptoms or test results. For example, there is some debate concerning the necessity or otherwise for positive electro-diagnostic test results in diagnosing Carpal Tunnel Syndrome (Silverman *et al* 1995). A degree of discrepancy between symptoms and clinical diagnoses is therefore to be expected within the data collected in the validation process.

Although great caution must be exercised in interpreting such a small data set, it can reasonably be stated that the results do at least give an indication that there does not appear to be any fundamental deficiency in the diagnostic categories developed and allocated.

Identification of cases was nevertheless based solely upon self-report of symptoms. There have been some suggestions that certain work characteristics may influence the reporting of symptoms and therefore introduce a distortion of any results. For example, psychological and physiological explanations have been put forward that suggest that psychological loads might either change the perception of pain (Theorell, 1992) or induce physiological changes that might result in musculoskeletal problems (Bongers *et al* 1993). The relationship may also be confounded by physical stressors such as static load or repetitive work.

A study by Theorell *et al* (1993) indicated that the perception of pain may be different under situations that differ in job demands and decision latitude. The researchers found that high job demands are associated with an increase pain threshold, which may result in an under-reporting of health symptoms. They suggest that sympathetic activation may be the underlying physiological mechanism. Low intellectual discretion was found to be associated with a lowering of the pain threshold, which may result in an increased tendency to report symptoms. In the present study, the WES subscale of autonomy could be regarded as reflecting the intellectual discretion associated with a particular job. However, this subscale did not show any significant differences across the syndrome groups, suggesting that it was not significantly associated with ULDs.

Although a degree of over-reporting might be expected in individual instances others may, for various reasons, underplay any symptoms they may be experiencing. Therefore, although it must be borne in mind that the study is based upon self-reported symptoms there are no reasons to suspect the presence of systematic biased reporting across such a large sample.

8.5.2 Reliability of structured interview

The Structured Interview relied on the subjects having accurate memories of the work situation at the time of completing the ULSQ. This could have been up to two years prior to the interview. At the start of the interview, subjects were asked to spend a few minutes thinking about the work situation at that time. The vast majority of subjects had no problem remembering what the work had been like then. Many of the questions concerned factual information that could be expected to be perceived objectively by the subjects, and remembered relatively accurately.

Only ten of the subjects interviewed had much difficulty recalling some details of the work, furniture, equipment, environment, and activities outside of work at the time of completing the

ULSQ. This is a low percentage (2%) of the total number of subjects seen, and it is unlikely that it will have a significant effect on the sample. Where subjects were unsure of a variable it was coded as 'missing', so as to avoid introducing false information into the results.

Collection both of the dependent variables (ULSQ) and of a number of the independent variables (risk factors) was by self-report instruments. It is therefore possible that subjects may have biassed their responses based on the symptoms they were experiencing. However, this is unlikely for a number of reasons:

1. There was a time delay between completing the ULSQ and undertaking the fieldwork, such that some subjects may have forgotten how they responded to the ULSQ.

2. Many of the questions asked in the fieldwork are not obviously related to ULDs, for example, wearing glasses, educational status etc, so it would be difficult for subjects to deliberately bias their response.

3. Studies in which relations are reported between survey-based independent variables and more objective indicators of health such as morbidity or mortality, show odds ratios or relative risks of comparable magnitude as, or even larger than, those in this study (Karasek *et al* 1988, Siegrist *et al* 1990).

Finally, although not examined systematically, there were opportunities for cross-validation between subjects within the same organisation. Researchers usually interviewed a number of subjects at any one site and any misrepresentation of previous conditions would have become apparent in receiving conflicting recollections from other staff. It would appear therefore that, whilst individual lapses of memory may well have occurred, it is unlikely that systematic misreporting on a scale likely to have influenced the findings would have occurred or have gone undetected.

8.5.3 Reliability of observations

In addition to the collection of self-report data, some of the factors investigated were examined by observations carried out by members of the research team. There were a number of reasons why the reliability of such observations might have been compromised, some relating to what was being observed and others relating to the observers.

In relation to the reliability of the observed postures, it should be remembered that it was a 'snapshot' of the range of postures adopted over time. Posture is dynamic and therefore unlikely to remain the same throughout the day. There is also a possibility that the subject might have changed their posture, either as a self-conscious adjustment because of being observed or because of changes in equipment, furniture or awareness in the intervening period between ULSQ administration and the case-control study. Every effort was made to place the subject at ease, to gain their confidence and to discourage them from modifying their normal manner of working. However, the possibility that subjects may have adjusted their posture to sit 'correctly' during the observed period cannot be ruled out.

In order to examine the possible impact on posture of changes to the working environment, an attempt was made to determine the reliability of the observations based on the changes that had occurred to the furniture and equipment, through the use of 'reliability indicators'. These gave an indication of how representative the observations may be of the postures as they would have been at the time of completing the ULSQ. The indicators showed that for most subjects, many factors in the work environment had changed (e.g. chair, desk, use of footrest), and therefore on the basis of the indicators the postures observed could be said to be not a reliable representation of those adopted a the time of completing the ULSQ. The reliability indicators used very strict criteria such that if any one factor at work had changed, the posture it was said to affect was judged unreliable.

Considerable thought was given to possible ways of refining the indicators to make them somewhat less stringent. However, after preliminary analyses indicated that few of the postural factors were showing any statistically significant relationships this was not pursued further.

The other element in the observational data was the possible variability between the observers themselves and variability over time. Several procedures were adopted to ensure consistency between observers including a detailed procedural manual; initial training by observing IOM staff prior to pilot studies; collective debriefings after the pilot studies to address any problems in interpretation; and periods of parallel observation of subjects between pairs of observers. Three repeat periods of observation were also undertaken to measure inter- and intra-observer reliability.

The results of the inter- and intra-observer reliability tests show that the reliability of observations was generally very good. Inter-observer reliability was good for all postural and typing variables, with the possible exception of if the subject was a 'clacker'.

There are a number of indicators of this typing style, including gross forearm actions, finger action and even auditory cues from the keyboard itself. However, the latter can be misleading because of differences between keyboards. Observers may have placed varying degrees of reliance on these different indices which, with the difficulty in defining qualifying criteria, probably accounts for the relatively poor reliability of this measure.

However, overall the results are encouraging in that there is a high degree of agreement between the different observers for most measures. The intra-observer reliability was also good, with the one observation where there was lower agreement apparently being due to the camera angle from which the video material was taken. This problem would be unlikely to occur 'live' as the observer could alter their viewing angle to confirm a judgement.

8.5.4 Reliability of WES

Moos (1981) reported a study in which test-retest reliability was examined with a one month interval between administration. The test-retest reliabilities were all in an acceptable range (correlations from .69 to .83). Test-retest over a 12 month period was also measured where the work environment had not changed. Correlations of the WES values were moderately high for this time interval (around .6). It therefore appears that the WES is relatively robust over time, although it has not been tested over a two year period.

It was recognised that there would have been changes to the work environment between the time of completing the ULSQ and the survey work being undertaken. For this reason a series of questions were asked concerning the change in subjects' attitude to the work environment. This showed that subjects perceived that they now felt more extreme on the values asked about than they did at the time of completing the ULSQ, i.e. if they now had a low score on the physical comfort scale (which indicated that they thought they had a poor working environment) they thought that it was now worse than it had been at the time of completing the ULSQ. The converse of this was also true.

The effect of this would have been to accentuate any consistent differences in response between different case/control groups. However, it would also be expected to increase the magnitude of any variability in response, thereby possibly masking weak associations. This issue and other considerations regarding these data will be discussed in considering the results themselves.

8.5.5 Replicability of goniometer data

In order to examine the replicability, or perhaps more correctly consistency of the goniometer data, repeat visits were made to a small sample of subjects in order to determine the day-to-day variability in what was ostensibly the same task. An informal analysis of this data set showed considerable variability in the readings obtained on different occasions. Goniometer placement was determined from fixed anatomical landmarks and it is therefore unlikely that the variability arose from this source (which would be expected to introduce an offset in an otherwise similar pattern). Visual inspection of the individual records suggests that the data are more consistent during periods of actual typing but that the extent of such activities and the nature of other activities varied considerably in the sample studied. During the recording period, operators were asked to undertake their normal keyboard work, including any paper work or other activities that they would usually undertake. This was a deliberate decision to avoid obtaining an erroneous picture of exposure by only sampling during actual keyboard work. The implications of this are discussed further in Section 8.8.6.

8.6 RELIABILITY OF ASSOCIATIONS

8.6.1 Multiple explanatory variables

A strategy for the analysis was necessary because of the large number of potential explanatory variables or confounders. The screening procedure adopted was, in fact, highly conservative in putting forward for regression those variables which either showed more than one statistically significant association or were considered to be of scientific interest on ergonomic grounds. Thus, the strategy incorporated both ergonomic as well as statistical considerations.

In the regressions by group of variables, it was possible that confounding by one variable in another group to that being analysed could be important, but this would be unlikely. The important confounders of age and gender were always entered first in any regression model (if significantly related to the syndrome group). For a variable to be a confounder it would, by definition, have to be related to both the syndrome group and the risk factor under consideration. Hence, it is likely that strong confounders would come through the initial group regressions to be considered in the final models.

8.6.2 Power and sample size

The power of a study is the probability of detecting significant associations between variables and syndromes if they are truly present. As noted in Section 5.4.3, a sample size of approximately 80 was estimated to give 80% power to detect odds ratios of around two for tests at the 5% significance level. This was not achieved for some syndrome groups (notably the Tendon Disorders syndrome group, n = 38) and so power was lower in analyses relating to these syndrome groups. However, as odds ratios of two or more were commonly obtained in the results, even with such low sample sizes, significant associations were still found.

8.6.3 Statistical significance

As discussed above, the strategy for analysis included screening all variables potentially related to the syndrome groups and therefore consisted of over 100 tests. If the usual level of statistical significance is taken as 5%, this implies that 1 in 20 tests will give a significant result by chance alone. A common procedure often used to take multiple testing into account is to adjust the significance level to 5/k where the 5% significance level is assumed to indicate statistical significance and k is the number of tests carried out. A more conservative approach was taken initially, as this study was aiming to explore possible relationships between risk factors and syndrome group status and it was important not to exclude variables at an early stage. In any case, there were many variables which were significant at the 0.01% significance level and these are unlikely to be chance findings, even when multiple testing is taken into account.

8.7 INTERPRETATION: ASSOCIATIONS WITH AGE AND GENDER

There was a positive significant association between being a case and increased age for the Any Syndrome group and for the Nerve Entrapment, Epicondylitis and Shoulder Disorders syndrome groups. There were weak (non-significant) associations of increased age with case status in the Tendon Disorders and Forearm Pain groups. The only group not showing an association was the Trigger Digit syndrome group.

The general trend for increased prevalence of ULDs with increased age supports the findings of English *et al* (1995) and Dimberg *et al* (1989). Although some researchers have not reported this trend (eg. Jeyaratnam *et al* 1989; Sauter, 1984), these researchers were considering more general musculoskeletal disorders rather than only ULDs. Hagberg *et al* (1995) accounted for this by the fact that the ability to tolerate external stress on different tissues decreases with age, and the normal reparative and wound-healing process is slowed with age.

There was a positive significant association between being a case and being a woman for the Any Syndrome group, and for the Nerve Entrapment, Tendon Disorders, Shoulder Disorders and Forearm Pain syndrome groups. There were weak (non-significant) associations of being a female case in the Epicondylitis syndrome group. These findings support those of other researchers (eg. Knave *et al* 1985; Dimberg *et al* 1989) that women are more likely to develop these problems than men.

These two factors are often described in unison, such as statements to the effect that a particular syndrome is more common amongst older females. For example, Szabo and Madison (1991) describe Carpal Tunnel Syndrome as being 'a condition of middle age or later' and 'women outnumber men patients by about two to one'. The authors go on to suggest that there are some anatomical differences between the genders which could account for this increased susceptibility.

The association with age may be partly explained by changes in susceptibility, such as alterations in fluid balance (often associated with menopausal females, again linking the two factors). However, it is often suggested that age and exposure are closely related and not always easy to differentiate. In the present study, years in job did not differentiate between cases and controls for any of the syndrome groups. However, the more specific factor of number of years experience with a keyboard did show a significant association with case status in the preliminary regressions for the Nerve Entrapment and Epicondylitis syndrome groups although this did not remain significant in subsequent regressions. It is also interesting to note that, although gender-related biological changes with age are often implicated in the occurrence of some syndromes (eg. Carpal Tunnel Syndrome) a number of the syndrome groups (Any Syndrome, Nerve Entrapment, Epicondylitis, Shoulder Disorders) still displayed a significant association with age even after adjustment for male-female differences.

The variation between different syndrome groups in age/gender associations can be seen as justifying the decision not to match cases and controls for these variables. The differing patterns of response were subsequently taken into account in further analyses by differences in treatment of the age and gender variables in analysing the various syndrome groups.

8.8 INTERPRETATION OF RISK FACTORS

8.8.1 Introduction

The data analysis was conducted in three phases: initial screening, in which each variable was analysed for its association with case-control status in each syndrome group; preliminary regression modelling, where groups of variables with a common theme were analysed to determine the most relevant members of each group; and syndrome group modelling, where the most relevant elements of each group of variables from the second stage of analysis were analysed to develop a combined model. These analyses permit the results to be examined in two ways. Firstly, specific risk factors can be examined to determine their association, if any, with case-control status (discussed in Sections 8.8.2-8.8.6). Secondly, syndrome groups can be analysed to determine which specific risk factors are associated with case status (discussed in Sections 8.9.2-8.9.7).

It must be emphasised that, in a case-control study of this design, the statistical associations can not necessarily be interpreted as causal as the design does not permit any examination of the temporal relationship between exposure to risk factors and the development of symptoms.

8.8.2 General work exposure factors

The strongest associations with case status of any factor in this group of variables were with the reported number of hours spent keying per week. This clear positive relationship between exposure and symptoms was strongly significant for all seven syndrome groups. It should, however, be remembered that this is not necessarily a causal relationship, although it is unlikely that those experiencing symptoms will increase their time spent at the keyboard as a result of those symptoms.

It can be argued that keyboard activities have the potential both to cause symptoms and to aggravate pre-existing conditions and it is not possible on the basis of the finding to differentiate between these two pathways. The relatively less consistent relationship of symptoms with number of years keyboard experience (both typewriters and VDUs) and the failure of number of years experience with VDUs to demonstrate any significant associations have to be interpreted with caution. If symptoms develop only after the occurrence of a non-work related precipitating event, then exposure prior to the development of symptoms would not be expected to contribute to their emergence, supporting a theory of aggravation. However, the relatively recent introduction of VDUs and the use of VDUs by many who had not previously used a typewriter undoubtedly complicates the situation and could be interpreted as indicating a causal relationship. Perhaps more importantly, it can be argued that the duration over which a keyboard has been used is a less important index of exposure than the actual extent of use (hours spent keying) which was strongly significant. Certainly, there are many informal and ad hoc reports of symptoms developing following an increase in keyboard usage.

These findings were identified from the initial analysis of individual variables. When the selected variables were included in the preliminary regression analysis, hours spent keying remained a highly significant factor for most syndrome groups even when adjusted for the influence of gender. From other studies, which have demonstrated that some of the ULDs represented by the syndrome groups are positively associated with gender, it would be easy to conclude that more women spend more time keying and therefore this explains the relationship. This is not supported by the present findings which demonstrate a continuing significant association between keying time and case status even after the effect of gender is incorporated. Similar arguments and findings also apply where there is an age-related association, with number of hours spent keying per week remaining significant after adjusting for age.

Another factor related to the hours spent keying was the typical longest spell at the keyboard without a break, reported in the ULSQ. This was again strongly and positively related to case status and remained so after appropriate adjustments for gender and age. In the final regressions however, when both number of hours keying per week and the longest spell at the keyboard were entered, number of hours keying per week emerged as the stronger of the two factors, normally entering the regression first and then preventing the longest spell at the keyboard from entering. This indicates that those who spend a high number of hours per week at the keyboard also spend long periods at the keyboard without a break. Thus, for example, in the Epicondylitis Syndrome Group, number of hours spent keying was the dominant factor and longest spell without a break was not subsequently significant. The only exception to this was with the Nerve Entrapment where the length of time spent keying without a break was the stronger factor.

The exception to all of these analyses was the Shoulder Disorders syndrome group. Although significant in the initial analysis, hours spent keying was not significant in the preliminary regression although longest spell without a break was. However, in the final regression even this variable ceased to be significant. This could be regarded as an indication that the factors associated with causing shoulder symptoms are not directly related to keyboard usage per se but possibly to other elements in the environment.

Love *et al* (1989), in a series of case-study investigations, indicated a possible contributory role of other office activities in the development of ULDs. In the present study, hours spent undertaking other 'risky' office activities (which may be associated with ULDs) eg. stapling, filing etc. were not significantly associated with case status. This was a very broad question and it would have been impractical to have examined non-keyboard work with any degree of detail given the already extensive test battery. It should not therefore be concluded that these activities do not contribute to upper limb problems on the basis of such limited evidence. In addition, very few people reported any involvement in such activities, which further reduced the sensitivity of the analysis.

The findings of associations between symptoms and number of hours spent keying and longest spell without a break could lend themselves to the development of an exposure limit aimed at reducing the incidence of symptoms. The two are clearly interrelated, with those going longer before a break also spending more hours per week keying. The strongest associations with case status are generally with hours keying. This shows a generally linear trend, and there is not therefore an obvious 'break' point creating a marked increase in risk. In contrast, time without a break shows a considerable increase in risk amongst those keying for more than two hours without a break. Clear benefits in terms of reduced risk of symptoms would therefore accrue from ensuring that keyboard workers do have regular breaks, a provision incorporated into the Health and Safety (Display Screen Equipment) Regulations 1992 [the DSE Regulations].

8.8.3 Non-work factors

Symptoms of ULDs can be caused or aggravated by many different factors which are not related to work and it was important that these were considered in the present study. Included in these were health factors and activities outside of work. Not least of these are the existence of known medical conditions. In the initial analysis, the results showed that arthritis (including both rheumatoid and osteo-) were significantly associated with cases in the Epicondylitis, Shoulder Disorders and Forearm Pain syndrome groups, and weakly significant in the Tendon Disorders syndrome group. Other medical conditions that had been identified in previous research as contributing to the development of ULDs were not present in enough subjects for statistical analysis and therefore were not found to be significant.

When introduced into the preliminary regressions, including relevant adjustment for age and gender, arthritis was just significant in the Any Syndrome group, together with the Trigger Digit, Epicondylitis and Forearm Pain syndrome groups and highly significant for the Shoulder Disorders syndrome group. This variation from the initial analysis probably reflects the strong association between arthritic conditions and age. When incorporated into the final regressions with other significant variables, arthritis remained significant for the Epicondylitis, Shoulder Disorders and Forearm Pain syndrome groups. Although significantly related to case status, examination of the numbers of cases and controls reporting arthritic conditions shows the absolute number to be very small with fewer than 10% of cases indicating a positive response.

Only five subjects (approximately 1%) were pregnant at the time of completing the ULSQ and this factor did not therefore emerge as a significant variable as the numbers involved were too small.

Approximately 25% of cases related their symptoms to an accident. Initial analysis revealed this as highly significant although it was recognised that this analysis was spurious as only cases could answer positively to the question as presented. The potential contribution of accidental injury was therefore accommodated in the final analysis by removing those reporting accidents from the sample and repeating the regression. Generally, although this influenced the minor entries into the regression, it did not have a major impact. This variable should however be interpreted with caution. An examination of additional details provided by respondents in completing the ULSQ indicated that a number who had responded positively to a specific accident then reported a non-accident diagnosis (eg. Carpal Tunnel Syndrome). Others simply repeated the symptoms (eg. sore arm).

There was evidence of an association between non-work activities (risky sports and hobbies) and case status. As with keyboard usage it should not be assumed that this is a causal relationship. This does indicate however, that the study is not primarily detecting what those with symptoms are able to do as it would be expected that the extent of involvement in such aggravating activities would decrease with case status, not increase. Other factors considered were previous jobs with repetitive movements, or second jobs (i.e. part-time), again with repetitive movements. The initial analyses identified a single weakly significant, association namely between a second (repetitive) job and being a case in the Forearm Pain syndrome group. Because of their perceived importance, these factors were nevertheless introduced into the preliminary regression modelling for all syndrome groups, where they failed to enter the model and attain statistical significance for any group. It appears therefore that these elements do not make a significant contribution to the development of symptoms although it should be noted that very few subjects (approximately 6% of cases and controls combined) reported having a second job of this nature.

Exposure to hand-arm vibration was included in the survey because of the established relationship between such exposure and at least one ULD (Carpal Tunnel Syndrome). A significant positive association was revealed in the initial analysis between reported hand-arm vibration exposure and case status for all syndrome groups with the exception of the Tendon Disorders syndrome group. Inclusion of this variable in the preliminary regressions resulted in it no longer being significantly associated with the Trigger Digit syndrome group but continuing to show a significant positive association with case status in the other five groups. However, when combined with variables from other parts of the study in the final regressions it failed to emerge as a significant factor for any of the syndrome groups. Vibration exposure is not a characteristic feature of office work but it was anticipated that non-work exposure could be a contributory factor. It is likely that the failure of such exposure to emerge as a factor in the final regression can be attributed to its close association with risky sports and hobbies (eg. DIY), as these are likely to constitute the source of such exposure in many instances.

Smoking has been implicated in the incidence of upper limb and cervico-brachial problems by a number of authors and was therefore included in the present study. It emerged in the initial analysis as a significant variable in most of the syndrome groups (excluding the Tendon Disorders syndrome group). When adjusted for age and gender in the preliminary regression, being a cigarette smoker was identified as a significant factor in the Any Syndrome, Trigger Digit and Epicondylitis syndrome groups and remained as a significant factor in the final regression for each of these groups. A causative pathway is not immediately apparent to explain these associations. If cigarette smoking was regarded as a response to the pain and discomfort it might be expected to be more generally associated with case status. Paradoxically, the vast majority of the establishments visited had a no-smoking policy and it could be expected that the excuse to leave your workstation to have a cigarette would reduce the risk of developing symptoms. Alternatively, the inability to smoke at work may increase the stress and tension of the job. Smoking has also been widely shown to be related to socio-economic status, a factor which was not examined in the present study but which may be related to type of job and therefore keyboard use. Smoking has been implicated in a wide range of health problems. It was not examined in detail in this study and further explanation must await further research.

In summary, although some factors related to prior exposure or non-work factors have been shown to play a role in case status these are mainly minor in that they either do not remain as significant in the final regression modelling or they only apply to a small minority of cases. Clearly, for example, some of those reporting symptoms in the initial ULSQ did so as a result of prior accidents or established illnesses. Equally clearly however the majority of those designated as cases had no such history which would explain their symptoms.

8.8.4 Job characteristics

Some of the factors in Section A of the structured interview, together with those from the WES, can collectively be regarded as relating to the association of job characteristics (both physical and psychosocial) with ULDs. The manner of presentation of material, (e.g. audio or visual), frustrations with the software, busy periods and having a specified keying rate all come into this category.

The presence of particularly intense periods of keyboard work (busy periods) did not generally emerge as a significant factor in the initial analysis. The exception to this was with the Shoulder Disorders syndrome group where significantly more cases than controls reported experiencing particularly busy periods at the keyboard. However, this factor was not strongly significant and did not emerge as a significant factor in the preliminary regression. This negative finding is interesting as some case studies have shown that the emergence of symptoms in individual cases is often associated with being 'very busy at work' (unpublished reports).
Having to work to a specified keying rate and being faced with frustrating software are often associated, in informal reports, with the development of ULDs. With the exception of the Nerve Entrapment and Tendon Disorders syndrome groups, which did not show a significant association with frustrating software, these two factors were highly significant in the initial analyses with significantly more cases giving a positive response. The preliminary regressions showed a slightly more haphazard picture with problem software making a significant contribution to five of the seven groups (including the Nerve Entrapment syndrome group) but a specified keying rate only significant in four instances. In the final regression analysis, both factors were significantly associated with being in the Any Syndrome group with a specified keying rate featuring in three of the other six regressions and problems with software seldom being selected. With all cases being included in the Any Syndrome group these regressions had a greater power to detect significant associations and it is not therefore surprising that this group showed the most consistent relationships. Enquiries during the interviews indicated that for most of those subjects, working to a required rate took the form of pages of text per day rather than keystroke rates. The significant role of a specified work rate can be interpreted in two ways. Firstly it can be regarded as a further indicator of workload (as with hours spent keying etc.), those with a specified rate presumably having more extensive keyboard activities. Secondly it can be interpreted as creating a psychological pressure, generating a demand on the individual which may then be associated with the development or aggravation of symptoms via increased tension, or to the increased propensity to report symptoms. The inclusion of work rate in several of the regressions as well as other workload factors, such as hours spent

keying, suggests that these factors were operating fairly independently. This points towards psychological pressure as the mediating pathway. Frustrations with software would also be expected to have a similar pathway.

The psychosocial pressures at work were primarily addressed by the use of the WES, dividing sources of pressure into ten categories, nine dealing with psychological work characteristics and one with perceived physical comfort. In the initial analysis of WES variables, physical comfort emerged most consistently as displaying significant differences between controls and the various case groups. Only the Epicondylitis syndrome group failed to show any significance with the physical environment variable, although that for the Tendon Disorders syndrome group was only weakly significant. Three factors: autonomy; clarity; and control, showed no significant effects at all. Physical comfort remained the most influential factor in the preliminary regressions, emerging as significant in five of the seven analyses (the two exceptions being the two identified above). It remained significant in four of the final regressions although, interestingly, in two of these it did not enter the regression when those who associated their symptoms with an accident were excluded.

Reference has been made previously to the fact that the WES checklist applies specifically to the time of completion and to the uncertainties over interpreting it retrospectively (Section 8.5.4). Indications from the short questionnaire concerning attitude changes were that where responses had altered this had been in a reasonably consistent manner which would help to ensure that comparative scores would be unaltered relative to cases and controls although the magnitude of any differences may be altered. It was also suggested that a negative outcome of this might be to increase the range of scores thereby increasing variances and decreasing the prospects for identifying significant differences. Some support for this can be drawn from a comparison of the sizes of the standard deviations relative to the means from this study with those reported by Moos (1981). Although the difference is not large, there does appear to be a tendency for the standard deviations from the present study to be larger. However, the results clearly indicate that reduced physical comfort was reasonably consistently associated with case status.

The term 'physical comfort' is possibly misleading, implying an indication of uncomfortable chairs etc. Moos (1981) describes the dimension as 'the extent to which the physical surroundings contribute to a pleasant work environment'. An examination of the questions from which this dimension is formed shows them to be more concerned with the ambience rather than more solid elements. In short, cases are more likely to regard their surroundings as dull and dismal. Although the lack of a blanket response, whatever the syndrome group, mitigates against such a conclusion, it is tempting to conclude that those with symptoms are possibly more likely to have a jaded view of their surroundings. The differences in means between cases and controls are however comparatively small and undue emphasis should not be placed on this finding or any conjecture as to its implications.

The failure of any other dimensions to show anything other than isolated significant relationships is disappointing. Many researchers have suggested a psychosocial element in the aetiology of ULDs and some (eg. Hopkins, 1990) have illustrated this amongst groups of keyboard workers. Apart from the increased variability as shown by the standard deviations, an examination of the data reported by Hopkins reveals another possible explanatory factor. The report shows that four keyboard jobs were studied separately, showing quite disparate scores between the four groups. In the present study, although the type of work was examined, there was a greater divergence in the jobs represented. From the data reported by Hopkins this would appear to be a further probable source of variability. Paradoxically, the groups studied by Hopkins were more distinctive for type of job than the present study but were not as distinctly separated into those with or without upper limb symptoms. They were also drawn from separate government departments suggesting that the WES is perhaps better at differentiating between types of work or departmental variations than indicating psychosocial determinants of upper limb symptoms.

8.8.5 Workplace and work equipment characteristics

Since ULDs emerged as an occupational health problem of concern to office (keyboard) workers, considerable attention has been focused on the work equipment provided and the physical environment. These factors were extensively examined as part of the present project. As well as aspects of the screen and keyboard, attention was directed towards the furniture, particularly the chair, and ancillary items either of furniture (e.g. document holders, footrests) or additional equipment such as the mouse and telephone.

Several questions were asked about the chair and the adjustments which were possible with it. In the initial screening, whether the chair had armrests was significant for all syndrome groups except for the Shoulder Disorders group. Cases were significantly less likely to have armrests than controls although, for each case group, approximately 50% of cases nevertheless had armrests. This appears to run contrary to conventional thinking. There is no doubt that in many instances armrests prevent the user from adopting an accepted 'ideal' working posture and it has been widely accepted that this will increase the load on the arm muscles and increase the incidence of awkward postures. However, in many organisations the style of chair provided, together with the features it possesses, is frequently closely linked to status within the organisation and the nature of work performed. It is perhaps therefore significant that despite this consistent relationship with case status, the relationship does not persist when other factors are also taken into account.

Examining other aspects of seating, fewer than ten people (approximately 2%) from the entire sample reported that they had a fixed height chair. Not surprisingly therefore this factor did not differentiate between case-control status. Characteristics of the backrest did however provide some significant case-control differences in the preliminary analysis. The majority of both cases and controls reported that their chair did not provide support for the upper back. Although there was a tendency in most syndrome groups for more cases to report absence of upper back support, this did not normally attain statistical significance. Backrest height adjustment was more likely to differentiate between case-control status. Although, in most syndrome groups, the majority of cases reported that their chair did have a height adjustable backrest, more controls than cases in each group always reported this feature although it did not necessarily attain statistical significance. Finally, although in most syndrome groups the majority of both cases and controls did not report experiencing any problems with their chairs (e.g. finding it uncomfortable, not being able to adjust it adequately etc.), there was a difference between cases and controls over the number reporting that they experienced problems with their chairs. This relationship was statistically significant for all except one syndrome group (Tendon Disorders).

In the preliminary regressions, when the questions regarding seating were analysed in conjunction with other furniture and equipment questions, such as those regarding document holders and footrests, 'having problems with the chair' emerged very strongly as a highly significant variable in most syndrome groups. It remained significant for most groups in the final regressions when other factors were also included in the analysis, entering into the final model for four out of the six syndrome groups for which it was included as a possible variable.

Unlike the other seating questions which address factual information (e.g. presence of armrests), the question about having problems with the chair asked for a value judgement or opinion regarding the chair used. This is not always entirely independent of the other variables as the problems alluded to may stem from one of the physical attributes of the chair. However, the inclusion in some analyses of both this variable and the factual variables clearly show that it is also indicating more than a subjective reflection of physical attributes addressed by the other questions. It could be suggested that this significant difference between cases and controls simply reflects an enhanced propensity to complain. Clearly, it is not possible to discount this suggestion completely. However, a number of indicators do suggest that there may be more to this factor than general dissatisfaction. Firstly, it should be recalled that no attempt was made to ask subjects for any associations between work factors and their symptoms. Secondly, despite its statistical significance, the majority of cases reported no problems with their chair. Thirdly, although the WES category of low physical comfort was often significant, both parameters entered into some final regressions as independent factors. Collectively, these tend to reinforce the suggestion that this could be a genuine factor. Equally however, there is some evidence, as would be expected, that this general question does in part include the influence of some of the more factual issues. Thus, in some comparisons, problems with chair entered the regression earlier than or in preference to other chair-related variables and its deliberate omission from the regressions strengthened the contribution of other factors or allowed them to enter.

Whatever the precise interpretation of the detailed results, collectively the results support the suggestion that shortcomings in seating appear to contribute to the risk of experiencing upper limb symptoms as represented by case status in the present study.

Turning to other aspects of furniture and equipment, footrests and document holders are now widely regarded as essential peripheral items for some VDU users, particularly given their inclusion in the DSE Regulations. At the time of the survey, the majority of both cases and controls did not have either item. However, somewhat paradoxically, more cases than controls had been issued with a footrest and/or a document holder. In most syndrome groups, this difference was highly significant for both factors. It would seem very unlikely that these relationships could be regarded as causal. An alternative explanation would link these items to the nature of the job, with more intensive keyboard users (using a keyboard for longer periods) being more likely to utilise a document holder and possibly also a footrest. There is the suggestion, supported by anecdotal evidence, that footrests have been given to all intensive keyboard users (e.g. all those in a typing pool) whether they require one or not. In the final regression analyses, when these parameters were analysed together with factors such as time spent keying, they were not found to be associated with the majority of syndrome groups, providing some support for this hypothesis. This held particularly for the document holder where it only entered the final regression model on one of the six occasions it was available.

Three basic factors relating to the display screen equipment: a tiltable keyboard; screen flicker; and a screen which could swivel, also yielded highly significant comparisons in the initial analysis, particularly the keyboard tilt and screen flicker. The majority of both cases and controls had a keyboard which could be tilted in some way. However, the proportion of cases with a non-tiltable keyboard was markedly greater than amongst the controls (approximately double) and this difference was statistically significant for all but the Tendon Disorders syndrome group. The lack of a tilt facility could be interpreted as imposing a postural limitation on some individuals, preventing them from adopting a more suitable posture and therefore creating additional strain, particularly at the wrist. In addition, experience has shown that non-tiltable keyboards tend to be older and often possess other potential deficiencies i.e. they tend to be thicker (again imposing postural constraints) and require more force to depress their keys (a known risk factor in the development of ULDs in industrial environments).

More cases than controls had screens that could not be swivelled and more cases reported problems with screen flicker, again both an indication of older equipment, potentially resulting in postural constraint, eyestrain and frustration. The initial case-control comparison of screen swivel was statistically significant for four of the syndrome groups and that for screen flicker significant for six of the seven comparisons. Screen flicker persists as a significant factor in a number of the final regressions for which it was made available. Finally, experience in a number of companies has shown that the more intensive keyboard users (secretaries, typists etc.) tended to be those who were first issued with the 'new technology' and that they may have been left with this older equipment when newer devices have been acquired for others. Age-related problems or deficiencies with display screen equipment may therefore be to some extent associated with the type of job, although the inclusion of screen flicker in some final regressions, even where job-related factors have already been incorporated, shows this explanation not to provide the whole answer. It is likely that older equipment (which does not comply with the requirements of the DSE Regulations) is associated with symptoms of ULDs. The requirements of the DSE Regulations include the keyboards to be able to tilt, screens to swivel and tilt and for the image on the screen not to flicker. The findings of this study support the principles enshrined in these Regulations, that provision of suitable equipment should reduce the incidence of upper limb symptoms.

In conclusion, it is likely that all of these explanations contribute to this group of factors being associated with ULDs. The persistence of keyboard tilt in the final regression of a syndrome group strongly related to wrist postures and movement (Epicondylitis) suggests that the postural impact on the wrist may be an element; the group of equipment age-related factors supports the suggested influence of deficiencies in older equipment and the tendency for general work-related factors to enter the final regression ahead of, and often in preference to these factors, supports the hypothesis of a partial correlation with type of work.

Finally, in dealing with furniture and equipment, reference must be made to the use of the mouse as an interface device. In recent years, many more computer programs have been devised which require the use of a mouse. This has resulted in concerns being expressed regarding possible adverse effects on the hand and forearm of extensive mouse use. Across the entire sample, approximately one in four individuals used an input accessory (usually a mouse). However, there were no significant differences in mouse use between cases and controls. At the time of the initial survey (1992), mouse use was far less widespread and limited to comparatively new software. It should not therefore be concluded on the basis of this study that mouse use has no association with symptoms of ULDs although it bears no relationship to case-control status in the present study.

Environmental factors have also been associated by some as relating to upper limb symptoms. Needing to sit awkwardly to avoid disabling glare or reflections, sitting in draughts, or the general increase in stress or tension caused by high background noise levels have all been the subject of concern at some time. In Section 8.5.4, reference was made to the physical comfort subscale of the WES which indicated that the general psychological impact of the physical environment did appear to influence case status. However, some questions in the structured interview addressed environmental topics more directly. There were no consistent influences of perceived disturbance from noise or lighting on case-control status. In two syndrome groups (Nerve Entrapment and Tendon Disorders) significantly more cases than controls reported disturbance due to noise although these were isolated instances. However, with all syndrome groups, significantly more cases than controls reported general problems with 'other environmental factors' (e.g. draughts, smells, extremes of temperature). In the preliminary regression analyses, disturbance from noise proved to be the strongest factor in the two syndrome groups where it had been significant in the initial comparisons. However, in the other comparisons, 'other environmental factors' made a significant contribution to the regression, normally at less than the 1% level of significance. In the final regressions, disturbing office noise emerged as a significant element in the regression for the Nerve Entrapment syndrome case group. Other than this, the only remaining entry of either factor was in the Forearm Pain syndrome group when those reporting accidental injury were excluded.

It appears from these analyses that environmental factors are not particularly strong influences of case status, when analysed with other factors. As at least one hypothesised pathway is via effects on posture this is perhaps not surprising as other factors, more directly influencing posture, may be preferentially included in the regression. However, the strong emergence of 'other environmental factors' in the preliminary regressions does give some indication of a possible association. When asked to specify the nature of these disturbances, the majority of individuals indicated that draughts and seasonal fluctuations (too cold in the winter, too hot in the summer), were the major factors of concern. The latter factor is most likely to operate as an indirect influence on general dissatisfaction/satisfaction with the workplace which may be mediated via general tension. Draughts however, as well as operating indirectly via this same route, may promote the adoption of awkward postures or, in extreme circumstances, could contribute to muscle stiffness or possible even spasm. Finally, as with other subjective opinions expressed by participants, it is possible that the increased propensity to report problems is indicative of a higher level of dissatisfaction or discomfort prompted by the symptoms. The influence of climate is highly personal and difficult to predict, as shown by BS EN ISO 7730, the International Standard on thermal comfort. In addition, draughts can be very transient, local and difficult to locate or source. Whether the case-control relationships identified are causal or not there does appear to be evidence for the association of the physical environment with the incidence of ULD symptoms, which should be investigated further.

8.8.6 Working posture

In examining the potential contributory role of furniture, equipment and the physical environment, it has been suggested that these aspects may influence case-control status via their effect on the working posture. It can be debated whether postures observed during fieldwork are representative of those adopted when not being observed, as the presence of an observer often makes a subject self-conscious. Assessing posture retrospectively is even more difficult, not only because of equipment and furniture changes which may affect posture but also, if symptoms begin to emerge, the individual may seek to modify their posture to alleviate the symptoms. Nevertheless, the importance of posture cannot be overlooked. The indirect influences such as the characteristics of seating, were in part regarded as one means of addressing this issue, and analysis of such factors has identified parameters whose effect could be mediated via an effect on posture as discussed above (Section 8.8.5). However, other more direct postural variables were also documented and analysed. These were categorised in two ways. Firstly there were observed characteristics, often relating to general body posture such as arm position whilst typing or to related aspects such as typing style (gross postural variables). The second set of variables were the more detailed posture and movements of the wrist, measured using electrogoniometers.

Although some of the gross postural variables approached statistical significance, none showed any consistent pattern in the initial analysis and, particularly given the large number of statistical comparisons performed, it is difficult to refute the suggestion that these were chance occurrences. However, two aspects of typing style did reveal more associations. Although, in each syndrome group, the largest single category of typist was that described as 'hunt and peck', more cases than controls fell into the touch typist category of not needing to look at the keyboard whilst typing. In four of the seven case-control comparisons this difference was statistically significant. Similarly, in four case-control comparisons out of seven, cases were significantly more likely to have the heavy-handed style of typing described as a 'clacker'. Although this was an observer-based classification it should be remembered that the observers were blind to case-control status.

It is highly unlikely that the positive statistical association between being a touch typist and having symptoms is causal. The most plausible explanation is that this reflects an association between type of job and case status, with those being in jobs which require extensive keyboard work being more likely to be touch typists. The preliminary regression analyses showed this association not to be particularly strong, with typing style only entering the regression equation for one syndrome group (Epicondylitis). In the final regression, when factors such as hours spent keying were included into the equation even this association disappeared, supporting the hypothesis that typing style related more to type of job than to case-control status.

Tendency to be a 'clacker' also emerged as a significant variable in the initial analysis of four groups. This persisted only in the Shoulder Disorders syndrome group when the preliminary regression analysis was conducted. Unlike typing style however, this persisted in the final regression as a highly significant contributor to the regression equation. Heavy handedness has become regarded as being of some interest, partly as it is an inappropriate action for computer keyboards as opposed to manual typewriters. It may be expected to give rise to upper limb symptoms associated with more immediately relevant structures such as the finger flexors or possibly, depending on the nature of the action, wrist flexors. On this basis, a biomechanical explanation for its association with shoulder problems is not immediately apparent. If a clacker is not a touch typist (and the two categories are not mutually exclusive) then it might be expected that an increased degree of forearm movement and elbow flexion could occur. As some elbow flexors and extensors originate from the shoulder girdle rather than the humerus, some load might be expected to be transmitted to the shoulder during elbow movement although this link to possible symptoms is purely conjectural and does not seem strong. Alternatively, a heavy-handed typing style could be indicative of a general high level of muscle tension, possibly resulting in a degree of compression along the complex neural pathways in the shoulder girdle.

Because of the perceived importance of the association between postural characteristics and ULDs, gross postural variables were considered for the preliminary regressions despite their general lack of statistical significance in the initial analyses. Two comparisons did emerge in the regressions as statistically significant: a tendency to elevate the right shoulder when using the keyboard in the Epicondylitis syndrome group and a tendency to sit with the trunk twisted (in the Shoulder Disorders syndrome group). A posture frequently observed amongst keyboard users sitting at conventional desks is one where the screen is offset to one corner of the desk but the user cannot sit directly facing the screen because of the intrusion of desk drawers. As a result, the user sits with a degree of trunk and/or neck rotation to view the screen. Depending upon the sitting height, there will also be a tendency to work with the arm closest to the desk extended (right arm when twisted to the left and vice versa) or the shoulder elevated, both of which will potentially increase the load on the muscles and other structures of the shoulder. Through this therefore, a plausible biomechanical link between trunk rotation and shoulder problems can be hypothesised although it must remain purely conjectural at present.

A comparable explanation for the apparent relationship between shoulder elevation when typing and the Epicondylitis syndrome group is less forthcoming. Disorders in this syndrome group result in painful symptoms during forearm and wrist movements. Attempts to avoid such movements may result in movement effectively being transferred up the limb leading to more shoulder activity and, possibly, the resultant observation of working with the shoulder elevated whilst typing. Again such a link is purely hypothetical.

The lack of association found between symptoms of ULDs and the observed postures was perhaps disappointing. Reasons for this, as outlined above are due to the non-static nature of postures and their variability depending on the equipment and furniture used as well as the task being undertaken.

Turning to the more detailed postural and movement information obtained from the electrogoniometers, these wrist/hand movements are arguably the most sensitive to change, particularly in response to symptoms. It is perhaps not surprising therefore, albeit disappointing, for few case-control comparisons of these data to attain statistical significance.

In determining the survey protocol it was decided not to constrain subjects solely to keying during the observation period where their work required other movements such as turning pages of text, writing, speaking on the telephone. The results obtained therefore represent a 'snapshot' of wrist activities whilst doing keyboard-related work rather than specifically when keying, and this may account for the low number of significant associations.

Median flexion/extension angle of the right hand was the parameter which most frequently differentiated between cases and controls, and the Tendon Disorders syndrome group, the group which demonstrated most differences which attained or approached statistical significance. It is perhaps noteworthy that the majority of comparisons which approached or attained statistical significance were for syndrome groups primarily related either to structures in the wrist or to wrist movements. It should also be noted that, although statistically significant, no such comparisons yielded differences in wrist angle between cases and controls greater than approximately 5°.

In three case-control comparisons (Nerve Entrapment, Tendon Disorders, Epicondylitis) cases were more likely to have their right wrist more flexed than controls and, in one instance (Tendon Disorders) this was also reflected in the extreme of flexion which approached significance. The flexion-extension angle was also significantly more varied for cases belonging to this syndrome group. Only the preliminary regression for this syndrome group showed any relationship, with two variables making a statistically significant contribution ($p < .05$) and one other approaching significance ($p = .09$). These were the right hand flexion/extension median and standard deviation and the left hand extreme flexion. The variability in flexion/extension, as shown by the standard deviation, also contributed to the final regression for the Tendon Disorders syndrome group although it was the only goniometer variable to do so for any of the groups.

Radio-ulnar deviation has been the focus of a considerable amount of attention with alternative designs of keyboard being developed which seek to rectify a perceived problem of a tendency towards ulnar deviation with conventional keyboards. The results of this study do not support this as an issue. Indeed, the median values show a slight tendency towards radial deviation amongst both cases and controls. The few comparisons which demonstrated anything approaching statistical significance tended towards an increased degree of radial deviation amongst controls although, as stated above, the absolute magnitude of any changes were relatively small.

It should however be re-emphasised that the results from the goniometers need to be interpreted with caution due to the other activities also undertaken during the data collection period.

8.9 INTERPRETATION OF SYNDROME GROUPS

8.9.1 Introduction

In the previous Sections (8.8.1-8.8.6) the results were discussed in the context of different categories of potential risk factors. The following Sections present the findings in relation to each of the syndrome groups. To avoid excessive replication, the factors identified are only presented in summary form and the reader is referred to the relevant preceding Sections for discussion of these factors. The factors described are limited to those identified in the final regression analysis.

8.9.2 Any Syndrome Group

This was the composite group made up of a combination of all members of the other six syndrome groups. It therefore represents the findings in relation to all those classified as cases, regardless of the part of the upper limb affected.

- Older females were more likely to be cases in this syndrome group although many work-related factors remained significant after these factors were accommodated.

- Cases reported spending more time per week keying than controls.

- Cases were more likely than controls to have a specified rate of keying (more usually in terms of pages of work rather than keystroke rates).

- Cases were more likely to experience frustrating problems with software or difficulties in reading text on the screen, including experiencing screen flicker.

- Having to type information presented through a hand-held telephone was more likely to be a characteristic of the work of a case than a control.

- Cases were more likely than controls to take part in sports or hobbies which could cause or aggravate symptoms, although the majority of cases did not do so. They were also more likely to smoke cigarettes.

- Cases were more likely to experience problems with their chairs of some sort and were also more likely to have a footrest (although this latter factor probably reflected the type of work done).

8.9.3 Trigger Digit syndrome group

- Females were more likely than males to be cases in the Trigger Digit syndrome group.

- Cases in this syndrome group reported spending more time a week keying than controls.

- Cases were more likely than controls to take part in sports or hobbies which could cause or aggravate symptoms, although the majority of cases did not do so. They were also more likely to smoke cigarettes.

- Cases were more likely than controls to have a display screen which flickered.

- Cases were more likely to have experienced problems with their chairs of some sort or to rate their workplace as low on general physical comfort.

- Cases were more likely to have a document holder. This is likely to relate either to their type of job or to reflect efforts to alleviate their symptoms.

8.9.4 Nerve Entrapment syndrome group

- Older females were more likely to be cases in this syndrome group although many work factors remained significant after these factors were accommodated.

- Cases were likely to spend longer at the keyboard without a break and to have a specified rate of keying.

- Cases were likely to rate their workplace as low on general physical comfort and to be disturbed by office noise.

8.9.5 Tendon Disorders syndrome group

- Females were more likely than males to be cases in the Tendon Disorders syndrome group.

- Cases were more likely to spend longer per week at the keyboard and to have a specified rate of keying

- Cases were more likely to experience difficulties in reading test on the screen.
- There was some indication that cases had more varied wrist movements than controls.
- Cases reportedly experienced lower peer cohesion (support from colleagues) than controls.

8.9.6 Epicondylitis syndrome group

- Cases in this group were likely to be older than controls.
- Cases reported spending more time per week keying than controls.
- Cases were more likely than controls to take part in sports or hobbies which could cause or aggravate symptoms, although the majority did not do so. They were also more likely to smoke cigarettes.
- A minority of cases attributed their symptoms to disorders such as osteoarthritis.
- Having to type information presented through a hand-held telephone was more likely to be a characteristic of the work of a case than a control.
- Cases were more likely to experience difficulties in reading text on the screen.
- Cases were more likely to have experienced problems with their chair of some sort.

8.9.7 Shoulder Disorders syndrome group

- Older females were more likely to be cases in this syndrome group although many work factors remained significant after these factors were accommodated.
- Cases were more likely than controls to have a display screen which flickered.
- Cases were more likely to have experienced problems with their chair of some sort or to rate their workplace as low on general physical comfort.
- A minority of cases attributed their symptoms to disorders such as osteoarthritis.
- The only factor relating to the nature of their work which differentiated between cases in this syndrome group and controls was having a specified rate of keying.
- Cases were more likely than controls to appear to be heavy handed in their use of the keyboard ('clacker').
- Cases were more likely than controls to take part in sports or hobbies which could cause or aggravate symptoms although the majority did not do so.
- Cases were more likely than controls to have a footrest (although this probably reflected the type of work done).

8.9.8 Forearm Pain syndrome group

- Females were more likely than males to be cases in this syndrome group.
- Cases in this syndrome group reported spending more time a week keying than controls.
- Cases were more likely to experience difficulties in reading text on the screen.
- Cases were more likely than controls to take part in sports or hobbies which could cause or aggravate symptoms although the majority of cases did not do so.
- A minority of cases attributed their symptoms to disorders such as osteoarthritis.
- Cases were more likely to rate their workplace as low on physical comfort.
- Cases were less likely to have had the facility to adjust the angle of the backrest on their chair. This may have related more to the implications relating to the age of their furniture than any direct physical influence on symptoms.

8.10 SUMMARY

This discussion has considered the methods used in the research, the representativeness of the sample seen both in Phase 1 and Phase 2, the reliability of the findings, and has sought to explain some of the findings. The findings in relation to each syndrome group have also been outlined.

9. RECOMMENDATIONS FOR THE PREVENTION OF SYMPTOMS OF ULDs

9.1 INTRODUCTION

The research reported above has identified a number of factors associated with symptoms of ULDs, relating to work at a computer keyboard. This Section incorporates these into recommendations and guidance for those using such keyboards in the hope of reducing the risk of developing or aggravating upper limb symptoms. The case-control study showed that many keyboard users who were experiencing symptoms associated them with a specific event or accident. However, it is recognised that keyboard work may aggravate these symptoms and the intention here is to make recommendations that will hopefully prevent work activities from doing so, or for those who have not had a specific injury, possibly delaying their onset.

The extensive array of variables examined in the research is testimony to the complexity of the circumstances which may lead to the development of upper limb symptoms. The statistical analyses conducted as part of this research have identified a number of associations between these variables and those individuals with upper limb symptoms. Many other associations however have not emerged from the analysis. Some factors may genuinely not be associated with symptoms, others however may not have been identified for a variety of reasons. Comments have been made where too few cases or controls have used a particular item of equipment (e.g. a mouse) for meaningful analysis; other analyses have shown how the influence of some factors may be masked by other, stronger factors. While it is recognised that case-control studies of this nature cannot prove causation, plausible causative mechanisms can be reasoned for some of the associations (e.g. number of hours per week spent keying). Recommendations are made, based on the findings of this study, supported by others published in the scientific literature, together with practical experience. It is hoped that these will reduce the risk of such injuries occurring.

9.2 JOB DESIGN AND WORK CHARACTERISTICS

The case-control study showed a strong association between case status and number of hours of keyboard use in a week and with period of keyboard use without a break. The association of symptoms with hours of use increased steadily with increased keyboard use and did not reveal any critical duration or other 'break-point' from which a maximum recommended period of use per week could be derived. Any recommendations for limiting use based on this finding would therefore be based on some arbitrary criterion such as a doubling of risk. It is not therefore proposed at this point to make any recommendation regarding maximum keyboard usage per week. However, it is clear that those using a keyboard most extensively are most likely to experience upper limb pain and discomfort. Jobs which allow keyboard operators to undertake other tasks away from the keyboard will reduce the risk of developing upper limb symptoms, although it is not possible to say what proportion of the work time should be spent away from the keyboard.

Length of keyboard use without a break revealed a less gradual increase in risk, with periods of keyboard use without a break in excess of two hours creating a significant increase in risk of experiencing symptoms. This was not documented as a continuous variable however and should therefore be interpreted with caution. The current Health and Safety (Display Screen Equipment) Regulations 1992 require employers to plan for periodic breaks or changes of activity (Regulation 4). No period is specified in the Regulation, although the accompanying guidance refers to 5-10 minutes every hour and this appears to have developed as the 'norm' through custom and practice. The current research offers clear support for the idea that extensive periods of work at the keyboard, uninterrupted by breaks are to be discouraged and can be seen as endorsing the need for regular breaks as embodied in this Regulation.

The study identified associations between a number of factors which could be interpreted as being indicative of psychological pressures and frustrations, and experiencing symptoms of ULDs. Whilst not conclusive, and individually open to alternative interpretations, collectively they add support to the growing body of literature which presents evidence for such a link. Psychologically-mediated tension, particularly in the shoulder-neck region, could theoretically contribute to mechanisms for causing or aggravating symptoms, although the possibility cannot be discounted that psychological 'dissatisfaction' may be a product of continual pain or discomfort. Some elements of display screen equipment work with the potential to cause annoyance or frustration, notably the software used, are covered by the DSE Regulations. In practice, such factors are difficult to assess effectively. Nevertheless, the emergence of issues such as frustration with software in the present study offers support for a need to attend to the psychological as well as the physical loads in assessing keyboard work. As well as frustrations related to the use of the DSE, the wider psychosocial factors in the organisation (such as emphasis on hard work, support from peers) need to be considered.

9.3 FURNITURE, EQUIPMENT AND THE WORKING ENVIRONMENT

Office furniture is of course covered extensively by the DSE Regulations. Of all the factors relating to the furniture examined by the present study, aspects of the seating emerged as being most commonly associated with having ULD symptoms. The authors' experience in a wide variety of office environments, with jobs ranging from highly ordered data entry tasks through to the individualistic styles often associated with computer programming, strongly support this finding. Problems with seating, often easily rectified, were commonly encountered during the case-control study and have also often been identified in other office workplaces not associated with this study.

During the life of this project, the DSE Regulations came into force, although compliance with the Schedule of Minimum Requirements was not initially required for existing workstations. In the majority of workplaces visited during this study these Regulations had, at least in part, been implemented and 'assessments' conducted. However, in many instances, the benefits of compliance with the Schedule had largely been negated by inadequate implementation of the requirement for training staff in the correct adjustment and use of furniture. At many of the sites visited during the case-control phase, subjects (cases and controls) indicated that they had only received limited training in connection with the Regulations. Lack of knowledge of the correct seating posture, as well as how to adjust the chair, was widespread and correct adjustment could bring an immediate improvement in sitting posture and often an immediately stated improvement in postural comfort. However, even with seating which apparently complied with the requirements of the Schedule, this was not always possible. Although, for reasons discussed earlier, armrests did not emerge from the statistical analysis in the expected direction, experience during the case-control studies, supported by widespread experience elsewhere, identified postural deficiencies associated with armrests as the most commonly encountered problem with seating. Armrests may intrude into the occupant's arm space, causing a variety of compensatory changes in arm or shoulder posture. Alternatively they may create conflicts with the desk either when sitting at the keyboard or when attempting to move away from the keyboard to retrieve papers, answer the telephone, etc. In general, the conclusion may be reached that chairs allow a better posture to be adopted if they are provided without armrests. The results of the study suggest that general complaints about seating should be attended to, as this was the factor most strongly associated with ULD symptoms. Although it could be argued that those who complained about their seating did so because they experienced discomfort, seating complaints should still be investigated.

Characteristics more often associated with older equipment, such as non-tiltable keyboards; screens which did not swivel; and deteriorating (flickering) displays; were often significantly associated with case status. These features are all covered by the provisions of the Schedule of Minimum Requirements in the DSE Regulations, and compliance with this Schedule, (a requirement for all workstations since January 1997) should avoid the risk of such factors contributing in some way to ULD symptoms.

In a similar manner, widespread environmental problems, particularly those relating to lighting, should be identified and rectified through adequate implementation of the provisions of the DSE Regulations. Wherever possible, complaints about the physical environment should be addressed as this was significantly associated with many symptoms of ULDs.

9.4 WORKING POSTURE

Although only persisting through to the final regression for one syndrome group, tending to be a heavy-handed 'clacker' when keying did feature in many of the initial analyses. Coupled with a lack of typing skill, this produces a characteristic typing style observed during the case-control studies with the individual hunched over the keys (looking down at them rather than at the screen) and hammering the keyboard. Acquiring improved typing skills so that the keyboard user looks at the screen or documents (ideally on a document holder), and training in reducing keying force may ameliorate such postures and associated neck and upper limb problems.

Finally, although the most direct evaluations of posture in the case-control study failed to identify consistently significant factors, a number of indirect indicators were identified. Whilst not necessarily indicative of a causative relationship, working with significant prolonged asymmetry in posture (e.g. neck flexion and rotation) or with marked deviation from an anatomically neutral position (e.g. shoulder elevation) undoubtedly creates unnecessary and avoidable loading on the musculoskeletal system which has the potential to exacerbate pre-existing symptoms. Again, careful and thorough implementation of the DSE Regulations, including competent risk assessments and adequate training for users in obtaining and maintaining a good posture, should identify and remove such factors, helping to reduce ULD symptoms amongst keyboard users. The importance of varying posture should be stressed.

10. SUMMARY AND CONCLUSIONS

1. Responses to a questionnaire completed by 3503 keyboard users (79% of sample), drawn from a total of 61 locations representing 11 different organisations, showed that approximately 55% had experienced symptoms associated with upper limb disorders at some time and 49% stated that they had experienced such symptoms within the preceding three months.

2. Fourteen percent of the total sample stated that they had sought medical or other professional advice regarding their symptoms.

3. Care should be taken in placing any wider interpretation on these figures as the participating companies were not randomly selected.

4. 959 subjects, drawn from the 3503 respondents to the questionnaire, were classified into six syndrome groups based on their questionnaire responses: Trigger Digit; Nerve Entrapment; Tendon Disorders; Epicondylitis; Shoulder Disorders; and Forearm Pain. Small-scale examinations of medical diagnoses tended to confirm these classifications.

5. A case-control study, involving workplace evaluations of 295 of these subjects experiencing symptoms, together with 154 symptom-free controls, showed a significant positive association between case status and increased age for three of these syndrome groups together with an overall 'Any Syndrome' classification. These were the Nerve Entrapment; Epicondylitis; and Shoulder Disorders syndrome groups. Weak trends for two other groups (Tendon Disorders and Forearm Pain) were not statistically significant.

6. The case-control study also showed a significant association between case status and gender for four of the six syndrome groups (Nerve Entrapment; Tendon Disorders; Shoulder Disorders and Forearm Pain) together with the Any Syndrome group, with females being significantly more likely to be cases in all of these groups.

7. Those who spent most time using a keyboard or who had the longest periods of keyboard use without a break were significantly more likely to be a case. This held for all syndrome groups when the influence of age, gender and medical conditions was taken into account. This association was highly significant.

8. Workplace and work equipment factors, particularly seating and deficiencies in the display screen equipment provided, often emerged as significant factors. Some of the equipment-related factors which showed association with ULD symptoms appeared to relate to older equipment. Compliance with the Health and Safety (Display Screen Equipment) Regulations 1992 should reduce this risk.

9. Dissatisfaction with the physical environment, and complaints about disturbances from noise or other environmental factors (smells, draughts, extremes of temperatures) was associated with symptoms of ULDs.

10. A number of the equipment or furniture-related problems could be interpreted as indicating a likely effect on working posture. However, few direct assessments of postural factors emerged as significant factors. One factor was that of heavy-handed use of the keyboard which was significantly associated with case status in three of the six syndrome groups (Nerve Entrapment; Shoulder Disorders; and Forearm Pain) together with the Any Syndrome group.

11. Analysis of wrist postures, measured using electrogoniometers, did not generally differentiate between cases and controls. In particular, the data did not support ulnar deviation of the wrist as a causative factor in ULDs.

12. Psychosocial work factors were found to be associated with symptoms of ULDs, such as experiencing frustration problems with the programs, and wider organisational issues such as an emphasis placed on hard work and a lack of support from peers.

13. Multiple regression analyses, adjusting for age and/or gender as appropriate, showed diagnosed arthritic conditions to be significantly associated with a small proportion of cases.

14. Some factors outside work were also associated with symptoms of ULDs. In particular, participating in sports or hobbies which involve repetitive, awkward or forceful hand or arm movements (e.g. racket sports, knitting, computer games) was associated with experiencing symptoms of ULDs.

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TABLES OF RESULTS

Table 4.1 **Numbers of subjects by organisation or company, and symptom group (% in brackets)**

Symptom Group	Organisation or Company (2 digit code)											
	01	02	03	04	05	10	11	12	15	16	17	All
Asymptomatic	95 (37)	160 (49)	166 (32)	302 (48)	280 (50)	57 (48)	15 (50)	105 (63)	141 (42)	232 (45)	26 (42)	1579 (45)
"Old" symptoms	25 (10)	22 (7)	26 (5)	36 (6)	27 (5)	8 (7)	1 (3)	7 (4)	19 (6)	29 (6)	4 (6)	204 (6)
Recent mild symptoms	102 (39)	94 (29)	231 (45)	185 (30)	175 (31)	42 (35)	11 (37)	37 (22)	120 (36)	192 (38)	28 (45)	1217 (35)
Recent severe symptoms	37 (14)	50 (15)	88 (17)	101 (16)	78 (14)	13 (11)	3 (10)	18 (11)	53 (16)	58 (11)	4 (6)	503 (14)
All	259 (100)	326 (100)	511 (100)	624 (100)	560 (100)	120 (100)	30 (100)	167 (100)	333 (100)	511 (100)	62 (100)	3503 (100)

Codes 01 - 05 : Civil Service
Codes 10 - 17 : Private Sector

Table 4.2 Numbers of subjects by sex and symptom group (% in brackets)

Symptom Group	SEX		
	M	F	All
Asymptomatic	748 (51)	821 (41)	1569 (45)
"Old" symptoms	78 (5)	124 (6)	202 (6)
Recent mild symptoms	488 (33)	718 (36)	1206 (35)
Recent severe symptoms	163 (11)	338 (17)	501 (14)
All	1477 (100)	2001 (100)	*3478 (100)

* 25 subjects did not enter M/F on the questionnaire

Table 4.3 Numbers of subjects by age and symptom group (% in brackets)

Symptom Group	AGE					
	<24	25-34	35-44	45-54	55-	All
Asymptomatic	400 (45)	534 (49)	328 (44)	216 (39)	101 (44)	1579 (45)
"Old" symptoms	47 (5)	63 (6)	44 (6)	34 (6)	16 (7)	204 (6)
Recent mild symptoms	355 (40)	384 (35)	253 (34)	158 (29)	67 (29)	1217 (35)
Recent severe symptoms	89 (10)	112 (10)	115 (16)	142 (26)	45 (20)	503 (14)
All	891 (100)	1093 (100)	740 (100)	550 (100)	229 (100)	3503 (100)

Table 4.4 **Numbers of subjects by symptom group and accident indicator variable (ie. whether or not subjects associated any symptoms they reported with a specific accident or injury) (% in brackets)**

Symptom Group	Symptoms associated with accident or injury		
	No	Yes	All
Old symptoms	158 (79)	41 (21)	199 (100)
Recent mild symptoms	1052 (88)	148 (12)	1200 (100)
Recent severe symptoms	297 (60)	199 (40)	496 (100)
* All	1507 (80)	388 (20)	1895 (100)

* 1579 subjects did not report any symptoms. Of the 1924 subjects with symptoms, 29 did not respond to this item.

Table 5.1 Definitions of Syndrome Groups in Terms of Present Symptoms

Syndrome Group	Syndromes	Symptoms
Trigger Digit	Trigger finger/Trigger thumb	A2
Nerve Entrapment	Carpal tunnel syndrome/Ulnar neuritis/Thoracic outlet syndrome	A1 and A5 and A6
Tendon Disorders	De Quervain's disease/Tenosynovitis	(C1 or C4) and C3
Epicondylitis	Tennis elbow/Golfer's elbow	D1 and D2
Shoulder Disorders	Frozen shoulder/Rotator cuff tendinitis/Osteoarthritis of acromio-clavicular joint	E1 and E2
Forearm Pain	Forearm pain	C3

Table 5.2 **Number and percentage (in bold) of potential cases in syndrome groups by severity, purity and newness**

	Trigger Digit	Nerve Entrapment	Tendon Disorders
Severe	54 **(26.6)**	90 **(37.0)**	33 **(39.3)**
Not severe	149 **(73.4)**	153 **(63.0)**	51 **(60.7)**
Pure	82 **(40.4)**	52 **(21.4)**	0 **(0.0)**
Not pure	121 **(59.6)**	191 **(78.6)**	84 **(100)**
New	68 **(33.5)**	40 **(16.5)**	15 **(17.9)**
Not new	135 **(66.5)**	203 **(83.5)**	69 **(82.1)**
Total	203 **(100)**	243 **(100)**	84 **(100)**

	Epicondylitis	Shoulder Disorders	Forearm pain
Severe	70 **(41.7)**	196 **(38.3)**	97 **(25.5)**
Not severe	98 **(58.3)**	316 **(61.7)**	283 **(74.5)**
Pure	44 **(26.2)**	278 **(54.3)**	118 **(31.1)**
Not pure	124 **(73.8)**	234 **(45.7)**	262 **(68.9)**
New	42 **(25.0)**	121 **(23.6)**	110 **(28.9)**
Not new	126 **(75.0)**	391 **(76.4)**	270 **(71.1)**
Total	168 **(100)**	512 **(100)**	380 **(100)**

Table 5.3 **Number and percentage (in bold) of potential cases in each syndrome group and controls by age group and sex**

		SYNDROME GROUP						
Sex	Age	Trigger Digit	Nerve Entrapment	Tendon Disorders	Epicondylitis	Shoulder Disorders	Forearm Pain	Controls
Males	15-24	24	14	7	8	35	28	156
	%	**32**	**23**	**41**	**16**	**23**	**27**	**22**
	25-34	20	18	6	10	47	33	257
	%	**27**	**30**	**35**	**20**	**30**	**32**	**36**
	35-44	14	15	1	14	35	16	168
	%	**19**	**25**	**6**	**28**	**23**	**16**	**24**
	45-54	12	10	3	15	25	20	89
	%	**16**	**17**	**18**	**30**	**16**	**20**	**12**
	55+	4	3	0	3	12	5	37
	%	**5**	**5**	**0**	**6**	**8**	**5**	**5**
	Total	74	60	17	50	154	102	707
	%	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Females	15-24	28	29	11	16	76	50	202
	%	**22**	**16**	**17**	**14**	**22**	**19**	**26**
	25-34	34	42	19	26	81	73	257
	%	**27**	**24**	**29**	**23**	**23**	**27**	**33**
	35-44	20	44	14	24	75	71	145
	%	**16**	**25**	**22**	**22**	**21**	**26**	**19**
	45-54	31	42	16	32	85	57	119
	%	**25**	**24**	**25**	**29**	**24**	**21**	**15**
	55+	12	19	5	13	32	18	56
	%	**10**	**11**	**8**	**12**	**9**	**7**	**7**
	Total	125	176	65	111	349	269	779
	%	**100**	**100**	**100**	**100**	**100**	**100**	**100**

24 cases and 28 controls had missing age or sex information.

Table 5.4 **Power of Detecting Odds Ratios = 2 or 3 at 5% Significant Level for a Range of Values of Percentage Exposed in the Control Group**

Percent exposed (controls)	Power or Percent Probability (%) of detecting a statistically significant difference (P = 0.05) when the underlying odds ratio is:	
	OR = 2	OR = 3
10	50	90
20	64	97
30	71	98
40	72	98
50	71	97
60	62	94
70	48	87
80	36	61
90	13	26

Table 5.5 **Number and Percentage Pair-wise of Inter-Observer Agreements for Selected Postural Measures**

Risk Factor	No. of Agreements	Percentage (Out of 27)
Right arm abducted	26	96
Left arm abducted	26	96
Right hand - percentage of time spent keying *	20	74
Left hand - percentage of time spent keying *	20	74
Right arm flexion/extension	26	96
Left arm flexion/extension	20	74
Right wrist rested on desk	25	93
Left wrist rested on desk	26	96
Right wrist higher than elbow	20	74
Left wrist higher than elbow	22	81
Stretching of interdigital skin	22	81
Typing style	25	93
Tendency to be a clacker	14	52

* agreement within 10%

Table 5.6 **Number and Percentage of Intra-observer Agreements for Selected Postural Measures**

Risk Factor	No. of Agreements	Percentage (out of 27)
Right arm abducted	8	100
Left arm abducted	7	88
Right hand - percentage of time spent keying	8	100
Left hand - percentage of time spent keying	8	100
Right arm flexion/extension	7	88
Left arm flexion/extension	8	100
Right wrist rested on desk	6	75
Left wrist rested on desk	7	88
Right wrist higher than elbow	4	50
Left wrist higher than elbow	4	50
Stretching of interdigital skin	4	50
Typing style	8	100
Tendency to be a clacker	8	100

Table 6.1 **Number and percentage (in bold) of cases in each syndrome group compared to controls by age group and sex**

Sex	Age	Any Syndrome	Trig. Digit	Nerve Entrap -ment	Tendon Dis-orders	Epicondy -litis	Shoulder Dis-orders	Fore-arm Pain	Controls
Males	15-24	22	7	2	3	3	7	9	18
	%	**21.4**	**26.9**	**15.4**	**37.5**	**13.6**	**13.7**	**26.5**	**24.0**
	25-34	34	9	4	2	4	16	9	21
	%	**33.0**	**34.6**	**30.8**	**25.0**	**18.2**	**31.4**	**26.5**	**28.0**
	35-44	24	7	2	1	6	15	5	19
	%	**23.3**	**26.9**	**15.4**	**12.5**	**27.3**	**29.4**	**14.7**	**25.3**
	45-54	20	3	4	2	8	11	9	15
	%	**19.4**	**11.5**	**30.8**	**25.0**	**36.4**	**21.6**	**26.5**	**20.0**
	55+	3	0	1	0	1	2	2	2
	%	**2.9**	**0.0**	**7.7**	**0.0**	**4.5**	**3.9**	**5.9**	**2.7**
	Total	103	26	13	8	22	51	34	75
	% Males	**34.9**	**40.0**	**17.3**	**21.1**	**38.6**	**32.9**	**25.8**	**48.7**
Females	15-24	27	6	6	3	2	13	16	21
	%	**14.1**	**15.4**	**9.7**	**10.0**	**5.7**	**12.5**	**16.3**	**26.6**
	25-34	57	15	17	10	8	27	25	21
	%	**29.7**	**38.5**	**27.4**	**33.3**	**22.9**	**26.0**	**25.5**	**26.6**
	35-44	54	10	19	12	12	30	33	21
	%	**28.1**	**25.6**	**30.6**	**40.0**	**34.3**	**28.8**	**33.7**	**26.6**
	45-54	40	7	15	3	10	27	21	13
	%	**20.8**	**17.9**	**24.2**	**10.0**	**28.6**	**26.0**	**21.4**	**16.5**
	55+	14	1	5	2	3	7	3	3
	%	**7.3**	**2.6**	**8.1**	**6.7**	**8.6**	**6.7**	**3.1**	**3.8**
	Total	192	39	62	30	35	104	98	79
	% Females	**65.1**	**60.0**	**82.7**	**78.9**	**61.4**	**67.1**	**74.2**	**51.3**

Table 6.2 Means and standard deviations of continuous variables from the Structured Interview in cases and controls (Medians and ranges are given for skewed data).

		Any Syndrome (n=295)	Trigger Digit (n=65)	Nerve Entrapment (n=75)	Tendon Disorders(n=38)	Epicondylitis (n=57)	Shoulder Disorders (n=155)	Forearm Pain (n=132)	Controls (n=154)
Years experience with keyboard	**Median**	**10.0**	**10.0**	**12.0**	**10.5**	**15.0**	**10.0**	**10.0**	**9.0**
	Range	2, 45	3, 38	2, 42	2, 44	2, 42	2, 45	2, 44	2, 35
	Nmiss	0	0	0	0	0	0	0	1
	p-value	0.30	0.77	0.01	0.51	0.003	0.57	0.25	-
No. hours keying per week	**Mean**	**18.18**	**22.13**	**20.63**	**21.03**	**20.46**	**16.71**	**19.46**	**12.87**
	s.d.	11.03	10.97	11.41	11.51	11.71	10.56	11.37	9.11
	Nmiss	10	4	3	4	5	5	4	7
	p-value	0.0001	0.0001	0.0001	0.0004	0.0001	0.001	0.0001	-
No. hours risky sports or hobbies per week	**Median**	**5.0**	**7.0**	**4.0**	**5.0**	**6.0**	**5.0**	**5.0**	**3.0**
	Range	0, 48	0, 48	0, 28	0, 30	0, 33	0, 48	0, 30	0, 35
	Nmiss	9	1	2	2	1	4	6	6
	p-value	0.005	0.009	0.11	0.28	0.01	0.02	0.03	-

Nmiss = number missing.

p-values are for t-tests of each syndrome group vs. controls; for skewed data the tests were carried out on log transformed values.

Table 6.3 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Any Syndrome group compared to controls**

		Cases (n=295)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	17	**5.8**	20	**13.2**	4	0.007
	Visual	128	**43.7**	74	**48.7**		
	Audible	9	**3.1**	6	**3.9**		
	V and A	81	**27.6**	23	**15.1**		
	T and V	58	**19.8**	29	**19.1**		
Visual	Flat on desk	225	**76.3**	117	**76.0**	0	0.03
	Doc. holder	35	**11.9**	6	**3.9**		
	Other	7	**2.4**	3	**1.9**		
	NA	28	**9.5**	28	**18.2**		
Audible	Direct/ Recording	43	**14.6**	11	**7.1**	0	0.06
	Tel. hand held	36	**12.2**	9	**5.8**		
	Tel. Head set	11	**3.7**	9	**5.8**		
	NA	205	**69.5**	125	**81.2**		
Diffs. reading	Yes	115	**39.4**	31	**20.1**	3	0.0001
	No	177	**60.6**	123	**79.9**		
Accessories	Mouse	72	**24.4**	37	**24.0**	0	0.94
	Other	8	**2.7**	5	**3.2**		
	NA	215	**72.9**	112	**72.7**		
Frustr. progs	Yes	168	**57.9**	62	**40.3**	5	0.0004
	No	122	**42.1**	92	**59.7**		
Able to take breaks	Yes	236	**81.1**	141	**93.4**	7	0.0005
	No	55	**18.9**	10	**6.6**		
Busy periods	Yes	161	**54.9**	74	**48.1**	2	0.16
	No	132	**45.1**	80	**51.9**		
Spec. rate keying	Yes	39	**13.3**	6	**3.9**	2	0.002
	No	223	**76.1**	138	**89.6**		
	NA	31	**10.6**	10	**6.5**		

Table 6.4 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Trigger Digit syndrome group compared to controls**

		Cases (n=65)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	5	**7.8**	20	**13.2**	3	0.09
	Visual	31	**48.4**	74	**48.7**		
	Audible	1	**1.6**	6	**3.9**		
	V and A	19	**29.7**	23	**15.1**		
	T and V	8	**12.5**	29	**19.1**		
Visual	Flat on desk	47	**72.3**	117	**76.0**	0	0.01
	Doc. holder	11	**16.9**	6	**3.9**		
	Other	0	**0.0**	3	**1.9**		
	NA	7	**10.8**	28	**18.2**		
Audible	Direct/ Recording	9	**13.8**	11	**7.1**	0	0.52
	Tel. hand held	7	**10.8**	9	**5.8**		
	Tel. Head set	2	**3.1**	9	**5.8**		
	NA	47	**72.3**	125	**81.2**		
Diffs. reading	Yes	24	**36.9**	31	**20.1**	0	0.009
	No	41	**63.1**	123	**79.9**		
Accessories	Mouse	20	**30.8**	37	**24.0**	0	0.63
	Other	0	**0.0**	5	**3.2**		
	NA	45	**69.2**	112	**72.7**		
Frustr. progs	Yes	36	**55.4**	62	**40.3**	0	0.04
	No	29	**44.6**	92	**59.7**		
Able to take breaks	Yes	48	**73.8**	141	**93.4**	3	0.0001
	No	17	**26.2**	10	**6.6**		
Busy periods	Yes	29	**44.6**	74	**48.1**	0	0.64
	No	36	**55.4**	80	**51.9**		
Spec. rate keying	Yes	12	**18.5**	6	**3.9**	0	0.0006
	No	46	**70.8**	138	**89.6**		
	NA	7	**10.8**	10	**6.5**		

Table 6.5 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Nerve Entrapment syndrome group compared to controls**

		Cases (n=75)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	2	**2.7**	20	**13.2**	2	0.007
	Visual	29	**38.7**	74	**48.7**		
	Audible	2	**2.7**	6	**3.9**		
	V and A	23	**30.7**	23	**15.1**		
	T and V	19	**25.3**	29	**19.1**		
Visual	Flat on desk	56	**74.7**	117	**76.0**	0	0.01
	Doc. holder	12	**16.0**	6	**3.9**		
	Other	3	**4.0**	3	**1.9**		
	NA	4	**5.3**	28	**18.2**		
Audible	Direct/ Recording	15	**20.0**	11	**7.1**	0	0.20
	Tel. hand held	8	**10.7**	9	**5.8**		
	Tel. Head set	2	**2.7**	9	**5.8**		
	NA	50	**66.7**	125	**81.2**		
Diffs. reading	Yes	32	**42.7**	31	**20.1**	0	0.0003
	No	43	**57.3**	123	**79.9**		
Accessories	Mouse	18	**24.0**	37	**24.0**	0	0.89
	Other	1	**1.3**	5	**3.2**		
	NA	56	**74.7**	112	**72.7**		
Frustr. progs	Yes	38	**50.7**	62	**40.3**	0	0.14
	No	37	**49.3**	92	**59.7**		
Able to take breaks	Yes	54	**73.0**	141	**93.4**	4	0.0001
	No	20	**27.0**	10	**6.6**		
Busy periods	Yes	40	**54.1**	74	**48.1**	1	0.40
	No	34	**45.9**	80	**51.9**		
Spec. rate keying	Yes	14	**18.9**	6	**3.9**	1	0.0001
	No	50	**67.6**	138	**89.6**		
	NA	10	**13.5**	10	**6.5**		

Table 6.6 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Tendon Disorders syndrome group compared to controls**

		Cases (n=38)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	4	**10.5**	20	**13.2**	2	0.23
	Visual	16	**42.1**	74	**48.7**		
	Audible	1	**2.6**	6	**3.9**		
	V and A	12	**31.6**	23	**15.1**		
	T and V	5	**13.2**	29	**19.1**		
Visual	Flat on desk	24	**63.2**	117	**76.0**	0	0.007
	Doc. holder	7	**18.4**	6	**3.9**		
	Other	1	**2.6**	3	**1.9**		
	NA	6	**15.8**	28	**18.2**		
Audible	Direct/ Recording	7	**18.4**	11	**7.1**	0	0.71
	Tel. hand held	3	**7.9**	9	**5.8**		
	Tel. Head set	3	**7.9**	9	**5.8**		
	NA	25	**65.8**	125	**81.2**		
Diffs. reading	Yes	19	**50.0**	31	**20.1**	0	0.0002
	No	19	**50.0**	123	**79.9**		
Accessories	Mouse	10	**26.3**	37	**24.0**	0	0.79
	Other	0	**0.0**	5	**3.2**		
	NA	28	**73.7**	112	**72.7**		
Frustr. progs	Yes	20	**52.6**	62	**40.3**	0	0.17
	No	18	**47.4**	92	**59.7**		
Able to take breaks	Yes	28	**73.7**	141	**93.4**	3	0.0004
	No	10	**26.3**	10	**6.6**		
Busy periods	Yes	21	**55.3**	74	**48.1**	2	0.43
	No	17	**44.7**	80	**51.9**		
Spec. rate keying	Yes	4	**10.5**	6	**3.9**	0	0.01
	No	27	**71.1**	138	**89.6**		
	NA	7	**18.4**	10	**6.5**		

Table 6.7 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Epicondylitis syndrome group compared to controls**

		Cases (n=57)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	5	**8.8**	20	**13.2**	2	0.01
	Visual	19	**33.3**	74	**48.7**		
	Audible	1	**1.8**	6	**3.9**		
	V and A	21	**36.8**	23	**15.1**		
	T and V	11	**19.3**	29	**19.1**		
Visual	Flat on desk	40	**70.2**	117	**76.0**	0	0.007
	Doc. holder	10	**17.5**	6	**3.9**		
	Other	1	**1.8**	3	**1.9**		
	NA	6	**10.5**	28	**18.2**		
Audible	Direct/ Recording	12	**21.1**	11	**7.1**	0	0.18
	Tel. hand held	8	**14.0**	9	**5.8**		
	Tel. Head set	1	**1.8**	9	**5.8**		
	NA	36	**63.2**	125	**81.2**		
Diffs. reading	Yes	37	**66.1**	31	**20.1**	1	0.0001
	No	19	**33.9**	123	**79.9**		
Accessories	Mouse	14	**24.6**	37	**24.0**	0	0.74
	Other	2	**3.5**	5	**3.2**		
	NA	41	**71.9**	112	**72.7**		
Frustr. progs	Yes	32	**57.1**	62	**40.3**	1	0.03
	No	24	**42.9**	92	**59.7**		
Able to take breaks	Yes	42	**73.7**	141	**93.4**	3	0.0001
	No	15	**26.3**	10	**6.6**		
Busy periods	Yes	29	**51.8**	74	**48.1**	1	0.63
	No	27	**48.2**	80	**51.9**		
Spec. rate keying	Yes	9	**15.8**	6	**3.9**	0	0.008
	No	43	**75.4**	138	**89.6**		
	NA	5	**8.8**	10	**6.5**		

Table 6.8 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Shoulder Disorders syndrome group compared to controls**

		Cases (n=155)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	5	**3.2**	20	**13.2**	3	0.002
	Visual	68	**44.2**	74	**48.7**		
	Audible	3	**1.9**	6	**3.9**		
	V and A	44	**28.6**	23	**15.1**		
	T and V	34	**22.1**	29	**19.1**		
Visual	Flat on desk	125	**80.6**	117	**76.0**	0	0.16
	Doc. holder	15	**9.7**	6	**3.9**		
	Other	6	**3.9**	3	**1.9**		
	NA	9	**5.8**	28	**18.2**		
Audible	Direct/ Recording	25	**16.1**	11	**7.1**	0	0.12
	Tel. hand held	20	**12.9**	9	**5.8**		
	Tel. Head set	5	**3.2**	9	**5.8**		
	NA	105	**67.7**	125	**81.2**		
Diffs. reading	Yes	61	**39.6**	31	**20.1**	1	0.0002
	No	93	**60.4**	123	**79.9**		
Accessories	Mouse	37	**23.9**	37	**24.0**	0	0.92
	Other	5	**3.2**	5	**3.2**		
	NA	113	**72.9**	112	**72.7**		
Frustr. progs	Yes	88	**57.9**	62	**40.3**	3	0.002
	No	64	**42.1**	92	**59.7**		
Able to take breaks	Yes	133	**87.5**	141	**93.4**	6	0.08
	No	19	**12.5**	10	**6.6**		
Busy periods	Yes	92	**60.1**	74	**48.1**	2	0.03
	No	61	**39.9**	80	**51.9**		
Spec. rate keying	Yes	20	**12.9**	6	**3.9**	0	0.004
	No	118	**76.1**	138	**89.6**		
	NA	17	**11.0**	10	**6.5**		

Table 6.9 **Number and percentage (bold) in response to Section A of the Structured Interview in cases in the Forearm Pain syndrome group compared to controls**

		Cases (n=132)		Controls (n=154)		No. missing	p-value
Information presented	Top of head	7	**5.3**	20	**13.2**	3	0.03
	Visual	62	**47.3**	74	**48.7**		
	Audible	5	**3.8**	6	**3.9**		
	V and A	37	**28.2**	23	**15.1**		
	T and V	20	**15.3**	29	**19.1**		
Visual	Flat on desk	98	**74.2**	117	**76.0**	0	0.02
	Doc. holder	19	**14.4**	6	**3.9**		
	Other	3	**2.3**	3	**1.9**		
	NA	12	**9.1**	28	**18.2**		
Audible	Direct/ Recording	23	**17.4**	11	**7.1**	0	0.06
	Tel. hand held	15	**11.4**	9	**5.8**		
	Tel. Head set	4	**3.0**	9	**5.8**		
	NA	90	**68.2**	125	**81.2**		
Diffs. reading	Yes	49	**37.7**	31	**20.1**	2	0.001
	No	81	**62.3**	123	**79.9**		
Accessories	Mouse	27	**20.5**	37	**24.0**	0	0.49
	Other	1	**0.7**	5	**3.2**		
	NA	104	**78.8**	112	**72.7**		
Frustr. progs	Yes	69	**53.1**	62	**40.3**	2	0.03
	No	61	**46.9**	92	**59.7**		
Able to take breaks	Yes	97	**74.6**	141	**93.4**	5	0.0001
	No	33	**25.4**	10	**6.6**		
Busy periods	Yes	68	**51.5**	74	**48.1**	0	0.56
	No	64	**48.5**	80	**51.9**		
Spec. rate keying	Yes	19	**14.6**	6	**3.9**	2	0.002
	No	99	**76.2**	138	**89.6**		
	NA	12	**9.2**	10	**6.5**		

Table 6.10 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Any Syndrome group compared to controls**

		Cases (n=295)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	152	**51.9**	93	**62.8**	8	0.03
	No	141	**48.1**	55	**37.2**		
Seat height adjustment	Yes	287	**98.0**	148	**98.0**	5	0.97
	No	6	**2.0**	3	**2.0**		
Backrest angle adjustment	Yes	167	**57.0**	98	**66.2**	8	0.06
	No	126	**43.0**	50	**33.8**		
Support upper back	Yes	59	**20.1**	40	**27.0**	7	0.09
	No	235	**79.9**	108	**73.0**		
Any problems with chair	Yes	132	**44.9**	42	**28.0**	5	0.0006
	No	162	**55.1**	108	**72.0**		
Footrest	Yes	103	**34.9**	34	**22.1**	0	0.005
	No	192	**65.1**	120	**77.9**		
Use document holder	Yes	42	**14.2**	9	**5.8**	0	0.008
	No	253	**85.8**	145	**94.2**		
Detachable keyboard	Yes	280	**96.2**	148	**97.4**	6	0.53
	No	11	**3.8**	4	**2.6**		
Tiltable keyboard	Yes	225	**77.1**	132	**87.4**	6	0.009
	No	67	**22.9**	19	**12.6**		
Prev. screen flicker	Yes	70	**23.7**	15	**9.7**	0	0.0001
	No	158	**53.6**	111	**72.1**		
	NA	67	**22.7**	28	**18.2**		
Screen swivel	Yes	223	**76.9**	128	**84.8**	8	0.05
	No	67	**23.1**	23	**15.2**		

Table 6.11 Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Trigger Digit syndrome group compared to controls

		Cases (n=65)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	27	**42.2**	93	**62.8**	7	0.005
	No	37	**57.8**	55	**37.2**		
Seat height adjustment	Yes	61	**96.8**	148	**98.0**	5	0.60
	No	2	**3.2**	3	**2.0**		
Backrest angle adjustment	Yes	30	**46.9**	98	**66.2**	7	0.008
	No	34	**53.1**	50	**33.8**		
Support upper back	Yes	15	**23.4**	40	**27.0**	7	0.58
	No	49	**76.6**	108	**73.0**		
Any problems with chair	Yes	35	**54.7**	42	**28.0**	5	0.0002
	No	29	**45.3**	108	**72.0**		
Footrest	Yes	26	**40.0**	34	**22.1**	0	0.007
	No	39	**60.0**	120	**77.9**		
Use document holder	Yes	15	**23.1**	9	**5.8**	0	0.0002
	No	50	**76.9**	145	**94.2**		
Detachable keyboard	Yes	62	**96.9**	148	**97.4**	3	0.84
	No	2	**3.1**	4	**2.6**		
Tiltable keyboard	Yes	49	**76.6**	132	**87.4**	4	0.04
	No	15	**23.4**	19	**12.6**		
Prev. screen flicker	Yes	20	**30.8**	15	**9.7**	0	0.0001
	No	31	**47.7**	111	**72.1**		
	NA	14	**21.5**	28	**18.2**		
Screen swivel	Yes	47	**73.4**	128	**84.8**	4	0.05
	No	17	**26.6**	23	**15.2**		

Table 6.12 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Nerve Entrapment syndrome group compared to controls**

		Cases (n=75)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	32	**43.2**	93	**62.8**	7	0.006
	No	42	**56.8**	55	**37.2**		
Seat height adjustment	Yes	73	**97.3**	148	**98.0**	3	0.74
	No	2	**2.7**	3	**2.0**		
Backrest angle adjustment	Yes	35	**47.3**	98	**66.2**	7	0.007
	No	39	**52.7**	50	**33.8**		
Support upper back	Yes	13	**17.6**	40	**27.0**	7	0.12
	No	61	**82.4**	108	**73.0**		
Any problems with chair	Yes	37	**50.0**	42	**28.0**	5	0.001
	No	37	**50.0**	108	**72.0**		
Footrest	Yes	32	**42.7**	34	**22.1**	0	0.001
	No	43	**57.3**	120	**77.9**		
Use document holder	Yes	17	**22.7**	9	**5.8**	0	0.0002
	No	58	**77.3**	145	**94.2**		
Detachable keyboard	Yes	70	**93.3**	148	**97.4**	2	0.14
	No	5	**6.7**	4	**2.6**		
Tiltable keyboard	Yes	55	**73.3**	132	**87.4**	3	0.008
	No	20	**26.7**	19	**12.6**		
Prev. screen flicker	Yes	20	**26.7**	15	**9.7**	0	0.0004
	No	39	**52.0**	111	**72.1**		
	NA	16	**21.3**	28	**18.2**		
Screen swivel	Yes	58	**77.3**	128	**84.8**	3	0.17
	No	17	**22.7**	23	**15.2**		

Table 6.13 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Tendon Disorders syndrome group compared to controls**

		Cases (n=38)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	15	**40.5**	93	**62.8**	7	0.01
	No	22	**59.5**	55	**37.2**		
Seat height adjustment	Yes	37	**97.4**	148	**98.0**	3	0.81
	No	1	**2.6**	3	**2.0**		
Backrest angle adjustment	Yes	20	**55.6**	98	**66.2**	8	0.23
	No	16	**44.4**	50	**33.8**		
Support upper back	Yes	5	**13.5**	40	**27.0**	7	0.09
	No	32	**86.5**	108	**73.0**		
Any problems with chair	Yes	16	**43.2**	42	**28.0**	5	0.07
	No	21	**56.8**	108	**72.0**		
Footrest	Yes	15	**39.5**	34	**22.1**	0	0.03
	No	23	**60.5**	120	**77.9**		
Use document holder	Yes	9	**23.7**	9	**5.8**	0	0.0007
	No	29	**76.3**	145	**94.2**		
Detachable keyboard	Yes	36	**94.7**	148	**97.4**	2	0.41
	No	2	**5.3**	4	**2.6**		
Tiltable keyboard	Yes	30	**78.9**	132	**87.4**	3	0.18
	No	8	**21.1**	19	**12.6**		
Prev. screen flicker	Yes	5	**13.1**	15	**9.7**	0	0.31
	No	21	**55.3**	111	**72.1**		
	NA	12	**31.6**	28	**18.2**		
Screen swivel	Yes	27	**73.0**	128	**84.8**	3	0.09
	No	10	**27.0**	23	**15.2**		

Table 6.14 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Epicondylitis syndrome group compared to controls**

		Cases (n=57)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	26	**45.6**	93	**62.8**	6	0.03
	No	31	**54.4**	55	**37.2**		
Seat height adjustment	Yes	56	**100.0**	148	**98.0**	4	0.29
	No	0	**0.0**	3	**2.0**		
Backrest angle adjustment	Yes	31	**54.4**	98	**66.2**	6	0.12
	No	26	**45.6**	50	**33.8**		
Support upper back	Yes	9	**15.8**	40	**27.0**	6	0.09
	No	48	**84.2**	108	**73.0**		
Any problems with chair	Yes	32	**56.1**	42	**28.0**	4	0.0002
	No	25	**43.9**	108	**72.0**		
Footrest	Yes	23	**40.4**	34	**22.1**	0	0.007
	No	34	**59.6**	120	**77.9**		
Use document holder	Yes	9	**15.8**	9	**5.8**	0	0.02
	No	48	**84.2**	145	**94.2**		
Detachable keyboard	Yes	49	**90.7**	148	**97.4**	5	0.04
	No	5	**9.3**	4	**2.6**		
Tiltable keyboard	Yes	39	**70.9**	132	**87.4**	5	0.005
	No	16	**29.1**	19	**12.6**		
Prev. screen flicker	Yes	11	**19.3**	15	**9.7**	0	0.009
	No	26	**45.6**	111	**72.1**		
	NA	20	**35.1**	28	**18.2**		
Screen swivel	Yes	40	**72.7**	128	**84.8**	5	0.05
	No	15	**27.3**	23	**15.2**		

Table 6.15 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Shoulder Disorders syndrome group compared to controls**

		Cases (n=155)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	89	**58.2**	93	**62.8**	8	0.41
	No	64	**41.8**	55	**37.2**		
Seat height adjustment	Yes	155	**100.0**	148	**98.0**	3	0.08
	No	0	**0.0**	3	**2.0**		
Backrest angle adjustment	Yes	89	**58.2**	98	**66.2**	8	0.15
	No	64	**41.8**	50	**33.8**		
Support upper back	Yes	33	**21.4**	40	**27.0**	7	0.26
	No	121	**78.6**	108	**73.0**		
Any problems with chair	Yes	75	**48.7**	42	**28.0**	5	0.0002
	No	79	**51.3**	108	**72.0**		
Footrest	Yes	56	**36.1**	34	**22.1**	0	0.007
	No	99	**63.9**	120	**77.9**		
Use document holder	Yes	17	**11.0**	9	**5.8**	0	0.10
	No	138	**89.0**	145	**94.2**		
Detachable keyboard	Yes	148	**96.7**	148	**97.4**	4	0.74
	No	5	**3.3**	4	**2.6**		
Tiltable keyboard	Yes	116	**75.3**	132	**87.4**	4	0.007
	No	38	**24.7**	19	**12.6**		
Prev. screen flicker	Yes	45	**29.0**	15	**9.7**	0	0.0001
	No	78	**50.3**	111	**72.1**		
	NA	32	**20.6**	28	**18.2**		
Screen swivel	Yes	110	**71.9**	128	**84.8**	3	0.007
	No	43	**28.1**	23	**15.2**		

Table 6.16 **Number and percentage (bold) in response to Section B of the Structured Interview in cases in the Forearm Pain syndrome group compared to controls**

		Cases (n=132)		Controls (n=154)		No. missing	p-value
Chair armrests	Yes	56	**42.7**	93	**62.8**	7	0.0008
	No	75	**57.3**	55	**37.2**		
Seat height adjustment	Yes	129	**97.7**	148	**98.0**	3	0.87
	No	3	**2.3**	3	**2.0**		
Backrest angle adjustment	Yes	69	**53.1**	98	**66.2**	8	0.03
	No	61	**46.9**	50	**33.8**		
Support upper back	Yes	22	**16.8**	40	**27.0**	7	0.04
	No	109	**83.2**	108	**73.0**		
Any problems with chair	Yes	59	**45.0**	42	**28.0**	5	0.003
	No	72	**55.0**	108	**72.0**		
Footrest	Yes	50	**37.9**	34	**22.1**	0	0.003
	No	82	**62.1**	120	**77.9**		
Use document holder	Yes	22	**16.7**	9	**5.8**	0	0.003
	No	110	**83.3**	145	**94.2**		
Detachable keyboard	Yes	122	**93.1**	148	**97.4**	3	0.09
	No	9	**6.9**	4	**2.6**		
Tiltable keyboard	Yes	103	**78.6**	132	**87.4**	4	0.048
	No	28	**21.4**	19	**12.6**		
Prev. screen flicker	Yes	22	**16.7**	15	**9.7**	0	0.04
	No	77	**58.3**	111	**72.1**		
	NA	33	**25.0**	28	**18.2**		
Screen swivel	Yes	106	**82.2**	128	**84.8**	6	0.56
	No	23	**17.8**	23	**15.2**		

Table 6.17 Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Any Syndrome group compared to controls

		Cases (n=295)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	147	**50.0**	79	**52.7**	5	0.14
	Sometimes	95	**32.3**	55	**36.7**		
	Always	52	**17.7**	16	**10.7**		
Lighting disturbed you	Never	115	**39.7**	69	**45.7**	8	0.36
	Sometimes	96	**33.1**	49	**32.5**		
	Always	79	**27.2**	33	**21.9**		
Other environ. factors	Yes	215	**72.9**	87	**56.5**	0	0.0004
	No	80	**27.1**	67	**43.5**		
Prev. job with repetitive movements	Yes	102	**34.7**	49	**32.0**	2	0.57
	No	192	**65.3**	104	**68.0**		
Second job with repet. movements	Yes	16	**5.5**	10	**6.5**	2	0.66
	No	277	**94.5**	144	**93.5**		
Exposed to vibration	Yes	71	**24.3**	18	**11.8**	4	0.002
	No	221	**75.7**	135	**88.2**		

Table 6.18 **Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Trigger Digit syndrome group compared to controls**

		Cases (n=65)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	33	**50.8**	79	**52.7**	4	0.43
	Sometimes	21	**32.3**	55	**36.7**		
	Always	11	**16.9**	16	**10.7**		
Lighting disturbed you	Never	26	**40.0**	69	**45.7**	3	0.70
	Sometimes	22	**33.8**	49	**32.5**		
	Always	17	**26.2**	33	**21.9**		
Other environ. factors	Yes	49	**75.4**	87	**56.5**	0	0.009
	No	16	**24.6**	67	**43.5**		
Prev. job with repetitive movements	Yes	28	**43.1**	49	**32.0**	1	0.12
	No	37	**56.9**	104	**68.0**		
Second job with repet. movements	Yes	5	**7.8**	10	**6.5**	1	0.73
	No	59	**92.2**	144	**93.5**		
Exposed to vibration	Yes	15	**23.8**	18	**11.8**	3	0.03
	No	48	**76.2**	135	**88.2**		

Table 6.19 Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Nerve Entrapment syndrome group compared to controls

		Cases (n=75)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	31	**41.9**	79	**52.7**	5	0.0007
	Sometimes	20	**27.0**	55	**36.7**		
	Always	23	**31.1**	16	**10.7**		
Lighting disturbed you	Never	26	**35.6**	69	**45.7**	5	0.22
	Sometimes	24	**32.9**	49	**32.5**		
	Always	23	**31.5**	33	**21.9**		
Other environ. factors	Yes	53	**70.7**	87	**56.5**	0	0.04
	No	22	**29.3**	67	**43.5**		
Prev. job with repetitive movements	Yes	25	**33.3**	49	**32.0**	1	0.84
	No	50	**66.7**	104	**68.0**		
Second job with repet. movements	Yes	5	**6.7**	10	**6.5**	0	0.96
	No	70	**93.3**	144	**93.5**		
Exposed to vibration	Yes	17	**23.0**	18	**11.8**	2	0.03
	No	57	**77.0**	135	**88.2**		

Table 6.20 **Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Tendon Disorders syndrome group compared to controls**

		Cases (n=38)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	16	**43.2**	79	**52.7**	5	0.01
	Sometimes	10	**27.0**	55	**36.7**		
	Always	11	**29.7**	16	**10.7**		
Lighting disturbed you	Never	14	**37.8**	69	**45.7**	4	0.66
	Sometimes	13	**35.1**	49	**32.5**		
	Always	10	**27.0**	33	**21.9**		
Other environ. factors	Yes	29	**76.3**	87	**56.5**	0	0.03
	No	9	**23.7**	67	**43.5**		
Prev. job with repetitive movements	Yes	13	**34.2**	49	**32.0**	1	0.80
	No	25	**65.8**	104	**68.0**		
Second job with repet. movements	Yes	2	**5.3**	10	**6.5**	0	0.78
	No	36	**94.7**	144	**93.5**		
Exposed to vibration	Yes	7	**18.4**	18	**11.8**	1	0.28
	No	31	**81.6**	135	**88.2**		

Table 6.21 **Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Epicondylitis syndrome group compared to controls**

		Cases (n=57)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	24	**42.9**	79	**52.7**	5	0.28
	Sometimes	22	**39.3**	55	**36.7**		
	Always	10	**17.9**	16	**10.7**		
Lighting disturbed you	Never	21	**38.9**	69	**45.7**	6	0.25
	Sometimes	15	**27.8**	49	**32.5**		
	Always	18	**33.3**	33	**21.9**		
Other environ. factors	Yes	42	**73.7**	87	**56.5**	0	0.02
	No	15	**26.3**	67	**43.5**		
Prev. job with repetitive movements	Yes	19	**33.3**	49	**32.0**	1	0.86
	No	38	**66.7**	104	**68.0**		
Second job with repet. movements	Yes	3	**5.3**	10	**6.5**	0	0.74
	No	54	**94.7**	144	**93.5**		
Exposed to vibration	Yes	16	**28.1**	18	**11.8**	1	0.004
	No	41	**71.9**	135	**88.2**		

Table 6.22 **Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Shoulder Disorders syndrome group compared to controls**

		Cases (n=155)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	72	**46.8**	79	**52.7**	5	0.43
	Sometimes	59	**38.3**	55	**36.7**		
	Always	23	**14.9**	16	**10.7**		
Lighting disturbed you	Never	54	**35.5**	69	**45.7**	6	0.07
	Sometimes	48	**31.6**	49	**32.5**		
	Always	50	**32.9**	33	**21.9**		
Other environ. factors	Yes	115	**74.2**	87	**56.5**	0	0.001
	No	40	**25.8**	67	**43.5**		
Prev. job with repetitive movements	Yes	57	**36.8**	49	**32.0**	1	0.38
	No	98	**63.2**	104	**68.0**		
Second job with repet. movements	Yes	9	**5.8**	10	**6.5**	0	0.80
	No	146	**94.2**	144	**93.5**		
Exposed to vibration	Yes	34	**22.1**	18	**11.8**	2	0.02
	No	120	**77.9**	135	**88.2**		

Table 6.23 **Number and percentage (bold) in response to Sections C and D of the Structured Interview in cases in the Forearm Pain syndrome group compared to controls**

		Cases (n=132)		Controls (n=154)		No. missing	p-value
Level noise disturbed you	Never	63	**48.1**	79	**52.7**	5	0.14
	Sometimes	43	**32.8**	55	**36.7**		
	Always	25	**19.1**	16	**10.7**		
Lighting disturbed you	Never	51	**39.2**	69	**45.7**	5	0.52
	Sometimes	45	**34.6**	49	**32.5**		
	Always	34	**26.2**	33	**21.9**		
Other environ. factors	Yes	99	**75.0**	87	**56.5**	0	0.001
	No	33	**25.0**	67	**43.5**		
Prev. job with repetitive movements	Yes	43	**32.8**	49	**32.0**	2	0.89
	No	88	**67.2**	104	**68.0**		
Second job with repet. movements	Yes	3	**2.3**	10	**6.5**	1	0.09
	No	128	**97.7**	144	**93.5**		
Exposed to vibration	Yes	29	**22.1**	18	**11.8**	2	0.02
	No	102	**77.9**	135	**88.2**		

Table 6.24 **Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Any Syndrome group compared to controls**

		Cases (n=295)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	155	**52.9**	72	**46.8**	2	0.43
	No	138	**47.1**	82	**53.2**		
Type of eyewear	Contacts	25	**16.1**	18	**25.0**	220	0.10
	Glasses	102	**65.8**	48	**66.7**		
	Bifocals	11	**7.1**	4	**5.6**		
	VDU glasses	17	**11.0**	2	**2.8**		
Smoke cigarettes	Yes	78	**26.5**	23	**15.1**	3	0.006
	No	216	**73.5**	129	**84.9**		
Permanent employment	Yes	285	**96.9**	151	**98.7**	2	0.26
	No	9	**3.1**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	21	**7.1**	3	**1.9**	0	0.12
	No	274	**92.9**	151	**98.1**		
Accident related to symptoms	Yes	62	**21.3**	0	**0.0**	23	0.0001
	No	229	**78.7**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	102	**35.1**	78	**52.0**	8	0.03
	30mins - 1hr	64	**22.0**	25	**16.7**		
	1 - 2 hrs	57	**19.6**	18	**12.0**		
	> 2 hrs	47	**16.2**	6	**4.0**		
	NA	21	**7.2**	23	**15.3**		

Table 6.25 **Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Trigger Digit syndrome group compared to controls**

		Cases (n=65)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	28	**43.1**	72	**46.8**	0	0.68
	No	37	**56.9**	82	**53.2**		
Type of eyewear	Contacts	6	**23.1**	18	**25.0**	121	0.35
	Glasses	15	**57.7**	48	**66.7**		
	Bifocals	2	**7.7**	4	**5.6**		
	VDU glasses	3	**11.5**	2	**2.8**		
Smoke cigarettes	Yes	27	**41.5**	23	**15.1**	2	0.0001
	No	38	**58.5**	129	**84.9**		
Permanent employment	Yes	61	**95.3**	151	**98.7**	2	0.13
	No	3	**4.7**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	4	**6.2**	3	**1.9**	0	0.11
	No	61	**93.8**	151	**98.1**		
Accident related to symptoms	Yes	13	**20.3**	0	**0.0**	20	0.0001
	No	51	**79.7**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	20	**30.8**	78	**52.0**	4	0.0001
	30mins - 1hr	12	**18.5**	25	**16.7**		
	1 - 2 hrs	11	**16.9**	18	**12.0**		
	> 2 hrs	16	**24.6**	6	**4.0**		
	NA	6	**9.2**	23	**15.3**		

Table 6.26 **Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Nerve Entrapment syndrome group compared to controls**

		Cases (n=75)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	50	**66.7**	72	**46.8**	1	0.008
	No	24	**33.3**	82	**53.2**		
Type of eyewear	Contacts	9	**18.0**	18	**25.0**	107	0.17
	Glasses	30	**60.0**	48	**66.7**		
	Bifocals	6	**12.0**	4	**5.6**		
	VDU glasses	5	**10.0**	2	**2.8**		
Smoke cigarettes	Yes	21	**28.0**	23	**15.1**	2	0.02
	No	54	**72.0**	129	**84.9**		
Permanent employment	Yes	73	**97.3**	151	**98.7**	1	0.46
	No	2	**2.7**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	3	**4.0**	3	**1.9**	0	0.36
	No	72	**96.0**	151	**98.1**		
Accident related to symptoms	Yes	14	**19.2**	0	**0.0**	21	0.0001
	No	59	**80.8**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	20	**27.0**	78	**52.0**	5	0.0001
	30mins - 1hr	15	**20.3**	25	**16.7**		
	1 - 2 hrs	18	**24.3**	18	**12.0**		
	> 2 hrs	18	**24.3**	6	**4.0**		
	NA	3	**4.1**	23	**15.3**		

Table 6.27 Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Tendon Disorders syndrome group compared to controls

		Cases (n=38)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	20	**52.6**	72	**46.8**	0	0.47
	No	18	**47.4**	82	**53.2**		
Type of eyewear	Contacts	2	**10.5**	18	**25.0**	101	0.08
	Glasses	12	**63.2**	48	**66.7**		
	Bifocals	2	**10.5**	4	**5.6**		
	VDU glasses	3	**15.8**	2	**2.8**		
Smoke cigarettes	Yes	10	**26.3**	23	**15.1**	2	0.10
	No	28	**73.7**	129	**84.9**		
Permanent employment	Yes	37	**97.4**	151	**98.7**	1	0.56
	No	1	**2.6**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	3	**7.9**	3	**1.9**	0	0.06
	No	35	**92.1**	151	**98.1**		
Accident related to symptoms	Yes	7	**18.4**	0	**0.0**	19	0.0001
	No	31	**81.6**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	10	**26.3**	78	**52.0**	4	0.0002
	30mins - 1hr	10	**26.3**	25	**16.7**		
	1 - 2 hrs	8	**21.1**	18	**12.0**		
	> 2 hrs	8	**21.1**	6	**4.0**		
	NA	2	**5.3**	23	**15.3**		

Table 6.28 **Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Epicondylitis syndrome group compared to controls**

		Cases (n=57)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	35	**61.4**	72	**46.8**	0	0.048
	No	22	**38.6**	82	**53.2**		
Type of eyewear	Contacts	7	**20.6**	18	**25.0**	105	0.02
	Glasses	16	**47.1**	48	**66.7**		
	Bifocals	6	**17.6**	4	**5.6**		
	VDU glasses	5	**14.7**	2	**2.8**		
Smoke cigarettes	Yes	18	**31.6**	23	**15.1**	2	0.008
	No	39	**68.4**	129	**84.9**		
Permanent employment	Yes	56	**98.2**	151	**98.7**	1	0.81
	No	1	**1.8**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	6	**10.5**	3	**1.9**	0	0.006
	No	51	**89.5**	151	**98.1**		
Accident related to symptoms	Yes	17	**30.4**	0	**0.0**	20	0.0001
	No	39	**69.6**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	19	**33.3**	78	**52.0**	4	0.0001
	30mins - 1hr	14	**24.6**	25	**16.7**		
	1 - 2 hrs	12	**21.1**	18	**12.0**		
	> 2 hrs	11	**19.3**	6	**4.0**		
	NA	1	**1.8**	23	**15.3**		

Table 6.29 **Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Shoulder Disorders syndrome group compared to controls**

		Cases (n=155)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	86	**55.5**	72	**46.8**	0	0.10
	No	69	**44.5**	82	**53.2**		
Type of eyewear	Contacts	9	**10.7**	18	**25.0**	153	0.02
	Glasses	57	**67.9**	48	**66.7**		
	Bifocals	6	**7.1**	4	**5.6**		
	VDU glasses	12	**14.3**	2	**2.8**		
Smoke cigarettes	Yes	37	**23.9**	23	**15.1**	2	0.05
	No	118	**76.1**	129	**84.9**		
Permanent employment	Yes	153	**98.7**	151	**98.7**	1	0.99
	No	2	**1.3**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	17	**11.0**	3	**1.9**	0	0.001
	No	138	**89.0**	151	**98.1**		
Accident related to symptoms	Yes	35	**23.0**	0	**0.0**	22	0.0001
	No	117	**77.0**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	65	**42.5**	78	**52.0**	6	0.0001
	30mins - 1hr	29	**19.0**	25	**16.7**		
	1 - 2 hrs	25	**16.3**	18	**12.0**		
	> 2 hrs	21	**13.7**	6	**4.0**		
	NA	13	**8.5**	23	**15.3**		

Table 6.30 Number and percentage (bold) in response to Section E of the Structured Interview and questions from the ULSQ in cases in the Forearm Pain syndrome group compared to controls

		Cases (n=132)		Controls (n=154)		No. missing	p-value
Wear glasses or contacts	Yes	76	**58.0**	72	**46.8**	1	0.045
	No	55	**42.0**	82	**53.2**		
Type of eyewear	Contacts	15	**20.0**	18	**25.0**	138	0.24
	Glasses	46	**61.3**	48	**66.7**		
	Bifocals	6	**8.0**	4	**5.6**		
	VDU glasses	8	**10.7**	2	**2.8**		
Smoke cigarettes	Yes	32	**24.4**	23	**15.1**	3	0.049
	No	99	**75.6**	129	**84.9**		
Permanent employment	Yes	126	**95.5**	151	**98.7**	1	0.10
	No	6	**4.5**	2	**1.3**		
Rheumatoid or osteo-arthritis	Yes	9	**6.8**	3	**1.9**	0	0.04
	No	123	**93.2**	151	**98.1**		
Accident related to symptoms	Yes	25	**19.4**	0	**0.0**	22	0.0001
	No	104	**80.6**	135	**100.0**		
Longest spell at keyboard without break	<30 mins	44	**33.6**	78	**52.0**	5	0.0001
	30mins - 1hr	29	**22.1**	25	**16.7**		
	1 - 2 hrs	29	**22.1**	18	**12.0**		
	> 2 hrs	22	**16.8**	6	**4.0**		
	NA	7	**5.3**	23	**15.3**		

Table 6.31 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Any Syndrome group compared to controls**

		Cases (n=295)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	34	**11.6**	15	**9.8**	2	0.57
	No	260	**88.4**	138	**90.2**		
L. shoulder elevated	Yes	40	**13.7**	15	**9.8**	3	0.24
	No	253	**86.3**	138	**90.2**		
R. arm abducted	Yes	84	**28.6**	46	**30.1**	2	0.74
	No	210	**71.4**	107	**69.9**		
L. arm abducted	Yes	42	**14.3**	24	**15.7**	3	0.70
	No	251	**85.7**	129	**84.3**		
Trunk twisted	Yes	79	**27.0**	34	**22.4**	4	0.29
	No	214	**73.0**	118	**77.6**		
R. upper arm	Flexed	182	**63.9**	92	**63.4**	19	0.77
	Neutral	102	**35.8**	53	**36.6**		
	Extended	1	**0.4**	0	**0.0**		
L. upper arm	Flexed	152	**57.4**	77	**57.9**	51	0.36
	Neutral	113	**42.6**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	64	**22.5**	31	**21.7**	21	0.86
	No	221	**77.5**	112	**78.3**		
L. wrist rested on desk	Yes	76	**28.9**	39	**28.7**	50	0.96
	No	187	**71.1**	97	**71.3**		
R. wrist relative to elbow	Higher	51	**18.1**	28	**19.4**	24	0.95
	Horizontal	204	**72.6**	103	**71.5**		
	Lower	26	**9.3**	13	**9.0**		
L. wrist relative to elbow	Higher	42	**15.8**	18	**13.3**	49	0.59
	Horizontal	200	**75.5**	108	**80.0**		
	Lower	23	**8.7**	9	**6.7**		
Undue stretching digits	Yes	20	**6.8**	11	**7.2**	4	0.87
	No	273	**93.2**	141	**92.8**		
Use some fingers freq.	Yes	221	**75.2**	111	**73.5**	4	0.70
	No	73	**24.8**	40	**26.5**		
Typing style	Touch (screen)	87	**29.6**	32	**20.9**	2	0.13
	Touch(keybd.)	39	**13.3**	25	**16.3**		
	Hunt & peck	168	**57.1**	96	**62.7**		
Tendency to be a clacker	Yes	100	**34.5**	38	**25.3**	9	0.05
	No	190	**65.5**	112	**74.7**		

Table 6.32 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Trigger Digit syndrome compared to controls**

		Cases (n=65)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	11	**16.9**	15	**9.8**	1	0.14
	No	54	**83.1**	138	**90.2**		
L. shoulder elevated	Yes	13	**20.3**	15	**9.8**	2	0.04
	No	51	**79.7**	138	**90.2**		
R. arm abducted	Yes	22	**33.8**	46	**30.1**	1	0.58
	No	43	**66.2**	107	**69.9**		
L. arm abducted	Yes	13	**20.3**	24	**15.7**	2	0.41
	No	51	**79.7**	129	**84.3**		
Trunk twisted	Yes	17	**26.2**	34	**22.4**	2	0.55
	No	48	**73.8**	118	**77.6**		
R. upper arm	Flexed	41	**65.1**	92	**63.4**	11	0.82
	Neutral	22	**34.9**	53	**36.6**		
	Extended	0	**0.0**	0	**0.0**		
L. upper arm	Flexed	34	**58.6**	77	**57.9**	28	0.80
	Neutral	24	**41.4**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	17	**26.6**	31	**21.7**	12	0.44
	No	47	**73.4**	112	**78.3**		
L. wrist rested on desk	Yes	18	**30.5**	39	**28.7**	24	0.80
	No	41	**69.5**	97	**71.3**		
R. wrist relative to elbow	Higher	10	**16.1**	28	**19.4**	13	0.78
	Horizontal	45	**72.6**	103	**71.5**		
	Lower	7	**11.3**	13	**9.0**		
L. wrist relative to elbow	Higher	8	**13.8**	18	**13.3**	26	0.88
	Horizontal	45	**77.6**	108	**80.0**		
	Lower	5	**8.6**	9	**6.7**		
Undue stretching digits	Yes	2	**3.1**	11	**7.2**	2	0.24
	No	63	**96.9**	141	**92.8**		
Use some fingers freq.	Yes	50	**76.9**	111	**73.5**	3	0.60
	No	15	**23.1**	40	**26.5**		
Typing style	Touch (screen)	22	**33.8**	32	**20.9**	1	0.11
	Touch(keybd.)	7	**10.8**	25	**16.3**		
	Hunt & peck	36	**55.4**	96	**62.7**		
Tendency to be a clacker	Yes	23	**35.4**	38	**25.3**	4	0.13
	No	42	**64.6**	112	**74.7**		

Table 6.33 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Nerve Entrapment syndrome group compared to controls**

		Cases (n=75)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	6	**8.0**	15	**9.8**	1	0.66
	No	69	**92.0**	138	**90.2**		
L. shoulder elevated	Yes	10	**13.3**	15	**9.8**	1	0.42
	No	65	**86.7**	138	**90.2**		
R. arm abducted	Yes	28	**37.3**	46	**30.1**	1	0.27
	No	47	**62.7**	107	**69.9**		
L. arm abducted	Yes	10	**13.3**	24	**15.7**	1	0.64
	No	65	**86.7**	129	**84.3**		
Trunk twisted	Yes	13	**17.6**	34	**22.4**	3	0.40
	No	61	**82.4**	118	**77.6**		
R. upper arm	Flexed	46	**63.0**	92	**63.4**	11	0.95
	Neutral	27	**37.0**	53	**36.6**		
	Extended	0	**0.0**	0	**0.0**		
L. upper arm	Flexed	38	**55.1**	77	**57.9**	27	0.70
	Neutral	31	**44.9**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	17	**23.0**	31	**21.7**	12	0.83
	No	57	**77.0**	112	**78.3**		
L. wrist rested on desk	Yes	21	**30.0**	39	**28.7**	23	0.84
	No	49	**70.0**	97	**71.3**		
R. wrist relative to elbow	Higher	12	**16.4**	28	**19.4**	12	0.17
	Horizontal	59	**80.8**	103	**71.5**		
	Lower	2	**2.7**	13	**9.0**		
L. wrist relative to elbow	Higher	11	**15.5**	18	**13.3**	23	0.73
	Horizontal	57	**80.3**	108	**80.0**		
	Lower	3	**4.2**	9	**6.7**		
Undue stretching digits	Yes	5	**6.7**	11	**7.2**	2	0.87
	No	70	**93.3**	141	**92.8**		
Use some fingers freq.	Yes	52	**69.3**	111	**73.5**	3	0.51
	No	23	**30.7**	40	**26.5**		
Typing style	Touch (screen)	32	**42.7**	32	**20.9**	1	0.003
	Touch(keybd.)	10	**13.3**	25	**16.3**		
	Hunt & peck	33	**44.0**	96	**62.7**		
Tendency to be a clacker	Yes	29	**39.7**	38	**25.3**	6	0.03
	No	44	**60.3**	112	**74.7**		

Table 6.34 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Tendon Disorders syndrome group compared to controls**

		Cases (n=38)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	4	**10.5**	15	**9.8**	1	0.89
	No	34	**89.5**	138	**90.2**		
L. shoulder elevated	Yes	4	**10.5**	15	**9.8**	1	0.89
	No	34	**89.5**	138	**90.2**		
R. arm abducted	Yes	11	**28.9**	46	**30.1**	1	0.89
	No	27	**71.1**	107	**69.9**		
L. arm abducted	Yes	2	**5.3**	24	**15.7**	1	0.09
	No	36	**94.7**	129	**84.3**		
Trunk twisted	Yes	6	**15.8**	34	**22.4**	2	0.37
	No	32	**84.2**	118	**77.6**		
R. upper arm	Flexed	20	**54.1**	92	**63.4**	10	0.09
	Neutral	16	**43.2**	53	**36.6**		
	Extended	1	**2.7**	0	**0.0**		
L. upper arm	Flexed	15	**40.5**	77	**57.9**	22	0.13
	Neutral	22	**59.5**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	8	**21.6**	31	**21.7**	12	0.99
	No	29	**78.4**	112	**78.3**		
L. wrist rested on desk	Yes	11	**29.7**	39	**28.7**	19	0.90
	No	26	**70.3**	97	**71.3**		
R. wrist relative to elbow	Higher	4	**11.1**	28	**19.4**	12	0.35
	Horizontal	30	**83.3**	103	**71.5**		
	Lower	2	**5.6**	13	**9.0**		
L. wrist relative to elbow	Higher	4	**10.8**	18	**13.3**	20	0.87
	Horizontal	31	**83.8**	108	**80.0**		
	Lower	2	**5.4**	9	**6.7**		
Undue stretching digits	Yes	6	**16.2**	11	**7.2**	3	0.09
	No	31	**83.8**	141	**92.8**		
Use some fingers freq.	Yes	27	**71.1**	111	**73.5**	3	0.76
	No	11	**28.9**	40	**26.5**		
Typing style	Touch (screen)	17	**44.7**	32	**20.9**	1	0.01
	Touch(keybd.)	4	**10.5**	25	**16.3**		
	Hunt & peck	17	**44.7**	96	**62.7**		
Tendency to be a clacker	Yes	13	**34.2**	38	**25.3**	4	0.27
	No	25	**65.8**	112	**74.7**		

Table 6.35 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Epicondylitis syndrome group compared to controls**

		Cases (n=57)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	10	**17.9**	15	**9.8**	2	0.11
	No	46	**82.1**	138	**90.2**		
L. shoulder elevated	Yes	8	**14.3**	15	**9.8**	2	0.36
	No	48	**85.7**	138	**90.2**		
R. arm abducted	Yes	14	**25.0**	46	**30.1**	2	0.47
	No	42	**75.0**	107	**69.9**		
L. arm abducted	Yes	6	**10.7**	24	**15.7**	2	0.36
	No	50	**89.3**	129	**84.3**		
Trunk twisted	Yes	13	**23.2**	34	**22.4**	3	0.90
	No	43	**76.8**	118	**77.6**		
R. upper arm	Flexed	29	**55.8**	92	**63.4**	14	0.17
	Neutral	22	**42.3**	53	**36.6**		
	Extended	1	**1.9**	0	**0.0**		
L. upper arm	Flexed	25	**47.2**	77	**57.9**	25	0.31
	Neutral	28	**52.8**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	10	**19.2**	31	**21.7**	16	0.71
	No	42	**80.8**	112	**78.3**		
L. wrist rested on desk	Yes	11	**20.8**	39	**28.7**	22	0.27
	No	42	**79.2**	97	**71.3**		
R. wrist relative to elbow	Higher	7	**13.5**	28	**19.4**	15	0.43
	Horizontal	42	**80.8**	103	**71.5**		
	Lower	3	**5.8**	13	**9.0**		
L. wrist relative to elbow	Higher	9	**17.0**	18	**13.3**	23	0.64
	Horizontal	42	**79.2**	108	**80.0**		
	Lower	2	**3.8**	9	**6.7**		
Undue stretching digits	Yes	8	**14.3**	11	**7.2**	3	0.12
	No	48	**85.7**	141	**92.8**		
Use some fingers freq.	Yes	33	**58.9**	111	**73.5**	4	0.04
	No	23	**41.1**	40	**26.5**		
Typing style	Touch (screen)	25	**44.6**	32	**20.9**	2	0.002
	Touch(keybd.)	4	**7.1**	25	**16.3**		
	Hunt & peck	27	**48.2**	96	**62.7**		
Tendency to be a clacker	Yes	20	**35.7**	38	**25.3**	5	0.14
	No	36	**64.3**	112	**74.7**		

Table 6.36 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Shoulder Disorders syndrome group compared to controls**

		Cases (n=155)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	14	**9.0**	15	**9.8**	1	0.82
	No	141	**91.0**	138	**90.2**		
L. shoulder elevated	Yes	15	**9.7**	15	**9.8**	1	0.97
	No	140	**90.3**	138	**90.2**		
R. arm abducted	Yes	53	**34.2**	46	**30.1**	1	0.44
	No	102	**65.8**	107	**69.9**		
L. arm abducted	Yes	22	**14.2**	24	**15.7**	1	0.71
	No	133	**85.8**	129	**84.3**		
Trunk twisted	Yes	49	**31.8**	34	**22.4**	3	0.06
	No	105	**68.2**	118	**77.6**		
R. upper arm	Flexed	97	**63.8**	92	**63.4**	12	0.95
	Neutral	55	**36.2**	53	**36.6**		
	Extended	0	**0.0**	0	**0.0**		
L. upper arm	Flexed	78	**56.1**	77	**57.9**	37	0.55
	Neutral	61	**43.9**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	30	**19.9**	31	**21.7**	15	0.70
	No	121	**80.1**	112	**78.3**		
L. wrist rested on desk	Yes	36	**26.1**	39	**28.7**	35	0.63
	No	102	**73.9**	97	**71.3**		
R. wrist relative to elbow	Higher	34	**22.8**	28	**19.4**	16	0.76
	Horizontal	101	**67.8**	103	**71.5**		
	Lower	14	**9.4**	13	**9.0**		
L. wrist relative to elbow	Higher	24	**17.1**	18	**13.3**	34	0.60
	Horizontal	105	**75.0**	108	**80.0**		
	Lower	11	**7.9**	9	**6.7**		
Undue stretching digits	Yes	11	**7.1**	11	**7.2**	2	0.96
	No	144	**92.9**	141	**92.8**		
Use some fingers freq.	Yes	120	**77.4**	111	**73.5**	3	0.43
	No	35	**22.6**	40	**26.5**		
Typing style	Touch (screen)	36	**23.2**	32	**20.9**	1	0.86
	Touch(keybd.)	23	**14.8**	25	**16.3**		
	Hunt & peck	96	**61.9**	96	**62.7**		
Tendency to be a clacker	Yes	57	**37.0**	38	**25.3**	5	0.03
	No	97	**63.0**	112	**74.7**		

Table 6.37 **Number and percentage (bold) in response to Gross Postural variables of the Structured Interview in cases in the Forearm Pain syndrome group compared to controls**

		Cases (n=132)		Controls (n=154)		Nmissing	p-value
R. shoulder elevated	Yes	14	**10.6**	15	**9.8**	1	0.82
	No	118	**89.4**	138	**90.2**		
L. shoulder elevated	Yes	16	**12.1**	15	**9.8**	1	0.53
	No	116	**87.9**	138	**90.2**		
R. arm abducted	Yes	31	**23.5**	46	**30.1**	1	0.21
	No	101	**76.5**	107	**69.9**		
L. arm abducted	Yes	14	**10.6**	24	**15.7**	1	0.21
	No	118	**89.4**	129	**84.3**		
Trunk twisted	Yes	26	**19.8**	34	**22.4**	3	0.60
	No	105	**80.2**	118	**77.6**		
R. upper arm	Flexed	78	**60.0**	92	**63.4**	11	0.50
	Neutral	51	**39.2**	53	**36.6**		
	Extended	1	**0.8**	0	**0.0**		
L. upper arm	Flexed	73	**58.9**	77	**57.9**	29	0.62
	Neutral	51	**41.1**	55	**41.4**		
	Extended	0	**0.0**	1	**0.8**		
R. wrist rested on desk	Yes	28	**21.5**	31	**21.7**	13	0.98
	No	102	**78.5**	112	**78.3**		
L. wrist rested on desk	Yes	34	**27.9**	39	**28.7**	28	0.89
	No	88	**72.1**	97	**71.3**		
R. wrist relative to elbow	Higher	19	**15.0**	28	**19.4**	15	0.39
	Horizontal	100	**78.7**	103	**71.5**		
	Lower	8	**6.3**	13	**9.0**		
L. wrist relative to elbow	Higher	13	**10.7**	18	**13.3**	29	0.80
	Horizontal	101	**82.8**	108	**80.0**		
	Lower	8	**6.6**	9	**6.7**		
Undue stretching digits	Yes	11	**8.4**	11	**7.2**	3	0.72
	No	120	**91.6**	141	**92.8**		
Use some fingers freq.	Yes	95	**72.0**	111	**73.5**	3	0.77
	No	37	**28.0**	40	**26.5**		
Typing style	Touch (screen)	50	**37.9**	32	**20.9**	1	0.007
	Touch(keybd.)	17	**12.9**	25	**16.3**		
	Hunt & peck	65	**49.2**	96	**62.7**		
Tendency to be a clacker	Yes	48	**36.6**	38	**25.3**	5	0.04
	No	83	**63.4**	112	**74.7**		

Table 6.38 **Means and standard deviations of WES scores for cases in the Any Syndrome group (n=291) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Involvement	Case	**43.6**	17.0	**32.2**	14.8	49	**41.4**	16.8	125	**50.7**	14.9	115
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**48.9**	18.7	**33.6**	17.1	56	**51.1**	16.8	159	**55.9**	18.1	70
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**42.7**	18.1	**32.3**	16.7	78	**45.6**	17.0	126	**47.6**	17.6	85
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**45.4**	17.1	**35.4**	14.7	39	**43.8**	17.2	124	**50.1**	16.2	125
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**50.7**	15.8	**45.6**	19.1	25	**51.2**	15.9	129	**51.2**	15.3	129
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**63.5**	17.3	**51.4**	19.7	39	**57.7**	16.5	106	**71.3**	13.2	142
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**38.8**	16.0	**31.8**	17.0	58	**41.1**	15.2	158	**40.3**	15.8	68
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**52.2**	14.7	**43.7**	15.5	30	**51.7**	14.2	188	**57.3**	13.7	69
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**46.0**	16.1	**37.9**	14.8	28	**41.7**	14.7	132	**52.0**	15.6	131
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**40.8**	18.6	**30.9**	15.4	54	**42.2**	17.2	123	**44.1**	20.0	110
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.39 **Means and standard deviations of WES scores for cases in the Trigger Digit syndrome group (n=62) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	**Mn**	Sd	No.	**Mn**	Sd	No.	**Mn**	Sd	No.
Involvement	Case	**43.2**	16.9	**31.8**	13.3	10	**39.5**	19.0	19	**48.8**	14.6	33
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**49.0**	19.8	**34.5**	18.7	11	**47.3**	18.4	26	**58.0**	18.5	22
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**44.0**	18.6	**34.1**	19.4	15	**42.1**	19.4	23	**52.4**	14.3	23
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**46.0**	16.4	**43.6**	16.9	8	**42.7**	15.7	28	**50.4**	16.6	26
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**50.1**	13.8	**43.5**	21.9	2	**52.1**	15.0	27	**48.9**	12.8	31
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**59.4**	18.5	**49.9**	21.8	8	**52.3**	16.9	26	**69.6**	14.3	26
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**38.3**	16.6	**28.4**	17.0	10	**40.0**	15.6	36	**42.6**	17.3	14
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**51.8**	14.2	**46.0**	15.4	8	**50.0**	14.0	40	**59.9**	11.4	13
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**46.8**	15.5	**46.3**	21.2	7	**43.9**	16.2	30	**50.3**	12.4	25
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**38.8**	18.9	**28.3**	11.3	11	**40.6**	17.9	20	**41.5**	20.7	31
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.40 **Means and standard deviations of WES scores for cases in the Nerve Entrapment syndrome group (n=75) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Involvement	Case	**45.1**	16.7	**32.5**	15.9	12	**43.2**	17.3	27	**51.1**	14.2	34
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**49.1**	19.2	**26.6**	17.7	14	**54.0**	13.1	39	**54.9**	20.5	19
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**43.9**	19.0	**23.0**	15.7	17	**48.3**	14.7	31	**51.9**	16.0	27
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**45.9**	17.2	**30.2**	16.1	9	**44.2**	17.5	29	**51.7**	14.9	34
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**52.5**	15.7	**45.1**	20.5	8	**53.8**	13.8	29	**53.1**	16.8	34
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**63.9**	15.8	**51.1**	18.1	13	**63.1**	14.1	27	**70.5**	12.6	33
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**38.7**	17.2	**26.0**	16.4	16	**43.4**	16.0	36	**41.2**	16.8	20
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**52.9**	15.7	**39.9**	13.5	11	**55.0**	14.1	49	**55.5**	18.9	14
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**48.3**	16.0	**39.0**	17.6	11	**45.0**	13.2	32	**54.8**	15.9	32
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**39.9**	18.7	**25.8**	14.7	14	**38.9**	16.0	30	**47.7**	19.6	30
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.41 **Means and standard deviations of WES scores for cases in the Tendon Disorders syndrome group (n=37) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	**Mn**	Sd	No.	**Mn**	Sd	No.	**Mn**	Sd	No.
Involvement	Case	**43.5**	16.4	**37.9**	16.7	15	**35.0**	13.7	7	**52.7**	13.3	14
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**45.6**	19.3	**29.9**	11.2	8	**54.0**	15.1	13	**45.7**	21.8	15
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**39.5**	19.6	**27.4**	17.6	11	**47.5**	15.4	12	**42.1**	20.7	14
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**45.4**	19.3	**38.8**	16.8	6	**35.1**	17.1	14	**57.1**	17.1	15
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**51.1**	15.1	**46.4**	20.4	5	**51.8**	20.0	9	**51.6**	12.5	21
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**65.4**	17.1	**42.3**	18.1	6	**63.1**	9.6	9	**73.4**	13.2	21
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**37.4**	15.2	**32.9**	18.0	8	**40.1**	16.8	15	**37.0**	12.4	12
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**54.7**	15.1	**39.5**	19.4	6	**50.7**	12.0	16	**65.6**	8.3	14
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**45.3**	16.0	**37.5**	15.1	8	**41.1**	13.9	15	**54.3**	15.3	14
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**39.2**	17.2	**28.1**	13.3	13	**40.6**	15.5	11	**50.2**	16.6	12
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.42 **Means and standard deviations of WES scores for cases in the Epicondylitis syndrome group (n=56) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Involvement	Case	**44.3**	17.5	**22.6**	15.1	12	**48.5**	13.5	20	**51.4**	12.7	23
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**47.6**	20.4	**49.7**	17.2	29	**23.1**	9.4	12	**66.0**	9.8	13
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**44.8**	19.9	**27.4**	18.7	16	**46.5**	18.5	20	**57.1**	10.7	20
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**43.8**	19.2	**33.4**	18.6	10	**38.5**	20.8	18	**51.0**	16.0	26
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**49.1**	13.3	**47.2**	18.7	6	**49.0**	11.8	21	**49.4**	14.3	26
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**65.9**	17.2	**54.4**	22.3	11	**63.4**	14.9	20	**73.9**	12.9	24
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**39.5**	16.9	**33.6**	20.9	10	**41.6**	16.1	29	**39.7**	17.6	14
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**53.9**	14.2	**39.5**	16.7	6	**53.3**	11.9	32	**60.0**	14.7	17
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**45.1**	15.3	**39.0**	17.6	6	**53.3**	11.9	32	**60.0**	14.7	17
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**40.7**	21.6	**24.5**	14.7	16	**46.5**	21.2	19	**48.4**	20.8	20
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.43 **Means and standard deviations of WES scores for cases in the Shoulder Disorders syndrome group (n=154) compared to controls (n=150), relative to scores at the time of completion of ULSQ**

Variable	Stat	Total		Less			Same			More		
		Mn	Sd	**Mn**	Sd	No.	**Mn**	Sd	No.	**Mn**	Sd	No.
Involvement	Case	**43.0**	17.1	**32.0**	14.7	26	**40.3**	16.9	69	**51.0**	14.7	58
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**47.7**	18.7	**33.5**	16.4	26	**48.8**	17.2	87	**54.2**	19.1	39
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**42.2**	17.7	**31.7**	16.2	42	**45.8**	16.5	66	**46.4**	17.2	45
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**45.6**	17.0	**33.8**	16.1	16	**43.6**	17.1	72	**50.8**	15.5	64
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**51.0**	16.2	**48.6**	20.4	10	**50.1**	17.9	67	**52.2**	14.1	72
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**65.8**	16.4	**56.3**	15.9	19	**59.2**	17.4	53	**72.9**	12.3	79
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**39.6**	15.5	**33.9**	17.4	31	**41.8**	13.8	78	**41.3**	16.1	40
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**54.0**	14.4	**45.0**	18.4	11	**53.6**	13.9	102	**58.0**	13.4	37
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**45.6**	16.0	**35.9**	11.7	15	**41.3**	15.3	71	**52.4**	15.0	68
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**40.3**	19.2	**29.6**	14.5	28	**43.8**	17.9	63	**41.5**	20.7	59
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.44 Means and standard deviations of WES scores for cases in the Forearm Pain syndrome group (n=131) compared to controls (n=150), relative to scores at the time of completion of ULSQ

Variable	Stat	Tot		Less			Sam			More		
		Mn	Sd	Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Involvement	Case	**45.4**	17.1	**32.0**	14.7	26	**40.3**	16.9	69	**51.0**	14.7	58
	Cont	**46.4**	16.7	**36.4**	17.5	21	**46.2**	16.9	74	**50.6**	14.8	55
Peer Cohesion	Case	**50.3**	19.0	**33.5**	16.4	26	**48.8**	17.2	87	**54.5**	19.1	39
	Cont	**52.0**	17.4	**39.5**	19.4	19	**53.0**	17.7	92	**56.1**	12.7	38
Supervisory Support	Case	**44.2**	19.5	**31.7**	16.2	42	**45.8**	16.5	66	**46.4**	17.2	45
	Cont	**45.8**	17.4	**34.9**	17.9	33	**49.1**	16.8	79	**48.3**	14.9	38
Autonomy	Case	**45.9**	17.1	**33.8**	16.1	16	**43.6**	17.1	72	**50.8**	15.5	64
	Cont	**47.2**	15.9	**35.8**	15.3	21	**48.0**	14.6	62	**50.0**	15.8	67
Task Orientation	Case	**52.3**	15.1	**48.6**	20.4	10	**50.1**	17.9	67	**52.2**	14.1	72
	Cont	**53.7**	13.9	**37.3**	23.0	4	**54.4**	13.4	86	**53.8**	13.7	59
Work Pressure	Case	**62.4**	17.9	**56.3**	15.9	19	**59.2**	17.4	53	**72.9**	12.3	79
	Cont	**64.0**	16.8	**56.6**	18.0	16	**57.3**	16.7	57	**70.5**	13.9	77
Clarity	Case	**39.8**	16.2	**33.9**	17.4	31	**41.8**	13.4	78	**41.3**	16.1	40
	Cont	**41.1**	16.0	**35.6**	11.9	23	**43.5**	16.5	90	**40.1**	16.1	34
Control	Case	**51.6**	16.2	**45.0**	18.4	11	**53.6**	13.9	102	**58.0**	13.4	37
	Cont	**53.9**	14.5	**50.8**	10.5	9	**52.7**	14.3	104	**59.0**	14.2	36
Innovation	Case	**47.6**	16.4	**35.9**	11.7	15	**41.3**	15.3	71	**52.4**	15.0	68
	Cont	**49.5**	15.1	**35.0**	6.3	8	**46.5**	15.5	71	**54.0**	13.8	71
Physical Comfort	Case	**40.0**	17.1	**29.6**	14.5	28	**43.8**	17.9	63	**41.5**	20.7	59
	Cont	**45.5**	18.4	**31.4**	16.3	16	**46.2**	18.6	87	**49.5**	16.5	46

Table 6.45 **Means and standard deviations for goniometer variables for cases in the Any Syndrome group compared to controls**

Hand & Motion	Variable	Status	Total			Reliable			Unreliable		
			Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Right Flexion/ Extension	Median	Case	**22.0**	14.4	280	**21.6**	13.0	123	**22.3**	15.4	157
		Cont	**21.0**	10.6	144	**21.0**	10.8	66	**21.1**	10.5	78
	99th percentile	Case	**41.2**	15.2	270	**41.0**	12.9	118	**41.4**	16.8	152
		Cont	**42.3**	14.5	142	**42.2**	14.0	66	**42.4**	15.1	76
	1st percentile	Case	**-7.5**	17.6	281	**-7.9**	17.0	123	**-7.2**	18.2	158
		Cont	**-4.7**	15.1	146	**-3.1**	14.5	68	**-6.2**	15.6	78
	Ln Std deviation	Case	**2.30**	0.56	281	**2.28**	0.56	123	**2.32**	0.55	158
		Cont	**2.24**	0.57	146	**2.20**	0.56	68	**2.28**	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	**-6.2**	12.1	276	**-6.1**	10.8	121	**-6.3**	13.0	155
		Cont	**-7.7**	13.6	143	**-5.6**	15.2	65	**-9.5**	11.8	78
	99th percentile	Case	**10.8**	15.8	266	**12.0**	14.2	117	**9.9**	17.0	149
		Cont	**8.8**	15.6	137	**10.2**	14.6	62	**7.6**	16.4	75
	1st percentile	Case	**-23.0**	10.1	278	**-22.9**	10.1	122	**-23.1**	10.0	156
		Cont	**-23.2**	12.6	145	**-21.0**	13.8	67	**-25.2**	11.2	78
	Ln Std deviation	Case	**2.01**	0.64	281	**2.01**	0.61	123	**2.01**	0.66	158
		Cont	**1.97**	0.65	146	**2.00**	0.69	68	**1.95**	0.61	78
Left Flexion/ Extension	Median	Case	**20.7**	13.1	276	**20.0**	13.6	122	**21.3**	12.7	154
		Cont	**20.4**	12.3	143	**20.7**	11.1	65	**20.0**	13.2	78
	99th percentile	Case	**39.5**	16.0	266	**39.5**	16.0	117	**39.6**	16.2	149
		Cont	**40.0**	15.4	137	**40.0**	16.5	63	**40.0**	14.5	74
	1st percentile	Case	**-11.6**	19.7	279	**-14.5**	18.7	122	**-9.4**	20.2	157
		Cont	**-9.6**	18.4	145	**-8.4**	17.1	67	**-10.6**	19.4	78
	Ln Std deviation	Case	**2.39**	0.67	281	**2.40**	0.63	122	**2.38**	0.71	159
		Cont	**2.38**	0.63	145	**2.42**	0.59	67	**2.34**	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	**7.2**	14.0	281	**7.2**	13.3	122	**7.2**	14.5	159
		Cont	**6.9**	12.9	144	**8.4**	13.2	66	**5.6**	12.5	78
	99th percentile	Case	**23.6**	15.9	273	**24.2**	15.1	119	**23.2**	16.5	154
		Cont	**22.3**	16.2	140	**23.4**	14.2	64	**21.3**	17.7	76
	1st percentile	Case	**-12.0**	11.4	280	**-13.8**	10.5	122	**-10.7**	12.0	158
		Cont	**-10.7**	13.4	144	**-9.8**	14.0	67	**-11.4**	12.9	77
	Ln Std deviation	Case	**1.97**	0.80	279	**2.04**	0.75	123	**1.93**	0.84	156
		Cont	**1.95**	0.76	146	**2.03**	0.59	68	**1.89**	0.88	78

Table 6.46 **Means and standard deviations for goniometer variables for cases in the Trigger Digit syndrome group compared to controls**

Hand & Motion	Variable	Status	Total Mn	Total Sd	Total No.	Reliable Mn	Reliable Sd	Reliable No.	Unreliable Mn	Unreliable Sd	Unreliable No.
Right Flexion/ Extension	Median	Case	**22.0**	12.4	60	**22.2**	12.1	20	**21.8**	12.6	40
		Cont	**21.0**	10.6	144	**21.0**	10.8	66	**21.1**	10.5	78
	99th percentile	Case	**40.4**	15.7	56	**41.1**	17.5	19	**40.1**	15.0	37
		Cont	**42.3**	14.5	142	**42.2**	14.0	66	**42.4**	15.1	76
	1st percentile	Case	**-8.0**	15.3	61	**-9.5**	11.8	20	**-7.2**	16.8	41
		Cont	**-4.7**	15.1	146	**-3.1**	14.5	68	**-6.2**	15.6	78
	Ln Std deviation	Case	**2.33**	0.67	60	**2.28**	0.84	20	**2.35**	0.58	40
		Cont	**2.24**	0.57	146	**2.20**	0.56	68	**2.28**	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	**-6.2**	13.0	61	**-6.7**	9.7	20	**-6.0**	14.5	41
		Cont	**-7.7**	13.6	143	**-5.6**	15.2	65	**-9.5**	11.8	78
	99th percentile	Case	**10.9**	15.8	55	**14.3**	13.7	19	**9.1**	16.7	36
		Cont	**8.8**	15.6	137	**10.2**	14.6	62	**7.6**	16.4	75
	1st percentile	Case	**-22.0**	9.5	61	**-22.7**	7.7	20	**-21.7**	10.4	41
		Cont	**-23.2**	12.6	145	**-21.0**	13.8	67	**-25.2**	11.2	78
	Ln Std deviation	Case	**2.05**	0.75	60	**2.10**	0.59	20	**2.03**	0.82	40
		Cont	**1.97**	0.65	146	**2.00**	0.69	68	**1.95**	0.61	78
Left Flexion/ Extension	Median	Case	**18.3**	12.6	60	**20.7**	12.6	20	**17.1**	12.6	40
		Cont	**20.4**	12.3	143	**20.7**	11.1	65	**20.0**	13.2	78
	99th percentile	Case	**38.7**	13.2	56	**40.5**	14.1	18	**37.8**	12.8	38
		Cont	**40.0**	15.4	137	**40.0**	16.5	63	**40.0**	14.5	74
	1st percentile	Case	**-13.2**	20.3	61	**-14.3**	13.8	20	**-12.6**	23.0	41
		Cont	**-9.6**	18.4	145	**-8.4**	17.1	67	**-10.6**	19.4	78
	Ln Std deviation	Case	**2.42**	0.72	61	**2.44**	0.75	20	**2.41**	0.71	41
		Cont	**2.38**	0.63	145	**2.42**	0.59	67	**2.34**	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	**8.6**	12.1	61	**6.1**	8.0	20	**9.8**	13.6	41
		Cont	**6.9**	12.9	144	**8.4**	13.2	66	**5.6**	12.5	78
	99th percentile	Case	**25.6**	14.5	59	**26.5**	12.0	20	**25.1**	15.7	39
		Cont	**22.3**	16.2	140	**23.4**	14.2	64	**21.3**	17.7	76
	1st percentile	Case	**-10.8**	10.6	60	**-14.4**	10.2	20	**-9.0**	10.4	40
		Cont	**-10.7**	13.4	144	**-9.8**	14.0	67	**-11.4**	12.9	77
	Ln Std deviation	Case	**2.04**	0.71	61	**2.15**	0.40	20	**1.98**	0.82	41
		Cont	**1.95**	0.76	146	**2.03**	0.59	68	**1.89**	0.88	78

Table 6.47 **Means and standard deviations for goniometer variables for cases in the Nerve Entrapment syndrome group compared to controls**

Hand & Motion	Variable	Status	Total			Reliable			Unreliable		
			Mn	Sd	No.	Mn	Sd	No.	Mn	Sd	No.
Right Flexion/ Extension	Median	Case	23.8	12.0	74	22.1	12.7	32	25.0	11.4	42
		Cont	21.0	10.6	144	21.0	10.8	66	21.1	10.5	78
	99th percentile	Case	42.8	13.0	70	41.3	16.5	31	43.9	9.5	39
		Cont	42.3	14.5	142	42.2	14.0	66	42.4	15.1	76
	1st percentile	Case	-3.8	17.3	74	-4.6	16.4	32	-3.3	18.1	42
		Cont	-4.7	15.1	146	-3.1	14.5	68	-6.2	15.6	78
	Ln Std deviation	Case	2.25	0.58	73	2.17	0.70	32	2.31	0.47	41
		Cont	2.24	0.57	146	2.20	0.56	68	2.28	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	-6.8	9.3	74	-7.0	11.3	32	-6.6	7.7	42
		Cont	-7.7	13.6	143	-5.6	15.2	65	-9.5	11.8	78
	99th percentile	Case	10.2	13.7	70	8.9	13.8	30	11.1	13.7	40
		Cont	8.8	15.6	137	10.2	14.6	62	7.6	16.4	75
	1st percentile	Case	-22.8	9.1	74	-24.1	10.1	32	-21.9	8.2	42
		Cont	-23.2	12.6	145	-21.0	13.8	67	-25.2	11.2	78
	Ln Std deviation	Case	1.96	0.61	73	1.97	0.66	32	1.96	0.58	41
		Cont	1.97	0.65	146	2.00	0.69	68	1.95	0.61	78
Left Flexion/ Extension	Median	Case	21.0	14.6	73	18.5	16.9	32	23.0	12.5	41
		Cont	20.4	12.3	143	20.7	11.1	65	20.0	13.2	78
	99th percentile	Case	40.9	12.2	69	38.4	12.1	30	42.7	12.0	39
		Cont	40.0	15.4	137	40.0	16.5	63	40.0	14.5	74
	1st percentile	Case	-8.3	21.6	74	-12.5	20.0	32	-5.1	22.4	42
		Cont	-9.6	18.4	145	-8.4	17.1	67	-10.6	19.4	78
	Ln Std deviation	Case	2.34	0.68	73	2.30	0.66	31	2.36	0.70	42
		Cont	2.38	0.63	145	2.42	0.59	67	2.34	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	7.1	9.7	74	7.3	10.2	32	7.0	9.4	42
		Cont	6.9	12.9	144	8.4	13.2	66	5.6	12.5	78
	99th percentile	Case	23.4	14.1	71	22.4	11.3	30	24.1	16.0	41
		Cont	22.3	16.2	140	23.4	14.2	64	21.3	17.7	76
	1st percentile	Case	-11.9	9.9	74	-13.3	10.8	32	-10.8	9.2	42
		Cont	-10.7	13.4	144	-9.8	14.0	67	-11.4	12.9	77
	Ln Std deviation	Case	1.94	0.92	74	1.98	1.03	32	1.90	0.84	42
		Cont	1.95	0.76	146	2.03	0.59	68	1.89	0.88	78

Table 6.48 **Means and standard deviations for goniometer variables for cases in the Tendon Disorders syndrome group compared to controls**

Hand & Motion	Variable	Status	Total Mn	Total Sd	Total No.	Reliable Mn	Reliable Sd	Reliable No.	Unreliable Mn	Unreliable Sd	Unreliable No.
Right Flexion/ Extension	Median	Case	**26.5**	11.7	36	**27.6**	10.7	13	**25.9**	12.3	23
		Cont	**21.0**	10.6	144	**21.0**	10.8	66	**21.1**	10.5	78
	99th percentile	Case	**47.7**	14.6	34	**49.2**	13.4	12	**46.9**	15.4	22
		Cont	**42.3**	14.5	142	**42.2**	14.0	66	**42.4**	15.1	76
	1st percentile	Case	**-9.2**	23.4	36	**-8.3**	21.5	13	**-9.6**	24.9	23
		Cont	**-4.7**	15.1	146	**-3.1**	14.5	68	**-6.2**	15.6	78
	Ln Std deviation	Case	**2.47**	0.56	36	**2.47**	0.61	13	**2.47**	0.55	23
		Cont	**2.24**	0.57	146	**2.20**	0.56	68	**2.28**	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	**-7.5**	8.0	36	**-4.4**	10.3	13	**-9.2**	6.0	23
		Cont	**-7.7**	13.6	143	**-5.6**	15.2	65	**-9.5**	11.8	78
	99th percentile	Case	**10.5**	16.4	31	**9.3**	13.4	11	**11.1**	18.2	20
		Cont	**8.8**	15.6	137	**10.2**	14.6	62	**7.6**	16.4	75
	1st percentile	Case	**-24.6**	7.7	36	**-23.0**	10.3	13	**-25.5**	5.7	23
		Cont	**-23.2**	12.6	145	**-21.0**	13.8	67	**-25.2**	11.2	78
	Ln Std deviation	Case	**2.16**	0.90	36	**2.10**	0.95	13	**2.20**	0.90	23
		Cont	**1.97**	0.65	146	**2.00**	0.69	68	**1.95**	0.61	78
Left Flexion/ Extension	Median	Case	**20.1**	12.5	36	**24.9**	14.1	13	**17.3**	10.9	23
		Cont	**20.4**	12.3	143	**20.7**	11.1	65	**20.0**	13.2	78
	99th percentile	Case	**40.1**	9.8	32	**43.4**	6.7	10	**38.6**	10.7	22
		Cont	**40.0**	15.4	137	**40.0**	16.5	63	**40.0**	14.5	74
	1st percentile	Case	**-11.8**	17.4	36	**-14.1**	20.1	13	**-10.5**	16.1	23
		Cont	**-9.6**	18.4	145	**-8.4**	17.1	67	**-10.6**	19.4	78
	Ln Std deviation	Case	**2.45**	0.57	35	**2.53**	0.51	12	**2.41**	0.60	23
		Cont	**2.38**	0.63	145	**2.42**	0.59	67	**2.34**	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	**10.3**	10.1	36	**10.5**	10.0	13	**10.2**	10.3	23
		Cont	**6.9**	12.9	144	**8.4**	13.2	66	**5.6**	12.5	78
	99th percentile	Case	**27.5**	17.6	33	**24.7**	12.7	11	**29.0**	19.6	22
		Cont	**22.3**	16.2	140	**23.4**	14.2	64	**21.3**	17.7	76
	1st percentile	Case	**-10.2**	10.7	36	**-14.5**	9.4	13	**-7.7**	10.8	23
		Cont	**-10.7**	13.4	144	**-9.8**	14.0	67	**-11.4**	12.9	77
	Ln Std deviation	Case	**2.09**	0.91	36	**2.27**	0.89	13	**1.98**	0.92	23
		Cont	**1.95**	0.76	146	**2.03**	0.59	68	**1.89**	0.88	78

Table 6.49 **Means and standard deviations for goniometer variables for cases in the Epicondylitis syndrome group compared to controls**

Hand & Motion	Variable	Status	Total Mn	Total Sd	Total No.	Reliable Mn	Reliable Sd	Reliable No.	Unreliable Mn	Unreliable Sd	Unreliable No.
Right Flexion/ Extension	Median	Case	24.7	13.5	56	25.1	16.5	27	24.4	10.3	29
		Cont	21.0	10.6	144	21.0	10.8	66	21.1	10.5	78
	99th percentile	Case	43.1	13.3	53	39.8	11.8	25	46.1	14.1	28
		Cont	42.3	14.5	142	42.2	14.0	66	42.4	15.1	76
	1st percentile	Case	-6.6	19.6	56	-5.7	17.9	27	-7.4	21.2	29
		Cont	-4.7	15.1	146	-3.1	14.5	68	-6.2	15.6	78
	Ln Std deviation	Case	2.31	0.58	55	2.26	0.62	27	2.36	0.56	28
		Cont	2.24	0.57	146	2.20	0.56	68	2.28	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	-6.4	8.6	55	-4.0	8.8	26	-8.6	7.9	29
		Cont	-7.7	13.6	143	-5.6	15.2	65	-9.5	11.8	78
	99th percentile	Case	9.3	11.2	50	10.4	9.6	25	8.1	12.7	25
		Cont	8.8	15.6	137	10.2	14.6	62	7.6	16.4	75
	1st percentile	Case	-23.4	9.0	56	-22.0	10.8	27	-24.8	6.8	29
		Cont	-23.2	12.6	145	-21.0	13.8	67	-25.2	11.2	78
	Ln Std deviation	Case	2.07	0.79	55	2.03	0.80	27	2.11	0.79	28
		Cont	1.97	0.65	146	2.00	0.69	68	1.95	0.61	78
Left Flexion/ Extension	Median	Case	21.5	13.0	56	20.8	13.6	27	22.1	12.6	29
		Cont	20.4	12.3	143	20.7	11.1	65	20.0	13.2	78
	99th percentile	Case	42.4	11.4	55	40.6	10.8	26	43.9	11.9	29
		Cont	40.0	15.4	137	40.0	16.5	63	40.0	14.5	74
	1st percentile	Case	-10.8	17.6	56	-13.7	19.3	27	-8.0	15.7	29
		Cont	-9.6	18.4	145	-8.4	17.1	67	-10.6	19.4	78
	Ln Std deviation	Case	2.33	0.59	55	2.28	0.73	26	2.36	0.44	29
		Cont	2.38	0.63	145	2.42	0.59	67	2.34	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	10.9	13.0	56	11.1	15.9	27	10.7	9.9	29
		Cont	6.9	12.9	144	8.4	13.2	66	5.6	12.5	78
	99th percentile	Case	25.7	14.4	54	25.3	13.5	26	26.1	15.4	28
		Cont	22.3	16.2	140	23.4	14.2	64	21.3	17.7	76
	1st percentile	Case	-11.4	9.9	56	-14.0	9.0	27	-9.1	10.3	29
		Cont	-10.7	13.4	144	-9.8	14.0	67	-11.4	12.9	77
	Ln Std deviation	Case	2.04	0.79	56	2.16	0.67	27	1.92	0.88	29
		Cont	1.95	0.76	146	2.03	0.59	68	1.89	0.88	78

Table 6.50 **Means and standard deviations for goniometer variables for cases in the Shoulder Disorders syndrome group compared to controls**

Hand & Motion	Variable	Status	Total Mn	Total Sd	Total No.	Reliable Mn	Reliable Sd	Reliable No.	Unreliable Mn	Unreliable Sd	Unreliable No.
Right Flexion/ Extension	Median	Case	21.4	14.1	149	20.9	10.9	73	21.9	16.6	76
		Cont	21.0	10.6	144	21.0	10.8	66	21.1	10.5	78
	99th percentile	Case	41.0	15.9	143	41.3	13.0	70	40.8	18.4	73
		Cont	42.3	14.5	142	42.2	14.0	66	42.4	15.1	76
	1st percentile	Case	-8.3	17.7	149	-9.7	17.1	73	-6.9	18.3	76
		Cont	-4.7	15.1	146	-3.1	14.5	68	-6.2	15.6	78
	Ln Std deviation	Case	2.33	0.55	149	2.31	0.58	73	2.34	0.52	76
		Cont	2.24	0.57	146	2.20	0.56	68	2.28	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	-6.2	12.5	147	-6.1	10.2	72	-6.2	14.5	75
		Cont	-7.7	13.6	143	-5.6	15.2	65	-9.5	11.8	78
	99th percentile	Case	11.8	17.5	143	12.7	13.6	69	11.0	20.5	74
		Cont	8.8	15.6	137	10.2	14.6	62	7.6	16.4	75
	1st percentile	Case	-23.2	11.3	147	-23.6	10.9	72	-22.8	11.7	75
		Cont	-23.2	12.6	145	-21.0	13.8	67	-25.2	11.2	78
	Ln Std deviation	Case	2.05	0.58	149	2.06	0.57	73	2.04	0.59	76
		Cont	1.97	0.65	146	2.00	0.69	68	1.95	0.61	78
Left Flexion/ Extension	Median	Case	21.5	13.2	147	20.5	13.8	72	22.5	12.6	75
		Cont	20.4	12.3	143	20.7	11.1	65	20.0	13.2	78
	99th percentile	Case	40.6	14.6	140	40.1	16.7	69	41.1	12.4	71
		Cont	40.0	15.4	137	40.0	16.5	63	40.0	14.5	74
	1st percentile	Case	-12.4	18.6	148	-16.1	19.5	72	-8.8	17.1	76
		Cont	-9.6	18.4	145	-8.4	17.1	67	-10.6	19.4	78
	Ln Std deviation	Case	2.44	0.64	149	2.49	0.47	72	2.39	0.77	77
		Cont	2.38	0.63	145	2.42	0.59	67	2.34	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	6.4	11.8	149	5.8	11.1	72	7.0	12.4	77
		Cont	6.9	12.9	144	8.4	13.2	66	5.6	12.5	78
	99th percentile	Case	23.4	15.2	143	23.7	15.2	69	23.0	15.3	74
		Cont	22.3	16.2	140	23.4	14.2	64	21.3	17.7	76
	1st percentile	Case	-12.7	10.4	149	-15.2	10.0	72	-10.4	10.3	77
		Cont	-10.7	13.4	144	-9.8	14.0	67	-11.4	12.9	77
	Ln Std deviation	Case	2.04	0.74	148	2.11	0.71	73	1.97	0.77	75
		Cont	1.95	0.76	146	2.03	0.59	68	1.89	0.88	78

Table 6.51 Means and standard deviations for goniometer variables for cases in the Forearm Pain syndrome group compared to controls

Hand & Motion	Variable	Status	Total Mn	Total Sd	Total No.	Reliable Mn	Reliable Sd	Reliable No.	Unreliable Mn	Unreliable Sd	Unreliable No.
Right Flexion/ Extension	Median	Case	**22.4**	14.0	125	**21.2**	12.6	53	**23.3**	14.9	72
		Cont	**21.0**	10.6	144	**21.0**	10.8	66	**21.1**	10.5	78
	99th percentile	Case	**41.6**	14.4	123	**40.6**	13.3	52	**42.4**	15.3	71
		Cont	**42.3**	14.5	142	**42.2**	14.0	66	**42.4**	15.1	76
	1st percentile	Case	**-7.6**	19.5	125	**-8.1**	18.4	53	**-7.2**	20.3	72
		Cont	**-4.7**	15.1	146	**-3.1**	14.5	68	**-6.2**	15.6	78
	Ln Std deviation	Case	**2.26**	0.57	125	**2.23**	0.60	53	**2.28**	0.55	72
		Cont	**2.24**	0.57	146	**2.20**	0.56	68	**2.28**	0.58	78
Right Radial/ Ulnar Deviation	Median	Case	**-6.0**	12.1	122	**-3.9**	13.5	52	**-7.6**	10.7	70
		Cont	**-7.7**	13.6	143	**-5.6**	15.2	65	**-9.5**	11.8	78
	99th percentile	Case	**10.7**	15.6	117	**11.3**	16.2	50	**10.3**	15.2	67
		Cont	**8.8**	15.6	137	**10.2**	14.6	62	**7.6**	16.4	75
	1st percentile	Case	**-22.7**	11.0	123	**-21.4**	11.6	52	**-23.6**	10.6	71
		Cont	**-23.2**	12.6	145	**-21.0**	13.8	67	**-25.2**	11.2	78
	Ln Std deviation	Case	**1.95**	0.66	125	**1.91**	0.61	53	**1.98**	0.70	72
		Cont	**1.97**	0.65	146	**2.00**	0.69	68	**1.95**	0.61	78
Left Flexion/ Extension	Median	Case	**21.1**	13.4	123	**19.7**	13.5	52	**22.1**	13.3	71
		Cont	**20.4**	12.3	143	**20.7**	11.1	65	**20.0**	13.2	78
	99th percentile	Case	**38.9**	19.7	121	**37.4**	20.4	50	**39.9**	19.3	71
		Cont	**40.0**	15.4	137	**40.0**	16.5	63	**40.0**	14.5	74
	1st percentile	Case	**-11.6**	19.1	123	**-15.4**	21.2	52	**-8.9**	17.1	71
		Cont	**-9.6**	18.4	145	**-8.4**	17.1	67	**-10.6**	19.4	78
	Ln Std deviation	Case	**2.39**	0.56	124	**2.38**	0.62	52	**2.39**	0.51	72
		Cont	**2.38**	0.63	145	**2.42**	0.59	67	**2.34**	0.66	78
Left Radial/ Ulnar Deviation	Median	Case	**6.9**	15.5	125	**5.7**	15.4	53	**7.8**	15.7	72
		Cont	**6.9**	12.9	144	**8.4**	13.2	66	**5.6**	12.5	78
	99th percentile	Case	**22.7**	16.8	122	**21.1**	15.2	51	**23.9**	17.8	71
		Cont	**22.3**	16.2	140	**23.4**	14.2	64	**21.3**	17.7	76
	1st percentile	Case	**-12.1**	13.5	125	**-15.2**	13.0	53	**-9.8**	13.5	72
		Cont	**-10.7**	13.4	144	**-9.8**	14.0	67	**-11.4**	12.9	77
	Ln Std deviation	Case	**1.97**	0.71	123	**2.01**	0.64	53	**1.93**	0.75	70
		Cont	**1.95**	0.76	146	**2.03**	0.59	68	**1.89**	0.88	78

Table 7.1 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to age and sex**

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.21 (1.00,1.45)		1.19 (0.99,1.43)	1.19 (0.99,1.43)	0.83 (0.45,1.54)
p-value	**0.047**		**0.07**	**0.07**	**0.55**
Sex (Female vs Male)		1.77 (1.19,2.63)	1.73 (1.16,2.59)	1.73 (1.16,2.59)	0.79 (0.20,3.05)
p-value		**0.005**	**0.007**	**0.007**	**0.72**
Age.Sex					1.26 (0.86,1.83)
p-value					**0.23**

Table 7.2 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to age and sex**

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	0.93 (0.71,1.23)		0.93 (0.71,1.23)	0.93 (0.71,1.23)	0.64 (0.25,1.66)
p-value	**0.63**		**0.62**	**0.62**	**0.34**
Sex (Female vs Male)		1.42 (0.79,2.57)	1.43 (0.79,2.58)	1.43 (0.79,2.58)	0.65 (0.09,4.67)
p-value		**0.24**	**0.24**	**0.24**	**0.66**
Age.Sex					1.27 (0.72,2.24)
p-value					**0.42**

Table 7.3 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to age and sex**

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.42 (1.10,1.84)		1.42 (1.08,1.87)	1.42 (1.08,1.87)	0.90 (0.29,2.82)
p-value	**0.008**		**0.01**	**0.01**	**0.86**
Sex (Female vs Male)		4.53 (2.29,8.94)	4.51 (2.27,8.98)	4.51 (2.27,8.98)	1.76 (0.17,18.7)
p-value		**<0.0001**	**<0.0001**	**<0.0001**	**0.64**
Age.Sex					1.29 (0.69,2.44)
p-value					**0.43**

Table 7.4 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to age and sex**

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.15 (0.83,1.59)		1.14 (0.81,1.60)	1.14 (0.81,1.60)	0.49 (0.11,2.14)
p-value	**0.41**		**0.45**	**0.45**	**0.52**
Sex (Female vs Male)		3.56 (1.53,8.30)	3.55 (1.52,8.29)	3.55 (1.52,8.29)	0.70 (0.04,11.2)
p-value		**0.004**	**0.004**	**0.004**	**0.80**
Age.Sex					1.62 (0.72,3.63)
p-value					**0.24**

Table 7.5 Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to age and sex

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.62 (1.21,2.17)		1.63 (1.21,2.18)	1.63 (1.21,2.18)	1.50 (0.55,4.06)
p-value	**0.001**		**0.001**	**0.001**	**0.43**
Sex (Female vs Male)		1.51 (0.81,2.82)	1.54 (0.81,2.91)	1.54 (0.81,2.91)	1.26 (0.12,13.3)
p-value		**0.19**	**0.19**	**0.19**	**0.84**
Age.Sex					1.05 (0.58,1.92)
p-value					**0.86**

Table 7.6 Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to age and sex

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.38 (1.12,1.71)		1.38 (1.11,1.71)	1.38 (1.11,1.71)	1.08 (0.52,2.24)
p-value	**0.003**		**0.004**	**0.004**	**0.84**
Sex (Female vs Male)		1.94 (1.22,3.07)	1.92 (1.20,3.06)	1.92 (1.20,3.06)	1.11 (0.22,5.65)
p-value		**0.005**	**0.007**	**0.007**	**0.90**
Age.Sex					1.17 (0.75,1.81)
p-value					**0.49**

Table 7.7 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to age and sex**

Variable	Model 1 Age	Model 2 Sex	Model 3 Sex + Age	Model 4 Age + Sex	Model 5 Age + sex + Age.Sex Interaction
Age (+ 10 years)	1.20 (0.97,1.49)		1.20 (0.96,1.50)	1.20 (0.96,1.50)	0.89 (0.41,1.95)
p-value	**0.10**		**0.12**	**0.12**	**0.77**
Sex (Female vs Male)		2.74 (1.65,4.53)	2.73 (1.64,4.53)	2.73 (1.64,4.53)	1.45 (0.27,7.81)
p-value		**0.0001**	**0.0001**	**0.0001**	**0.66**
Age.Sex					1.20 (0.75,1.91)
p-value					**0.44**

Table 7.8 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Age + Sex	Model 2 Age + sex + Longest spell
Age (+ 10 yrs)	1.11 (0.91,1.35)	1.09 (0.89,1.33)
p-value	**0.31**	**0.42**
Sex (Female vs Male)	1.79 (1.18,2.72)	1.56 (1.01,2.41)
p-value	**0.006**	**0.05**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		2.03 (1.14, 3.60)
1 - 2 hrs		2.34 (1.22, 4.48)
> 2 hrs		5.02 (0.29, 1.22)
p - value		**< 0.0001**

Table 7.9 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Longest spell
Longest spell at keyboard relative to < 30 mins:	
30 - 60 mins	2.07 (0.85, 5.04)
1 - 2 hrs	2.44 (0.92, 6.43)
> 2 hrs	10.10 (3.39,30.10)
p - value	**< 0.0001**

Table 7.10 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Age + Sex	Model 2 Age + sex + Longest spell
Age (+ 10 yrs)	1.36 (1.02,1.80)	1.31 (0.96,1.78)
p-value	**0.04**	**0.09**
Sex (Female vs Male)	4.37 (2.18,8.76)	3.05 (1.45,6.39)
p-value	**0.0001**	**0.004**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		2.21 (0.94, 5.23)
1 - 2 hrs		3.02 (1.23, 7.38)
> 2 hrs		6.53 (2.13,20.00)
p - value		**0.0004**

Table 7.11 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Sex	Model 2 Sex + Longest spell
Sex (Female vs Male)	3.50 (1.49, 8.24)	2.37 (0.95, 5.92)
p-value	**0.005**	**0.06**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		3.12 (1.09, 8.87)
1 - 2 hrs		3.25 (1.04,10.20)
> 2 hrs		7.41 (1.94,28.30)
p - value		**0.01**

Table 7.12 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Age	Model 2 Age + Longest spell
Age (+ 10 yrs)	1.46 (1.07,1.98)	1.38 (0.99,1.94)
p-value	**0.02**	**0.05**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		2.41 (1.00, 5.78)
1 - 2 hrs		2.73 (1.05, 7.10)
> 2 hrs		5.91 (1.81,19.30)
p - value		**0.02**

Table 7.13 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Age + Sex	Model 2 Age + sex + Longest spell
Age (+ 10 yrs)	1.26 (1.00,1.59)	1.27 (1.00,1.62)
p-value	**0.05**	**0.05**
Sex (Female vs Male)	2.10 (1.28, 3.45)	1.96 (1.17, 3.29)
p-value	**0.004**	**0.002**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		1.27 (0.64, 2.99)
1 - 2 hrs		1.39 (0.64, 2.99)
> 2 hrs		3.36 (1.22, 9.27)
p - value		**0.03**

Table 7.14 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to longest spell at the keyboard**

Variable	Model 1 Sex	Model 2 Sex + Longest spell
Sex (Female vs Male)	2.73 (1.62, 4.58)	2.15 (1.24, 3.73)
p-value	**0.0002**	**0.007**
Longest spell at keyboard relative to < 30 mins:		
30 - 60 mins		2.07 (1.04, 4.09)
1 - 2 hrs		2.63 (1.25, 5.53)
> 2 hrs		4.48 (1.62,12.40)
p - value		**0.0009**

Table 7.15 **Results of logistic regression represented by the odds ratio for cases in the Any Syndromegroup (95% confidence interval in brackets) in relation to Section A of Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Age (+ 10 years)	1.19 (0.98,1.45)	1.23 (1.01,1.51)	1.26 (1.03,1.55)	1.28 (1.03,1.57)	1.34 (1.08,1.66)	1.37 (1.10,1.71)
p-value	**0.08**	**0.05**	**0.03**	**0.02**	**0.009**	**0.006**
Sex (Female)	1.47 (0.96,2.25)	1.24 (0.80,1.93)	1.32 (0.84,2.06)	1.32 (0.84,2.08)	1.25 (0.79,1.98)	1.35 (0.83,2.18)
p-value	**0.07**	**0.32**	**0.23**	**0.23**	**0.34**	**0.22**
No. hours keying (+10)		1.59 (1.28,1.99)	1.64 (1.31,2.05)	1.59 (1.27,2.00)	1.50 (1.18,1.92)	1.64 (1.25,2.14)
p-value		**<0.0001**	**<0.0001**	**0.0001**	**0.001**	**0.0003**
Problems with progs			2.17 (1.40,3.37)	2.17 (1.39,3.39)	2.43 (1.53,3.84)	2.39 (1.49,3.82)
p-value			**0.0006**	**0.0007**	**0.0002**	**0.0003**
Diffs. reading				2.15 (1.30,3.56)	2.07 (1.25,3.44)	2.01 (1.19,3.38)
p-value				**0.002**	**0.005**	**0.009**
Specified rate keying						
Yes vs No					2.62 (0.91,7.57)	3.02 (0.99,9.18)
NA vs No					2.78 (1.14,6.77)	3.36 (1.33,8.45)
p-value					**0.02**	**0.007**
Teleph. hand held*						3.64 (1.14,11.6)
Teleph. headset*						0.52 (0.14,1.92)
Other*						1.64 (0.67,4.01)
p-value						**0.02**

* Comparison group consists of those who received audible information direct or from a recording machine

Table 7.16 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

Variable	Step 1
No. hours keying (+10)	2.32 (1.68,3.21)
p-value	**<0.0001**

Table 7.17 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Age (+ 10 year)	1.42 (1.07,1.89)	1.50 (1.11,2.03)	1.60 (1.17,2.19)	1.70 (1.23,2.34)	1.68 (1.22,2.32)	1.77 (1.25,2.50)
p-value	**0.02**	**0.01**	**0.004**	**0.003**	**0.003**	**0.003**
Sex (Female)	3.87 (1.88,7.95)	2.80 (1.32,5.93)	2.82 (1.30,6.10)	3.07 (1.39,6.77)	2.89 (1.30,6.45)	3.01 (1.32,6.89)
p-value	**0.0003**	**0.008**	**0.01**	**0.009**	**0.01**	**0.01**
No. hours keying (+10)		1.77 (1.30,2.41)	1.57 (1.12,2.22)	1.66 (1.16,2.37)	1.64 (1.14,2.35)	1.88 (1.26,2.81)
p-value		**<0.0001**	**0.01**	**0.01**	**0.01**	**0.005**
Specified rate keying						
Yes vs No			3.26 (0.94,11.2)	3.33 (0.93,11.9)	3.45 (0.95,12.5)	4.62 (1.08,19.7)
NA vs No			4.14 (1.31,13.1)	4.97 (1.51,16.3)	4.58 (1.38,15.2)	6.51 (1.81,23.4)
p-value			**0.01**	**0.01**	**0.02**	**0.008**
Problems with progs				2.34 (1.16,4.72)	2.29 (1.12,4.68)	2.38 (1.14,4.96)
p-value				**0.04**	**0.03**	**0.03**
Diffs. reading					2.23 (1.08,4.57)	2.11 (1.00,4.45)
p-value					**0.04**	**0.07**
Teleph. hand held*						4.44 (0.90,21.9)
Teleph. headset*						0.24 (0.02,2.81)
Other*						2.10 (0.62,7.10)
p-value						**0.03**

* Comparison group consists of those who received audible information direct or from a recording machine

Table 7.18 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3
Sex (Female)	3.24 (1.31,7.99)	2.23 (0.86,5.78)	2.23 (0.84,5.98)	2.17 (0.79,5.94)
p-value	**0.01**	**0.10**	**0.10**	**0.14**
No. hours keying (+10)		1.86 (1.27,2.72)	1.90 (1.24,2.91)	1.81 (1.17,2.79)
p-value		**0.001**	**0.003**	**0.009**
Specified rate keying				
Yes vs No			1.43 (0.31,6.67)	1.36 (0.27,6.79)
NA vs No			5.45 (1.65,18.0)	5.91 (1.79,19.4)
p-value			**0.02**	**0.02**
Difficulties reading				2.77 (1.16,6.59)
p-value				**0.02**

Table 7.19 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4
Age (+ 10 year)	1.69 (1.22,2.32)	1.63 (1.17,2.29)	1.73 (1.21,2.47)	2.16 (1.41,3.33)	2.25 (1.45,3.50)
p-value	**0.002**	**0.004**	**0.003**	**0.0002**	**0.0001**
Difficulties reading		5.55 (2.66,11.6)	4.63 (2.15,9.96)	4.49 (2.00,10.1)	4.55 (1.98,10.4)
p-value		**<0.0001**	**0.0001**	**0.0001**	**0.0001**
No. hours keying (+10)			1.85 (1.29,2.65)	1.95 (1.26,3.02)	2.00 (1.28,3.14)
p-value			**0.001**	**0.002**	**0.001**
Telephone hand held*				5.69 (1.12,28.8)	4.73 (0.90,24.8)
Telephone headset*				0.00 -	0.00 -
Other*				0.72 (0.23,2.26)	0.56 (0.17,1.84)
p-value				**0.003**	**0.008**
Problems with progs					2.89 (1.23,6.79)
p-value					**0.01**

* Comparison group consists of those who received audible information direct or from a recording machine

Table 7.20 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Age (+10yrs)	1.38 (1.09,1.73)	1.45 (1.14,1.83)	1.52 (1.19,1.95)	1.58 (1.22,2.05)	1.57 (1.21,2.04)	1.64 (1.25,2.14)
p-value	**0.007**	**0.003**	**0.001**	**0.001**	**0.001**	**0.001**
Sex (Female)	1.57 (0.96,2.58)	1.71 (1.03,2.83)	1.49 (0.89,2.50)	1.44 (0.83,2.49)	1.47 (0.84,2.56)	1.31 (0.74,2.32)
p-value	**0.07**	**0.04**	**0.14**	**0.21**	**0.18**	**0.36**
Probs. progs		2.17 (1.31,3.59)	2.58 (1.52,4.38)	2.72 (1.57,4.71)	2.76 (1.58,4.81)	2.66 (1.52,4.66)
p-value		**0.003**	**0.0007**	**0.0006**	**0.0005**	**0.001**
Spec. rate keying						
Yes vs No			5.13 (1.72,15.3)	5.18 (1.56,17.1)	4.81 (1.45,15.9)	4.22 (1.26,14.1)
NA vs No			3.08 (1.16,8.22)	4.14 (1.46,11.7)	3.96 (1.39,11.3)	3.79 (1.32,10.9)
p-value			**0.003**	**0.002**	**0.003**	**0.007**
Teleph. handheld*				2.74 (0.80,9.33)	2.98 (0.86,10.3)	2.80 (0.75,10.4)
Teleph. headset*				0.17 (0.03,1.05)	0.20 (0.03,1.27)	0.20 (0.03,1.36)
Other*				0.79 (0.32,1.98)	0.90 (0.35,2.28)	0.81 (0.30,2.19)
p-value				**0.01**	**0.02**	**0.02**
Diffs. reading					2.02 (1.12,3.63)	1.81 (1.00,3.30)
p-value					**0.02**	**0.06**
Doc. holder vs flat						1.27 (0.38,4.29)
Other vs flat						2.55 (0.46,14.3)
Not visual vs flat						0.33 (0.14,0.82)
p-value						**0.04**

* Comparison group consists of those who received audible information direct or from a recording machine

Table 7.21 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to Section A of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4
Sex (Female)	2.36 (1.38,4.01)	1.80 (1.03,3.15)	1.76 (1.00,3.09)	1.70 (0.97,2.99)	1.80 (1.01,3.21)
p-value	**0.002**	**0.04**	**0.05**	**0.07**	**0.05**
No. hours keying (+10)		1.66 (1.28,2.16)	1.62 (1.24,2.10)	1.44 (1.09,1.92)	1.45 (1.09,1.94)
p-value		**0.0002**	**0.0004**	**0.01**	**0.01**
Difficulties reading			1.99 (1.11,3.57)	2.07 (1.15,3.74)	1.92 (1.05,3.48)
p-value			**0.02**	**0.01**	**0.03**
Able to take breaks				0.41 (0.17,0.98)	0.37 (0.16,0.90)
p-value				**0.04**	**0.03**
Problems with progs					1.77 (1.02,3.06)
p-value					**0.04**

Table 7.22 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Age (+ 10 yrs)	1.17 (0.97,1.42)	1.21 (0.99,1.47)	1.24 (1.01,1.52)	1.24 (1.01,1.52)	1.24 (1.01,1.52)	1.24 (1.01,1.53)
p-value	**0.10**	**0.07**	**0.04**	**0.04**	**0.04**	**0.04**
Sex (Female)	1.83 (1.21,2.78)	1.79 (1.17,2.74)	1.74 (1.13,2.68)	1.57 (1.01,2.43)	1.42 (0.91,2.22)	1.52 (0.96,2.39)
p-value	**0.004**	**0.008**	**0.01**	**0.04**	**0.13**	**0.08**
Screen flicker						
Yes vs No		4.16 (2.08,8.33)	3.91 (1.94,7.89)	4.27 (2.10,8.66)	4.56 (2.24,9.30)	4.53 (2.21,9.27)
NA vs No		1.43 (0.84,2.42)	1.36 (0.79,2.32)	1.49 (0.87,2.56)	1.42 (0.82,2.46)	1.49 (0.86,2.60)
p-value		**0.0003**	**0.0003**	**0.0003**	**0.0002**	**0.0002**
Problems with chair			2.10 (1.33,3.33)	2.22 (1.40,3.54)	2.34 (1.47,3.75)	2.29 (1.43,3.67)
p-value			**0.002**	**0.001**	**0.0005**	**0.0007**
Document holder				3.22 (1.41,7.36)	2.88 (1.25,6.66)	3.07 (1.32,7.15)
p-value				**0.006**	**0.01**	**0.01**
Footrest					1.88 (1.13,3.13)	1.94 (1.16,3.24)
p-value					**0.02**	**0.01**
Support upper back						0.56 (0.33,0.94)
p-value						**0.03**

Table 7.23 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 1	Step 2	Step 3	Step 4	Step 5
Problems with chair	3.58 (1.90,6.74)	3.90 (2.00,7.60)	3.75 (1.85,7.60)	4.00 (1.93,8.27)	3.87 (1.86,8.07)
p-value	**0.001**	**0.0001**	**0.0004**	**0.0002**	**0.0002**
Document holder		6.10 (2.29,16.3)	7.92 (2.80,22.4)	6.32 (2.13,18.7)	7.27 (2.44,21.7)
p-value		**0.0004**	**0.0002**	**0.001**	**0.0005**
Screen flicker					
Yes vs No			6.49 (2.52,16.7)	7.37 (2.78,19.5)	7.16 (2.66,19.3)
NA vs No			1.76 (0.74,4.17)	1.69 (0.69,4.12)	1.71 (0.69,4.24)
p-value			**0.0009**	**0.0004**	**0.0008**
Footrest				2.66 (1.22,5.83)	2.56 (1.15,5.69)
p-value				**0.02**	**0.02**
Backrest angle adjust.					0.44 (0.21,0.90)
p-value					**0.02**

Table 7.24 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Age (+ 10 yrs)	1.41 (1.06,1.86)	1.49 (1.12,2.00)	1.54 (1.15,2.07)	1.61 (1.18,2.18)	1.58 (1.16,2.16)	1.51 (1.10,2.08)	1.55 (1.12,2.13)
p-value	**0.02**	**0.007**	**0.004**	**0.002**	**0.003**	**0.008**	**0.007**
Sex (Female)	4.66 (2.32,9.35)	4.62 (2.25,9.49)	4.20 (2.02,8.75)	4.00 (1.87,8.53)	4.20 (1.94,9.10)	3.47 (1.57,7.68)	3.52 (1.57,7.85)
p-value	**<0.0001**	**<0.0001**	**0.0002**	**0.0003**	**0.0002**	**0.002**	**0.002**
Problems with chair		2.84 (1.49,5.40)	3.06 (1.57,5.97)	2.80 (1.40,5.61)	2.67 (1.31,5.42)	2.84 (1.38,5.88)	2.83 (1.36,5.88)
p-value		**0.002**	**0.001**	**0.003**	**0.006**	**0.004**	**0.004**
Document holder			5.07 (1.86,13.8)	6.05 (2.12,17.3)	6.78 (2.27,20.2)	6.11 (2.03,18.4)	6.90 (2.22,21.4)
p-value			**0.002**	**0.0007**	**0.0005**	**0.004**	**0.0007**
Screen flicker							
Yes vs No				4.85 (1.85,12.7)	4.67 (1.75,12.5)	5.02 (1.85,13.6)	4.94 (1.80,13.6)
NA vs No				1.63 (0.70,3.79)	1.72 (0.74,4.00)	1.62 (0.68,3.85)	1.75 (0.73,4.24)
p-value				**0.005**	**0.006**	**0.005**	**0.006**
Backrest angle adjust.					0.45 (0.23,0.90)	0.43 (0.21,0.86)	0.42 (0.21,0.86)
p-value					**0.02**	**0.01**	**0.01**
Footrest						2.18 (1.01,4.68)	2.27 (1.04,4.95)
p-value						**0.04**	**0.03**
Support upper back							0.41 (0.17,0.99)
p-value							**0.04**

Table 7.25 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2
Sex (Female)	4.06 (1.65,9.97)	3.64 (1.46,9.12)	3.85 (1.52,9.77)
p-value	**0.003**	**0.008**	**0.005**
Document holder		4.79 (1.62,14.2)	6.46 (1.98,21.1)
p-value		**0.006**	**0.002**
Support upper back			0.28 (0.09,0.90)
p-value			**0.03**

Table 7.26 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Age (+ 10 yrs)	1.59 (1.17,2.16)	1.58 (1.15,2.17)	1.62 (1.17,2.24)	1.64 (1.17,2.30)	1.66 (1.17,2.34)	1.72 (1.21,2.46)
p-value	**0.003**	**0.005**	**0.004**	**0.005**	**0.005**	**0.003**
Problems with chair		3.48 (1.76,6.89)	4.04 (1.98,8.24)	3.83 (1.81,8.11)	3.74 (1.73,8.07)	3.71 (1.69,8.13)
p-value		**0.0004**	**0.0002**	**0.0005**	**0.0008**	**0.001**
Doc. holder			4.96 (1.63,15.1)	6.89 (2.06,23.1)	7.28 (2.06,18.7)	8.35 (2.25,31.0)
p-value			**0.006**	**0.002**	**0.002**	**0.001**
Screen flicker						
Yes vs No				5.28 (1.80,15.5)	6.25 (2.09,18.7)	7.09 (2.33,21.6)
NA vs No				2.98 (1.27,6.97)	3.44 (1.42,8.30)	3.52 (1.44,8.62)
p-value				**0.003**	**0.001**	**0.001**
Keyboard detach.					0.12 (0.02,0.69)	0.12 (0.02,0.71)
p-value					**0.02**	**0.02**
Support upper back						0.38 (0.14,1.00)
p-value						**0.04**

Table 7.27 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4
Age (+ 10 yrs)	1.36 (1.08,1.70)	1.44 (1.14,1.82)	1.51 (1.19,1.93)	1.54 (1.20,1.97)	1.57 (1.22,2.02)
p-value	**0.008**	**0.003**	**0.001**	**0.001**	**0.0006**
Sex (Female)	1.94 (1.20,3.14)	1.93 (1.17,3.21)	1.85 (1.10,3.10)	1.62 (0.96,2.76)	1.52 (0.89,2.60)
p-value	**0.008**	**0.01**	**0.02**	**0.08**	**0.13**
Screen flicker					
Yes vs No		5.92 (2.79,12.6)	5.15 (2.40,11.0)	5.56 (2.57,12.0)	4.83 (2.20,10.6)
NA vs No		1.43 (0.77,2.67)	1.39 (0.73,2.65)	1.35 (0.70,2.61)	1.34 (0.69,2.59)
p-value		**<0.0001**	**0.0002**	**0.0001**	**0.0006**
Problems with chair			2.52 (1.47,4.30)	2.80 (1.61,4.85)	2.81 (1.62,4.90)
p-value			**0.001**	**0.0004**	**0.0003**
Footrest				2.42 (1.35,4.36)	2.58 (1.42,4.67)
p-value				**0.004**	**0.002**
Screen swivel					0.52 (0.27,1.01)
p-value					**0.05**

Table 7.28 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to Section B of the Structured Interview**

	Step 0	Step 1	Step 2	Step 3	Step 4	Step 5
Sex (Female)	2.89 (1.72,4.86)	2.63 (1.55,4.46)	2.33 (1.36,3.99)	2.50 (1.44,4.33)	2.23 (1.27,3.91)	2.27 (1.28,4.00)
p-value	**0.0001**	**0.0004**	**0.002**	**0.001**	**0.006**	**0.006**
Problems with chair		1.94 (1.14,3.30)	2.09 (1.22,3.58)	2.02 (1.17,3.47)	2.15 (1.24,3.73)	2.08 (1.19,3.63)
p-value		**0.01**	**0.008**	**0.01**	**0.008**	**0.01**
Doc. holder			3.05 (1.25,7.42)	3.42 (1.37,8.52)	3.11 (1.24,7.85)	3.20 (1.26,8.11)
p-value			**0.01**	**0.009**	**0.02**	**0.02**
Support upper back				0.46 (0.24,0.87)	0.45 (0.23,0.86)	0.47 (0.24,0.91)
p-value				**0.02**	**0.02**	**0.03**
Footrest					1.84 (1.02,3.32)	1.86 (1.03,3.38)
p-value					**0.04**	**0.04**
Backrest angle adjust.						0.58 (0.34,0.99)
p-value						**0.04**

Table 7.29 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.23 (1.02,1.48)	1.22 (1.01,1.48)
p-value	**0.03**	**0.04**
Sex (Female)	1.76 (1.17,2.64)	1.68 (1.12,2.53)
p-value	**0.006**	**0.01**
Other environ. factors		
Yes vs No		1.94 (1.27,2.95)
p-value		**0.002**

Table 7.30 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 1
Other environ. factors	
Yes vs No	2.34 (1.22,4.50)
p-value	**0.008**

Table 7.31 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.45 (1.10,1.91)	1.45 (1.08,1.95)
p-value	**0.01**	**0.01**
Sex (Female)	4.80 (2.36,9.76)	5.87 (2.73,12.6)
p-value	**<0.0001**	**<0.0001**
Noise level disturbing		
Sometimes vs Never		0.94 (0.46,1.92)
Always vs Never		5.01 (2.10,12.0)
p-value		**0.0006**

Table 7.32 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 0	Step 1
Sex (Female)	4.06 (1.67,9.88)	4.26 (1.71,10.6)
p-value	**0.002**	**0.002**
Noise level disturbing		
Sometimes vs Never		0.92 (0.38,2.25)
Always vs Never		3.70 (1.37,9.98)
p-value		**0.02**

Table 7.33 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.66 (1.23,2.24)	1.66 (1.22,2.25)
p-value	**0.001**	**0.001**
Other environ. factors		
Yes vs No		2.14 (1.05,4.37)
p-value		**0.03**

Table 7.34 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to Section C of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.42 (1.14,1.78)	1.40 (1.12,1.75)
p-value	**0.002**	**0.001**
Sex (Female)	1.98 (1.23,3.19)	1.94 (1.20,3.15)
p-value	**0.006**	**0.007**
Other environ. factors		
Yes vs No		2.07 (1.25,3.42)
p-value		**0.004**

Table 7.35 Results of logistic regression represented by the odds ratio for cases in the **Forearm Pain syndrome group** (95% confidence interval in brackets) in relation to **Section C** of the Structured Interview

	Step 0	Step 1
Sex (Female)	2.79 (1.67,4.64)	2.61 (1.56,4.39)
p-value	**0.0001**	**0.0003**
Other environ. factors		
Yes vs No		2.15 (1.27,3.66)
p-value		**0.004**

Table 7.36 Results of logistic regression represented by the odds ratio for cases in the **Any Syndrome group** (95% confidence interval in brackets) in relation to **Section D** of the Structured Interview

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.21 (1.00,1.46)	1.16 (0.96,1.41)	1.16 (0.96,1.41)
p-value	**0.04**	**0.13**	**0.13**
Sex (Female)	1.63 (1.08,2.46)	1.98 (1.28,3.05)	2.20 (1.41,3.44)
p-value	**0.02**	**0.002**	**0.001**
No. hrs/week risky sports/hobbies (log)		1.41 (1.15,1.73)	1.34 (1.09,1.65)
p-value		**0.001**	**0.005**
Exposure to vibration			2.26 (1.24,4.12)
p-value			**0.007**

Table 7.37 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to Section D of the Structured Interview**

	Step 0
No. hrs/week risky sports/hobbies (log)	1.41 (1.06,1.89)
p-value	**0.02**

Table 7.38 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to Section D of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.43 (1.08,1.88)	1.46 (1.10,1.94)
p-value	**0.01**	**0.01**
Sex (Female)	4.07 (2.03,8.17)	5.28 (2.47,11.3)
p-value	**0.0001**	**<0.0001**
Exposure to vibration		3.41 (1.45,8.04)
p-value		**0.004**

Table 7.39 Results of logistic regression represented by the odds ratio for cases in the **Tendon Disorders syndrome group** (95% confidence interval in brackets) in relation to **Section D 6 the Structured Interview**

	Step 0	Step 1
Sex (Female)	3.71 (1.52,9.07)	4.99 (1.93,12.9)
p-value	**0.004**	**0.004**
No. hrs/week risky sports/hobbies (log)		1.51 (1.03,2.21)
p-value		**0.03**

Table 7.40 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to Section D of the Structured Interview**

	Step 0	Step 1
Age (+ 10 years)	1.60 (1.19,2.14)	1.58 (1.17,2.13)
p-value	**0.002**	**0.003**
Exposure to vibration		2.72 (1.24,5.98)
p-value		**0.01**

Table 7.41 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to Section D of the Structured Interview**

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.38 (1.11,1.72)	1.32 (1.05,1.65)	1.31 (1.04,1.64)
p-value	**0.004**	**0.02**	**0.02**
Sex (Female)	1.83 (1.13,2.96)	2.14 (1.29,3.53)	2.25 (1.35,3.76)
p-value	**0.01**	**0.003**	**0.02**
No. hrs/week risky sports/hobbies (log)		1.37 (1.08,1.73)	1.31 (1.03,1.66)
p-value		**0.007**	**0.03**
Exposure to vibration			1.89 (0.97,3.69)
p-value			**0.05**

Table 7.42 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to Section D of the Structured Interview**

	Step 0	Step 1	Step 2
Sex (Female)	2.66 (1.58,4.49)	3.55 (2.01,6.28)	4.13 (2.27,7.52)
p-value	**0.0003**	**<0.0001**	**<0.0001**
No. hrs/week risky sports/hobbies (log)		1.57 (1.21,2.03)	1.51 (1.16,1.97)
p-value		**0.0008**	**0.003**
Exposure to vibration			2.38 (1.15,4.94)
p-value			**0.02**

Table 7.43 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to Section E of the Structured Interview**

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.20 (0.99,1.44)	1.20 (0.99,1.44)	1.16 (0.96,1.40)
p-value	**0.06**	**0.06**	**0.12**
Sex (Female)	1.72 (1.15,2.58)	1.66 (1.11,2.50)	1.68 (1.12,2.52)
p-value	**0.008**	**0.01**	**0.01**
Cigarette smoker		1.95 (1.16,3.27)	1.90 (1.13,3.21)
p-value		**0.01**	**0.01**
Arthritis			3.05 (0.87,10.7)
p-value			**0.05**

Table 7.44 Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to Section E of the Structured Interview

	Step 1	Step 2
Cigarette smoker	3.99 (2.04, 7.77)	4.35 (2.21, 8.56)
p-value	**<0.0001**	**<0.0001**
Arthritis		4.94 (1.05, 23.3)
p-value		**0.04**

Table 7.45 Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to Section E of the Structured Interview

	Step 0	Step 1	Step 2
Age (+10 years)	1.63 (1.22, 2.18)	1.62 (1.20, 2.17)	1.55 (1.14, 2.09)
p-value	**0.001**	**0.002**	**0.005**
Cigarette smoker		2.52 (1.20, 5.28)	2.57 (1.21, 5.42)
p-value		**0.02**	**0.01**
Arthritis			4.39 (1.00, 19.4)
p-value			**0.04**

Table 7.46 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to Section E of the Structured Interview**

	Step 0	Step 2
Age (+ 10 years)	1.39 (1.12,1.72)	1.31 (1.05,1.64)
p-value	**0.003**	**0.02**
Sex (Female)	1.92 (1.20,3.07)	1.94 (1.21,3.13)
p-value	**0.007**	**0.01**
Arthritis		5.08 (1.42,18.2)
p-value		**0.004**

Table 7.47 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to the Postural variables of the Structured Interview**

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.51 (1.09,2.09)	1.46 (1.04,2.05)	1.54 (1.09,2.18)
p-value	**0.01**	**0.03**	**0.02**
Typing style:			
Touch (keyb.) vs Touch (scrn)		0.21 (0.05,0.81)	0.23 (0.05,0.90)
Hunt & Peck vs Touch (scrn)		0.37 (0.17,0.78)	0.36 (0.17,0.76)
p-value		**0.008**	**0.01**
R shoulder elevated			3.00 (1.04,8.63)
p-value			**0.04**

Table 7.48 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to the Postural variables of the Structured Interview**

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.29 (1.02,1.65)	1.32 (1.03,1.68)	1.32 (1.03,1.69)
p-value	**0.04**	**0.03**	**0.03**
Sex (Female)	1.93 (1.15,3.24)	1.95 (1.15,3.29)	2.00 (1.17,3.41)
	0.01	**0.01**	**0.01**
Trunk twisted		0.50 (0.27,0.93)	0.46 (0.24,0.86)
p-value		**0.03**	**0.02**
Tendency to be a clacker			1.99 (1.13,3.51)
p-value			**0.02**

Table 7.49 **Results of logistic regression represented by the odds ratio for cases in the Any Syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1	Step 2
Age (+ 10 years)	1.18 (0.98,1.43)	1.20 (0.99,1.45)	1.21 (1.00,1.46)
p-value	**0.08**	**0.06**	**0.05**
Sex (Female)	1.79 (1.20,2.69)	2.12 (1.39,3.24)	2.09 (1.36,3.20)
p-value	**0.005**	**0.0006**	**0.001**
Task orientation (+ 15)		0.73 (0.59,0.91)	0.77 (0.61,0.96)
p-value		**0.004**	**0.02**
Physical comfort (+ 15)			0.84 (0.71,0.99)
p-value			**0.04**

Table 7.50 **Results of logistic regression represented by the odds ratio for cases in the Trigger Digit syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 1	Step 2	Step 3
Physical comfort (+ 15)	0.74 (0.58,0.96)	0.71 (0.54,0.92)	0.20 (0.06,0.61)
p-value	**0.02**	**0.01**	**0.002**
Work pressure (+ 15)		0.75 (0.57,0.98)	0.31 (0.14,0.69)
p-value		**0.03**	**0.005**
Physical comfort x Work pressure			1.35 (1.05,1.75)
p-value			**0.01**

Table 7.51 **Results of logistic regression represented by the odds ratio for cases in the Nerve Entrapment syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1
Age (+ 10 years)	1.40 (1.06,1.84)	1.47 (1.10,1.95)
p-value	**0.02**	**0.01**
Sex (Female)	4.58 (2.30,9.12)	4.52 (2.25,9.06)
p-value	**<0.0001**	**<0.0001**
Physical comfort (+ 15)		0.75 (0.59,0.97)
p-value		**0.02**

Table 7.52 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1
Sex (Female)	3.53 (1.51,8.27)	3.78 (1.59,8.97)
p-value	**0.004**	**0.003**
Peer cohesion (+ 15)		0.71 (0.52,0.98)
p-value		**0.03**

Table 7.53 **Results of logistic regression represented by the odds ratio for cases in the Epicondylitis syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1
Age (+ 10 years)	1.60 (1.19,2.15)	1.65 (1.22,2.23)
p-value	**0.002**	**0.001**
Task orientation (+ 15)		0.68 (0.48,0.95)
p-value		**0.02**

Table 7.54 **Results of logistic regression represented by the odds ratio for cases in the Shoulder Disorders syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1
Age (+ 10 years)	1.36 (1.09,1.69)	1.38 (1.11,1.73)
p-value	**0.007**	**0.004**
Sex (Female)	1.99 (1.24,3.19)	2.06 (1.27,3.33)
p-value	**0.005**	**0.004**
Physical comfort (+ 15)		0.77 (0.64,0.93)
p-value		**0.007**

Table 7.55 **Results of logistic regression represented by the odds ratio for cases in the Forearm Pain syndrome group (95% confidence interval in brackets) in relation to WES variables**

	Step 0	Step 1
Sex (Female)	2.78 (1.67,4.61)	2.70 (1.62,4.50)
p-value	**0.0001**	**0.0002**
Physical comfort (+ 15)		0.79 (0.64,0.97)
p-value		**0.02**

Table 7.56 **Results of logistic regression represented by the odds ratio for cases in the Tendon Disorders syndrome group (95% confidence interval in brackets) in relation to the goniometer variables.**

	Step 0	Step 1	Step 2	Step 3
Sex (Female)	3.32 (1.34,8.24)	3.57 (1.41,9.02)	3.52 (1.37,9.03)	4.13 (1.54,11.1)
p-value	**0.01**	**0.008**	**0.008**	**0.004**
RH flex/ext median (+10°)		1.67 (1.08,2.58)	1.74 (1.11,2.72)	1.99 (1.22,3.24)
p-value		**0.02**	**0.01**	**0.004**
RH flex/ext st.dev. (+5°)			1.58 (1.04,2.39)	1.72 (1.11,2.64)
p-value			**0.03**	**0.01**
LH flex/ext 99th percentile (+15°)				0.67 (0.43,1.05)
p-value				**0.09**

Table 7.57 Relationship between the mean and standard deviation number of hours keying per week and the longest spell at the keyboard without a break

Number of hours keying per week	Longest spell at the keyboard without a break			
	< 30 mins	30-60 mins	1-2 hours	> 2 hours
Mean	13.0	16.1	21.9	27.3
Standard deviation	8.4	9.4	10.6	10.5

Table 7.58 Mean and standard deviation of number of hours keying per week in relation to Trigger Digit syndrome group in males and females.

		Controls	Cases
Males	Mean	10.7	22.0
	SD	6.9	9.3
	N	70	24
Females	Mean	14.8	22.2
	SD	10.4	12.1
	N	77	37

Table 7.59 Relationship between the number and percentage of cases in each category of the longest spell at the keyboard without a break in males and females

	Longest spell at the keyboard without a break			
	< 30 mins	30-60 mins	1-2 hours	> 2 hours
Males	5.8%	40.0%	33.3%	50.0%
N	3	6	2	1
Odds ratio (95% CI)	-	**19.9 (3.19,124)**	**11.6 (1.21,111)**	**22.9 (0.19,30.7)**
Females	37.0%	36.0%	53.3%	77.3%
N	17	9	16	17
Odds ratio (95% CI)	-	**0.69 (0.22,2.19)**	**1.90 (0.65,5.54)**	**7.73 (1.88,31.8)**

(Odds ratios are given for each category relative to the <30 minutes category, adjusted for age and sex).

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