

WORKSTATION DESIGN AND POSTURAL STRESS PART 2: CASE STUDY

SUMMARY

An evaluation of the musculoskeletal problems associated with seated workstations was undertaken for employees of the Human Sciences Research Council. A sample of 37 workers was studied for 14 days to determine which symptoms were due to chronic disorders and which were linked to postural stress or constrained posture as a result of workstation and task design. Techniques used included two subjective comfort ratings, clinical examinations by physiotherapists, anthropometric and workstation measurement, and video recordings of subjects' posture over time. Subjects were selected from four occupations characterised by different levels of constraint in their work posture; data-entry typists, typists, programmers and researchers.

Examinations revealed that 68% of the presenting symptoms were not related to any known previous trauma or pathology. Of these problems 86% were reported to be occupationally aggravated or related. The findings confirmed the hypothesis that postural constraint is accompanied by an increased likelihood of developing chronic musculoskeletal disorders.

* The concepts of postural stress and postural constraint and their relationship to the development of muscle strain are discussed in Part 1: Background to occupational syndromes.

OPSOMMING

'n Evaluasie van die muskuloskeletale probleme verbonde aan sitwerkstasie is onderneem vir die werknemers van die Raad vir Geesteswetenskaplike Navorsing. 'n Steekproef van 37 werkers is oor 'n periode van 14 dae bestudeer om te bepaal watter simptome toe te skryf kan word aan kroniese afwykings, en watter aan postuurstres of -bepertheid, veroorsaak deur werkstasie-en-taakontwerp, te wyte is. Tegnieke wat gebruik is sluit in twee subjektiewe gerief skattinge, kliniese ondersoeke deur fisioterapeute, antropometriese en werkstasie mates, en video opnames van proefpersone se liggamshoudings oor 'n sekere tydperk. Proefpersone is geselekteer uit vier beroepsgroepe wat kenmerkend verskil in die mate van postuurbepanking wat in die werkstasie ondervind is, naamlik datatikers, tiksters, programmeerders en navorsers.

Ondersoeke het getoon dat 68% van aanmeldingssimptome geen verband gehad het met 'n vorige trauma of patologie. Dit is gemeld dat 86% van die genoemde probleme beroepsverwant of -vererger is. Die bevindings het die hipotese bevestig dat beperkte lagaamshoudings gepaard gaan met 'n vergrote waarskynlikheid van die ontwikkeling van kroniese muskuloskeletale probleme.

* Die begrippe van postuurstres en postuurbepanking en hul verhouding met die ontwikkeling van gespanne spiere word bespreek in Deel 1: Agtergrond tot werksverwante sindrome.

Anthony Golding*

ferentiate between workers suffering from chronic disorders as a result of pathology or trauma and complaints with "unknown" causes. The results, whilst not strictly generalisable, still provide indications of what findings might be expected in a large-scale investigation.

The degree of postural constraint is a function of the task and workstation. The most constrained task, that of the data-entry typist, consists of keying in numbers with the right hand while documents are paged with the left hand. This requires the head to be inclined and twisted to the left. Typists copy from documents to wordprocessors. The absence of document-holders means that the neck is twisted frequently. Programmers work on printouts in front which means that the terminals are placed at the far left-hand corner of the desk, necessitating twisting and leaning. Researchers perform desk work and terminal work.

INTRODUCTION

A preliminary survey on a sample of 70 employees of the Human Sciences Research Council (HSRC) showed that furniture was generally inappropriate for the tasks performed and that health complaints were a cause for concern. For instance, headache was experienced at least once a week by 38% of employees, backache by 37%, neckache by 40% and shoulderache by 31%. In view of these findings it was decided to investigate in greater depth using a smaller sample of 37 people.

An aim of the present study was to determine whether constrained work postures result in more musculoskeletal problems. To answer this question it was necessary to dif-

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METHODOLOGY

Subjects were selected on the basis of the relative postural constraint of their occupations. The sample included 7 data-typists, 5 typists, 8 programmers and 17 researchers (7 of whom were male). The bulk of the subjects was thus female. The mean ages and standard deviations of the groups were: data-typists 30,83 years (7,20); typists 33,60 (7,89); programmers 21,40 (2,90); and researchers 32,67 (8,35). The mean age of the programmers was found to be significantly different from those of the other groups using Student's *t* Test ($p,01$).

TECHNIQUES AND PROCEDURE

Several methods were used in evaluating workstations and health. These included measurement of anthropometric and workstation dimensions, clinical examination by physiotherapists, video recording of subjects' postural change over time, rating of general comfort using the scale of Shackel *et al*¹ and rating of discomfort in different body areas using a body map². A modified version of the scale of Roland and Morris³ was used to rate discomfort severity, ranging from "just noticeable discomfort" (1) to "almost unbearable discomfort" (5). A questionnaire incorporating these scales was administered to each subject 6 times daily for 14 consecutive days (Fig 1).

NAME DATE TIME

GENERAL COMFORT RATING

Please rate your feelings now. Mark the scale.

- I feel completely relaxed
- I feel perfectly comfortable
- I feel quite comfortable
- I feel barely comfortable
- I feel uncomfortable
- I feel restless and fidgety
- I feel cramped
- I feel stiff
- I feel numb (or pins and needles)
- I feel sore
- I feel very painful

BODY PART DISCOMFORT

Please look at the figure. Do you feel discomfort in any part of your body? YES/NO.

If YES, mark the uncomfortable parts of your body on the chart in order of importance from A to Z.

For each body part which you have mentioned please rate the discomfort using the scale:

- SCALE:**
1. Just noticeable discomfort
 2. Moderate discomfort
 3. Quite bad discomfort
 4. Severe discomfort
 5. Almost unbearable discomfort

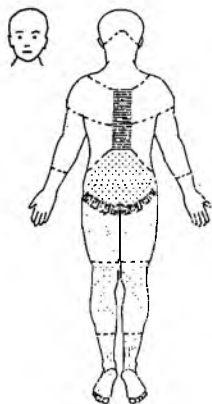


Figure 1. The subjective questionnaire.

RESULTS

General Comfort Ratings: Discomfort was assumed to be indicative of postural stress or fatigue. Cumulative fatigue

increased over time and was found to be significant for all groups ($p,01$) using Page's test of trend. The effect is reduced by a lunch break but the fatigue continues rising afterwards. This confirms the finding of Corlett and Bishop (*ibid*) that perceptions of postural discomfort are linearly related to the time of exposure to that posture. The fatigue builds up rapidly early in the day for the data-typists. The 30-minute lunch break is inadequate as a recovery period for the data-typists and typists.

Body Part Discomfort Ratings: This asked whether subjects felt discomfort. If they answered "Yes" they were required to mark the location of discomfort on a body manikin and the severity of pain using the 5 point rating scale. The frequency of "Yes" responses changed throughout the day with the range at Time 1 being 5-25%, at Time 4 (before lunch) 25-50%, and at Time 6 (end of the day) 30-40%. Ratings for the severity of discomfort have to be judged against its frequency. At Time 1 this varied from 1-1,8, at Time 4 from 1,8-2,7, and at Time 6 from 1,4-3,5. Clearly some subjects were in considerable pain since these were mean values.

Body parts in discomfort: The number of occasions on which discomfort was registered is expressed as a percentage of the number of times the questionnaire was administered. Figure 2 shows the neck and lower back to be the main sites of discomfort. There is also great variability between the occupations. Problems with the right shoulder/arm were unique in the data-typist profile. Low back, neck and shoulder discomfort was confirmed in the clinical examination and the video assessment of postural change; largely indicative of deficiencies in workstation design.

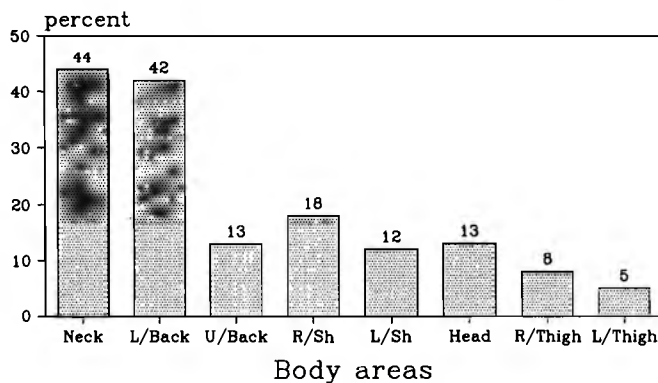


Figure 2. Body parts in discomfort.

Clinical examination: A computerised subjective assessment was followed by an objective examination (based on the Maitland principle), including assessment of physical posture; range of body movements; neurological aspects of sensations, reflexes and muscle power; and used palpation to determine soft tissue spasm, thickening, pain and stiffness. Figure 3 reveals which of the reported symptoms were related to previous trauma and/or pathology and which were not (Clinical). Overall 68% of problems clinically verified had no known cause. Neckache was experienced by 78% of subjects. Of these 65% had no known cause. All of the subjects who complained of upper backache and 62% of subjects who complained of low back pain had no known previous trauma or pathology. Breakdown by group showed an average of 3 presenting symptoms for data-typists, 2 for typists, 1,85 for

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programmers and 1,8 for researchers. In the subjective assessment 86% of problems were reported to be occupationally aggravated (97% for the neck and 67% for the low back). The physiotherapists' reports on each subject suggest that constrained working posture is likely to be at the root of many of the problems, especially in the case of neck symptoms where in the majority of cases there was associated trapezii and rhomboid spasm which is indicative of static loading and/or repetitive movements.

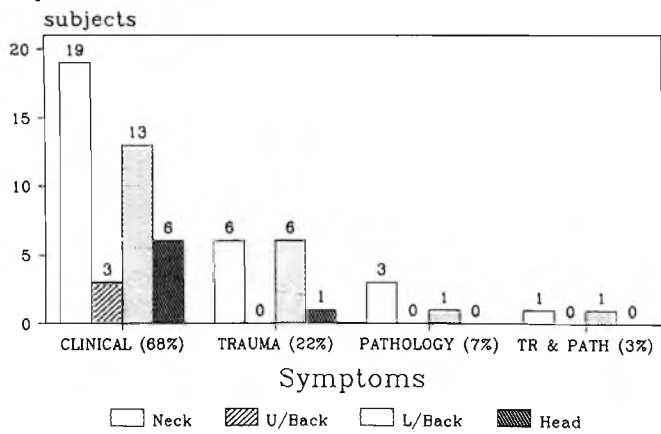


Figure 3. Classification of clinical symptoms.

Comparison	Student's t test	p	n
Work surface height versus Elbow height	2,22	<0.05	37
Seat height versus Popliteal height	3,28	<0.01	37
Seat depth versus Buttock-popliteal	2,45	<0.05	23

Anthropometric and workstation dimensions: The major points noted here were that work surfaces were higher than elbow height, leading to hunched shoulders and neck tension; seat height higher than popliteal height, with resultant ischaemia in the thighs; seat depth greater than buttock-popliteal length for programmers and researchers where older chairs were in use, rendering impossible proper use of the backrest. Basically the workstations were such that some 84% of subjects were forced to adopt poor postures in some way in order to work.

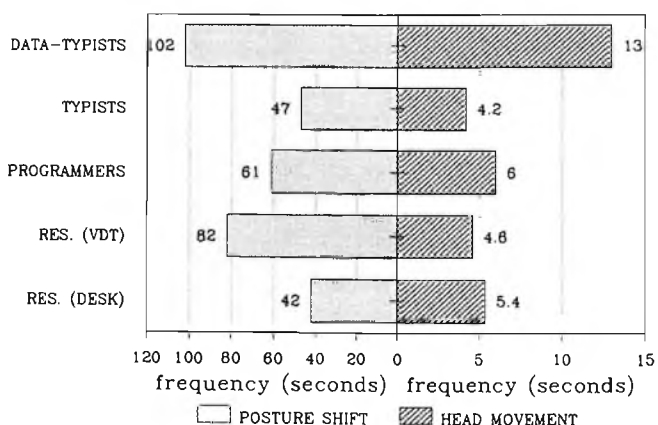


Figure 4. Postural change

Assessment of work posture: Video was used to examine the frequency of postural change, amount of time spent in

different postures and the relationship between work posture and physical symptoms. Figure 4 shows the frequency of shifts in posture and head movements. It is evident how the task performed determines the work posture. The speed of data-entry typing and emphasis on visual information retrieval lead to a comparative immobility of this group. Shifts in posture occur only once every 102 seconds and head movements every 13 seconds..

Postures were coded according to the posture of the head, trunk and arms. The relative fixity of immobility of posture may be derived by comparing the percentage of time spent in the most frequent position for the various groups. Figure 5 reveals the trend of postural constraint. The data-typists' typical position was with the head bent down and twisted to the left, reading from the source documents and typing with the right hand with the trunk against the backrest. Typists turn their heads from the screen to the source document in quick succession. Researchers using VDTs are fairly constrained but do not use the terminals constantly. The Programmers' work layout was unusual with a VDT occupying the far left corner of the desk. Terminal work thus required twisting the neck. Hunched shoulders were also observed in 6 of the subjects as a result of high desk height. These factors are thought to be largely responsible for the neck problems reported by this group in the clinical examination.

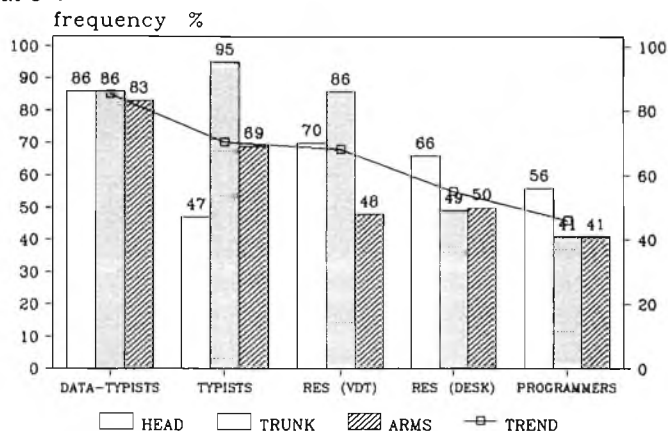


Figure 5. Duration of postures (group median body position)

To endeavour to eliminate some of the bias that must inevitably creep into observations made by one person it was arranged for the consultant physiotherapist to view the video films and give an independent judgement on the sites of probable symptoms according to the work postures of subjects. The physiotherapist watched 22 video films selected at random. Common instances of bad posture were sitting with back support, desks being too high or chairs too low, where the head was rotated, and other cramped positions. The identified sites of probable symptoms were later compared with the results of the clinical examination. In 16 of the 22 cases the correspondence between the two was exact. That is, where a probable site was identified as low back, then this symptom was revealed in the examination. Clearly the use of the "expert eye" of the physiotherapist may be a potential substitute for lengthy video analysis.

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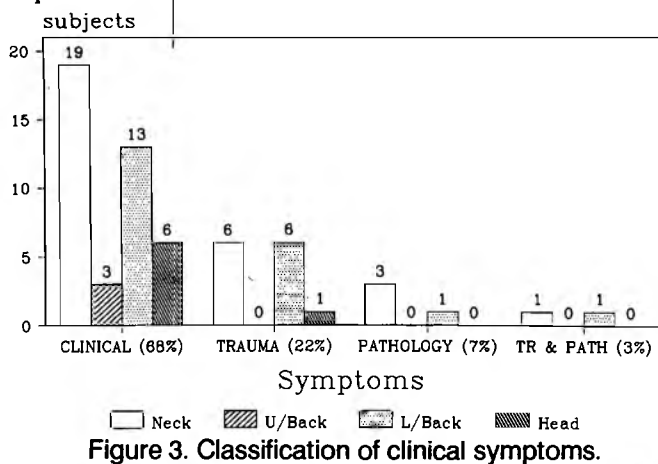


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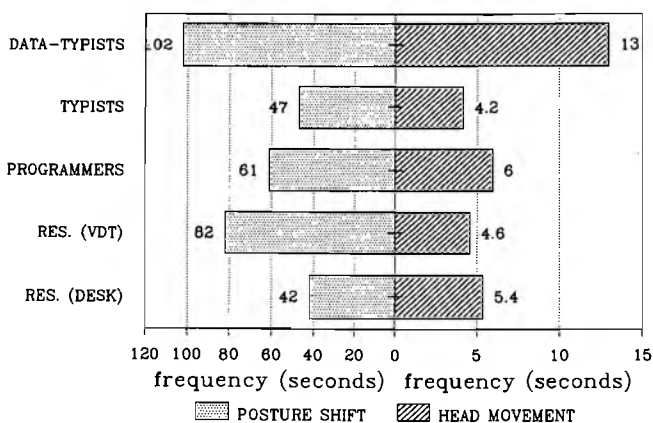


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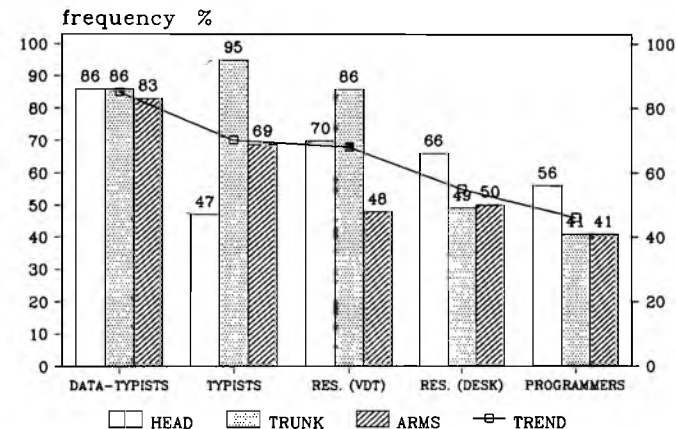


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employed to collect data. In such case studies where the sample is small it is necessary to insure against methodological inadequacies by using several techniques in order to get cross-validation. Tests of significance should be treated with caution since the chance of introducing spurious errors is relatively high. However, a brief summary of how some methods compared may be of interest, whilst bearing in mind the need for caution in their interpretation. There was a strong association revealed between the general comfort ratings and the body part discomfort ratings at each time level using the Chi-square test ($p < 0,001$) – it appears these ratings are measuring the same thing in the same subjects i.e. discomfort. Both these subjective ratings were found to correlate with postural constraint (percentage of time in one position). Spearman's rho rank coefficients were $r_s = 0,36$ ($p,05$) for postural constraint and general comfort and $r_s = 0,41$ ($p,05$) for postural constraint and body part discomfort. Again, this result is tenuous in view of the fact that the postural analysis is a rather gross measure and the technique is in its infancy.

DISCUSSION

The findings here may be described as interesting but not substantive. The sample was too small to permit generalisations to be made about occupational differences in work posture. Nevertheless, the findings are broadly in line with the results of overseas research. The most important result was that as much as 68% of reported symptoms verified clinically had no known cause. It is possible that long forgotten events such as motor vehicle accidents, whilst not producing any pain at the time, could be the precursor of later problems. Mini-traumas over long periods is also a possibility. When symptoms appear it is understandable that people will associate present events with their occurrence.

Given such complications it is not that easy to identify the cause of symptoms. However, the analysis of work posture, corroborated by the other evidence does suggest that in many instances work design is a major source of postural stress which appears to aggravate, if not actually cause, some symptoms. The reduction in the frequency of symptoms of the programmers has occurred simultaneously with a change in the workstation layout. Neck complaints were caused by hunched shoulders and twisted necks. New workstations with dedicated terminal desks were purchased, which no longer require these constrained postures.

It therefore seems that interventions to change the postural demands of work by redesigning the layout of workstations will often be successful, especially if the problem is fairly obvious as in the case of the programmers. Indeed the main emphasis in the interventionist approach is that aetiology is frequently too obscure or complex and that if jobs posing risks can be identified then it makes more sense to reduce postural stress by redesigning the work. It is not so easy to assess the contribution of work exposure to a chronic disorder first appearing as a result of trauma. In several cases symptoms were reported to occur only when the individual was working or when engaged in another activity at home. Gardening for low back sufferers was a common response whilst neck/shoulder problems could be triggered by a range of activities. Data-entry typing was an activity which led to prob-

lems and two aspects could be responsible for this the repetitive nature of the task and the static loading. Interventions overseas have concentrated on work reorganisation in this instance introducing more frequent rest pauses and other tasks to increase the amount of postural variety. The consequence is that postural fatigue is not permitted to build up and there is reduced discomfort⁴.

CONCLUSION

Further research should employ much larger samples but intervention programmes must be run longitudinally before the effects can be properly assessed. This presents a problem as far as continuous monitoring of subjective discomfort is concerned because of the time involved in administering questionnaires. Diary recording has met with mixed success, the main problem being that subjects need to be highly motivated. If there is an appropriate health professional available such as an occupational health nurse then a daily monitoring programme may well be feasible. The most likely possibility would seem to be the administration of a questionnaire on a regular basis over a number of years to monitor the progress of intervention efforts.

It appears that the techniques used in the measurement of postural discomfort have considerable potential for identifying problems in work environments other than the office, where the hazards associated with musculoskeletal disorders are greater. At present there is little involvement of physiotherapists in occupational settings in South Africa, possibly because the need for their presence has not been realised. It is argued that if the contribution of occupational exposure to disorders is high⁵ then prevention efforts would indeed be more effective if initiated at this point. Physiotherapists are uniquely qualified to identify the problems associated with poor posture and the field of occupational physiotherapy offers an interesting challenge for those concerned with the prevention of symptoms rather than their cure.

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