THE FREQUENCY OF RESTRICTED RANGE OF MOVEMENT IN INDIVIDUALS WITH SELF-REPORTED SHOULDER PAIN: RESULTS FROM A POPULATION-BASED SURVEY

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SUMMARY
Prevalence studies suggest that shoulder pain is very common (7–20%) in the adult population, though little is known about the severity and impact of such pain. Disability results, in part, from the restriction of movement and we therefore determined the frequency of restricted shoulder movement in individuals in a general population sample reporting shoulder pain and associated disability. In all, 232 individuals were interviewed about shoulder pain and related disability, and their range of shoulder movement in the following planes was measured: elevation, forward flexion, backward flexion, external rotation and internal rotation, together with the minimum difference achieved between the tip of a thumb and the spinous process of C7. In total, 48 (21%) subjects reported current pain and disability in one or both shoulders. Using receiver operating characteristic (ROC) analysis, cut-offs for restricted movements were selected at the point of maximal discrimination between painful and pain-free shoulders. There was considerable overlap in the distribution of range of movement, at all six sites, between these two groups. The highest positive predictive value for pain was observed in restriction of the thumb to cervical spine movement (53%), but this also had the lowest negative predictive value. By contrast, the highest negative predictive value was observed for restriction of external rotation (96%). Restriction in any plane was observed in 77% of those individuals with pain, but was also present in half of those without pain. In summary, most people with self-reported shoulder pain in the community do not have widespread restriction of movement. Reduction in external rotation was the most discriminatory, but it is necessary to examine movement in multiple planes to assess the true burden of shoulder pain in the community.

KEY WORDS: Shoulder restriction pain, Cross-sectional studies.

PAINFUL shoulder syndromes form a large part of the new patient workload at specialist rheumatologist clinics [1]. Such patients are often referred because of the combination of pain and restriction of movement contributing to substantial disability. Episodic shoulder pain is also a frequent cause of attendance in primary care [2] and many of these patients may also have a restriction in movement [3].

Community pain surveys have shown very high prevalence rates of shoulder pain in unselected population samples, with proportions varying between 7 and 20% [4, 5]. Clearly, therefore, only a minority of subjects in the community developing shoulder pain receive medical attention. It is unknown, however, how much of this pain is minor in nature. One approach to assess this is to consider how often self-reported shoulder pain in the community is associated with a restricted range of movement.

We, therefore, set out to investigate the frequency with which self-reported shoulder pain in the community is associated with restriction of movement. A further objective was to determine whether any particular planes of movement were more likely to be restricted than others.

SUBJECTS AND METHODS

Design
The study design was a cross-sectional population screening survey in which a random sample of the adult population were interviewed about shoulder pain and related disability, and were examined.

Subjects
Five hundred individuals aged between 18 and 75 yr were selected from the age–sex register of a local general practitioner. With >95% of the general population in the UK being registered with a general practitioner [6], age–sex registers form ideal sampling frames. The study sample was selected using a random sampling approach, stratifying by age and sex in order to reflect the demographic characteristics of the area. A questionnaire was mailed to the study group which enquired about both current and past musculoskeletal pain. In addition, responders were asked whether they would be willing to have an examination of their shoulder movement. In all, 312 subjects responded to the questionnaire. Owing to inaccuracies in the age–sex register, only an estimated 392 subjects actually received the questionnaire; a 'corrected' response rate of 80%. In all, 232 (74%) of the 312 responders agreed to be interviewed and have an examination of their shoulders. Information was sought by the questionnaire about the occurrence of shoulder pain experienced in the month prior to the survey both in answer to a direct question and also by indication on a line

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Fio. 1.—Boundary used for the shoulder in defining shoulder pain.

drawing of the body of the area(s) where pain was experienced. Using an arbitrary boundary for 'shoulder' (Fig. 1) from the drawing 107 (34%) of the survey respondents reported symptoms. This percentage was slightly higher (35 vs 28%) in those 232 who agreed to be further examined than in those 80 who declined the examination.

Follow-up
At the time of interview, all subjects were rescreened about the presence of shoulder pain on that day. Given that some of the individuals' pain status had changed, pain on the day of examination was used for the purposes of classifying individuals as either shoulder pain positive or negative. In addition, subjects with such pain completed a questionnaire enquiring about any disability related to their symptoms. This 22-item schedule includes items relating to domestic, recreational and psychosocial problems in relation to shoulder symptoms, and has been previously validated in a community setting [7].

Six movements were evaluated for each shoulder. These were elevation, forward flexion, backward flexion, external rotation, internal rotation, and a composite movement of adduction and internal rotation. Elevation, forward and backward flexion were measured with the arm initially in the anatomical position. The range of movement for elevation and forward flexion was 0–180° and for backward flexion 0–90°. External and internal rotation were assessed as follows: with the shoulder at 90° of elevation and the elbow flexed at 90°, the upward and downward arcs of movement of the outstretched hand were measured (range 0–90°) (Fig. 2). The composite movement of internal rotation and adduction was assessed by asking the subject to rotate the forearm internally and position the hand as far up the spine as possible with the thumb pointing upwards. The minimal distance between the apex of the thumb and the spinous process of C7 vertebra was assessed with a tape measure (Fig. 3). All other measurements were assessed using a fluid-filled plurimeter (Dr Jules Rippstein, personal correspondence).

Analysis
The relationship between pain and restriction of movement was analysed separately in left and right shoulders. On the day of examination, 76 subjects reported pain in one shoulder and 18 pain in both shoulders, a total of 112 painful shoulders. For the purpose of the analysis, the shoulder pain group was limited to individuals who, in addition, had answered positively to at least one of the 22 disability items (see above), thus excluding the more minor episodes of shoulder pain. This left 62 painful shoulders for which individuals reported some disability. Therefore, analysis was based on a comparison of these 62 shoulders
A cumulative frequency plot shows the distribution of movement restriction in shoulders with and without pain. The plot indicates that there is a significant overlap in the range of movement between painful and non-painful shoulders, with a tendency for greater restriction in painful shoulders. The data is used to identify the cut-offs that maximize discrimination between those with and without pain. For each movement, 10 equally spaced cut-offs are chosen, and sensitivity is plotted against 1-specificity. The point of maximum discrimination is identified, and odds ratios are used to measure the strength of association. Positive predictive values (PPVs) and negative predictive values (NPVs) are calculated for each cut-off.

**RESULTS**

The analysis compares those people reporting pain and associated disability with those without both features. Hereafter, the term shoulder pain will be used to define those people with pain and disability. There was a considerable overlap in the distribution of the range of movements between those with and without pain, although for all movements those with pain showed a shift in the distribution to greater restriction. This is demonstrated for one of the movements in Fig. 4 (a cumulative frequency plot of the composite movement of adduction and external rotation).

The cut-offs ascertained for each movement, based on the ROC curve analysis, are shown in Table I. Thus, for elevation, any subject who was not able to elevate their arm to $170^\circ$ was considered to have restricted shoulder movement: it was at this point that maximum discrimination was achieved between those with and without pain. There was a wide variation in the frequency of restriction between the six movements using these cut-offs. Using this approach, restricted thumb to cervical spine distance was ascertained most frequently (27%), with restriction in rotation, both internal and external, and elevation the least frequent.

The strength of the association of each of the levels of restriction for the presence of shoulder pain was between two and four for all movements as shown (Table I).

The PPVs and NPVs for shoulder pain and disability in identifying restriction in each of the six movements are shown in Table II. Although 77% of painful shoulders examined had restriction in at least one plane, considering each plane individually the large majority of individuals with self-reporting shoulder pain and disability did not have a restriction of movement at that site. By contrast, approximately half of the normal shoulders examined were restricted in at least one plane.

The strongest association with shoulder pain and
disability was for the thumb to cervical spine movement (PPV = 53.2%), with the weakest associations being for internal rotation (PPV = 24.2%) and external rotation (PPV = 19.4%). As a summary measure of discrimination, each of the likelihood ratios was in a relatively narrow range. These suggest, therefore, a relatively modest association, i.e. that patients with self-reporting shoulder pain and disability are only 2-3 times more likely to have a restricted movement compared with those without in the general population.

**DISCUSSION**

Self-reported shoulder pain was a frequent occurrence in this population, in line with other reported surveys [5]. This high level emphasizes the need for further investigations to try and identify those with a clinically significant problem.

The results from the physical examination showed that there was considerable overlap in the likelihood of restriction of movement between those reporting and those not reporting shoulder pain with some related disability and, even at the point of maximum discrimination, there was only a relatively modest increase in the likelihood of restricted movement. Shoulder pain and disability was not clearly discriminatory for any of the six movements, although restriction in the thumb to cervical spine distance had the highest PPV. Predictive values are dependent on prevalence and are difficult to extrapolate to other populations. Within this study population, however, it is reasonable to compare the predictive values for each of the movements examined. It is, thus, difficult to interpret the significance of the presence of shoulder restriction given its apparent high prevalence in the pain-free population.

There are a number of methodological issues that need to be considered. From the original random sample of 500 people selected from the age-sex register, only 312 responded to the original survey questionnaire. Of the people who did not respond, 108 (22%) were subsequently identified as so-called ‘ghost patients’. These patients are unlikely to have received the invitation to attend for screening since a consistency check carried out using the electoral role for the study area showed that they were not resident at the mailing address [8]. Such inaccuracies in age-sex registers resulting from population mobility are well documented [9]. It is unlikely that the relationship between disabling pain and restriction of movement would be different between responders and those people whose address was incorrectly recorded. However, even after excluding the ‘ghost patients’, there was an important non-response rate and a further refusal rate in those responders who did not agree to follow-up. The main purpose of this study was to describe the association between current shoulder pain and related disability and current restriction of movement, and it is possible that this association might vary between those with shoulder pain who agreed to be examined and those who neither responded to the survey nor agreed to examination. We do not have data to address this issue, but if there is a bias it is likely to be towards those attending having the greatest restriction. Therefore, the associations reported here may overestimate the true associations observed in the population with shoulder pain.

The definition of shoulder pain, as with all regional pain syndromes, is difficult and specifically what constitutes the clinical area ‘shoulder’ is not clear. Many subjects reporting shoulder pain are actually recording pain radiating from the neck [10], although neck and shoulder pathologies frequently co-exist [11]. We made no attempt to determine the anatomical origin of the shoulder pain, which in practice is difficult and subject to considerable error [12]. Thus, these data have to be considered on the basis of the association of patients’ self-reported shoulder pain with restriction. All these subjects reported pain lasting at least 24 h, but it would be interesting to investigate with larger numbers the influence of chronicity on the occurrence of restriction.

In addition, it is not clear how much of the shoulder pain reported by subjects was minor in nature. We attempted to exclude the more minor episodes of shoulder pain from our analysis by including responses to a self-completion disability schedule in the analysis. This meant that almost half of the shoulders with pain at examination (45%) were included in the reference group (no pain and disability) because subjects had answered negatively to all items on the disability schedule. Again, this might bias the analysis group towards having greater restriction and therefore overestimate the true association between shoulder pain and restriction observed in the general population.
It is very difficult to determine what cut-offs should be used for restricted movement. This is for two reasons. First, there is considerable variation in the normal range of movement, as shown in this and other studies [13]. Whether this variation represents true variation in normal range of movement or the consequence of subclinical shoulder disease is not clear. Any cut-off for normality would therefore have to be based on arbitrary criteria. It did not seem appropriate to take a statistical definition, firstly given the non-Gaussian distribution and also because of the arbitrary nature of any such definition. The choice was taken, therefore, to have a 'functional definition' based on that cut-off which maximized discrimination between pain and non-pain. This definition was used for all six movements, permitting a comparison between them in how well shoulder pain with disability could detect restriction.

A single observer was used throughout; however, she was not blind to the pain status of the individual and might have been reluctant to achieve maximal movement, despite instructions to the contrary. Such bias would have resulted in our estimates of association overestimating the strength of the effects.

In summary, therefore, there are moderate associations between the presence of restriction of movement and the presence of disabling shoulder pain in a community sample. However, no single plane of movement was restricted in a majority of the subjects and it is, therefore, necessary to examine movement in multiple planes to assess the true burden of shoulder pain in the community. The frequency of apparent restriction in the pain-free population was relatively high. As a consequence, it is not possible from these data to incorporate easily restriction of movement as a defining characteristic for shoulder pain presenting in the community.

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REFERENCES