

# Original Article

## Oxford shoulder score in a normal population

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### ABSTRACT

**Background:** The function of the asymptomatic normal shoulder may differ according to gender and could also deteriorate with age. This may result in a disparity in the normal Oxford shoulder score (OSS) according to these variables. If a difference were to exist an adjusted OSS, for age and gender, could be calculated from the raw score using the expected normal score.

**Aim:** The aim of this study was to define a normal OSS in an asymptomatic population according to age and gender.

**Materials and Methods:** During the study period 202 patients aged from 20 years to 99 years with subjectively asymptomatic shoulders completed an OSS. These patients presented to the study center during a 1 week period for management of disorders out with their shoulder girdle. Patients with a known prior shoulder pathology, injury, or polyarthropathy were excluded.

**Results:** The mean OSS varied according age and gender. There was a significant correlation between age and the OSS, with an increasing score (worse) being associated with older age ( $r = 0.62$ ,  $P < 0.0001$ ). The mean OSS for females was 18.8 (12-42, SD 5.4) and for males was 16.3 (12-30, SD 4.5), this difference was significant ( $P = 0.0001$ ). We propose that a normalized OSS could be calculated as a percentage by the using the expected normal for that patient's age and gender as demonstrated in this study ( $(\text{raw score}/\text{normal score}) \times 100$ ).

**Conclusion:** Our study provides normal data for an urban population presenting to orthopedic services and allows for a relative OSS to be calculated from the raw score.

**Key words:** Normal, outcome, Oxford, score, shoulder

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### INTRODUCTION

Quantitative assessment of shoulder function is essential to enable surgeons to evaluate their management, both conservative and interventional, of shoulder pathologies. Codman introduced the concept of the 'end result idea', asking the question 'what happens to the patient?'<sup>[1]</sup> The Constant score is a widely used and universally accepted assessment tool of shoulder function.<sup>[2]</sup> This score has both subjective (pain and activities of daily living) and objective (movement and strength) components. Concerns have been raised regarding the Constant score due to a low overall reliability, with 95% confidence limits of between 15 and 20 points from the true score.<sup>[3]</sup> In addition, there is an increasing trend toward the use of patient reported outcome measures, being subjective, assessing the patients perception of their own functional status.<sup>[4]</sup> This has led to

the development of validated joint-specific questionnaires, of which the Oxford shoulder score (OSS) is one.<sup>[5]</sup>

The OSS is a 12-point questionnaire, which has been demonstrated to have consistency, reproducibility, and validity, with a high correlation with both the Constant score and Short form 36 questionnaire.<sup>[5]</sup> A normal score, that expected in the general population, is known for the Constant score and has been shown to deteriorate with age and is different according to gender.<sup>[2]</sup> This normal score allows a 'relative Constant score' to be calculated by dividing the obtained score by their expected age- and gender-matched score.<sup>[6]</sup> This adjusted score enables a comparison of scores from differing institutions to be made, and gives a true reflection of patient outcome after adjusting for confounding variables.

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A normal OSS in an asymptomatic population has not yet been defined. This score was designed to assess a change in score after an intervention, and was not designed to evaluate if the patient returned to their expected normal functional state. However, if a normal score was established then a 'relative OSS' could be calculated and would adjust for any confounding variables, should they exist. This would allow a comparison of scores for research and audit purposes between differing centers, defining a normal baseline from which a comparison can be made.

The primary aim of this study was to define a normal OSS in an asymptomatic population according to age and gender. The secondary aim was to assess whether the OSS for the dominant arm differed from the non-dominant side.

## MATERIALS AND METHODS

During a 1 week period 202 patients aged 20 years or older with asymptomatic shoulders presenting to the study center were asked to complete an OSS for their dominant limb, and in addition they were also asked to complete an OSS for their non-dominant limb if they felt that the score would differ. Their age and gender was also recorded. Patients with a shoulder pathology, injury, or polyarthropathy were excluded. If patients were able to complete the questionnaire independently they were given the form which was collected upon completion. If a patient had difficulty in completing the questionnaire, due to visual or impaired dexterity, a research fellow (NDC) completed it for them by verbally asking the questions and recording their graded response.

The OSS is a 12 question score, with each question taking the form of a 5 response Likert scale, where 1 is the best response and 5 is the worst response. The score is then reported as a total of all 12 questions, which can range from 12, being least symptomatic, to 60 which is the most symptomatic score.

The study hospital serves a population of 780,000 and has 144 orthopedic and trauma beds. During the study period 87 acute trauma patients were admitted, of whom 8 had declared shoulder pathology prior to admission and a further 11 patients were unable to complete the questionnaire. Forty-seven patients underwent elective lower limb procedures, requiring in-patient admission, of which 46 had asymptomatic shoulders and completed an OSS. An additional 88 patients, with asymptomatic shoulders completed OSS when they presented to the outpatient department (fracture clinic). These patients were selected on an age basis, to ensure we had an equal spread of patients across and all age groups.

### Statistical analysis

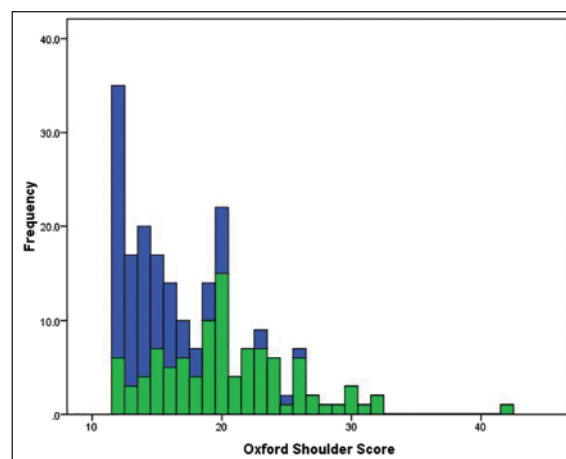
SPSS software was used for statistical analysis (Chicago, IL). Parametric and non-parametric tests were used, as appropriate,

to assess continuous variables for significant differences between groups. The cohort was divided by gender and into eight age groups by 10 year intervals from 20 years to 100 years. A Student's t-test (TT), Mann — Whitney U (MWU) test, and a Kruskal-Wallis test were used to compare linear variables between groups. A Spearman's Rank correlation coefficient was used to assess the association of linear variables. Multivariate linear regression analysis was used to confirm independent predictors of the normal OSS. A P-value of  $\leq 0.05$  determined statistical significance.

## RESULTS

There were 106 females with a mean age of 62.2 years (range 20 to 99), and 96 males with a mean age of 57.4 years (range 20 to 96), which was not statistically significantly different ( $P = 0.13$  TT). Only a single patient completed an OSS for the non-dominant limb declaring it to be different, but the OSS only differed by 3 points (16 versus 19). Hence, only data for the dominant limb was included for analysis.

There was a skewed distribution for the OSS with a median score of 16.0 (range 12 to 42) [Figure 1]. Analysis of the histogram illustrated in Figure 1 demonstrates a discrete peak centred on an OSS of 20. To analyze this distribution further the cohort was divided by age, into those patients 60 years old or less and those more than 60 years old. This demonstrated a skewed distribution for the younger group (median 14.0, skewness 1.6), but a normal distribution for the older group (median 20.0, skewness 0.8), which explains the peak centered at an OSS of 20 [Figure 1]. There was a significant correlation between age and the OSS, with an increasing score with older age (Spearman  $r = 0.62$ ,  $P < 0.0001$ ). However, the 95% confidence intervals for the median OSS increased with age [Figure 2].



**Figure 1:** A histogram demonstrating the variation in the OSS according for all patients ( $n = 202$ ). Overall there is a skewed distribution (skewness 0.97 and Kurtosis 1.1), but on subgroup analysis patients aged 60 years old or more (green) demonstrated a normal distribution

The mean OSS varied according age and gender [Table 1]. The mean OSS for females was 18.8 (range 12 to 42, SD 5.4) and for males was 16.3 (range 12 to 30, SD 4.5), this difference was significant ( $P = 0.0001$  MWU). On age group analysis this difference in OSS by gender was not significant, which may reflect a type II error due to the limited number of patients in each group and the wide standard deviations [Table 1]. There was a significant variation in the OSS between the age groups for both female and male gender (KW  $P < 0.0001$ ). Increasing age correlated with an increased OSS for both female and male gender (Spearman,  $r = 0.59$  and  $r = 0.65$  respectively,  $P < 0.0001$ ) [Figure 3]. Multivariate linear regression analysis confirmed the significance of age (B 0.131, 95% CI 0.106 to 0.156,  $P < 0.0001$ ) and gender (B 1.875, 95% CI 0.739 to 3.012,  $P < 0.0001$ ), with an  $R^2$  value of 0.39. These parameter estimates produced by the regression analysis model were used to produce a formula to predict an age and gender adjusted OSS:  $X = 6.927$  (95% CI 4.69 to 9.165) + (age  $\times$  0.131) + 1.875 (if female). Subgroup analysis was also performed according to point of presentation for each patient (elective surgical admission, trauma surgical admission, and out patients), and after adjusting for confounding variables multivariate linear regression analysis demonstrated no significant influence upon the OSS ( $P = 0.34$ ).

## DISCUSSION

We have demonstrated that the OSS for a population of patients presenting to orthopedic services varies according to age and gender. Limb dominance did not however affect the OSS. Increasing age correlated with the OSS, with older age resulting in a greater (worse) OSS. Female gender was also associated with a higher OSS, relative to male gender. This suggests that older age and female gender are associated with potentially asymptomatic shoulder pathology.

The OSS increases with increasing age, illustrating a deterioration of shoulder function with age. This pattern, of deteriorating score with age, was demonstrated for the Constant score by Constant in his original thesis<sup>[6]</sup> and more recently by Katolik *et al.*<sup>[7]</sup> However, Katolik *et al.*<sup>[7]</sup> did not observe the same rate of deterioration with age of the Constant score, but they recruited their “normal” cohort from patients presenting to a sports medicine clinic which may not be a representative population. Furthermore, they did not subgroup patients more than 70 years of age. Our study affirms this deterioration in outcome score with age is also observed for the OSS across all age groups, as Constant described.<sup>[6]</sup>

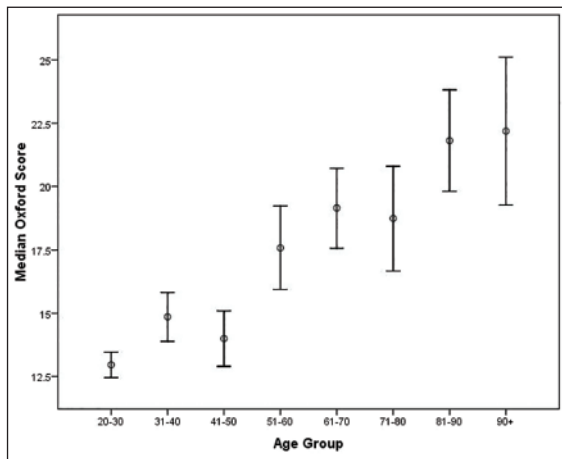


Figure 2: The 95% confidence intervals for the median OSS for each age group

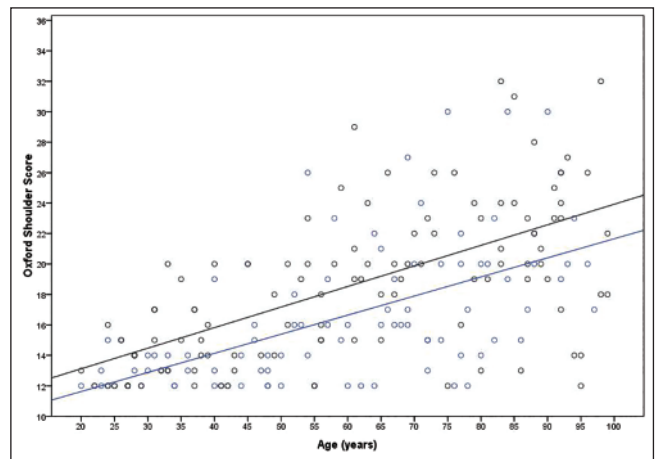


Figure 3: The correlation between the OSS and age, for both female (black) and male (blue) genders

Table 1: The mean OSS and standard deviation (SD) for each age group according to gender

Age group (years)	Female		Male		Difference (95% CI)	P-value*
	Number	OSS(SD)	Number	OSS(SD)		
20-30	11	13.1(1.4)	15	12.9(1.1)	0.2(-1.26-0.82)	0.66
31-40	17	15.7(2.5)	11	13.6(2.0)	2.1(-3.98-0.34)	0.20
41-50	8	14.6(2.9)	14	13.6(2.2)	1.0(-3.28-1.31)	0.38
51-60	12	18.3(3.7)	12	16.9(4.1)	1.4(-4.65-1.98)	0.41
61-70	15	20.3(3.8)	13	17.8(4.1)	2.5(-5.61-0.48)	0.09
71-80	11	20.4(4.9)	15	17.5(5.0)	2.9(-6.92-1.27)	0.17
81-90	16	22.3(4.8)	10	21.1(5.4)	1.2(-5.34-3.04)	0.58
91-100	16	22.7(7.5)	6	20.8(3.2)	1.9(-8.55-4.85)	0.57

\*MWU

**Table 2: The average Constant score (CS) in a normal population and the predicted CS using the normal OSS demonstrated in our cohort for each age group according to gender**

Age group (years)	Female		Male	
	CS	Predicted CS	CS	Predicted CS
20-30	97	78	98	78
31-40	90	73	93	76
41-50	80	74	92	76
51-60	73	69	90	71
61-70	70	66	83	69
71-80	69	66	75	69
81-90	64	63	66	64
91-100	52	61	56	64

Baker *et al.*<sup>[8]</sup> demonstrated a significant correlation between the OSS and the Constant score. Their conversion formula was used to calculate a predicted Constant score using the mean OSS we observed for each age group according to gender [Table 2]. These scores are far worse than those predicted from Constants "normal" scores for age and gender [Table 2]. This may be due to the cohort studied by Baker *et al.*,<sup>[8]</sup> with a mean age of 61.4 years whom were predominantly of female gender (20:80). Their formula did not account for age or gender, these variables affect the normal Constant score and we have demonstrated their effect on the OSS. Hence, using their formula results in a prediction tool for that age group in females, which is substantiated in Table 2 as the predicted scores for females are similar to the mean normal Constant scores for patients more than 60 years of age.

Female gender was associated with a significantly worse OSS, relative to male gender. This finding is similar to that observed for the Constant score,<sup>[6]</sup> with females having worse scores overall, but are only significantly different for patients aged 41 to 70 years old. We were not able to demonstrate a significant difference in the OSS between genders for any age group, due to the minimal difference with younger patients and with widening confidence intervals with increasing age despite a greater difference in the OSS. This may reflect the nature of the OSS, assessing the patients' subjective opinion, rather than objectively assessing function. The power component of the Constant score, for example, may obviously vary with gender but may be normal for that individual. The OSS does not assess strength, as a specific question, so this may account for our failure to demonstrate significant differences between genders by age groups.

The normal OSS we have presented could be used to calculate a normalized score. Although the OSS was not designed to compare patients to a mean score, and was only designed to measure a change in score, in some situations it is not possible to obtain a pre-intervention score e.g. trauma and retrospective studies. Wilson *et al.*<sup>[6]</sup> have demonstrated that a retrospective pre-intervention OSS is valid if assessed as part of a large group. However, individual patient recall of symptoms was variable.

We propose that a normalized OSS could be calculated as a percentage of expected shoulder function for example: Normalized OSS = (raw score/predicted score) × 100. This would allow an individual's normal score to be calculated and eliminate recall variability. For example, a 73 year woman with a raw OSS of 18 would have a normalized score of 100%, as her predicted score is also 18 using the prediction formula:  $6.927 + (73 \times 0.131) + 1.875 = 18$ .

We were unable to demonstrate whether a difference exists in the OSS for limb dominance due to the failure of our cohort to complete an additional OSS for the opposite, declaring it to be the same. Despite differences in the Constant score existing between right and left limbs, and dominant and non-dominant limbs, they did not reach significance.<sup>[6]</sup> Again, the subjective nature of the OSS may abolish the objective differences between dominant and non-dominant limbs, and from the patients prospective they are of equal functional ability.

The potential selection bias of our study, using patients presenting with musculoskeletal pathologies, is a limitation of our study. These patients may not represent the standard population in the community, with an asymptomatic shoulder. However, by definition the OSS will only be used to assess the outcome of patients with musculoskeletal pathologies, and hence our normal OSS is for the population for which they will be used. The population we have sampled may be different from other study centers, but we believe our cohort to be representative, with no selection bias, of a standard population presenting to an orthopedic department. In addition, the point of presentation was demonstrated to have no significant influence upon the OSS, supporting the homogeneity of our cohort.

The relative OSS, matched for age and gender, could be used to allow standardized comparisons to be made between different centers with differing case-mix variables. Our study provides normal data for an urban population presenting to orthopedic services and allows for a relative OSS to be calculated from the raw score to enable such comparisons to be made. This relative score could be used for both research and audit purposes.

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