Supplementary Material: Online Resource 3

Article Title: Investigating the Patient Acceptable Symptom State cut-offs: longitudinal data from a community cohort using the Shoulder Pain and Disability Index

Journal: Rheumatology International

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Online Resource 3. The problem with the 75th percentile method

Supplementary methods

To illustrate why the 75th percentile method for determining the PASS cut-off is not suitable for identifying changes in PASS cut-offs over time, we simulated three different normal random variables, each with standard deviation of 10, with means of 50, 40 or 20, deeming these to be simulated SPADI variables (n=500). We wanted to show how the cut-offs were affected under conditions of the group of interest undergoing a small change (mean 40) or a large change (mean 20) from a baseline condition (mean 50). For each variable we created an indicator of PASS status which assumed patients would report their state to be acceptable if their score was <50. In other words, there was a fixed PASS cut-off, which, in truth, did not change over time. We then calculated the 75th percentile of the simulated SPADI scores for the observations that were PASSpos, and contrasted the cut-offs obtained via this method with those obtained via receiver operating characteristic (ROC) curve analysis. The following Stata code was used for this analysis:

```
set scheme s1color
clear
set obs 500
set seed 12345
gen baseline = rnormal(50,10)
gen smalldiff = rnormal(40,10)
gen largediff = rnormal(20,10)
foreach x in baseline smalldiff largediff {
replace `x'=0 if `x'<0
recode `x' (50/100=0) (else=1), gen(PASS`x')
recode `x' (50/100=1) (else=0), gen(PASSrev`x')
sum PASS`x'
sum `x' if PASS`x'==1, detail
local p75=r(p75)
cutpt PASSrev`x' `x', youden
hist `x', xlabel(0(10)100) xscale(range(0 100)) xtitle("Simulated SPADI")
barwidth(2.5) plotr(lc(none)) addplot(pci 0 `p75' .05 `p75', lc(red)
lp(dash) || pci 0 50 .05 50, lc(green) lp(solid)) legend(lab(2 "75th
percentile in PASSpos") lab(3 "Actual PASS threshold"))
}
```

Supplementary results

The proportions achieving PASSpos (simulated SPADI <50) increased as the mean shifted from 50 (48%) to 40 (85%) to 20 (>99%). Although the 'true' PASS cut-off remained at 50, the cut-off determined by the 75th percentile method dropped from 47 to 43 to 28 (see Figure S2). Using ROC curve analysis the optimal cut-points (using the Youden index) were identified to be 50, 50 and 51 for means of 50, 40 and 20 respectively.

This illustrates the problem with using the 75th percentile method. Studies that aimed, for example, to discover whether PASS cut-offs were affected by treatment might find that the PASS cut-off changed considerably for a highly effective treatment but remained relatively stable for a less effective treatment, simply because the distribution of scores amongst those achieving PASS had changed to a greater extent in the former.

Similarly, we could imagine that instead of representing changes over time, the three simulated SPADI variables represented three different samples of patients with varying degrees of symptom severity. Using the 75th percentile method would yield different values for the PASS cut-off, even if in truth the cut-off were the same for each sample.

Figure S2. Histograms of simulated SPADI variables

Figure S2 shows the distribution of three simulated SPADI variables (n=500) with different means, intended to represent scores at baseline (a: mean=50) and following either a small (b: mean=40) or large (c: mean=20) change at follow-up. Solid green lines indicate the 'true' PASS cut-off of SPADI=50; dashed red lines indicate the PASS cut-off according to the 75th percentile method (75th percentile calculated in those achieving PASSpos).