Welcome to Practical Ergonomics for the Urologist!

We are excited to share some ergonomics lessons with you that we trust you will find useful in your daily work. What follows is a summary of the important points from our SIU class as well as some supplemental material. In particular, the attached RULA worksheet will be used during class for rating ergonomic positions on video. Please print out the RULA and bring at least one copy with you.

We look forward to meeting you all in Buenos Aires!

Sincerely,

Kristin Chrouser MD, MPH
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Human factors/ergonomics is the science concerned with ‘fit’ between people and their tasks, tools & environments

The two main groups of Musculoskeletal disorders (MSDs) are

- Back pain/injuries and
- Work-related upper limb disorders, aka:
  - Repetitive strain injuries
  - Cumulative trauma disorders
  - Overuse disorders
  - Carpal Tunnel

Risk factors for MSD associated with surgery

- Static work (holding the same position)
- Repetitive twisting and bending
- High force work
- Awkward posture, worse when crowded
- Long working periods without breaks
- High loading--- the greater the distance between what you are holding and the muscles doing the work, the greater the load.
- Lack of case variation
- Poor visual ergonomics

New ergonomic challenges in minimally invasive surgery compared to open surgery

- Fixed fulcrum
- Extra force requirements
- Static postures
- Twisted torso-- port and monitor placement
- Poor instrument design
- Higher cognitive load
Tips for improving MIS ergonomics

- **Adjust monitor** so viewing angle is 10-25° below eye level and in line with target quadrant
- **Adjust posture** so that the body faces the monitor and the target quadrant and the head is slightly flexed at an angle of 15 to 30° downward. Standing position is neutral, the arms are slightly abducted and rotated inward at shoulder. Elbows are bent at ~90-120°, wrists are (minimally) extended, and hands relaxed
- **Adjust table** so lap instrument handles are at (or up to 10 cm below) elbow level
- **Align foot pedals** in the direction of the target quadrant and toward monitors

General advice for preventing MSDs from surgery

- **Stay fit and exercise**
- **Adjust equipment and shift posture during cases**
- **Obtain/Use Ergonomic Equipment**
  - Anti-fatigue mats
  - Arm rests
  - Ergonomically designed surgical instruments
- **Proper posture**
- **Intra operative postural resets**
  - Take a break (screen off/hands off)
  - Stretch
  - Intra-operative exercises

In addition, we have attached a paper regarding the SURG TLX which is a workload measure used during surgery as well as an article on the Nordic questionnaire for analysis of musculoskeletal symptoms. These are for your educational use only and not for distribution.
Complete this worksheet following the step-by-step procedure below. Keep a copy in the employee’s personnel folder for future reference.

**A. Arm & Wrist Analysis**

**Step 1: Locate Upper Arm Position**
- If shoulder is raised: +1
- If upper arm is abducted: +1
- If arm is supported or person is leaning: -1

**Step 2: Locate Lower Arm Position**
- If arm out to side of body: +1
- If arm is working across midline of the body: +1

**Step 3: Locate Wrist Position**
- If wrist is bent from the midline: +1

**Step 4: Wrist Twist**
- If wrist is twisted mainly in mid-range: +1

**Step 5: Look-up Posture Score in Table A**
- Use values from steps 1, 2, 3 & 4 to locate Posture Score in Table A

**Step 6: Add Muscle Use Score**
- If posture mainly static (i.e. held for longer than 1 minute) or:
  - if action repeatedly occurs 4 times per minute or more: +1

**Step 7: Add Force/load Score**
- If load less than 2 kg (intermittent): +0;
- If 2 kg to 10 kg (intermittent): +1;
- If 2 kg to 10 kg (static or repeated): +2;
- If more than 10 kg load or repeated or shocks: +3

**Step 8: Find Row in Table C**
- The completed score from the Arm/wrist analysis is used to find the row on Table C

**B. Neck, Trunk & Leg Analysis**

**Step 9: Locate Neck Position**
- If neck is twisted: +1
- If neck is side-bending: +1

**Step 10: Locate Trunk Position**
- If trunk is twisted: +1
- If trunk is side-bending: +1

**Step 11: Legs**
- If legs & feet supported and balanced: +1

**Step 12: Look-up Posture Score in Table B**
- Use values from steps 8, 9, & 10 to locate Posture Score in Table B

**Step 13: Add Muscle Use Score**
- If posture mainly static or:
  - if action 4/minute or more: +1

**Step 14: Add Force/load Score**
- If load less than 2 kg (intermittent): +0;
- If 2 kg to 10 kg (intermittent): +1;
- If 2 kg to 10 kg (static or repeated): +2;
- If more than 10 kg load or repeated or shocks: +3

**Step 15: Find Column in Table C**
- The completed score from the Neck/Trunk & Leg analysis is used to find the column on Chart C

**FINAL SCORE:**
- 1 or 2 = Acceptable;
- 3 or 4 investigate further;
- 5 or 6 investigate further and change soon;
- 7 investigate and change immediately


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Development and Validation of a Surgical Workload Measure: The Surgery Task Load Index (SURG-TLX)

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Abstract

Background The purpose of the present study was to develop and validate a multidimensional, surgery-specific workload measure (the SURG-TLX), and to determine its utility in providing diagnostic information about the impact of various sources of stress on the perceived demands of trained surgical operators. As a wide range of stressors have been identified for surgeons in the operating room, the current approach of considering stress as a unidimensional construct may not only limit the degree to which underlying mechanisms may be understood but also the degree to which training interventions may be successfully matched to particular sources of stress.

Methods The dimensions of the SURG-TLX were based on two current multidimensional workload measures and developed via focus group discussion. The six dimensions were defined as mental demands, physical demands, temporal demands, task complexity, situational stress, and distractions. Thirty novices were trained on the Fundamentals of Laparoscopic Surgery (FLS) peg transfer task and then completed the task under various conditions designed to manipulate the degree and source of stress experienced: task novelty, physical fatigue, time pressure, evaluation apprehension, multitasking, and distraction.

Results The results were supportive of the discriminant sensitivity of the SURG-TLX to different sources of stress. The sub-factors loaded on the relevant stressors as hypothesized, although the evaluation pressure manipulation was not strong enough to cause a significant rise in situational stress.

Conclusions The present study provides support for the validity of the SURG-TLX instrument and also highlights the importance of considering how different stressors may load surgeons. Implications for categorizing the difficulty of certain procedures, the implementation of new technology in the operating room (man–machine interface issues), and the targeting of stress training strategies to the sources of demand are discussed. Modifications to the scale to enhance clinical utility are also suggested.

Introduction

The surgical operating room is a multifaceted environment that exposes operating surgeons and their teams to considerable stress-inducing conditions. Challenges, such as procedure complexity, time pressure, peer evaluation, multitasking, and distractions all have the potential to raise levels of intraoperative stress [1, 2]. Despite the multiple stressors that surgeons may face, they are more likely to deny potential effects of stress on their performance than individuals in other challenging environments [3]. Such an attitude has discouraged applied research in the field and limited organizational and educational change policies [4].
As intraoperative stressors are seldom factored in as potential contributors to surgical outcome, there are also significant negative implications for patient care and safety.

Stress is experienced when perceived resources are outweighed by demands [5, 6]. Given that multiple sources of stress have been identified, one weakness of current research is that it adopts a unidimensional approach to measurement. While validated instruments such as the State Trait Anxiety Inventory (STAI) [7] provide a measure of emotion (anxiety), other mechanisms may underpin the stress-performance relationship. Indeed, different stressors are likely to cause surgical performance to break down for different reasons. Considering stress as a unidimensional construct not only limits the degree to which underlying mechanisms may be understood but also the degree to which a training intervention may be successfully matched to a particular source of stress.

Few studies in surgery have attempted to gain insight into the specific demands imposed on surgeons by typically experienced stressors. In the fields of aviation and industrial ergonomics, however, the study of mental demand (workload) has been a major area of inquiry, as researchers have sought to examine the potential causes of poor performance linked to increased workload [8–11]. Workload is a multifaceted construct, determined by the interaction of the task demands, the circumstances under which the task is performed, and the skills, behaviors, and perceptions of the individual [12, 13]. It is apparent from this definition that anxiety (stress) may be but one factor with an impact on the demands of the task.

The most widely used measure of workload in human factors research has been the NASA-Task Load Index (NASA-TLX) [14], a multidimensional rating scale that has six bipolar dimensions: mental demand (MD); physical demand (PD); temporal demand (TD); own performance (P); effort (E); and frustration (F). The dimensions therefore reflect task-related (MD, PD, TD), subject-related (P), and behavior-related (F and E) factors. While multidimensional measures provide stronger diagnosticity (i.e., the capability of an instrument to discriminate between different types of workload [9, 13]), a weakness is that they are generally created for a specific environment or task, and therefore may not reflect different dimensions of workload in other environments [15].

Although the NASA-TLX has been adopted as a measure of workload in recent surgical research [16–20], in all cases the individual dimension scores were simply aggregated to provide a total workload measure. This process ignores the primary advantage of multidimensional scales: their ability to discriminate between different sources of workload. The purpose of the present study was therefore to develop and validate a surgery-specific version of the Task Load Index (SURG-TLX), and to determine whether it provides diagnostic information regarding the impact of various sources of stress on the perceived demands of trained surgical operators.

Methods

Scale development

As the NASA-TLX is a well-validated instrument [21, 22], the intention was to maintain its general structure but make it more relevant to the specific demands of surgery [15]. The first step was to consider the process adopted in developing another TLX variant, designed for car driving; the Driving Activity Load Index (DALI) [23]. The DALI’s six dimensions (effort of attention, visual demand, auditory demand, temporal demand, interference, and situational stress) were first determined by discussion with a number of experts in driving research. A study was then designed to test the sensitivity and diagnosticity of the instrument for typical driving tasks; interacting with a navigation system and operating a hands-free car phone. Results confirmed that the DALI dimensions were sensitive to these manipulations [23].

To develop a surgery-specific version of the NASA-TLX, we consulted qualitative research that has identified key intraoperative stressors [2] and considered which dimensions of the NASA-TLX and DALI best approximate the demands faced by surgical operators. The three task demand dimensions from the NASA-TLX were retained (mental, physical, and temporal demands), as were the environmental demand dimensions from the DALI (distractions and situational stress). It was felt that a final dimension reflecting Task Complexity was more appropriate than one related to effort or frustration. The specific dimensions for the SURG-TLX were therefore formulated and defined as follows:

1. Mental demands: How mentally fatiguing was the procedure?
2. Physical demands: How physically fatiguing was the procedure?
3. Temporal demands: How hurried or rushed was the pace of the procedure?
4. Task complexity: How complex was the procedure?
5. Situational stress: How anxious did you feel while performing the procedure?
6. Distractions: How distracting was the operating environment?

Eight experienced surgeons from a range of disciplines (four Consultants and four Specialist Registrars) were asked to provide their opinions of the SURG-TLX’s
dimensions, as well as provide “free” comments about which factors made procedures demanding. While a variety of specific factors were raised (e.g., negativity from others in the operating room, nonavailability of preferred equipment, patient expectations) there was general agreement that the dimensions were reflective of the typical demands experienced in surgery. The surgeons were provided with the NASA-TLX and DALI dimensions for comparison, and all 8 agreed that mental demands, temporal demands, task complexity, and distractions were important factors affecting workload judgments. Two of the Consultants felt that physical demands and situational stress may not be as relevant to workload as the frustration dimension from the NASA-TLX. However, because most of the surgeons were satisfied with the dimensions selected, we decided to maintain the original six-dimension structure of the index.

Having developed the instrument, the second phase of the study aimed to validate it by exposing trainee operators to various intraoperative stressors as they performed a well-validated laparoscopic task.

Subjects

Novices (n = 30 medical students) volunteered to take part in the research. Institutional ethical approval was obtained prior to the commencement of the study, and all subjects provided written informed consent and demographic information before testing. Subjects were informed that they would be given the opportunity to perform a laparoscopic task under a variety of conditions in a laboratory supporting clinical simulation. Subjects attended individually and were paid $HK150 for taking part.

Materials and task

The task adopted was the validated Fundamentals of Laparoscopic Surgery (FLS) peg transfer task [24]. The FLS training program model is endorsed by the American College of Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons, and consists of five tasks of increasing complexity [25, 26]. In the peg transfer task, six plastic objects are grasped, transferred, and positioned on a pegboard. Specifically, each object is picked up with grasper forceps from a pegboard on the surgeon’s left, transferred in space to a grasper in the right hand and then placed around a post on the right-hand side of the pegboard. After all six objects have been transferred from left to right the process is reversed, requiring transfer from the right hand to the left hand. The exercise is timed and a penalty score is assessed whenever an object is dropped outside the surgeon’s view.

As with the original TLX and the DALI, a two-part evaluation is required to complete the SURG-TLX. The first part involves calculating weights of the six dimensions following a set of 15 paired comparisons. The dimension with the highest weight is the most important contributing factor for the perceived workload (scores range from 0 to 5). The second part involves rating six bipolar scales reflecting the separate dimensions on a 20-point Likert scale, anchored between low and high (see Appendix 1 for the SURG-TLX). A workload score for each dimension is then calculated by determining the product of these two numbers. For example, a weight score of 4 and a rating of 15 equate to a workload score of 60 (scores range from 0 to 100). A total workload score is also determined by aggregating the scores from the six dimensions.

Procedure

Before training commenced, subjects watched an introductory video showing an expert complete the peg transfer task. They were then required to perform repetitions of the task until they reached proficiency; defined as completing the task in less than 54 s and without a penalty score on two consecutive trials and on ten additional nonconsecutive trials. Developers of the FLS skills curriculum [26] have recommended that surgical educators adopt this criterion for task proficiency, which is based on expert levels of performance [25]. Subjects were informed of the proficiency requirements at the outset of training and were offered feedback on their completion times whenever it was asked for.

The procedure consisted of training and testing phases. In the training phase, subjects trained on the peg transfer task for up to 90 min, or until proficiency was reached. Subjects completed the SURG-TLX after their fifth learning attempt (task novelty condition) and were asked to complete it with respect to their previous two attempts. Subjects also completed the SURG-TLX after their final attempt of this training session (physical fatigue condition). Again, subjects were asked to complete the instrument with respect to their previous two attempts. If proficiency was not attained in this time-frame then a second training session was organized for the following day. Sixteen of the 30 subjects had to complete an additional training session in order to reach the criterion level of proficiency. All subjects reached proficiency, taking on average 59.4 (SD = 20.8) trials to reach the criterion level of performance.

The testing phase was scheduled for the day after proficiency had been reached. Subjects first had to attain two consecutive criterion level completions. They then performed two trials in a control condition and each of three test conditions designed to simulate typical stressors.
experienced during surgical performance [1] (counterbalanced design). The test conditions consisted of a multitasking condition, an evaluative condition, and a time pressure condition. The SURG-TLX was completed after the second trial of each condition in the test phase.

In the control condition subjects were simply asked to do their best in completing the task. The multitasking condition was designed to be distracting and mentally demanding, as subjects were required to perform mental arithmetic while completing the peg transfer task [4, 27–29]. Specifically, on the first trial subjects started counting back from 737 in sevens, and on the second trial they started counting from whichever number they reached on the first trial.

The evaluative condition involved a manipulation designed to increase ego-threat and performance anxiety [28, 30]. Subjects were informed that their performance was to be videotaped so it could be viewed by three of their course tutors and compared to the performance of trainee surgeons from the United Kingdom and the United States of America. The subjects were made aware of a video camera being turned on and were asked to say their name and year of study for the camera prior to completing their two trials. The final condition was designed to create an element of time pressure [4, 28]. Subjects were informed that some surgeries have to be completed under time constraints, perhaps because of complications occurring during the procedure. They were informed of their best time during training and were instructed to try to complete the task more quickly than on that attempt.

Data analysis

A mean workload score for each dimension (and total workload) was computed for each of the six conditions of interest (training phase: task novelty and physical fatigue; test phase: control, multitasking, evaluation and time pressure) and subjected to one way analysis of variance (ANOVA). Significant main effects were followed up with Bonferroni adjusted paired sample t-tests, and effect sizes were reported as partial eta squared ($\eta^2_{p}$).

Hypotheses

A series of hypotheses were developed based on the expected effects of the manipulations affecting workload (compared to the control condition):

**Hypothesis 1**: Primarily the Task Complexity dimension will be raised in the “task novelty” condition, reflecting the fact that the task is unfamiliar and unpracticed.

**Hypothesis 2**: Primarily the Physical Demands (fatigue) dimension will be raised in the “physical fatigue” condition, as subjects will have completed up to 90 min of training of a novel task.

**Hypothesis 3**: Primarily the mental demands and distraction dimensions will be raised in the multitasking condition, due to concurrent task loading.

**Hypothesis 4**: Primarily the situational stress dimension will be raised in the “evaluation” condition, due to the ego-threatening nature of the instructions.

**Hypothesis 5**: Primarily the temporal demands dimension will be raised in the “time pressure” condition.

Results

Task complexity

Analysis of variance revealed a significant main effect for condition, $F(5, 145) = 45.5$, $P < .001$, $\eta^2_{p} = .61$. Bonferroni follow-up tests revealed that the multitasking condition was perceived to be significantly more complex than any other condition ($Ps < .001$; see Fig. 1). No other significant differences were evident.

Physical demands

Analysis of variance revealed a significant main effect for condition, $F(5, 145) = 13.0$, $P < .001$, $\eta^2_{p} = .31$. Bonferroni follow-up tests revealed that physical demands were significantly higher in the physical fatigue condition than all other conditions (all $Ps < .05$). Furthermore, the multitasking condition was perceived as being significantly less physically demanding than all other conditions (all $Ps < .005$; see Fig. 1).

Mental demands

Analysis of variance revealed a significant main effect for condition, $F(5, 145) = 8.3$, $P < .001$, $\eta^2_{p} = .22$. Bonferroni follow-up tests revealed that the reported mental demand in the multitasking condition was significantly higher than in all other conditions (all $Ps < .05$; see Fig. 1).

Distraction

Analysis of variance revealed a significant main effect for condition, $F(5, 145) = 12.7$, $P < .001$, $\eta^2_{p} = .31$. Follow-up Bonferroni tests revealed that the multitasking condition was significantly more distracting than all other conditions (all $Ps < .05$; see Fig. 1). No other significant differences were evident.
Situational stress

Analysis of variance revealed a significant main effect for condition, $F(5,145) = 3.1$, $P < .05$, $\eta^2_p = .10$. Follow-up Bonferroni tests revealed that the time pressure condition was most stressful, although this was only at a significant level when compared to the multitasking condition ($P < .05$) and the control condition ($P < .05$, see Fig. 1).

Temporal demands

Analysis of variance revealed a significant main effect for condition, $F(5,145) = 28.6$, $P < .001$, $\eta^2_p = .50$. Bonferroni follow-up tests revealed that subjects perceived the time pressure condition to have significantly higher temporal demands than all other conditions (all $P_s < .05$), except the novel task condition ($P = .49$). The temporal demands of the multitasking condition were also perceived to be significantly less than all other conditions (all $P_s < .001$, see Fig. 1).

Total workload

Analysis of variance revealed a significant main effect for condition, $F(5,145) = 7.68$, $P < .001$, $\eta^2_p = .21$. Follow-up Bonferroni tests revealed that the control condition was significantly less demanding than “physical fatigue” ($P < .05$), multitasking ($P < .005$), and time pressure ($P < .001$) conditions. The time pressure condition was also significantly more demanding than the evaluation condition ($P < .001$; see Fig. 2).

Discussion

The aim of this research was to develop and validate a surgery-specific, multidimensional workload measure (the SURG-TLX), based on the NASA-TLX [14] developed for
pilots. The advantage of multidimensional measures is that they provide a degree of diagnosticity, although this is at the expense of specificity [13, 15]. While the original TLX has been adopted in surgical settings, only the total workload data have been presented [16–20], limiting the utility of the instrument to provide insights into specific sources of workload. Given that a wide range of stressors have been identified for surgeons in the operating room [1, 13] a surgery-specific workload measure might provide useful information to categorize procedures, guide training, and design stress management interventions.

The results of the present study, using recently trained laparoscopic operators and a validated laparoscopic task, revealed that the SURG-TLX is sensitive to a variety of different surgical stressors; including physical fatigue, time pressure, multitasking, and increased complexity. Indeed, of the five hypotheses developed to test the sensitivity of the six dimensions, there were only two somewhat unexpected, but explainable, results. We expected that, as relative novices (five trials of laparoscopic training), subjects would consider the task to be demanding [31] (high task complexity; hypothesis 1). However, only the multitasking condition was perceived to be significantly more complex than the control condition (Fig. 1a). Although this was not an a priori prediction, it is perhaps not surprising that subjects found the task to be more complex when a concurrent cognitive load was added.

The other unexpected finding was that the situational stress dimension (Fig. 1e) was not significantly higher in the evaluative condition (hypothesis 4). Previous research has demonstrated that trainee surgeons find evaluation from their senior peers to be stressful [28, 30]. Our manipulation of ego threat may not have been as powerful as others reported in the literature, as there was no physical presence from a known evaluator. Previous research, however, has consistently shown that the mere presence of a video camera is sufficient to cause evaluation stress [32–34]. The fact that the time pressure condition was perceived as stressful was not expected; however, this may reflect the specific wording used to introduce the condition. Subjects were asked to consider that, because of complications, some operating room procedures require quick completion. This instruction highlights the clinical relevance of the current training and may have provoked a more real life emotional response. Alternatively, asking trainees to better their best time during training provides a clearer understanding of the demands of the task and highlights the extent to which those demands might outweigh the trainees’ perceived capabilities [5, 6].

The total workload data provide limited information beyond what could have been determined by asking subjects “how demanding was the task?” It provides no diagnostic information as to why multitasking and time pressure were the most demanding tasks (Fig. 2). This diagnostic information might be useful for a number of reasons. First, is the ability to assess why a procedure might be difficult, especially when performed under various demanding or stressful conditions (categorization). Second, the SURG-TLX may assist surgeons in making better decisions about the likely demands associated with introducing new techniques or technologies (e.g., robotic surgery) [13, 18, 20] into the operating room. In the ergonomics literature, where subjective workload is frequently considered during interface design, there has been a great deal of interest in understanding the “hidden” demands associated with the proliferation of technology [35, 36]. Third, the matching of appropriate training interventions to operator needs can only be assisted by diagnostic information about the sources of overload or stress. It is naïve to assume that the myriad of acute stress sources experienced by surgeons in the operating room will have an impact on performance through similar mechanisms. Training solutions should therefore be targeted at increasing coping resources for the particular demands experienced [37].

The current validation experiment followed the same approach as that adopted by a previous domain-specific adaptation of the TLX [23], by experimentally manipulating the demands of the task. Future research is required to assess “natural” sources of workload in the operating room for a variety of procedures and across experience levels. When possible, operators should complete both the paired comparison and the Likert scale components of the SURG-TLX. However, the Likert scale on its own can provide an informative visual analog of procedure demands. In this less stringent format the SURG-TLX has greater clinical utility; for example, it could be swiftly administered to help guide the self-reflection process of surgeons who have just performed poorly. Should the relative weighting between two dimensions remain unclear, paired comparisons could then be used to distinguish which of the dimensions makes the greatest contribution to workload.

Future research is required to determine whether the SURG-TLX is sensitive to the various combinations of stressors that occur in the operating room, and to the reflections of more experienced surgeons. However, this preliminary study supports the validity of the SURG-TLX as a multidimensional measure of surgical workload, which is sensitive to some of the typical stressors experienced during training.

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Appendix 1: The SURG-TLX

Weighted rating

There are six rating scales which are meant for evaluating your experience during the procedure.

Please evaluate the procedure by marking “X” on each of the six scales at the point which best fits your experience. The scale ranges from “low” on the left to “high” on the right. Please read the descriptions carefully.

**Mental Demands**
How mentally fatiguing was the procedure?

![Mental Demands Scale]

**Physical Demands**
How physically fatiguing was the procedure?

![Physical Demands Scale]

**Temporal Demands**
How hurried or rushed was the pace of the procedure?

![Temporal Demands Scale]

**Task Complexity**
How complex was the procedure?

![Task Complexity Scale]

**Situational Stress**
How anxious did you feel while performing the procedure?

![Situational Stress Scale]

**Distractions**
How distracting was the operating environment?

![Distractions Scale]
Pairwise comparisons

Following are a set of titles listed into boxes within a grid. From these boxes, you will choose which title you deem more applicable to your experience of workload in the procedure. Circle the title that you deem fitting of your experience. Please consider your choices carefully and make them consistent with how you used the rating scales. We are not looking for a right or wrong answer. We are only interested in your opinion.

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References

Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms


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Standardised questionnaires for the analysis of musculoskeletal symptoms in an ergonomic or occupational health context are presented. The questions are forced choice variants and may be either self-administered or used in interviews. They concentrate on symptoms most often encountered in an occupational setting. The reliability of the questionnaires has been shown to be acceptable. Specific characteristics of work strain are reflected in the frequency of responses to the questionnaires.

Keywords: Questionnaires, musculoskeletal disorders, occupational health

Background

Musculoskeletal disorders and symptoms in a working population are common, occurring predominantly in the low back (see review by Troup and Edwards, 1985), neck and upper limbs (e.g., Armstrong et al., 1982; Waris, 1979; Oxenburgh et al., 1985). Mechanical factors contribute to the development of these problems and in general influence symptoms (Kilbom et al., 1986; Maeda et al., 1979; Pope et al., 1984). To help define the problem and its relationship to work factors, increasing interest has been directed in many countries to the development of methods to estimate and record musculoskeletal symptoms. Questionnaires have proved to be the most obvious means of collecting the necessary data.

Standardisation is needed in the analysis and recording of the musculoskeletal symptoms. Otherwise it is difficult to compare the results from different studies. This consideration was the main motive for a Nordic group to start developing standardised questionnaires for the analysis of musculoskeletal symptoms. Even a modest degree of standardisation was regarded as useful. We found that the major part of most questionnaires used in previous studies could have been easily comparable, but that the individual questions often differed in trivial details from study to study and thus impeded the comparison of the results. It was evident that the knowledge about the musculoskeletal symptoms was not sufficient to allow an advanced degree of standardisation. Consequently, we faced a trade-off between the banality of the questionnaire and the depth of the approach. The questionnaires presented here are a compromise between the extremes. We are well aware, however, that use of identical questionnaires is not the only prerequisite for comparison of data from different studies.

The questionnaires follow the tradition of some earlier medical questionnaires – e.g., for cardiovascular (Rose and Blackburn, 1968) or pulmonary surveys (British Medical Research Council's questionnaire for chronic bronchitis (Anon., 1960a, 1960b)). The nature of the musculoskeletal symptoms dictates a different structure, however.

Supported by the Nordic Council of Ministers, a project was undertaken to develop and test standardised questionnaires on general, low back and neck/shoulder complaints. The text has been translated into four Nordic languages, using a multiple to-and-from technique from the source languages which were Swedish and Danish. Translation into English has been guided by native speakers of English, but might require further revision. If comparability with the Nordic languages is desired, a further check-and-cross translation is recommended.
Structure of the questionnaires

The questionnaires consist of structured, forced, binary or multiple choice variants and can be used as self-administered questionnaires or in interviews. There are two types of questionnaires: a general questionnaire, and specific ones focusing on the low back and neck/shoulders. The purpose of the general questionnaire is simple surveying, while the specific ones permit a somewhat more profound analysis.

The two main purposes of the questionnaires are to serve as instruments (1) in the screening of musculoskeletal disorders in an ergonomics context, and (2) for occupational health care service. The questionnaires may provide means to measure the outcome of epidemiological studies on musculoskeletal disorders. The questionnaires are not meant to provide a basis for clinical diagnosis. Screening of the musculoskeletal disorders may serve as a diagnostic tool for analysing the work environment, workstation and tool design. The incompatibility of the user and the task or the tool have been shown to relate to the musculoskeletal symptoms (van Wely, 1970; Corlett and Bishop, 1978). The localisation of symptoms may reveal the cause of loading. The occupational health service may use the questionnaire for multiple purposes — e.g., for diagnosis of the work strain, for follow-up of the effects of improvements of the work environment, and so on.

General questionnaire

The general questionnaire was designed to answer the following question: “Do musculoskeletal troubles occur in a given population, and if so, in what parts of the body are they localised?” With this consideration in mind, a questionnaire was constructed in which the human body (viewed from the back) is divided into nine anatomical regions. These regions were selected on the basis of two criteria: regions where symptoms tend to accumulate, and regions which are distinguishable from each other both by the respondent and a health surveyor. The intentional choice of the back aspect of the body leaves gaps when disorders are located in the frontal part of the shoulder or on the flexor side of the upper limbs. This choice has been made because numerous possible causes of pain in the front part of the body (abdominal and thoracical pains, etc.) might intermingle with the musculoskeletal pain in the upper thorax. Preliminary observations seem to point out that this choice does not significantly modify the response rates. The verbal questions deal with each anatomical area in turn, and inquire whether the respondent has, or has had, troubles in the respective area during the preceding 12 months, whether this pain is disabling and whether it is ongoing. Fig. 1 shows the anatomical areas and the layout of the questionnaire.

Special questionnaires for low back, neck and shoulder symptoms

The two specific questionnaires (Figs. 2 and 3) concentrate on anatomical areas in which the musculoskeletal symptoms are most common. These questionnaires probe more deeply into the analysis of the respective symptoms and contain questions on the duration of the symptoms over past time — i.e., entire life, last 12 months, and previous 7 days. The main broadening in these questionnaires is that they analyse more thoroughly the severity of the symptoms in terms of their effect on activities at work and during leisure time, and in terms of total duration of symptoms and sick-leave during the preceding 12 months.

Limitations of the questionnaires

The general limitations of questionnaire techniques also apply to these standardised questionnaires. The experience of the person who fills out the questionnaire may affect the results. Recent and more serious musculoskeletal disorders are prone to be remembered better than older and less serious ones. The environment and filling out situation at the time of the questioning may also affect the results (Brigham, 1975; Sinclair, 1975). From an epidemiological viewpoint, it is evident that this type of questionnaire is most applicable for cross-sectional studies with all the concomitant limitations.

Experience from the use of the questionnaires

The standardised questionnaires have been in extensive use in Denmark, Finland, Norway and Sweden. The questionnaires, mainly the general questionnaire, have been used in more than 100 different projects, as well as in routine work in occupational health care services. More than 50 000 persons have responded to one or more of the questionnaires.

Reliability and validity of the results

The reliability and validity of the questionnaires has been investigated. Subjects have filled and refilled questionnaires
How to answer the questionnaires: Please answer by putting a cross in the appropriate box — one cross for each question. You may be in doubt as to how to answer, but please do your best anyway. Please answer every question, even if you have never had trouble in any part of your body.

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

The date of inquiry: 

Sex: 1 Female 2 Male

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

How much do you weigh: ____________kg

How tall are you: ____________cm

Are you right-handed or left-handed: 1 Right-handed 2 Left-handed

Trouble with the locomotive organs

To be answered only if you have had trouble

Have you had lumbar trouble (ache, pain or discomfort) during the last 7 days?

1 No 2 Yes

Have you ever been hospitalized because of low back trouble?

1 No 2 Yes

Have you ever had to change job because of low back trouble?

1 No 2 Yes

Have you ever been on sick leave because of low back trouble during the last 12 months?

1 0 days 2 1–7 days 3 8–30 days 4 More than 30 days

Have you ever been on sick leave because of low back trouble during the last 7 days?

1 No 2 Yes

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

1 No 2 Yes

How long did low back trouble last during your normal work during the last 7 days?

1 0 days 2 1–7 days 3 8–30 days 4 More than 30 days

LOW BACK

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

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

1 No 2 Yes

If you answered No to Question 1 do not answer questions 2–8

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

1 No 2 Yes

3. Have you ever had to change job because of low back trouble?

1 No 2 Yes

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

1 0 days 2 1–7 days 3 8–30 days 4 More than 30 days

5. Have you had low back trouble for more than 30 days during the last 12 months?

1 No 2 Yes

6. Have you had low back trouble for more than 30 days during the last 7 days?

1 No 2 Yes

7. Have you been treated by a doctor, physiotherapist, chiropractor or other such person for low back trouble during the last 12 months?

1 No 2 Yes

8. Have you been treated by a doctor, physiotherapist, chiropractor or other such person for low back trouble during the last 7 days?

1 No 2 Yes

and the subjects' responses to the questionnaires have been compared with their clinical history.

Reliability tests with the test-retest method of preliminary versions of the general questionnaire (one study on 29 safety engineers, one on 17 medical secretaries and one on 22 railway maintenance workers) showed that the number of non-identical answers varied from 0 to 23%. Validity tests against clinical history (one study on 19 medical secretaries and one on 20 railway maintenance workers) showed that the number of non-identical answers varied between 0 and 20%.

Questionnaire about low back trouble

The date of inquiry: 

Sex: 1 Female 2 Male

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

How much do you weigh: ____________kg

How tall are you: ____________cm

Are you right-handed or left-handed: 1 Right-handed 2 Left-handed

Fig. 2 Low back trouble questionnaire
The reliability of the neck-shoulder questionnaire was tested on 27 women in clerical work, who answered the questionnaire twice with a 3-week interval. The percentage of disagreeing responses varied from 0 to 15%, except for questions 4 and 13 (Fig. 3) where it was 30 and 22%, respectively. The validity was tested on 82 women in electronics manufacturing. The questionnaire responses were compared with those obtained when a physiotherapist filled out the questionnaire after a thorough interview about medical history. The percentage of disagreement between the subjects' own responses and the physiotherapist's estimates varied from 0 to 13%.

The reliability of a preliminary version of the low back questionnaire was tested on 25 nursing staff members who answered the questionnaire twice with a 15-day interval. The percentage of disagreeing answers was on average 4-4, varying from 0 to 4%, except for one question where it was 25%. As a consequence, this question was reformulated in the final version.

The method of administration of the questionnaire has an effect on the response rates (Andersson et al., 1987).

**The usage of the questionnaire**

A critical question that arises is whether the questionnaires can provide useful information which can be used in decision-making in occupational health practice. Various studies have shown that response distributions are different for different occupational groups (Jonsson and Ydreborg, 1985) and that the differences are related to the estimated workload. In some studies the questionnaires have revealed a high prevalence of symptoms and disorders in certain anatomical regions which clearly correlate to the local physical demands (e.g., Brulin et al., 1985).

The questionnaire has been structured for computer analysis. Routine analysis of various statistical epidemiological programmes can be applied. The dichotomy of the response alternatives may require special consideration (see, for example, Fleiss, 1973).

In the opinion of the project group the questionnaires provide useful and reliable information on musculoskeletal symptoms. This information either gives rise to further in-depth investigation or gives hints for decision-making on preventive measures.

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**References**

Anon 1960 (a) *British Medical Journal*, 2, 1665. Medical Research Council's Committee on the Aetiology of Chronic Bronchitis: Standardised questionnaires on respiratory symptoms.

Anon 1960 (b) *British Medical Journal*, Medical Research Council's Committee on the Aetiology of Chronic Bronchitis: Instructions for the use of the questionnaire on respiratory symptoms.


Fig. 3 Neck and shoulder trouble questionnaire
NECK

How to answer the questionnaire: By neck trouble is meant ache, pain or discomfort. Please concentrate on this area, ignoring any trouble you may have in adjacent parts of the body. There is a separate questionnaire for shoulder trouble. There is no need to put a cross in the appropriate box for each question. If you are in doubt as to how to answer, but please do your best anyway.

1. Have you ever had neck trouble (ache, pain or discomfort)?
   1: No 2: Yes
   If you answered No to Question 1, do not answer the questions 2-8

2. Have you ever hurt your neck in an accident?
   1: No 2: Yes

3. Have you ever had to change jobs or duties because of neck trouble?
   1: No 2: Yes

4. What is the total length of time that you have had neck trouble during the last 12 months?
   1: < 1 day
   2: 1-7 days
   3: 8-30 days
   4: More than 30 days
   If you answered No to Question 4, do not answer the questions 5-8

5. Have neck trouble caused you to reduce your activity during the last 12 months?
   a. Work activity (at home or away from home)?
      1: No 2: Yes
   b. Leisure activity?
      1: No 2: Yes

6. If you answered Yes to Question 5, do not answer the questions 6-8

7. Have you been seen by a doctor, physiotherapist, chiropractor or other such person because of neck trouble during the last 12 months?
   1: No 2: Yes

8. Have you had neck trouble at any time during the last 12 months?
   1: No 2: Yes

9. Has neck trouble caused you to reduce your activity during the last 12 months?
   If you answered No to Question 9, do not answer the questions 10-17

10. Have you ever hurt your shoulder in an accident?
    1: No 2: Yes

11. Have you ever had to change jobs or duties because of neck trouble?
    1: No 2: Yes

12. Have you had shoulder trouble during the last 12 months?
    1: No 2: Yes

13. What is the total length of time that you have had shoulder trouble during the last 12 months?
    1: < 1 day
    2: 1-7 days
    3: 8-30 days
    4: More than 30 days

14. Has shoulder trouble caused you to reduce your activity during the last 12 months?
    a. Work activity (at home or away from home)?
       1: No 2: Yes
    b. Leisure activity?
       1: No 2: Yes

15. What is the total length of time that shoulder trouble has prevented you from doing your normal work (at home or away from home) during the last 12 months?
    1: < 1 day
    2: 1-7 days
    3: 8-30 days
    4: More than 30 days

16. Have you been seen by a doctor, physiotherapist, chiropractor or other such person because of shoulder trouble during the last 12 months?
    1: No 2: Yes

17. Have you had shoulder trouble at any time during the last 7 days?
    1: No 2: Yes

**References**


