2022 | VOLUME 50 | ISSUE 1: 1-52

ISSN 0303-7193 (PRINT)
ISSN 2230-4886 (ONLINE)

NZJP

NEW ZEALAND JOURNAL OF PHYSIOTHERAPY

- Patient profiles attending shoulder physiotherapy clinics
- Subacromial bursitis and shoulder pain
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- Physical activity following lower limb arthroplasty

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2022, VOLUME 50
ISSUE 1: 1–52

New Zealand Journal of Physiotherapy
Official Journal of Physiotherapy New Zealand

ISSN 0303-7193

Physiotherapy New Zealand
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Should We Provide a Clinical Diagnosis for People with Shoulder Pain? Absolutely, Maybe, Never! The Ongoing Clinical Debate Between Leavers and Retainers

When trauma results in a fracture of one of the shoulder bones, or a dislocation of one of the shoulder joints, providing a diagnosis is acceptable practice. Similarly, providing a diagnosis for the person seeking an explanation for their shoulder symptoms when an osteosarcoma is discovered in the humeral head is also viewed as acceptable. In these situations, the diagnosis is sensitively communicated, explained and, following shared decision-making, a management plan started, and modified as required.

However, the awkward reality is that most people seek care with a history of idiopathic and non-traumatic shoulder pain, and here lies one of the most hotly contested debates pertaining to clinical diagnosis in current clinical practice. On one side there are clinicians who wish to jettison all diagnostic labels (*leavers*), and on the other side are those who will fight to the end to retain them (*retainers*).

Those whose allegiance is with the *leavers* argue passionately that if we are prepared to call a twisted ankle a sprained ankle or an acute onset of back pain a sprained back then why can't we call non-traumatic shoulder pain a sprained shoulder (or an equivalent). By doing so, the possible hypervigilance, anxiety and fear that may consume a patient if provided with a pathoanatomical diagnosis is avoided. Opposing this view are the *retainers*, who argue equally passionately that the diagnostic terms are understood by patients, clinicians and in research. The *leavers* contend that pathoanatomical labels are unachievable, and concomitantly may cause harm. The *retainers* demand proof from the *leavers* for the definitive evidence of harm across the spectrum of shoulder conditions and caution against 'throwing the baby out with the bathwater'. The *retainers* argue that individuals seeking care for shoulder pain and weakness from the communities they serve would feel underwhelmed following a thorough interview, rigorously drawn body chart and clinical tests, with or without imaging, if they were then informed "you have a weak and painful shoulder or non-traumatic shoulder sprain".

Some clinicians whose natural habitat isn't at either extreme of the debate are metaphorically incapacitated. Does a 15-year-old girl who experiences frequent non-traumatic dominant side shoulder dislocations suffer from a recurring shoulder sprain, or possibly non-traumatic shoulder instability? How would either label play out for the patient, the patient's parents or carers, for other clinicians and for researchers?

A clinical diagnosis that has caused considerable angst to both sides of the debate is a relative newcomer – rotator cuff related shoulder pain (RCRSP). This term was introduced by Lewis (2016) with the aim of finding the middle ground between the *leavers* and the *retainers*. Lewis had previously argued that terms used in current practice, such as subacromial impingement syndrome, may have never existed (Lewis, 2011, 2015, 2018, 2022; Lewis et al., 2022) and being diagnosed with impingement, or related conditions, may lead to patient fear (Cuff & Littlewood, 2018; Malliaras et al., 2021). Lewis has also challenged the certainty that definitive pathoanatomical diagnoses to explain symptoms based on imaging findings of a glenoid labral tear, rotator cuff tendon tear, or enlarged subacromial bursa could be provided with confidence (Lewis, 2022; Lewis et al., 2022). Especially when elective surgery to 'fix' these structural lesions appear to perform no better than placebo or when surgery and relative rest, followed by rehabilitation, is compared to rehabilitation in isolation (Lewis, 2022).

Some *leavers* have argued that the term RCRSP is heresy and have become apoplectic that a modern clinical diagnosis that refers to a structure has entered the lexicon. Maybe what they don't appreciate is that it isn't a pathoanatomical label. Other *leavers* have argued that the term RCRSP is as nonsensical as 'multifidus related back pain' and suggest that subacromial (another anatomical location) pain syndrome trumps RCRSP. Again, we argue for the middle ground. When the word subacromial is typed into Google™ references to impingement are populated and, although some websites attempt to separate the terms, others are using the terms synonymously. If there were agreed clinical criteria (which there aren't) to hypothesise that back pain was related to the multifidus then this might become an acceptable clinical term.

People seeking care want to understand why they have shoulder pain. This inevitably leads to the expectation of a clear and coherent diagnosis to help causally explain why their pain may have emerged and what management options are available (Maxwell et al., 2021). Qualitative research evidence emphasises the personal importance of receiving a diagnosis for various non-traumatic musculoskeletal pain presentations (Barber et al., 2022; Maxwell et al., 2021; Plinsinga et al., 2021), and if we are to be truly person-centred in our approach to health care, this is evidence we should take seriously. British writer and sufferer of persistent pain Hilary Mantel (2013) flawlessly articulates this sentiment: "the worst pain is unexplained pain" (p. 9).

So, again, we argue for the middle ground. Let us join the *leavers* and jettison all uncertain pathoanatomical labels to explain symptoms, as they cannot currently be diagnosed with certainty. Let us incorporate the *retainers'* view that providing a diagnosis may support an individual's understanding of their condition, facilitate communication with the patient and with other health professionals, as well as informing the inclusion criteria for clinical research. However, let's move forwards and embrace nomenclature that are both 'safe' and understandable.

Clinicians may hypothesise that a 50-year-old woman with no co-morbidities who presents with idiopathic and severe, left, non-dominant-side shoulder pain, with nothing substantial identified on radiograph, an equal restriction of active and passive shoulder external rotation that is more than 50%

restricted when compared to the contralateral side may have a frozen shoulder. The clinician may consider saying, "Based on our discussion and the assessment it is *likely* that you have a frozen shoulder, this is what is means and these are the possible management options" (including wait and watch, and their possible harms and anticipated benefits).

Clinicians may equally hypothesise that RCRSP is present if evidence of increased load (physical and/or lifestyle) is identified at the interview stage. That during clinical assessment, referred pain as best as possible is excluded, as is shoulder instability and shoulder stiffness. That bilateral muscle performance tests – isometric, repetitions to pain, repetitions to fatigue – reveal discrepancies, most commonly (but not exclusively) in the directions of shoulder elevation and external rotation. The clinician could then inform the patient, "Based on our discussion and the findings of the clinical assessment it is *likely* that you have RCRSP. The rotator cuff are the muscles and tendons and surrounding structures that contribute to shoulder movement." This could facilitate a discussion about the different management options for muscles, tendons and related structures, within a shared decision-making model of care.

So, for those of us whose natural habitat is the middle ground, we argue that an appropriate and safe clinical diagnosis, such as RCRSP, devoid of inaccurate pathoanatomical, or indeterminate labels, is absolutely desirable for the reasons we have outlined.

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https://doi.org/10.15619/NZJP/50.1.01

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Shoulder Pain, Disability and Psychosocial Dimensions Across Diagnostic Categories: Profile of Patients Attending Shoulder Physiotherapy Clinics

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ABSTRACT

Patient-reported shoulder pain, function and psychosocial status inform physiotherapy intervention. Central nervous system sensitisation may also need to be considered. The aim of this retrospective chart review was to establish and compare patient-reported outcome measures and psychosocial factors across diagnostic categories for people with shoulder symptoms attending two shoulder physiotherapy specialist clinics. We analysed data of 445 patients including demographics, duration of pain and patient-reported outcome measures for shoulder pain and disability, central sensitivity and psychosocial factors. The physiotherapists defined diagnostic groups following the clinical assessment. The Instability group had lower pain scores (Shoulder Pain and Disability Index) compared to the Subacromial Pain ($p < 0.001$) and the Stiff Shoulder ($p < 0.001$) groups. The Stiff Shoulder group had worse disability scores than all other groups (Subacromial Pain group, $p < 0.001$; Instability group, $p < 0.001$; Acromioclavicular group, $p < 0.001$; Other group, $p = 0.044$). The Stiff Shoulder group had higher 'Optimal Screening for Prediction of Outcome' scores (pain-associated psychological distress) than the Instability group ($p = 0.040$). The two-item 'Pain Self-efficacy Questionnaire' scores were lower for the Other group than for the Subacromial Pain group ($p = 0.035$). Physiotherapists should screen psychosocial factors as part of their assessment of patients with shoulder pain, regardless of diagnostic category.

White, R. J., Olds, M., Cadogan, A., Betteridge, S., & Sole, G. (2022). Shoulder pain, disability and psychosocial dimensions across diagnostic categories: Profile of patients attending shoulder physiotherapy clinics. *New Zealand Journal of Physiotherapy, 50*(1), 6–20. https://doi.org/10.15619/NZJP/50.1.02

Key Words: Diagnostic Classification, Physiotherapy, Psychosocial Factors, Self-Reported Outcome Measures, Shoulder Pain

INTRODUCTION

Musculoskeletal conditions are the most significant contributors to the global burden of disability (Briggs et al., 2021; Vos et al., 2016). The shoulder is one of the most common causes of musculoskeletal pain, with increasing prevalence with age (Tekavec et al., 2012; Thorpe et al., 2016). The data from the Accident Compensation Corporation (ACC) for tendon and ligament claims (2010 to 2016) showed that shoulder injuries accounted for 33% of these, and 40% of all costs for such claims (Clark et al., 2020). There was an increase of 36% for costs for shoulder injuries across those six years (Clark et al., 2020). Treatment for patients with insidious onset shoulder pain is usually not covered by ACC. Thus, those figures underestimate the true burden of direct and indirect health costs attributed to shoulder pain. Besides tendon-related injuries, other frequent diagnostic categories include acromioclavicular joint injuries, stiff shoulders (frozen shoulder or osteoarthritis), instabilities, as well as fractures and nerve-related injuries. People with persistent pain (duration ≥ 3 months) contribute towards most of the health costs related to shoulder pain. True costs are compounded by high costs of sick leave, which can be as high as 80% of the total costs for society (Virta et al., 2012).

Earlier pathoanatomic medical models aimed at identifying pathologic or morphological tissues changes, and may not provide a basis for effective decision-making for some people with shoulder pain (McClure & Michener, 2015). Farmer and Schilstra (2012) formulated diagnostic categories into six groups: shoulder impingement, symptomatic rotator cuff and the long head of the biceps tears or pathology, acromioclavicular joint pathology, superior labral tear from anterior to posterior (SLAP), glenohumeral joint instability and adhesive capsulitis. The STaged Approach for Rehabilitation (STAR) classification system was developed specifically to guide physiotherapy rehabilitation interventions (McClure & Michener, 2015). This system combines impingement, rotator cuff and biceps pathology and SLAP lesions into ‘subacromial pain syndrome’, with adhesive capsulitis, glenohumeral instability and ‘other’ forming a total of four categories (McClure & Michener, 2015). The addition of acromioclavicular joint disorders in a separate category has been used to develop consensus guidelines on patient care pathways for shoulder conditions (Kulkarni et al., 2015, Appendix A). While diagnostic categories have been established for people with shoulder pain, little is known regarding the differences in these categories in self-reported pain, disability or psychosocial status.

Use of patient-reported outcomes measures (PROMs) forms part of comprehensive assessments, informing clinical interventions and screening patients for psychosocial status. Lower emotional and mental health function were associated with initial pain and function in patients with rotator cuff tears (Coronado et al., 2018; Wylie et al., 2016) and those with chronic shoulder pain (Martinez-Calderon et al., 2018). Apprehension or fear of re-injury or pain is common following glenohumeral dislocations (Olds & Webster, 2021) and for patients with higher levels of pain (Lentz et al., 2009). Such fear or fear-avoidance beliefs can influence persistence of pain and disability (Gottlieb & Springer, 2021; Martinez-Calderon et al., 2018) and influence decisions for return to work, sports or recreational activities (Lädermann et al., 2016; Olds & Webster, 2021). High levels of self-efficacy and higher patient expectations are associated with improved clinical outcomes for shoulder pain (Chester et al., 2018; Chester et al., 2019) and with lower levels of pain and disability (Martinez-Calderon et al., 2018). In contrast, specific structural diagnoses were not associated with patient-rated outcomes in patients with persistent shoulder symptoms referred for physiotherapy treatment (Chester et al., 2018; Wylie et al., 2016).

A wide range of validated PROMs are available to assess or screen clinical and psychosocial domains. The Shoulder Pain and Disability Index (SPADI) focuses on levels of pain and disability during daily activities (MacDermid et al., 2006). The Örebro Musculoskeletal Pain Questionnaire (MSKPQ) screens for psychosocial factors and risk of future work absenteeism (Linton & Boersma, 2003; Linton et al., 2011). A more recent questionnaire, the Optimal Screening for Prediction of Outcome (OSPRO), assesses negative mood, fear avoidance and positive affect or coping skills (Lentz et al., 2016). The Tampa Scale for Kinesiophobia (TSK-11) also assesses fear of movement (Bot et al., 2005; Woby et al., 2005). The Brief Resilience Scale (BRS) assesses the ability to recover from stress (Smith et al., 2008). Shorter questionnaires are available to screen patients, such as the 2-item Pain Self-Efficacy Questionnaire (PSEQ-2) (Nicholas, 2007) and the Patient Health Questionnaire-2 (PHQ-2) to screen for depression (Kroenke et al., 2003).

Central sensitisation is defined as the “amplification of neural signalling within the central nervous system that elicits pain hypersensitivity” (Nijs et al., 2021, p. e383). Psychosocial factors and, specifically, fear of pain have been found to be associated with central sensitisation in patients with shoulder pain (Sanchis et al., 2015). Central sensitisation can predict poor treatment outcomes, and levels vary within different pain conditions (Nijs et al., 2021). Whether such levels differ between diagnostic categories for shoulder pain has not been established.

Examination of the nature and prevalence of psychosocial factors and central sensitisation in people seeking care at shoulder physiotherapy clinics will provide insights into the presence and extent of psychosocial and pain sensitivity factors. People with high levels of psychosocial modifiers may be at risk of developing persistent pain and disability (Chester et al., 2018). Knowledge of these factors may inform future studies to define early tailored psychologically informed interventions, such as cognitive-behavioural approaches, as part of physiotherapy management. In the longer term, such analysis will provide baseline values to determine tailored interventions for patients with shoulder pain.

Thus, the primary aim of this study was to establish and compare the nature of PROMs relating to pain, disability, central sensitivity and psychosocial factors that are known to be associated with outcomes of interventions for shoulder pain across common diagnostic categories. The secondary aim was to compare such PROMs between the diagnostic sub-groups within each primary group.

METHODS

We undertook a retrospective chart review of de-identified data from consecutive patients who presented to two private shoulder physiotherapy clinics, in Auckland and Christchurch, New Zealand. Both practices accept patients via direct access (no referral) and those referred by other physiotherapists, general practitioners or orthopaedic surgeons. The practices include registered specialist physiotherapists in musculoskeletal physiotherapy (with a focus on shoulder disorders) and registered as general scope physiotherapists by the Physiotherapy Board of New Zealand.

Ethics approval was granted by the University of Otago Human Ethics Committee (reference number HD20/032). The ethical review committee approved a waiver of written consent from patients because the study was a retrospective chart audit and only non-identifiable data were extracted from patient notes.

Inclusion criteria

Data were included if patients were ≥ 18-years of age, enrolled between October 2019 and June 2020, and presented with shoulder pain.

Exclusion criteria

Data were excluded from the study if the person had any of the following: widespread chronic pain, complex regional pain syndrome, neuropathic pain, receiving treatment for active cancer, pain derived from the cervical region, or neurological disorder.

Data collection

The clinics’ usual processes include online completion of PROMs by the patients prior to their initial appointment. The clinic administrator sent the online form link to patients. After the initial consultation, the physiotherapists added the diagnostic categories based on the clinical assessment to the online form (Table 1). The primary diagnostic criteria were based on existing international guidelines for diagnosis of shoulder conditions (e.g., Kulkarni et al., 2015; McClure & Michener, 2015). The secondary diagnostic criteria were achieved by correlating clinical findings with imaging results, where available. Pain type was determined by the physiotherapist at the time of examination in accordance with the International Association for the Study of Pain definitions and clinical algorithms for neuropathic, nociceptive and nociplastic pain (Kosek et al., 2021). Referred pain from the cervical spine was determined when the predominant shoulder and upper limb symptoms were reproduced primarily with cervical spine movement testing.

Clinic administrative staff downloaded the results from the online questionnaire to a Microsoft Excel® spreadsheet and collated the de-identified data. De-identified data from the two practices were collated and analysed by the first author (RW).

Variables

Data included demographic data (age, gender, ethnicity), date of injury or onset of pain, PROMs and diagnostic criteria. Duration of symptoms was calculated from the date of injury (or onset of pain) to the date of initial consultation. PROMs included those specifically related to the SPADI, generic questionnaires for central sensitisation (CSI) and multiple psychosocial dimension (Örebro MSKPQ; OSPRO; resilience, BRS; depression, PSQ-2; self-efficacy, PSEQ-2; and kinesiophobia, TSK-11, Appendix B).

Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26 (IBM Corporation, Armonk, NY). Data distribution was assessed through histograms. Duration since onset of symptoms or injury was recorded in days, and categorised into acute (< 3 months) and chronic (> 3 months). Descriptive statistics were performed, reported as means and standard deviations unless stated otherwise. For nominal variables, numbers and percentages are given. For normally distributed data for PROMs, the differences between diagnostic categories were analysed using ANOVAs. The Levene statistic was used to assess homogeneity of variances between diagnostic categories. Where equal variance or homogeneity between diagnostic categories could not be assumed, the Brown-Forsyth F-ratio was used. If significant between-group differences were found, post-hoc independent *t*-tests were performed with Bonferroni corrections to explore differences between specific diagnostic groups. The Tamhane T2 correction was used for comparisons with unequal variance. For non-normal distributed data, the differences between groups were analysed using the Kruskal-Wallis test and post hoc analyses with Mann Whitney U-test with Bonferroni corrections were conducted, when appropriate. The alpha level was defined as p value of < 0.05.

RESULTS

Demographics

Data of 445 patients were included (mean age 43.6 years, SD 15.9; 186 women, 41.8%, Table 1). There was a significant effect for age across the diagnostic groups ($p < 0.001$). Post hoc analyses showed that, on average, patients in the Stiff Shoulder group were older than those in all other diagnostic categories ($p < 0.001$). Those in the Instability group were younger than all

Table 1

Demographic Data of Patients Across the Primary Diagnostic Classifications

Demographic characteristic	Group					
	Subacromial pain	Instability	Stiff shoulder	ACJ	Other	Total
Gender						
Men, *n* (%)	96 (21.9)	64 (14.6)	27 (6.1)	33 (7.4)	39 (8.8)	259 (58.2)
Women, *n* (%)	85 (19.4)	26 (5.9)	32 (7.3)	17 (3.8)	26 (5.8)	186 (41.8)
Total	181 (40.7)	90 (20.2)	59 (13.3)	50 (11.2)	65 (14.6)	445 (100)
Age (mean, SD)	46.9 (15.3)	29.9 (10.2)	58.2 (11.4)	40.5 (11.6)	42.6 (14.9)	43.6 (15.9)
Ethnicity, *n* (%)						
New Zealand European	106 (23.8)	58 (13.0)	34 (7.6)	34 (7.6)	38 (8.5)	270 (60.7)
Māori	7 (1.6)	7 (1.6)	4 (0.9)	2 (0.4)	1 (0.2)	21 (4.7)
Pasifika	2 (0.4)	1 (0.2)	2 (0.4)	0 (0)	0 (0)	5 (1.1)
European	24 (5.4)	10 (2.2)	8 (1.8)	6 (1.3)	9 (2)	57 (12.8)
Asian	17 (3.8)	7 (1.6)	3 (0.7)	2 (0.4)	3 (0.7)	32 (7.2)
Other	10 (2.2)	2 (0.4)	2 (0.4)	0 (0)	3 (0.7)	17 (3.8)
Not declared	15 (3.4)	5 (1.1)	6 (1.3)	7 (1.3)	11 (2.5)	43 (9.7)
Duration of symptoms (days) [a]	126 (230)	144 (265)	151 (209)	189 (165)	165 (420)	144 (245)
Acute pain (< 3 months), *n* (%)	62 (14.9)	30 (7.2)	19 (4.6)	9 (2.2)	19 (4.6)	139 (31.2)
Chronic pain (> 3 months), *n* (%)	119 (25.9)	60 (13.9)	36 (8.6)	38 (9.3)	37 (8.8)	306 (68.8)
Treated by						
Physiotherapy specialist, *n* (%)	89 (20.1)	57 (12.9)	28 (6.3)	28 (6.3)	30 (6.8)	232 (52.5)
Physiotherapy general scope, *n* (%)	91 (20.6)	33 (7.5)	31 (7.0)	22 (5.0)	33 (7.5)	210 (47.5)

Note. Nominal variables are reported as numbers and (%). Continuous data are reported as means (SD). ACJ = acromioclavicular joint.

[a] Duration of symptoms is reported as median (interquartile range, IQR).

other groups ($p < 0.001$). Those in the Subacromial Pain group were older than patients in the Acromioclavicular joint (ACJ) group ($p = 0.028$).

Of the 412 patients with recorded duration of symptoms, 306 (68.8%) had experienced pain for more than 3 months. There was no significant effect for self-reported duration of symptoms across the diagnostic groups ($p = 0.903$).

PROMS across primary diagnostic group

Table 2 summarises the PROMS across the diagnostic categories. Results of post hoc analyses performed for significant effects for PROM scores across groups are presented in Appendix C.

SPADI

Significant differences were found across diagnostic groups for SPADI-Pain, SPADI-Disability and SPADI-Total (Table 2). Post hoc between-group comparisons showed that the Instability group also had significantly lower SPADI-Pain scores than the Stiff Shoulder group ($p < 0.001$) (Appendix C). The Stiff Shoulder group had significantly higher SPADI-Disability scores (indicating worse functional limitations) than all other groups (Subacromial Pain, $p < 0.001$; Instability, $p < 0.001$; ACJ, $p < 0.001$; Other, $p = 0.044$). The SPADI-Total was higher (worse) for the Stiff Shoulder group compared to the Subacromial Pain, Instability and ACJ groups ($p < 0.001$ respectively). The SPADI-Total was lower for the Instability group compared to all other groups (Subacromial Pain, $p = 0.047$; Stiff Shoulder, $p < 0.001$; ACJ, $p < 0.001$; Other, $p < 0.001$).

CSI

There was no statistically significant effect for diagnostic categories for the CSI. Of the 348 patients completing the CSI, 35 (10.1%) patients had scores higher than the cut-off above 40 that has been found to be suggestive of central sensitivity syndrome (Neblett et al., 2013). For specific diagnostic groups, frequencies for scores above 40 ranged from 3 patients (7.1% of 42) in the ACJ group to 17 (12.2% of 139) for the Subacromial Pain group.

Psychosocial screening and outcome measures

No significant differences were found between diagnostic categories for the Örebro MSKPQ, the BRS, PHQ-2 and the TSK-11. Only one patient had a high-risk score for the Örebro MSKPQ (> 50), classified as ACJ dysfunction. Nineteen of 291

Table 2

Patient-reported Outcome Measures Across Primary Diagnostic Groups

Outcome measure	Group						
	Subacromial pain	Instability	Stiff shoulder	ACJ	Other	Total	*p*
Pain and function dimension							
SPADI-Pain	52.2 (22.2) *n* = 167	40.6 (22.8) *n* = 83	58.2 (16.7) *n* = 56	49.7 (20.4) *n* = 47	51.3 (22.8) *n* = 63	49.5 (22.3) *n* = 416	< 0.001
SPADI-Disability	29.4 (22.4) *n* = 167	22.7 (19.3) *n* = 83	46.3 (20.0) *n* = 56	25.9 (19.1) *n* = 47	35.9 (24.8) *n* = 63	30.9 (22.7) *n* = 416	< 0.001*
SPADI-Total	35.1 (22.3) *n* = 167	27.0 (20.0) *n* = 83	49.7 (18.9) *n* = 56	32.7 (19.2) *n* = 47	41.3 (23.4) *n* = 63	36.1 (22.3) *n* = 416	< 0.001
Central sensitisation							
CSI	25.3 (13.0) *n* = 139	22.1 (14.2) *n* = 73	26.5 (11.2) *n* = 41	23.6 (13.1) *n* = 42	26.4 (11.4) *n* = 53	24.7 (12.9) *n* = 348	0.259
Psychosocial dimensions							
Örebro MSKPQ	27.0 (8.2) *n* = 38	25.9 (6.6) *n* = 13	23.8 (7.8) *n* = 17	28.1 (10.7) *n* = 14	28.0 (7.4) *n* = 34	27.5 (7.8) *n* = 116	0.999
OSPRO	28.0 (10.1) *n* =128	26.1 (9.9) *n* = 68	32.8 (11.4) *n* = 30	26.7 (8.7) *n* = 30	28.6 (10.3) *n* = 21	28.0 (10.2) *n* = 277	0.044
BRS [a]	3.3 (2–5) *n* = 104	3.3 (2–5) *n* = 57	3.3 (3–5) *n* = 27	3.4 (2–5) *n* = 26	3.0 (2–4) *n* = 19	3.3 (2–5) *n* = 233	0.203
PHQ-2 [a]	0 (0–6) *n* = 124	0 (0–6) *n* = 66	0 (0–4) *n* = 37	0.5 (0–5) *n* = 31	1 (0–5) *n* = 33	0 (0–6) *n* = 291	0.395
PSEQ-2 [a]	11 (0–12) *n* = 131	10 (3–12) *n* = 69	10 (4–12) *n* = 42	10 (5–12) *n* = 37	10 (3–12) *n* = 47	10 (0–12) *n* = 326	0.012
TSK-11	23.8 (6.1) *n* = 126	24.1 (6.5) *n* = 81	24.8 (6.4) *n* = 33	24.6 (5.4) *n* = 32	24.4 (4.8) *n* = 29	24.1 (6.0) *n* = 301	0.897

Note. Presenting mean (SD), ANOVA or [a] median, (range) using the Kruskal Wallis test. ACJ = acromioclavicular joint; BRS = Brief Resilience Scale; CSI = Central Sensitization Inventory; OSPRO = Optimal Screening for Prediction of Outcome; PHQ-2 = 2-item Patient Health Questionnaire; PSEQ = Pain Self-efficacy Questionnaire; SPADI = Shoulder Pain and Disability Index; TSK-11 = Tampa Scale of Kinesiophobia short form.

* Equal variance not assumed; Brown-Forsyth F.

patients (4.3%) had PHQ-2 scores indicating depression (> 3). Significant differences were found between the diagnostic categories for the OSPRO and the PSEQ-2. For the OSPRO, higher scores were reported in the Stiff Shoulder group than the Instability group ($p = 0.040$, Appendix C). For the PSEQ-2, the Other group had significantly lower scores than the Subacromial Pain group ($p = 0.035$).

PROMS across secondary diagnostic group

For the Instability group, the only significant difference between the traumatic and atraumatic sub-groups was for the Örebro MSKPQ, with the atraumatic group having higher scores (traumatic instability, mean (SD): 22.3 (5.7); atraumatic instability, mean (SD): 30.0 (5.3); mean difference 7.7, 95% CI 0.9 to 14.5, $p = 0.029$). No significant differences were found between the Subacromial Pain sub-groups (atraumatic rotator cuff related pain versus traumatic rotator cuff tears), and between those of the Stiff Shoulder (frozen shoulder versus glenohumeral osteoarthritis) for all PROMs.

DISCUSSION

The aim of this study was to establish and compare the patient-reported outcomes measures, psychosocial factors and central sensitivity across common shoulder diagnostic categories, thereby providing a profile of patients with shoulder pain presenting to two New Zealand private shoulder physiotherapy practices. There were significant differences across diagnostic groups for shoulder pain and function (SPADI), and two psychological outcomes, the OSPRO and PSEQ-2. People with stiff shoulders had higher pain and disability levels (SPADI) compared to other diagnostic groups and higher OSPRO scores than the Instability group. The PSEQ-2 for the Other group had significantly lower scores, thus lower pain-related self-efficacy, than the Subacromial Pain group.

Two-thirds of the patients presented with chronic symptoms (> 3 months' duration). The higher proportion of patients with chronic symptoms may be reflected by the specialist physiotherapy status of the two clinics in that they may attract patients who have persistent or recurrent symptoms, perhaps following unsuccessful treatment or rehabilitation elsewhere. The high proportion for patients with symptom duration of more than 3 months may also reflect international findings: Most of the health care costs associated with shoulder pain were for persistent pain (Virta et al., 2012).

Diagnostic categories and demographics

The Subacromial Pain group was the most frequently reported diagnostic category, as also reported elsewhere (van der Windt et al., 1996). The mean age for the Subacromial Pain group (47 years) and the equal women-to-men ratio was similar to a group of patients with rotator cuff disease (Yamaguchi et al., 2006). The SPADI-Pain and -Disability scores were similar to those reported for participants with rotator cuff disease in earlier randomised controlled trials (Bennell et al., 2010).

The mean age (29 years) for the Instability group in this study was younger than those of a previous study (37 years) that described patients with shoulder instability who required closed reduction (Leroux et al., 2013). Both studies had a higher proportion of men than women (Leroux et al., 2013).

Other authors have reported increased frequency of first-time glenohumeral dislocations in young men (aged 15–24) (Shields et al., 2018). In general, the younger age groups have the highest prevalence of repeated dislocations and, consequently, may seek physiotherapy intervention. Interestingly, there was no difference for the mean duration since injury between the atraumatic instability (median 137 days) and the traumatic instability (median 138 days, $p = 0.505$) sub-groups seen at these clinics.

The Stiff Shoulder group mean age was 58 years, consistent with frozen shoulder and glenohumeral osteoarthritis being more common for middle aged and older adults (Hand et al., 2008). In contrast to earlier findings of higher ratio for women (61%) (Hand et al., 2008), the patients with stiff shoulders in our cohort had a relatively equal gender ratio. The SPADI-Total for this group was lower than reported in a previous study with patients with frozen shoulder (SPADI-Total ~ 60/100) (Sharma et al., 2017).

Māori comprised 5.3% of the patient population (5.4% in the Auckland and 3.4% in the Christchurch clinics). In the Auckland-based clinic, 1.7% of patients were Pasifika. Māori and Pasifika comprise 16.5% and 8.1% respectively of the New Zealand population (Stats NZ, 2018). The distribution of ethnicities varies across geographical areas – for example, in Christchurch, Māori and Pasifika comprise 7% and 5% of the local population, respectively (Stats NZ, 2018). We do not know why these clinics attract comparatively fewer Māori and Pasifika. In terms of general persistent pain, Māori, Pasifika and Asian patients have reported higher pain levels and disability, yet those ethnicities were under-represented at persistent pain services (Lewis & Upsdell, 2018). Possible factors could be lower awareness of the role of physiotherapy for patients with shoulder pain, geographic location of the clinics, or challenges with affordability of co-payments for general scope physiotherapy. There are no co-payments for specialist physiotherapy for ACC claimants; thus, the financial barrier is removed for access to these services.

If people do not access general scope physiotherapy services (possibly due to financial barriers) or a general practitioner, they may not enter the pathway to specialist physiotherapy referral. Referral of Māori and Pasifika to these pathways may need to be considered and improved. It is also possible that experiences of pain of diverse ethnic groups need to be considered, for example, by ensuring that for Māori, Māori holistic views of health are included to a greater extent in the rehabilitation (Hoeta et al., 2020). Lower health care use by people of specific ethnic groups represents a major challenge, and health care providers should explore and implement strategies to improve equity of access for Māori and Pacific peoples.

SPADI and CSI

Patients in this study had significant differences in SPADI-Pain, -Disability and -Total scores between diagnostic groups. The Instability group comprised both traumatic and atraumatic instabilities. In the acute phase, patients with traumatic instabilities are likely to present with high levels of pain (SPADI-Pain) and disability (SPADI-Disability). Significant improvements are expected by 6 months (SPADI-Pain) and 9 months (SPADI- Disability) (Olds et al., 2020). The low SPADI-Pain score for the Instability group in this study is possibly due to the late presentation to physiotherapy (mean symptom duration > 3 months) at these clinics. The SPADI questionnaire may also not be sufficiently responsive for individuals with shoulder instabilities, as the questionnaire only explores disability regarding activities of daily living. The SPADI and the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH), specifically the shortened version, the QuickDASH, are similarly responsive for patients with shoulder pain undergoing physiotherapy (Chester et al., 2017). The QuickDASH may, however, be more relevant with individuals with glenohumeral dislocations as that PROM includes sections related to work- and sports-related disability. Other PROMs frequently reported for individuals with glenohumeral instabilities are the Western Ontario Shoulder Instability Index and the Oxford Instability Shoulder Score (Şahinoğlu et al., 2019).

There were no statistically significant differences in the CSI between diagnostic groups. Thirty-four patients (10.1%) across all diagnostic groups were above the cut-off score that may indicate the presence of central sensitivity syndrome (≥ 40) (Neblett et al., 2013). Although we did not undertake a comprehensive sensory assessment for central sensitisation, based on CSI scores, our findings support previous reports of a sub-group of shoulder patients with central sensitisation regardless of diagnostic criteria (Sanchis et al., 2015). A post hoc analysis of symptom duration demonstrated no significant differences between those who had high CSI scores (≥ 40) and those with low. Thus, duration of symptoms, in isolation, was also unlikely to identify those who have high risk for central sensitisation.

Central sensitisation predicts worse outcomes in patients with lateral epicondylalgia (Jespersen et al., 2013), whiplash (Hendriks et al., 2020), osteoarthritis (Kim et al., 2015) and low back pain (Aguilar Ferrándiz et al., 2016). Such patients need treatment approaches that target desensitisation of the nervous system (Nijs et al., 2016). Interventions may comprise pain neuroscience education, lifestyle management (such as nutrition, stress and sleep), psychologically informed interventions and graded activity exposure programmes (Elma et al., 2020; Nijs et al., 2020; Nijs et al., 2016). Patients with high CSI scores may also benefit from considerations for pharmacological interventions (Nijs et al., 2021). Identifying patients with higher sensitisation is important to inform tailored, relevant interventions for the individual. The CSI score may identify those at risk, but further evaluation is required to confirm the presence of central sensitisation.

Psychosocial outcome measures

The main purpose of psychosocial screening is to identify factors that are likely to adversely influence treatment outcome and present a risk of long-term pain and disability (Chester et al., 2018; Struyf et al., 2016). An earlier study with patients with rotator cuff tears showed that mental health (assessed with the SF-36 Mental Component Score) had a stronger association with patient-reported shoulder pain, function and shoulder-specific health-related quality of life than morphological tear severity (Wylie et al., 2016). Thus, identifying those patients who have psychosocial risk factors is important to guide rehabilitation, as well as to estimate prognosis for recovery (Chester et al., 2018).

The Örebro MSKPQ was originally developed for use in the low back pain population (Linton & Boersma, 2003). This score indicates risk for future absenteeism due to sickness in people with low back pain (Linton & Boersma, 2003), and is also one of the criteria of the ACC to refer patients to the pain management service regardless of area of pain (Accident Compensation Corporation, 2021). In the current study, the Örebro MSKPQ identified only one patient above the cut-off score of 50. Close to 70% of patients already could be classified as having chronic pain, that is, self-reported duration longer than 3 months. Whether higher Örebro MSKPQ scores for people with persistent shoulder pain also predicts future absenteeism or long-term functional disability has not yet been confirmed. In this study, the OSPRO discriminated between diagnostic categories of people with shoulder pain. The construct validity of the OSPRO with unidimensional questionnaires has been explored for people with shoulder pain, indicating strong relationships (Razmjou et al., 2021). Further work is required to increase clinical utility of the tool and develop validated cut-points, before this tool can be recommended for clinical practice (George et al., 2017). The PHQ-2 found that 4.3% of patients completing this questionnaire had signs for depression. These patients were found across diagnostic groups.

Self-efficacy has been described as the confidence a person has in their own ability to achieve a desired outcome (Bandura, 1977; Nicholas, 2007). Chester et al. (2019) found that patients with shoulder pain with low baseline pain and low self-efficacy scores had similar or worse outcomes to patients with high baseline pain and high pain self-efficacy. Thus, high levels of pain self-efficacy may mediate outcomes of those with high levels of pain. Caution is needed when comparing outcomes of the 10-item PSEQ (used by Chester et al., 2019) to the 2-item PSEQ (Chiarotto et al., 2016). While the Subacromial Pain group in our study had higher self-efficacy (11/12) than those included by Chester et al. (2019), a wide range, as low as 0/10, was found in our study. We suggest that it remains important for physiotherapists to screen patients with shoulder pain so that those with low self-efficacy (≤ 5/10) can be identified and receive targeted rehabilitation support.

In a previous study (Olds et al., 2019), similar TSK-11 scores (26/44) were reported for people with glenohumeral dislocations within 12 weeks of their dislocation. Kinesiophobia scores did not demonstrate a significant change across time (Olds et al., 2020) and have been shown not to differ in primary or recurrent instability (Eshoj et al., 2019). Either kinesiophobia does not differ between traumatic and atraumatic instability and primary or recurrent instability, or current measures of kinesiophobia are not responsive in people with shoulder instability. More recent PROMs, such as the Shoulder Return to Sport after Injury scale, may be more relevant to assess fear of re-injury, confidence and emotions, for people with glenohumeral dislocations (Olds & Webster, 2021).

The Other shoulder group had significantly lower PSEQ-2 scores compared to the Subacromial Pain group. The Other diagnostic group included patients with post-operative conditions, muscle strains and fractures. These findings indicate that patients with those diagnoses may benefit from formal assessment of self-efficacy to determine appropriate management options. Patients with low levels of self-efficacy need support to improve self-management, confidence and motivation, and to decrease reliance on pain medication (Picha & Howell, 2018). Similar to those with high CSI scores, a multicomponent exercise programme and psychologically informed interventions may be relevant to encourage physical activity and exercise for patients with low self-efficacy (Martinez-Calderon et al., 2020).

Clinical implications

Lin et al. (2020) included psychosocial screening as one of 11 recommendations to improve the quality of care for musculoskeletal pain. Such screening allows identification of people at risk of developing persistent disability, and prioritisation of early relevant person-centred care and interventions. It is unlikely that physiotherapists can predict risk of chronicity for patients with musculoskeletal pain based only on their patient interview and physical examination, compared to results of screening tools such as the Örebro MSKPQ (Wassinger & Sole, 2021). Our findings suggest that such risk can be present, regardless of the diagnostic category of the patient. Thus, psychosocial screening is recommended to be used in conjunction with a clinical interview for patients with musculoskeletal pain in general (Kendall et al., 2009; Singh et al., 2021; Wassinger & Sole, 2021). Our results reinforce the importance for physiotherapists to routinely include psychosocial screening and assessment of factors that contribute to persistent pain presentations (e.g., central sensitivity) as part of their assessment of people with shoulder pain for longer than three months, across all diagnostic categories.

The processes used in the two practices indicate that it is possible to collect such data from patients prior to their first assessment. This allows the physiotherapist to integrate their clinical interviews and physical examination with findings of the screening tools, to identify factors with the potential to influence treatment outcomes, or who may need further assessment or referral. However, the burden on the patient in completing multiple questionnaires must be considered in the clinical setting. There may be a limit to the number of factors that can be assessed using pre-appointment questionnaires. Anecdotally, some patients questioned the relevance of some questions in the pre-appointment questionnaires, as also reported in other studies with patients with musculoskeletal disorders (Singh et al., 2021). The risk of adverse influence on the clinical encounter from a large number of questionnaires, or those that patients perceive to be personal or sensitive information, must be considered. The OSPRO appears to be associated with unidimensional psychological PROMs (such as the TSK-11 and PSEQ) (Lentz et al., 2016; Razmjou et al., 2021). Pre-appointment questionnaires could be limited to such multidimensional questionnaires, and unidimensional domains be explored during and following the first appointment, as determined by the assessing physiotherapist. Further work is required to investigate the prognostic capacity of these outcomes, specifically for people with shoulder pain, and the most efficient administration, considering the person and clinician burden.

Methodological considerations

A strength of this study is that a large group of patients (> 400) was included in this study. However, the PROMs were not consistently completed by all patients, as these differed across time and between clinics. The main limitation of this study was the retrospective design. As an exploratory study, we undertook a number of statistical analyses, which increases the risk of Type 1 errors. We also did not adjust comparisons between diagnostic categories for confounding factors. For example, age may confound outcomes of the PROMs. However, age and diagnostic categories may be inter-dependent, in which case adjusting for age would not be appropriate. Caution is needed with interpreting and applying the outcomes of this study. We did not include the follow-up examination nor number and frequency of physiotherapy treatments. Factors that could influence pain and disability are not reported, for example, comorbidities, smoking and alcohol status, socioeconomic status and employment status or type (Dunn et al., 2014; Plachel et al., 2019; Tashjian et al., 2004; Wærsted et al., 2020; Wylie et al., 2010). Finally, this study did not assess factors that predict outcomes and cost of physiotherapy.

CONCLUSION

The Subacromial Pain group had the highest frequency of patients in this retrospective study of two shoulder physiotherapy practices. The Stiff Shoulder group had the highest levels of pain and disability, as defined by the SPADI, as well as the highest risk of long-term disability, defined by the OSPRO. The highest and lowest levels of pain self-efficacy were reported in the Subacromial Pain group and Other group, respectively. People with shoulder pain across all diagnostic groups can present with high levels of pain, disability, features of central sensitisation and psychosocial distress, as well as low levels of pain self-efficacy. We suggest that physiotherapists should routinely include questionnaires that measure psychosocial factors in order to provide a comprehensive assessment of individual patients with shoulder pain.

KEY POINTS

1. The SPADI differed across diagnostic groups and was highest for pain and disability for the Stiff Shoulder group.
2. People with shoulder pain across all diagnostic groups can present with high levels of pain, disability, features of central sensitisation and psychosocial distress, as well as low levels of pain self-efficacy.
3. Physiotherapists should routinely include questionnaires that measure psychosocial factors and central sensitivity as part of a comprehensive assessment of people with shoulder pain.

DISCLOSURES

No funding was provided for this study. Margie Olds, Angela Cadogan and Sarah Betteridge were provider physiotherapists and contributed to the interpretation of results and revision of the manuscript. Roger White and Gisela Sole were responsible

for data processing and analysis and writing of the first manuscript draft. All authors approved the final draft. There are no conflicts of interest that may be perceived to interfere with or bias this study.

PERMISSIONS

Ethics approval was granted by the University of Otago Human Ethics Committee (reference number HD20/032). The ethical review committee approved a waiver of written consent from patients because the study was a retrospective chart audit and only non-identifiable data were extracted from patient notes.

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Appendix A

SHOULDER DIAGNOSTIC CRITERIA

Pre-requisite for all diagnoses below is full range of motion of the cervical spine, with no reproduction of the patient's primary symptom.

Primary diagnostic categories	Clinical diagnostic criteria	Secondary diagnostic categories	Specific diagnostic criteria
Shoulder instability	Glenohumeral joint subluxation or dislocation	Traumatic instability	Clinical History of subluxation or dislocation associated with trauma/high force Imaging May have imaging evidence for: Glenohumeral dislocation Hill Sachs /glenoid fracture (X-ray) Capsuloligamentous or labral tear (MRI/A)
		Atraumatic instability	Clinical History of subluxation/dislocations without trauma, or with low-force trauma only Imaging If available, normal with no structural instability lesion
Stiff shoulder	Loss of passive ROM of the glenohumeral joint	Primary frozen shoulder	Clinical Insidious onset pain/stiffness Loss of passive ROM in external rotation and in 2 other directions Imaging Normal X-ray (except calcium or osteopaenia) required to confirm diagnosis (to exclude other cause of stiffness)
		Secondary frozen shoulder	Clinical Post-trauma/surgery or associated with resorptive calcific tendinosis or other shoulder pathology Loss of passive ROM in external rotation and in 2 other directions Imaging Normal X-ray (except calcium or osteopaenia) required to confirm diagnosis (to exclude other cause of stiffness)
		Glenohumeral osteoarthritis	Clinical Loss of passive ROM in external rotation Imaging X-Ray or computerised tomography required to confirm diagnosis of glenohumeral joint osteoarthritis
Subacromial pain	Pain in deltoid region Full passive external rotation Pain and variable weakness with resisted abduction and/or external rotation	Calcific tendinopathy	Clinical RCRP (above) plus Imaging X-ray and/or ultrasound confirmation of calcium in rotator cuff (except linear calcium)
		Atraumatic RCRP	Clinical No significant trauma (may be mild trauma)

Primary diagnostic categories	Clinical diagnostic criteria	Secondary diagnostic categories	Specific diagnostic criteria
Subacromial pain		Traumatic rotator cuff tear	Clinical History of significant trauma/load (e.g., fall, heavy lifting, high velocity load) Significant weakness May have positive (cannot exclude if these are negative): Pseudoparalysis (supraspinatus) Positive lag signs (drop arm test, external rotation lag sign, internal rotation lag sign, lift-off test) Positive belly press test (subscapularis) Imaging Ultrasound/MRI evidence of acute rotator cuff tear required to confirm diagnosis
		Massive (chronic) rotator cuff tear	Clinical RCRP plus atrophy of the supra/infraspinatus Imaging X-Ray – superior migration humeral head and/or decreased acromio-humeral distance OR Ultrasound or MRI – confirmation of rotator cuff tear > 5cm (anterior-posterior dimension) OR 2 or more tendons involved
		ACJ ligament injury/instability	Clinical History of trauma Physical examination with or without deformity Imaging X-Ray may confirm ACJ disruption and can help grade injury
ACJ pain	Full passive external rotation Predominant pain is in superior shoulder/ supraclavicular/ suprascapular region No significant weakness with rotator cuff tests ACJ tenderness to palpation (provocative of typical pain) Provocative tests for ACJ (none diagnostic in isolation): Cross body adduction test Scapula elevation/ depression/ retraction/ protraction End range pain in elevation Active compression (O'Briens) test ACJ resisted extension test	ACJ arthropathy	Clinical No significant trauma, or mild/low-force trauma only Acromioclavicular joint may appear thickened Imaging X-Ray: acromioclavicular joint arthropathy or osteolysis Ultrasound: capsular hypertrophy/cortical irregularity/ capsular hyperaemia MRI: marrow oedema (acromion or clavicle or both) Clinical Sternoclavicular joint Long head of biceps pain Labral tear Post-operative pain Fracture
Other shoulder	Primary shoulder pain that is not included in any of the above diagnostic categories		

Note. ACJ = acromioclavicular joint; MRA = magnetic resonance angiography; MRI = magnetic resonance imaging; ROM = range of motion; RCRP = rotator cuff related pain.

Appendix B

SELF-REPORTED OUTCOME MEASURES

Dimension and outcome measure	Description and psychometric properties
Pain and function dimensions	
Shoulder pain and Disability Index (SPADI)	The Shoulder Pain and Disability Index (SPADI) has been shown to be a valid and reliable measure of shoulder pain and function across a variety of shoulder diagnostic categories (Paul et al., 2004). It consists of 2 subscales based on the domains of pain (5 items) and function (8 items). The sub-scales and total scale are converted to a maximum score of 100, with the higher the score indicating higher levels of pain and reduced function (Dabija et al., 2019; MacDermid et al., 2006)
Central sensitization	
Central Sensitization Inventory (CSI)	The Central Sensitization Inventory (CSI) consists of 2 parts: Part A. consists of 25 questions that are scored on a Likert scale of 0 (never) to 4 (always) to give a total score of 100. Part B. seeks to determine if the patient has been diagnosed by a medical doctor with several disorders that are linked to central sensitisation. Higher scores indicate higher levels of central sensitisation. A cut-off score of 40 has been established as distinguishing patients with central sensitisation (Neblett et al., 2013). The psychometric strength of the CSI has been established in a population with chronic musculoskeletal pain (Mayer et al., 2012) but, to our knowledge, not specifically in patients with shoulder pain
Psychosocial dimensions	
Örebro Musculoskeletal Pain Questionnaire (MSKPQ)	The Örebro Musculoskeletal Pain Questionnaire (MSKPQ) identifies psychosocial factors and risk of future work absenteeism and has been demonstrated to be a reliable tool (Linton & Boersma, 2003). The short-form Örebro MSKP, used in this study, consists of 10 questions. A correlation of 0.91 has been reported between the short form and the original scores. A cut-off score of 50 has been identified for predicting 14 days of accumulated sick leave for people with low back pain (Linton et al., 2011). The questionnaire has been validated for persistent low back and neck pain (Langenfeld et al., 2018). While this PROM has not been formally validated specifically for shoulder pain populations, it has been used as secondary outcomes for such patients (Butera et al., 2020; Warby et al., 2016)
Optimal Screening for Prediction of Outcome (OSPRO)	The 10-item Optimal Screening for Prediction of Outcome (OSPRO) measures the domains of negative mood, fear avoidance and positive affect/coping (Robarts et al., 2021) and is applicable to a variety of musculoskeletal conditions including the shoulder (Lentz et al., 2016). The OSPRO has been reported to be a reliable and valid multidimensional psychosocial assessment tool (Butera et al., 2020)
Brief Resilience Scale (BRS)	The Brief Resilience Scale (BRS) is a reliable measure of assessing resilience, defined as the ability to bounce back from stress. The BRS consists of 6 questions to give a score ranging from 1 to 5 with 1–2.99 indicating low resilience, 3–4.3 normal resilience and 4.31–5 high resilience (Smith et al., 2008)
2-Item Patient Health Questionnaire (PHQ-2)	The 2-item Patient Health Questionnaire (PHQ-2) consists of the first two questions of the original 9 item version and is a measure of depression screening (Kroenke et al., 2003) and is able to detect changes with treatment (Staples et al., 2019). Scores range from 0 to 6 with a score of 3 or greater indicating depression (Kroenke et al., 2003)
2-Item Pain Self-efficacy Questionnaire (PSEQ-2)	The 2-item Pain Self-efficacy Questionnaire (PSEQ-2) is a reliable and valid measure of the ability of a patient to lead a normal life despite pain. It is a shortened version of the original questionnaire consisting of 2 questions measured on a 0 to 6 scale, with 0 not at all confident and 6 completely confident. A cut-off score of 5 or less is thought to indicate that a patient will need help in improving their confidence in functioning with pain (Nicholas, 2007)
Tampa Scale of Kinesiophobia (TSK-11)	The Tampa Scale of Kinesiophobia (TSK-11) has been used to measure fear of movement in patients with shoulder pain (Bot et al., 2005; Mintken et al., 2010) and has demonstrated similar psychometric properties to the original longer version (Woby et al., 2005). The TSK-11 is scored on a 4-point scale from 1 (strongly disagree) to 4 (strongly agree) to give a total score between 11 and 44; the higher the score the higher the fear of movement

Appendix C

BETWEEN-DIAGNOSTIC GROUP COMPARISONS FOR ANALYSES WITH SIGNIFICANT EFFECTS ACROSS GROUPS

Group	Group Mean (95% confidence interval) *p* value				
	Subacromial pain	Instability	Stiff shoulder	ACJ	Other
SPADI-Pain					
Subacromial pain		7.5 (–0.3, 15.2) $p = 0.066$	–9.0 (–18.5, 0.5) $p = 0.075$	0.8 (–9.4, 11.0) $p = 1.000$	–1.1 (–9.8, 7.6) $p = 1.000$
Instability	–7.5 (–15.2, 0.3) $p = 0.066$		–16.5 (–26.8, –6.2) $p < 0.001$	–6.7 (–17.7, 4.3) $p = 0.865$	–18.6 (–18.2, 1.1) $p = 0.124$
Stiff shoulder	9.0 (–0.5, 18.5) $p = 0.075$	16.5 (6.2, 26.8) $p < 0.001$		9.9 (–2.4, 22.0) $p = 0.251$	7.9 (–3.1, 19.0) $p = 0.441$
ACJ	–0.8 (–11.0, 9.4) $p = 1.00$	6.7 (–4.3, 17.7) $p = 0.865$	–9.9 (–22.0, 2.4) $p = 0.251$		–1.9 (–13.6, 9.8) $p = 1.000$
Other	1.1 (–7.6, -9.8) $p = 1.00$	18.6 (–1.1, 18.2) $p = 0.124$	–7.9 (–19.0, 3.1) $p = 0.441$	1.9 (–9.8, 13.6) $p = 1.000$	
SPADI-Disability*					
Subacromial pain		5.9 (–1.4, 13.2) $p = 0.217$	–17.7 (–27.0, -8,4) $p < 0.001$	4.6 (–4.0, 13.2) $p = 0.743$	–6.0 (–15.8, 3.8) $p = 0.580$
Instability	–5.9 (–13.2, 1.4) $p = 0.217$		–23.6 (–33.2, –14.0) $p < 0.001$	–1.3 (–10.3, 7.8) $p = 1.000$	–11.9 (–22.0, -1.7) $p = 0.011$
Stiff shoulder	17.7 (8.4, 27.0) $p < 0.001$	23.6 (14.0, 33.2) $p < 0.001$		22.3 (11.8, 32.9) $p < 0.001$	11.7 (0.2, 23.2) $p = 0.044$
ACJ	–4.6 (–13.2, 4.0) $p = 0.743$	1.3 (–7.8, 10.3) $p = 1.000$	–22.3 (–32.9, –11.8) $p < 0.001$		–10.6 (–21.7, 0.4) $p = 0.069$
Other	6.0 (–3.8, 15.8) $p = 0.580$	6.0 (–3.8, 15.8) $p = 0.580$	–11.7 (–23.2, -0.2) $p = 0.044$	10.6 (–0.4, 21.7) $p = 0.069$	
SPADI-Total					
Subacromial pain		8.1 (0.1, 16.2) $p = 0.047$	–14.6 (–23.9, –5.3) $p < 0.001$	2.4 (–7.5, 12.4) $p = 1.000$	–6.1 (–15.0, 2.8) $p = 0.526$
Instability	–8.1 (–16.2; –0.1) $p = 0.047$		–22.7 (–33.1, –12.3) $p < 0.001$	–5.7 (–16.6, 5.3) $p < 0.001$	–14.2 (–24.3, –4.2) $p < 0.001$
Stiff shoulder group	14.6 (5.3, 23.9) $p < 0.001$	22.7 (12.3, 33.1) $p < 0.001$		17.0 (5.2, 28.9) $p < 0.001$	8.5 (–2.6, 19.5) $p = 0.307$
ACJ	–2.4 (–12.4, 7.5) $p = 1.000$	5.7 (–5.3, 16.6) $p = 1.000$	–17.0 (–28.9, –5.2) $p < 0.001$		–8.6 (–20.1, 3.0) $p = 0.375$
Other	6.1 (–2.8, 15.0) $p = 0.526$	14.2 (4.2, 24.3) $p < 0.001$	–8.5 (–19.5, 2.6) $p = 0.307$	8.6 (–3.0, 20.1) $p = 0.375$	
OSPRO					
Subacromial pain		1.3 (–2.7, 5.3) $p = 1.000$	–5.1 (–10.9, 0.8) $p = 0.154$	(–4.8, 6.9) $p = 1.000$	–0.1 (–6.0, 2.7) $p = 1.000$
Instability	–1.3 (–5.3, 2.7) $p = 1.000$		–6.4 (–12.6, -0.2) $p = 0.040$	–0.23 (–6.4, 6.0) $p = 1.000$	–1.4 (–7.6, 4.8) $p = 1.000$
Stiff shoulder	5.1 (–0.8, 10.9) $p = 0.154$	6.4 (0.2, 12.6) $p = 0.040$		6.1 (–1.4, 13.6) $p = 0.624$	5.0 (–2.5, 12.5) $p = 0.624$
ACJ	–1.1 (–6.9, 4.8) $p = 1.000$	0.23 (–6.0, 6.4) $p = 1.000$	–6.1 (–13.6, 1.4) $p = 0.624$		–1.2 (–8.7, 6.3) $p = 0.216$
Other	0.1 (–2.7, 6.0) $p = 1.000$	1.4 (–4.8, 7.6) $p = 1.000$	–5.0 (–12.5, 2.5) $p = 0.624$	1.2 (–6.3, 8.7) $p = 0.216$	

Group	Group Mean (95% confidence interval) *p* value				
	Subacromial pain	Instability	Stiff shoulder	ACJ	Other
PSEQ-2**					
Subacromial pain		$p = 1.000$		$p = 1.000$	$p = 0.035$
Instability	$p = 1.000$		$p = 0.480$	$p = 1.000$	$p = 0.345$
Stiff shoulder	$p = 0.060$	$p = 0.480$		$p = 0.265$	$p = 1.000$
ACJ	$p = 1.000$	$p = 1.000$	$p = 0.265$		$p = 0.275$
Other	$p = 0.035$	$p = 0.345$	$p = 1.000$	$p = 0.275$	

Note. ACJ = acromioclavicular joint; OSPRO = Optimal Screening for Prediction of Outcome; PSEQ = Pain Self-efficacy Questionnaire; SPADI = Shoulder Pain and Disability Index.

Post hoc analyses were performed with independent *t*-tests and Bonferroni corrections for SPADI-Pain, SPADI-Total and OSPRO.

* Post hoc analyses were performed with independent *t*-tests and Tamhane T2 corrections due to unequal variance for SPADI-Disability.

** Post hoc analyses were performed with Mann-Whitney U tests with Bonferroni corrections for PSEQ-2 (non-parametric comparison).

Subacromial Bursitis and Shoulder Pain: Exploring the Predictors for a Negative Anaesthetic Response

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ABSTRACT

The aim of this retrospective cross-sectional study was to (1) investigate the association between the presence of subacromial bursal pathology and response to subacromial anaesthetic injection; (2) identify variables that are predictive of a negative anaesthetic response; and (3) calculate diagnostic accuracy of these predictors. A total of 208 people with shoulder pain referred from primary care received an ultrasound guided local anaesthetic injection into the subacromial bursa following standardised clinical examination. Pain was recorded on a visual analogue scale immediately prior to and within 15 min post-anaesthetic injection. No difference in pain reduction post injection was found between those with and without bursal pathology ($p < 0.05$). Five potential predictors of a negative anaesthetic response were identified, but did not reach statistical significance. Clusters of three of the five predictors (high occupational shoulder demands; high or low sport/recreational shoulder demands; no current history of night pain; loss of passive external rotation range of motion of more than 30° and shoulder pain reproduced on cervical spine testing) may have clinical relevance despite not reaching statistical significance. Use of a cluster of any three predictors results in post-test probability of 93% (pre-test probability 69%). The identified predictors may inform clinical decisions regarding the use of injection therapy in those with bursal pathology observed with ultrasound and therefore potentially reduce unnecessary and costly healthcare utilisation.

Betteridge, S., Cadogan, A., & Devan, H. (2022). Subacromial bursitis and shoulder pain: Exploring the predictors for a negative anaesthetic response. *New Zealand Journal of Physiotherapy, 50*(1), 21–32. https://doi.org/10.15619/NZJP/50.1.03

Key Words: Bursitis, Diagnostic Accuracy, Local Anaesthetic, Sensitivity and Specificity, Shoulder Pain

INTRODUCTION

Shoulder pain is one of the most common musculoskeletal pain conditions for people seeking primary healthcare services (Urwin et al., 1998). The annual incidence has been reported as being between 0.9% and 2.5% in those aged 31–74 years, with a lifetime prevalence of up to 66.7% (Luime et al., 2004). Rotator cuff conditions account for up to 70% of reported shoulder conditions (Chard et al., 1991). *Rotator cuff related shoulder pain* is an over-arching term that includes common shoulder pathologies such as bursitis, rotator cuff tendinopathy and rotator cuff tears. This recent change in terminology is due to a greater understanding of aetiology in shoulder pain, pathological findings in asymptomatic individuals and the poor diagnostic accuracy of common shoulder special tests for identifying specific pathologies (Lewis, 2016).

Ultrasound imaging is an adjunct to the diagnostic process of rotator cuff-related shoulder pain. In the year 2018/19, the Accident Compensation Corporation (ACC) accepted 40,992 new claims for shoulder and rotator cuff sprains in New Zealand, of which approximately 37% received an ultrasound scan to aid diagnosis (Accident Compensation Corporation, 2019). Bursal pathology is common in both symptomatic and asymptomatic populations; however, its contribution to shoulder pain needs to be determined to avoid inappropriate treatment targeting the subacromial bursa (Cadogan et al., 2011). Girish et al. (2011) reported 78% (40/51) of healthy male asymptomatic volunteers were found to have subacromial bursal thickening. Furthermore, no significant differences in bursal thickness have been identified between people with shoulder pain and those without (Daghir et al., 2012).

Although it is known that pain is a multidimensional experience, the accepted reference standard test for identifying structures contributing to the experience of pain is a diagnostic injection of local anaesthetic (Bogduk, 2009; Cardone & Tallia, 2002). A cross-sectional study using intra-bursal anaesthetic injection in those with shoulder pain found radiological bursal features were similar in both responders and non-responders (Bouju et al., 2014). However, Lee et al. (2017) reported improved outcomes (i.e., self-reported pain intensity, active range of motion and ultrasound findings) following subacromial bursal corticosteroid injection in individuals with rotator cuff disease, and thickened or fluid-filled bursa when compared to those with normal bursal features.

Based on such conflicting evidence, it appears in some cases bursitis may be associated with shoulder pain (Lee et al., 2017); however, in others it may be an asymptomatic finding (Bouju et al., 2014). It is expected that if bursitis was the nociceptive source of shoulder pain, local anaesthetic injection into the subacromial bursa would result in a significant reduction in pain. Further, a lack of anaesthetic response would indicate the bursa was not the predominant source of nociception and further targeted treatments may not confer any clinical benefit.

Several studies have investigated the radiological features, patient history and clinical examination findings associated with a positive anaesthetic response to local anaesthetic bursal injection (Bouju et al., 2014; Cadogan et al., 2012; Lee et al., 2017). There is however no previous research on characteristics of patients who do not respond to local anaesthetic subacromial bursa injection. Identification of negative predictors may inform the clinical reasoning process by indicating when bursitis may not be the source of nociception. This may aid clinical diagnosis and thereby assist in the development of appropriate treatment strategies. Further, the identified predictors may facilitate the selective use of invasive injection therapies in people with shoulder pain and avoid unnecessary use in those for whom it is unlikely to change symptoms.

The aims of this study were to (1) investigate the association between presence of subacromial bursal pathology and response to subacromial bursal anaesthetic injection; (2) identify variables that predict a negative anaesthetic response in those with shoulder pain and subacromial bursa pathology observed on ultrasound and (3) calculate the diagnostic accuracy of predictors of a negative anaesthetic response.

METHODS

The data analysed in this retrospective cross-sectional study were collected prospectively, as part of a wider diagnostic accuracy study of shoulder pain in primary care (Cadogan et al., 2011). The study procedures for the primary study have been described previously (Cadogan et al., 2011), and thus only key procedures are described below.

Participant population

A total of 373 consecutive participants with a new episode of shoulder pain attending their GP or a physiotherapist were referred into the study between July 2009 and June 2010. Participants included were over 18 years of age, able to read written instructions, presenting for the first time with a new episode of shoulder pain and without contraindications to injection procedures such as infection of overlying skin and allergy to local anaesthetic.

Those with pain of cervical origin, previous surgery to the shoulder or cervical region, sensorimotor deficits of the upper limb and history of fracture or dislocation of the shoulder were excluded. Ethical approval for the current study was granted by the University of Otago Human Ethics Committee (reference number HD19/041). Participants gave written consent for all examinations and procedures. A total of 208 participants were included and their data were used for analyses in the current study.

History and self-report questionnaires

Participants completed medical screening and history questionnaires, a symptom chart, the Short Form-8™ health survey (Ware et al., 2001), the Fear Avoidance Beliefs Questionnaire (FABQ) (Waddell et al., 1993) and the Shoulder Pain and Disability Index (SPADI) (Roach et al., 1991).

Physical examination

Participants underwent a standardised physical examination performed by an experienced physiotherapist (AC).

Imaging

Standard x-ray series and ultrasound evaluation of the shoulder were completed by radiographers and trained musculoskeletal sonographers. Findings were reported on a standardised form by fellowship trained radiologists.

Diagnosis of subacromial bursitis

For the purpose of this current study, criteria for diagnosis of subacromial bursitis (SAB) includes the following ultrasonographic features: hypoechoic fluid or effusion present and > 2 mm thick; or bursal thickening ≥ 2 mm, measured from the deep margin of deltoid to the superficial margin of supraspinatus. The diagnostic criteria were similar to previous studies (Cadogan et al., 2012; Chang et al., 2017; Girish et al., 2011; Wang et al., 2019).

Reference standard

An ultrasound-guided diagnostic injection of local anaesthetic into the subacromial bursa was completed by standardised aseptic technique. A 5ml solution of 1% lidocaine hydrochloride (Xylocaine™) was injected by the radiologist. Immediately prior to and 5–15 min post-injection, participants completed up to six of the most painful tests identified on clinical examination. Pain intensity for each test was documented on a 100mm visual analogue scale (VAS). A negative anaesthetic response (NAR) was recorded when a mean reduction in pain intensity of less than 80% over the six tests was reported, consistent with the definition of the primary study (Cadogan et al., 2011).

Blinding

To minimise the influence of bias and under- or over-reporting of symptoms, participants and radiologists were blinded to examination findings and the physiotherapist was blinded to all referring information.

Statistical analyses

Missing data were excluded pairwise. Only those with a pre-injection VAS ≥ 20mm were included in the analysis to allow for a detectable reduction in VAS post-injection (Bogduk, 2013). Analyses were performed using IBM SPSS Statistics (Version 25) predictive analytics software. Diagnostic accuracy was calculated using MedCalc Statistical Software (version 19.1).

Aim 1: Investigate the association between presence of subacromial bursal pathology and response to subacromial bursal anaesthetic injection.

Participants with sufficient data for aim 1 were placed into four groups: group 1, SAB including other ultrasound pathology, e.g., rotator cuff tear, calcific tendinopathy (SAB+); group 2, SAB alone (excluding other ultrasound pathology) (SAB-); group 3, other pathology not including SAB (other not SAB); and group 4, no pathology. Participant flow for aim 1 is shown in Figure 1. Group data were cross tabulated with anaesthetic response (Appendix A). Due to non-parametric distribution of the data, the Kruskal-Wallis test was used to calculate differences in anaesthetic response between groups.

Aim 2: Identify variables that predict a NAR in those with shoulder pain and subacromial bursa pathology observed on ultrasound.

Logistic regression analyses were conducted on variables, which were selected *a priori*, to identify potential predictors of a NAR (Appendix B). Only those with SAB (SAB+ and SAB-) reporting a NAR were included in the analysis (Figure 2). Following the recommendations of Peduzzi et al. (1996) a minimum of 10 events were required for each independent variable to be included in the univariate logistic regression. Variables were checked for collinearity with the dependant variable: NAR (yes or no). The remainder were included in univariate regression with a variable selection cut point of $p \leq 0.25$ (Hosmer et al., 2013). Variables meeting the *a priori* cut point were included in a multivariate regression ($p \leq 0.05$).

Aim 3: Calculate diagnostic accuracy of predictors of NAR

Diagnostic accuracy statistics were calculated including sensitivity, specificity, positive likelihood ratios (LR+), negative likelihood ratios (LR-), predictive values with 95% confidence intervals (CI) of each variable and clustered variables.

RESULTS

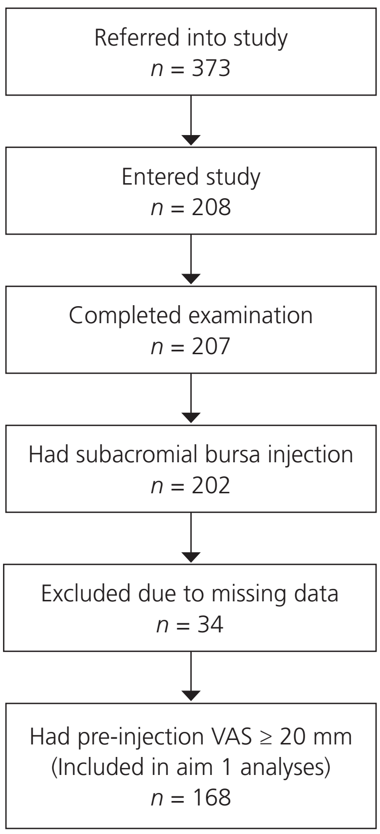
Participants

A total of 208 participants were enrolled in the primary study of whom 207 completed the clinical examination (Cadogan et al., 2011). Of the 202 participants who received a subacromial bursa local anaesthetic injection, 34 participants were excluded due to missing data (incomplete recording of ultrasound findings). A total of 168 participants had a pre-injection VAS ≥ 20mm and were included in the analysis linked to aim 1 (Figure 1). Of the 118 participants with SAB observed on ultrasound, three were excluded due to missing data. Seventy-nine of the remaining 115 had a NAR and were included in the analyses for aims 2 and 3 (Figure 2).

The mean age of participants was 43.4 (SD, 13.9) years, and median symptom duration was 7 weeks (Table 1). Overall prevalence of SAB observed with ultrasound was 57% (118/208) (Figure 2). As indicated in Table 1, there was no statistically significant difference between groups except for employment status.

Figure 1

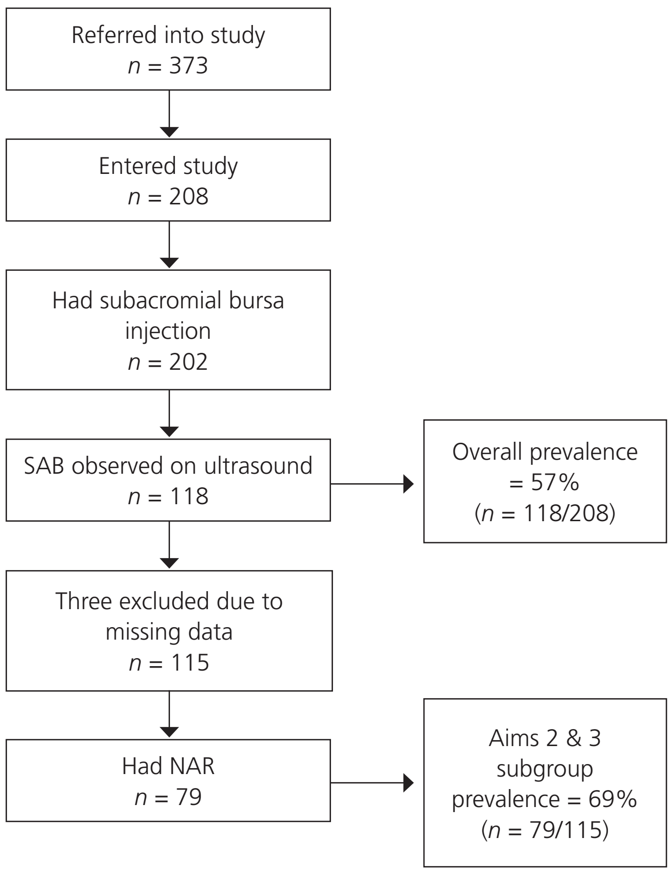
Participant Flow for Aim 1



Note. VAS = visual analogue scale.

Figure 2

Participant Flow for Aims 2 and 3



Note. SAB = subacromial bursitis; NAR = negative anaesthetic response.

Table 1

Participant Characteristics

Characteristic	All				SAB+			SAB-			Other not SAB			No pathology			p
	n = 168				n = 91			n = 24			n = 30			n = 23			
	M	*SD*	Range	%	*M*	*SD*	%	*M*	*SD*	%	*M*	*SD*	%	*M*	*SD*	%	
Age (years)	43.4	13.9	18–81		47.4	13.3		37.0	11.9		45.4	12.3		32.1	9.5		0.16
Body mass index	27.4	5.7	19–69		27.6	5.0		25.8	3.6		28.2	5.7		27.7	9.3		0.97
FABQ total %	26.6	16.7	0–79		28.5	17.8		22.7	14.2		26.0	18.0		23.7	11.9		0.28
Pre-injection VAS	68.8	20.1	20–100		71.0	19.8		71.4	18.5		68.4	18.7		57.6	22.1		0.31
Symptom duration (weeks)*	7.0	14.0	0–175		8.0	14.0		7.5	20.0		4.5	14.0		7.0	12.0		0.69
Gender (male)				54.8			56.0			41.7			56.7			60.9	0.57
Right hand dominant				88.1			90.1			87.5			86.7			82.6	0.95
Dominant arm affected				53.6			50.5			62.5			46.7			65.2	0.44
Receiving ACC				92.3			93.4			95.8			83.3			95.7	0.10
Physiotherapist referred				97.0			95.6			100			96.7			100	0.93
Employed				81.5			82.4			79.2			93.3			65.2	0.03**
Smoker				19.8			22.2			16.7			23.3			8.7	0.41

Note. ACC = Accident Compensation Corporation; FABQ = Fear Avoidance and Beliefs Questionnaire; SAB = subacromial bursitis; SAB- = subacromial bursitis excluding other pathology; SAB+ = subacromial bursitis including other pathology; VAS = visual analogue scale.

*Variable non-parametrically distributed, median (interquartile range) presented. **$p < 0.05$.

Aim 1: Investigate the association between presence of subacromial bursal pathology and response to subacromial bursal anaesthetic injection

A Kruskal-Wallis test revealed no statistically significant difference in percentage change of VAS scores across the four groups χ^2 (3, n = 168) = 3.25, *p* = 0.35 (Table 2).

Table 2

Change in Visual Analogue Scale Scores Following Subacromial Bursa Local Anaesthetic Injection

Group	Total	Median % change	Range
SAB+	91	–68	112
SAB-	24	–54	136
Other not SAB	30	–58	99
No pathology	23	–63	130
Total	168	–63	136

Note. SAB = subacromial bursitis; SAB- = subacromial bursitis excluding other pathology; SAB+ = subacromial bursitis including other pathology. Negative value indicates reduction in post-injection pain score.

Aim 2: Identify variables that predict a NAR in those with shoulder pain and subacromial bursa pathology observed on ultrasound

Of the 29 *a priori* selected independent variables included in the univariate logistic regression, none demonstrated a statistically significant association with a NAR (Appendix C). Five variables met the *a priori* cut point ($p \leq 0.25$) for inclusion in the multivariate analysis: high occupational shoulder demands (*p* = 0.20); high or low sport/recreational shoulder demands (i.e., not moderate) (*p* = 0.17); no current history of night pain (*p* = 0.10); loss of passive external rotation range of motion of more than 30° in neutral (*p* = 0.25); and shoulder pain reproduced on any cervical test (*p* = 0.11). Although our data suggested that participants with a loss of passive external rotation range of motion of more than 30° in neutral and those with reproduction of shoulder pain on any cervical test were both 3.6 times more likely to have a NAR (*OR* = 3.6, 95% CI [0.4, 30], *p* = 0.25; *OR* = 3.6, 95% CI [0.8, 16.7], *p* = 0.11), this finding should be considered carefully in light of the lack of statistical association. Those with high occupational shoulder demands, high or low sport/recreational demands and those with no current history of night pain were nearly two times more likely to have a NAR (*OR* = 1.9, 95% CI [0.7, 5.0], *p* = 0.20; *OR* = 1.8. 95% CI [0.8, 4.3], *p* = 0.17; *OR*, 2.1, 95% CI [0.9, 4.9], *p* = 0.10). Again, this finding should be considered carefully in light of the lack of statistical association.

No variables demonstrated collinearity with the dependent variable NAR (yes or no). Findings from the multivariate logistic regression analysis performed to explore how well individual variables included in the model predicted a NAR are provided in Table 3. Despite our Hosmer-Lemeshow test indicating good model fit (*p* = 4.6), none of the predictors were statistically significant in our multivariate analyses.

Table 3

Multivariate Analysis of Predictors of Negative Anaesthetic Response Following Subacromial Bursa Local Anaesthetic Injection

Predictor	*OR*	95% CI		*p*
		LL	*UL*	
High occupational shoulder demands [a]	2.3	0.8	7.1	0.14
High or low sport/recreation shoulder demands [b]	2.2	0.8	5.9	0.13
No current history of night pain	2.0	0.7	5.5	0.17
PROM ER loss > 30°	3.6	0.4	36.3	0.27
Shoulder pain on any cervical spine test [c]	7.8	0.9	67.9	0.06

Note. CI = confidence interval; *LL* = lower limit; *OR* = adjusted odds ratio; PROM ER, passive range of motion external rotation; *UL* = upper limit.

[a] Shoulder occupational demands: low e.g., clerical worker; moderate e.g., tradesperson; high e.g., heavy lifting or frequent overhead work. [b] Sport/recreation demands: low e.g., walking, running, hiking, lawn bowls, easy gardening, handcrafts; moderate e.g., golf, fishing, moderate gardening, soccer, mountain biking; high e.g., swimming, racquet sports, overhead sports, contact sports, throwing sports, weight-lifting, heavy landscaping. [c] Cervical tests: active range of motion, overpressure if pain free and Spurling's test.

Aim 3: Calculate diagnostic accuracy of predictors of NAR

The diagnostic accuracy of the five predictors included in the multivariate analyses are reported in Table 4. Most predictors had high specificity but low sensitivity values. Loss of passive external rotation of more than 30° in neutral and reproduction of shoulder pain on cervical testing both demonstrated the highest specificity of 97%, (95% CI [86, 100]) and 95%, (95% CI [82, 99]), respectively. The predictor with the highest sensitivity was sport/recreational shoulder demands rated as low or high (72%, 95% CI [60, 82]).

The diagnostic accuracy of various numbers of clustered predictors was calculated and data are presented in Table 5. A cluster of three predictors generated the highest specificity of 97.3%, 95% CI [86.0, 100], with a LR+ of 6.1 (95% CI [0.8, 44.8]) and positive predictive value (PPV) of 92.9% (95% CI [63.9, 99.0]). Such a cluster resulted in an increase in post-test probability of a NAR to 93% from the pre-test probability of 69% (Figure 3). The presence of two predictors produced the highest sensitivity of 39.2% (95% CI [28.4, 50.9]) and lowest LR- of 0.9 (95% CI [0.7, 1.1]).

DISCUSSION

Our retrospective cross-sectional study found a lack of association between the presence of bursal pathology observed with ultrasound and anaesthetic response to subacromial anaesthetic injection. Five variables predicted a NAR to subacromial injection in univariate analyses: high occupational shoulder demands; high or low sport/recreational shoulder

Table 4

Diagnostic Accuracy of Individual Predictors in Model

Predictor	TP	FN	FP	TN	Sensitivity			Specificity			Likelihood ratios						PPV			NPV			Post-test probability [a]
	n				%	95% CI		%	95% CI		LR+	95% CI		LR-	95% CI		%	95% CI		%	95% CI		%
						LL	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*	
High occupational shoulder demands	25	45	7	26	33.8	22.8	46.3	78.8	61.1	91.0	1.6	0.8	3.3	0.8	0.7	1.1	76.7	61.1	87.3	36.6	31.1	42.5	78
High or low sport/ recreation shoulder demands	52	20	20	14	72.2	60.4	82.1	41.2	24.7	59.3	1.2	0.9	1.7	0.7	0.4	1.2	72.2	65.5	78.1	41.2	28.8	54.8	73
No current history of night pain	35	44	10	26	44.3	33.1	55.9	72.2	54.8	85.8	1.6	0.9	2.9	0.8	0.6	1.0	77.8	66.2	86.2	37.1	43.5	62.4	78
PROM ER loss > 30°	7	71	1	36	9.0	3.7	17.6	97.3	85.8	99.9	3.3	0.4	26.0	0.9	0.9	1.0	86.7	60.7	96.5	33.6	31.7	35.6	88
Shoulder pain on any cervical spine test	13	64	2	35	16.9	9.3	27.1	94.6	81.8	99.3	3.1	0.7	13.1	0.9	0.8	1.0	80.0	53.0	94.0	35.4	32.5	38.3	87

Note. CI = confidence interval; FN = false negative; FP = false positive; *LL* = lower limit; LR- = negative likelihood ratio; LR+ = positive likelihood ratio; PPV = positive predictive value; NPV = negative predictive value; PROM ER = passive range of motion external rotation; TN = true negative; TP = true positive; *UL* = upper limit.

[a] Pre-test probability = 69%.

Table 5

Diagnostic Accuracy of Clustered Predictors

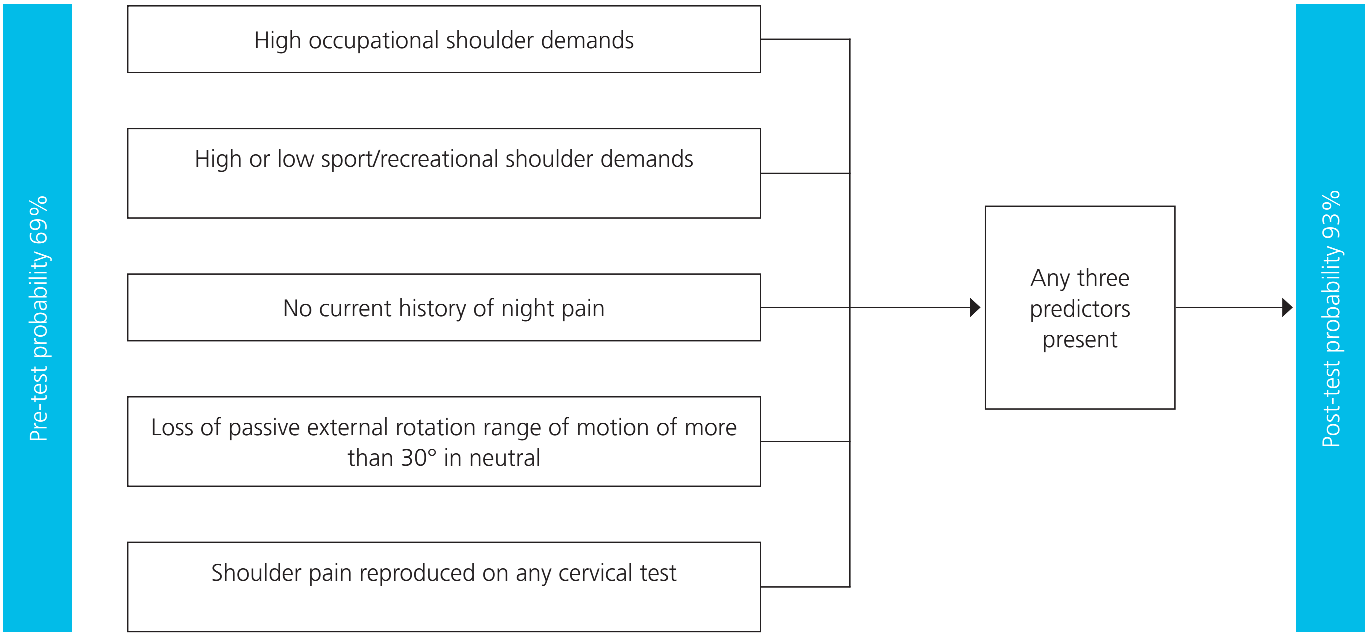
Predictors present	*n*				Sensitivity			Specificity			Likelihood ratios						PPV			NPV			Post-test probability [a]
	TP	FN	FP	TN	%	95% CI		%	95% CI		LR+	95% CI		LR-	95% CI		%	95% CI		%	95% CI		%
						LL	UL		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*	
1/5	29	50	14	23	36.7	26.1	48.3	62.2	44.8	77.5	1.0	0.6	1.6	1.0	0.8	1.4	67.4	55.6	77.4	31.5	25.4	38.4	69
2/5	31	48	11	26	39.2	28.4	50.9	70.3	53.0	84.1	1.3	0.8	2.3	0.9	0.7	1.1	73.8	61.5	76.5	35.1	29.2	41.6	74
3/5	13	66	1	36	16.5	9.1	26.5	97.3	85.8	99.9	6.1	0.8	44.8	0.9	0.7	1.0	92.9	63.9	99.0	35.3	32.8	37.9	93
4/5	1	78	0	37	1.3	0.0	6.9	100	90.5	100	— [b]			1.0	1.0	1.0	100			32.2	31.6	32.7	— [b]
5/5	0	79	0	37	— [b]			— [b]			— [b]			1.0	1.0	1.0	— [b]			31.9	31.9	31.9	— [b]

Note. CI = confidence interval; FN = false negative; FP = false positive; *LL* = lower limit; LR- = negative likelihood ratio; LR+ = positive likelihood ratio; PPV = positive predictive value; NPV = negative predictive value; TN = true negative; TP = true positive; *UL* = upper limit.

[a] Pre-test probability - 69%. — [b] Missing information due to only one or no participants scoring positively for 4 or 5 out of 5 variables.

Figure 3

Post-test Probability of Predictors and Clustered Predictors



demands; no current history of night pain; loss of passive external rotation range of motion of more than 30° in neutral; and reproduction of shoulder pain on cervical testing. None of these variables predicted a NAR in multivariate analyses. However, clusters of three of the five predictors demonstrated clinically useful diagnostic accuracy to help identify those who are unlikely to respond to subacromial bursal anaesthetic injection. These results should be interpreted with caution due to wide confidence intervals and lack of statistical significance of identified predictors from our univariate analyses.

The overall prevalence of SAB in this symptomatic primary care population was 57% (118/208) (Figure 2); however, it is necessary to establish the clinical relevance of bursitis observed with ultrasound to the patients' symptoms, particularly if targeted interventions such as corticosteroid injections are being considered. Our findings suggest that subacromial bursa local anaesthetic injection reduces shoulder pain regardless of the presence, or lack, of pathology observed with ultrasound. These findings are comparable to Bouju et al. (2014) who found bursal abnormalities observed with ultrasound did not predict efficacy of subacromial injection of local anaesthetic only. However, this contrasts with the findings of Lee et al. (2017) who reported significantly greater pain reduction following corticosteroid injection in those with bursitis. Methodological differences may explain the contrasting results. In our study, pain reduction was measured within 15 min post-injection (anaesthetic only), whereas in the study by Lee et al. (2017) pain reduction was measured eight weeks post-injection, at which point, response to the injected corticosteroid may have been systemic. The subacromial bursa is well vascularised and in anatomical proximity to the rotator cuff tendons, and the coracohumeral and superior glenohumeral ligaments (Põldoja et al., 2017). It is likely that over the eight weeks, the corticosteroid may have infiltrated surrounding anatomical structures (e.g., the rotator cuff tendons). The immune response and anti-inflammatory effects of the steroid may have decreased nociception related to these structures, therefore reducing confidence in the assumption that the subacromial bursa was the nociceptive generator. Participant symptoms during this time course may also have improved due to natural history.

We also identified significant pain reduction in people without any shoulder pathology detected with ultrasound. Although we have not attempted to investigate the reported pain reduction in this group, it is possible that there was pathology present but that this was undetected by ultrasound (Levine et al., 2012; Pavic et al., 2013). An alternative explanation could be a placebo effect in response to the subacromial bursal injection (Simmonds, 2000) or that low pre-injection pain levels may have led to inaccurate post-injection pain reduction due to diurnal variation (Bogduk, 2013).

Despite our multivariate regression analyses not meeting statistical significance, the variables identified in our univariate regression analyses may be associated with alternative pathologies or normal adaptive variation, which support findings from previous studies. Loss of passive external rotation is a finding frequently associated with glenohumeral joint pathology such as osteoarthritis or frozen shoulder (Cadogan & Mohammed, 2016), which are typically responsive to injection of the glenohumeral joint (Burbank et al., 2008; Cadogan & Mohammed, 2016; Le et al., 2017). Reproduction of shoulder pain on cervical testing (active range of motion, overpressure if pain free and Spurling's test) indicates somatic referred pain of cervical spine origin or radicular pain, which can refer into the regions commonly described by those with shoulder pain such as the lateral arm (Bokshan et al., 2016; Walker et al., 2018). Pain of cervical origin is unlikely to respond to subacromial bursal anaesthetic injection. Our findings suggest that, if a patient's shoulder pain is reproduced with cervical spine examination or if they have a significant (> 30°) loss of passive shoulder external rotation in neutral, they may not to respond to targeted bursal injections regardless of the appearance of bursal pathology observed with ultrasound.

Bursal thickening can be an adaptive response to occupational or recreational load or a normal anatomical variation. Connor et al. (2003) found bursal fluid in 47.5% of asymptomatic overhead athletes on magnetic resonance imaging. As such, a NAR could be anticipated in those with bursal thickening who report high occupational or sport/recreational demands. Low sport/recreation demands was an unexpected predictor of NAR; however, Girish et al. (2011) report bursal thickening can be a normal anatomical variation. Alternatively, pain may be related to pathology undetected by ultrasound such as intra-articular pathology, which would not be expected to respond to subacromial bursa injection.

Night pain is frequently described by those with shoulder pathology including rotator cuff tears and other subacromial pathologies (Gumina et al., 2016; Mulligan et al., 2015). Further, pro-inflammatory cells and pain mediators have been identified in the subacromial bursa of patients with shoulder pain and rotator cuff disease (Feng et al., 2019). Local anaesthetics act by blocking sodium channels and preventing nerve conduction (Catterall & Mackie, 2011). Injection of local anaesthetic into the subacromial bursa prevents nociception in those with symptomatic subacromial pathology. Therefore, it could be expected that those with night pain would be more likely to experience a positive anaesthetic response and those without night pain may be more likely to experience a NAR. In our study, absence of night pain was detected in univariate analysis as a possible predictor of a NAR. This may suggest that patients without night pain derive less benefits from anti-inflammatory therapies such as corticosteroid injections targeting the subacromial bursa, despite bursal pathology observed with ultrasound. However, it should be reiterated that the variables discussed above did not reach statistical significance in regression analysis. It is advised that these variables are not utilised in isolation for decision making regarding the use of subacromial injection.

In our study, we found four of the five identified predictors had specificity and positive predictive values that suggest they have some clinical utility for identifying patients who are unlikely to respond to a bursal injection. Predictors that resulted in the greatest change from pre- to post-test probability were loss of passive external rotation more than 30° (LR+ = 3.3) and shoulder pain reproduced on cervical spine testing (LR+ = 3.1) (Table 4). When a cluster of any three predictors was present, post-test probability increased from 69% to 93% (Table 5). These results should, however, be interpreted with caution due to wide confidence intervals and predictors not reaching significance levels in our multivariate regression analyses. The poor sensitivity, negative predictive value and negative likelihood ratios suggest that the absence of the predictors may not assist in ruling out a NAR.

Our study adds support to the evidence that the subacromial bursa may not be a nociceptive generator in patients despite structural changes of the bursa being observed with ultrasound. Reduction of reported pain levels following subacromial bursal injection was not statistically different between those with or without bursal pathology observed with ultrasound. These findings may assist clinicians in correlating ultrasound reports with clinical findings and patient education.

To our knowledge, predictors of a negative response following an anaesthetic injection into the subacromial bursa have not been investigated previously. With emerging research, physiotherapists are gaining a greater understanding of the prevalence of imaged pathology and its relevance to symptoms. Using evidence-based practice to identify those unlikely to respond to a local anaesthetic bursal injection may facilitate improved treatment planning and patient education in line with best-practice guidelines (Lin et al., 2019). Often patients' understanding of persistent pain is tissue-based. The use of education and treatments that reduce anxiety and fear and minimise unnecessary investigations and treatments could improve patients' pain experience and outcome (Caneiro et al., 2019; Lin et al., 2019).

The strengths of this cross-sectional study include evaluating a large primary care population with shoulder pain in New Zealand. This allows the study findings to be translated into day-to-day practice. However, the following limitations need to be acknowledged. First, it is unknown how long the local anaesthetic was contained within the subacromial bursa. As it was not possible to track the injectate with ultrasound we were unable to be certain the subacromial bursa was the only structure targeted by the Xylocaine™, which may confound results. To mitigate this, the index tests were repeated within 15 min of injection administration, thus limiting the effects of ongoing infiltration of the local anaesthetic. Second, the numbers of patients in whom predictors were present were low for some variables. It is possible that other variables may have reached our cut point ($p \leq 0.25$) had there been greater numbers. The wide confidence intervals of adjusted *OR*s and diagnostic accuracy calculations also suggest a larger sample size was needed. Third, the cut point used for NAR (< 80% reduction in VAS scores) was based on accepted anaesthetic response criteria to anaesthetic blocks (Bogduk, 2013) and sample size. However, 80% could be considered a high cut point for a NAR, and a reduction of less than 50% may be considered both appropriate and clinically relevant, although this is likely to have resulted in a smaller sample size with analytical implications.

CONCLUSION

Our study findings suggest that not all bursal pathology identified by ultrasound is symptomatic and that the administration of injection therapy based upon ultrasound findings may not be beneficial for some people with such findings. The high specificity and moderate LR+ associated with the presence of any three of the five predictors (high occupational shoulder demands; low or high sport/recreational shoulder demands; no current history of night pain; loss of passive external rotation more than 30°; and shoulder pain reproduced on cervical spine testing) provides support for an assumption that a patient with such a finding would be more likely not to respond to targeted injection therapies. Ultrasound results should be considered alongside clinical findings to better inform decisions regarding most appropriate treatment. This may lead to a reduction in the use of unnecessary injections in patients with shoulder pain.

KEY POINTS

1. Subacromial bursitis on ultrasound is not always symptomatic.
2. Of the five identified predictors, loss of passive external rotation range of motion of more than 30° in neutral, reproduction of shoulder pain on cervical testing; or a cluster of any three predictors resulted in the greatest post-test probability values. The presence of these predictors may help identify patients less likely to respond to injection therapies targeting the subacromial bursa. Although these did not reach statistical significance level they are of clinical relevance.
3. The absence of predictors does not imply symptomatic subacromial bursitis as indicated by the poor sensitivity and negative likelihood ratios of the identified predictors.
4. Findings should be interpreted with caution due to methodological limitations, e.g., lack of prospective validation in an independent sample, relatively broad criteria for negative anaesthetic response and low numbers of participants in later analyses.

DISCLOSURES

No funding was obtained for the completion of this retrospective cross-sectional study. There are no conflicts of interest that may be perceived to interfere with or bias this study.

PERMISSIONS

Permission was granted to complete this retrospective cross-sectional study by the University of Otago Human Ethics Committee (reference number HD19/041). All patients involved in the study provided written informed consent for participation.

ACKNOWLEDGEMENTS

We would like to thank the participants for their time and all the clinicians involved in data collection for the primary study.

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Appendix A

ANAESTHETIC RESPONSE

Group	Total	PAR	NAR
SAB+	91	34	57
SAB-	24	2	22
Other not SAB	30	10	20
No pathology	23	5	18
Total	168	51	117

Note. NAR = negative anaesthetic response; PAR = positive anaesthetic response; SAB = subacromial bursitis; SAB+ = subacromial bursitis including other pathology; SAB- = subacromial bursitis excluding other pathology.

Appendix B

A PRIORI VARIABLES INCLUDED IN LOGISTIC REGRESSION ANALYSES

Variable type	Variable
Demographic	Gender
	Age
	Co-existing health condition
	BMI
Outcome measure	SF-8 mental component
	SF-8 physical component
	SPADI
	FABQ
History	Description of current episode
	Mechanism of onset
	Shoulder 100% prior to onset
	Occupational shoulder demand
	Sport/recreation shoulder demand
	Main pain description
	Pain nature
	Pain medication taken within last 24 hr
	No current history of night pain
Physical examination	Positive Hawkins Kennedy
	Positive empty can
	Positive AROM abduction painful arc
	PROM ER loss of > 30°
	Shoulder pain reproduced on any cervical spine test
	Resisted abduction painful and weak
	Resisted abduction painful and strong
	Resisted ER painful and weak
	Resisted ER painful and strong
	Resisted IR painful and weak
	Resisted IR painful and strong
Radiographic	Pathology on x-ray

Note. AROM = active range of motion; BMI = body mass index; ER = external rotation; FABQ = Fear Avoidance and Beliefs Questionnaire; IR = internal rotation; PROM ER = passive range of motion external rotation; SF-8 = Short Form-8 health survey; SPADI = Shoulder Pain and Disability Index.

Appendix C

UNIVARIATE LOGISTIC REGRESSION OF *A PRIORI* VARIABLES: PREDICTORS OF A NEGATIVE ANAESTHETIC RESPONSE TO SUBACROMIAL BURSA LOCAL ANAESTHETIC INJECTION

Variable type	Variable name	*OR*	95% CI		*p*
			LL	*UL*	
Demographic	Gender (1= male, 0 = female)	1.0	0.5	2.4	0.86
	Age (continuous)	1.0	0.8	1.3	0.95
	Co-existing health factors (1 = yes, 0 = no)	0.8	0.3	2.0	0.64
	BMI high (1 = yes, 0 = no)	0.8	0.4	2.1	0.84
	SF-8 mental component (continuous)	0.1	1.0	1.0	0.89
	SF-8 physical component (continuous)	1.0	1.0	1.1	0.72
	SPADI total (continuous)	1.0	1.0	1.0	0.70
	FABQ total (continuous)	1.0	1.0	1.0	0.48
History	Description current episode (1 = new, 0 = recurrent)	1.2	0.4	3.3	0.74
	Mechanism of onset				
	1 = trauma	1.2	0.3	4. 8	0.84
	2 = strain	0.5	0.1	1.9	0.28
	3 = repetitive/overuse	0.5	0.1	2.3	0.36
	Shoulder previously 100% (1 = yes, 0 = no)	0. 9	0.3	2.5	0.83
	Occupational shoulder demands				
	1 = low	0. 9	0.4	2.1	0.79
	2 = moderate	0.6	0.3	1.5	0.31
	3 = high	1.9	0.7	5.0	0.20*
	Sport/recreational shoulder demands				
	1 = low	0.6	0.2	2.1	0.45
	2 = moderate**	-0.6	0.2	1.3	0.17*
	3 = high	1.3	0.6	2.9	0.59
	Sport/recreational shoulder demands NOT moderate (e.g., high or low) (1 = yes, 0 = no)	1.8	0.8	4.3	0.17*
	Main pain description				
	1 = sharp	1.4	0.7	3.2	0.37
	2 = aching	0.8	0.3	1.8	0.53
	3 = sharp and aching	0.9	0.3	2.2	0.75
	Pain nature (1 = constant, 0 = intermittent)	0.7	0.3	1.6	0.42
	Analgesics taken in last 24 hr (1 = yes, 0 = no)	1.9	0.6	5.5	0.26
	No current history of night pain (1 = yes, 0 = no)	2.1	0.9	4.9	0.10*
Clinical exam	Hawkins Kennedy (1 = yes, 0 = no)	1.4	0.6	3.3	0.39
	Empty can (1 = yes, 0 = no)	1.0	0.4	2.7	0.97
	AROM abduction painful arc (1 = yes, 0 = no)	1.2	0.5	2.9	0.62
	PROM external rotation loss > 30° (1 = yes, 0 = no)	3.6	0.4	30.0	0.25*
	Shoulder pain reproduced on any cervical spine test (1 = yes, 0 = no)	3.6	0.8	16.7	0.11*
	Resisted abduction, painful weak (1 = yes, 0 = no)	1.0	0.4	2.5	0.97
	Resisted abduction, painful strong (1 = yes, 0 = no)	1.4	0.1	3.1	0.44
	Resisted external rotation painful weak (1 = yes, 0 = no)	1.5	0.4	4.9	0.53
	Resisted external rotation painful strong (1 = yes, 0 = no)	1.4	0.7	2.6	0.39
	Resisted internal rotation painful weak (1 = yes, 0 = no)	0.8	0.3	2.1	0.61
	Resisted internal rotation painful strong (1 = yes, 0 = no)	0.9	0.4	2.0	0.74
Radiology	X-ray – any pathology (1 = yes, 0 = no)	0.7	0.3	1.5	0.35

Note. AROM = active range of motion; BMI = body mass index; FABQ = Fear Avoidance and Beliefs Questionnaire; *LL* = lower limit; PROM = passive range of motion; SF-8 = Short Form-8 health survey; SPADI = Shoulder Pain and Disability Index; *UL* = upper limit.

*$p \leq 0.25$. **Due to negative *OR*, NOT moderate sport/recreational shoulder demands was utilised and renamed high or low for clarity.

Facilitators and Barriers to Physical Activity for People of Pacific Heritage

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ABSTRACT

This research explored the facilitators and barriers to physical activity engagement for people of Pacific Island heritage. From an experiential constructionist position, we inductively applied thematic analysis to data collected via individual fully transcribed semi-interviews. Participants were five academics or tutors of Pacific Island descent interested in physical activity for Pacific peoples. The themes developed were: *Centrality of community*, *Physical activity is something you do* and *It depends on the 'environment'*. *Centrality of community* was a prominent theme that spoke to the high value placed on collectivism and communitarianism by Pacific communities, which may limit individual choices of physical activity participation. Such collective principles may, however, facilitate physical activity through collective responsibility for all to engage in health endeavours. Optimal facilitators of physical activity may be (i) mobilising a community response to participation in physical activity by motivating through improved understanding of the health benefits of physical activity for the community as a whole, (ii) a response role-modelled and championed by community leaders (such as church leaders) and (iii) choosing activity programmes that are group- and community-based, fun and social occasions. Approaches that target the individual, both in health benefits and individually based activities, may be less successful.

Enoka, P., Hale, L., & Higgs, C. (2022). Facilitators and barriers to physical activity for people of Pacific heritage. *New Zealand Journal of Physiotherapy, 50*(1), 33–41. https://doi.org/10.15619/NZJP/50.1.04

Key Words: Pacific, Physical Activity, Supported Self-Management, Qualitative

INTRODUCTION

Engaging in regular physical activity is a key message to benefit health and one that physiotherapists are well placed to support and facilitate (Lowe et al., 2016; World Physiotherapy, 2019). In doing so, physiotherapists need to be cognisant of the communities they work with to ensure their support and encouragement is appropriate and relevant. This study explored how Pacific peoples may be appropriately encouraged to be more physically active.

Pacific peoples make up 8% of New Zealand's population. This population group is diverse, comprising more than 40 Pacific ethnic groups in New Zealand, the largest populations being Samoan (49%), Cook Island Māori (21%), Tongan (20%), Niuean (8%), Fijian (5%), Tokelauan (2%), Tuvaluan (1%) and Kiribati (0.7%) (Health and Disability System Review, 2020; Pasefika Proud, 2016). While each ethnic group has its own unique cultures and traditions, common to all is the high value placed on family, collectivism and communitarianism underpinned by spirituality, reciprocity and respect (Health and Disability System Review, 2020).

Although Pacific peoples are collectively the youngest population group in New Zealand (median age 22.3 years, 53% under the age of 25 years), 54% live in high socioeconomic deprivation and have inequitable health outcomes compared with non-Māori non-Pacific people in New Zealand (Health and Disability System Review, 2020; Ministry of Health and Ministry of Pacific Island Affairs, 2004). Further, Pacific adults have a higher prevalence of non-communicable conditions in comparison to non-Pacific adults in New Zealand (Health and Disability System Review, 2020; Ministry of Health, 2012; Ministry of Health and Ministry of Pacific Island Affairs, 2004; Walsh & Grey, 2019). For example, for Pacific versus non-Pacific, the adjusted age–sex ratio for ischaemic heart disease is 1.21, 95% CI [0.96, 1.51], and for high cholesterol (medicated) and diabetes it is 1.64 [1.46,1.84] and 3.08 [2.70-3.51], respectively (Ministry of Health, 2021). Furthermore, 47% of all deaths in Pacific peoples have an avoidable cause, such as ischaemic heart disease, chronic obstructive pulmonary disease, cerebrovascular disease and female breast cancer (Walsh & Grey, 2019). Key risk factors for such health loss include tobacco use, unhealthy diet, excess weight, high blood pressure, high fasting plasma glucose, alcohol use and physical inactivity (Ministry of Health, 2020).

Physical activity is a proven way to reduce the prevalence and support management of long-term conditions (Ministry of Health, 2020). The Ministry of Health recommends that adults aged over 18 years do at least two and a half hours of moderate-intensity physical activity spread over a week, such as 30 min on five days of the week. In New Zealand, Pacific peoples are less likely to be physically active than non-Pacific peoples (adjusted (age and gender) ratio 0.89, 95% CI [0.84-0.95]) (Ministry of Health, 2021).

Supported self-management is a common approach used by health care professionals to enable people living with long-term conditions to manage their health conditions, including to become more physically active (Dineen-Griffin et al., 2019), a message that all health professionals should be encouraging. The New Zealand Ministry of Health's overarching principles of self-management support include a patient-centred approach, empowering patients to take a lead role in their care planning, and supporting people to work in partnership with their health care professionals to set goals and action plans, as well as ensuring self-management programmes are culturally sensitive and appropriate for diverse ethnic groups (Ministry of Health, 2016). Given the high value Pacific peoples place on family, collectivism and communitarianism (Health and Disability System Review, 2020), it is questionable whether 'self'-management support is a desirable approach to health for these people.

To encourage increased physical activity engagement by Pacific peoples, the approach of 'self' (referring to managing health as an individual) does not match the ideology of 'community' and community-based initiatives in Pacific culture (Heard et al., 2017). The few studies that have explored how to engage Pacific peoples more with physical activity have found that targeted programmes can be effective if they incorporate a cultural component (Albright et al., 2017; Capstick et al., 2009; Hafoka & Carr, 2018; Heard et al., 2017; Look et al., 2012). Including such culture components within physical activities can change perceptions of what physical activity entails (Kolt et al., 2006; LaBreche et al., 2016). Facilitators to physical activity participation have been identified as those that are faith-based (Kolt et al., 2006; Look et al., 2012; Wan et al., 2018), and community- and/or group-based (Albright et al., 2017; Biddle et al., 2011; Kolt et al., 2006; Wan et al., 2018), have a supportive environment (Albright et al., 2017; Hafoka & Carr, 2018; Schluter et al., 2011; Siefken et al., 2014) and focus on social and fun aspects (Albright et al., 2017; Biddle et al., 2011; Siefken et al., 2014, 2015; Wan et al., 2018). Barriers to physical activity acknowledged in extant literature include lack of motivation or self-confidence (Heard et al., 2017; Kolt et al., 2006; Look et al., 2012; Siefken et al., 2014, 2015; Wan et al., 2018), no time or inconvenience (Heard et al., 2017; Schluter et al., 2011; Siefken et al., 2015; Wan et al., 2018), commitments of daily life (Kolt et al., 2006; Schluter et al., 2011; Siefken et al., 2014), concerns for safety (Albright et al., 2017; Hafoka & Carr, 2018; Heard et al., 2017) and lack of support from health care professionals (Kolt et al., 2006; Look et al., 2012).

Given the significance of encouraging Pacific peoples to be more physically active for their health, knowing better how this could be enabled in a culturally appropriate and relevant manner is important. The aim of this research was to gain a deeper understanding of what enables or prevents Pacific peoples' engagement in physical activity. To achieve this aim we gained the perspectives of academics and tutors of Pacific heritage about physical activity. While we could have approached this research question from numerous viewpoints, considering the important role community leaders play in health promotion for Pacific people (Kolt et al., 2006; Look et al., 2012), understanding the thoughts of academics and tutors of Pacific heritage about facilitators and barriers to physical activity for Pacific people is an important one. These people play a significant role in health promotion and physical activity support for Pacific Islanders in local and national Pacific communities in New Zealand.

METHODS

Design

From an experiential constructionist position, we inductively applied thematic analysis (Braun & Clarke, 2006, 2018, 2020) to data collected via individual semi-interviews. Our interviews were underpinned by Talanoa research methodology, an approach that emphasises the importance of Pacific customs and protocols (Seiuli, 2013; Sopoaga, 2020; Vaioleti, 2006). This methodology is based in the oral traditions of Pacific peoples, in which conversations, whether they are formal or informal, are grounded in the values of reciprocity and respect. The 'noa' refers to the context in which the conversation takes place, ensuring the conditions and space enable respect and reciprocity. The 'tala' are open and respectful conversations in which ideas can be shared, supported or challenged, and thereby a deeper understanding gained (Vaioleti, 2006). This openness necessitates a flexible interview framework so that dialogue can occur with differing levels of complexity to enable new knowledge and thinking to evolve (Vaioleti, 2006).

The primary researcher (PE) in this project was an undergraduate Pacific (Cook Island heritage who grew up in New Zealand) physiotherapy student with a background in exercise and sports science. She was supported by her New Zealand Pākehā physiotherapy supervisors (LH, CH), and by Va'a o Tautai, an academic department that supports Pacific students and leads in Pacific health teaching and research. The supervisors, one female and one male, both are experienced in qualitative research and with working with Pacific students and populations. As the research team were not, or not fully, of Pacific heritage, this study was only guided by, but did not fully utilise, Talanoa research methodology. Instead, the research team were supported by Va'a o Tautai academics in their application of this methodology as part of developing Pacific research capacity and capability in New Zealand (University of Otago, 2011).

Thematic analysis is contingent both on the collected data and the interpretation of it by the researchers (Braun & Clarke, 2020). Thus, researcher subjectivity is intrinsically woven into the process of the analysis. Prior to conducting the interviews and during the analysis process, the research team discussed their views of the importance of physical activity for health, their observations to date of working with Pacific peoples' in exercise related activities (e.g., facilitating exercise classes at the Otago Pacific Trust), their knowledge of the Pacific cultures and what they had read in the extant literature. This enabled the team to recognise and then reflect on the assumptions and beliefs they brought to the process.

Ethical approval was gained from the University of Otago Ethics Committee (reference SOP-EC-2020-07). All participants interviewed provided signed informed consent prior to participating.

Participant recruitment

Participants were five academics or tutors of Pacific descent aged ≥ 18 years expressing an interest in the topic of physical activity and self-management. Study invitations were sent via email to University of Otago staff, with specific focus on the Centre for Pacific Health and the Pacific Academic Staff Caucus. Those expressing interest in participating were asked to contact the researchers, who confirmed eligibility and addressed any questions volunteers had. On consenting, an interview time was arranged.

Data collection and analysis

Three semi-structured interviews were conducted by two researchers (PE, LH); the subsequent two interviews were conducted by one researcher (PE). Two interviews were conducted in person, while the other three were conducted via Zoom video conferencing. Participants were only interviewed once. While with the Talanoa approach, interviews should be conducted in person (Vaioleti, 2006), the location of three participants meant that the convenience of a Zoom interview was preferred. In-person interviews took place at a mutually agreeable location and time. Interviews were 45–75 min in duration, were audio-recorded and then fully transcribed word for word by one researcher (PE). The interview guide (see Table 1) was developed by the research team guided by extant literature. The guide questions were used with appropriate prompts to encourage free-flowing dialogue. In keeping with Talanoa methodology, the interview started with general conversations to develop connectedness and establish common ground, such as where the interviewer and participant were each from and about their Pacific heritage (Sopoaga, 2020). Given the interviewer was a student and the participants were academics or tutors, and all were of Pacific heritage, a supportive environment prevailed. On completion of the interview, the interviewer made field notes of important points and considerations made during the interview.

Data were analysed using thematic analysis (Braun & Clarke, 2006, 2018, 2020) and thus followed this approach's 5-step process, namely familiarisation; coding; generating initial themes; reviewing and developing themes; and refining, defining and naming themes. As the three researchers were not completely familiar with Pacific culture, even PE who had Pacific heritage, we applied a semantic approach to the coding, acknowledging we would miss deeper nuances. One researcher (PE) familiarised herself with the interview data through the transcription process followed by multiple readings of the transcriptions. As each interview was conducted and transcribed, PE met frequently with another research team member (LH) to discuss what the interviewees were saying and what it might mean. As new transcripts were discussed, patterns in the data were identified. As the research team's understandings of Pacific culture developed, not only from the interviews, but from their meetings with staff from Va'a o Tautai, visits they had had to regional Pacific Islands, attendance at a local Pacific festival (the Moana Nui Festival) alongside PE's developing knowledge and awareness of her Pacific heritage and discussions with her family, the implications of the data began to take shape. Applying these growing understandings across the whole data set enabled patterns in the

Table 1

Interview Guide

Introduce where I (the interviewer) grew up and my Pacific heritage. Why I (the interviewer) am doing this research. Encourage participant to share their story.
The concept of physical activity we are using is any bodily movement done for leisure (recreation, play), work, house and garden chores, or active transportation.
What are your thoughts on Pacific people's participation in physical activity in general? Do you think physical activity is important to Pacific people? What do you think, if any, would be differences in physical activity levels between Pacific Island nations? What do you think are the differences in Pacific people's engagement in physical activity in the Islands as compared to in New Zealand? What do you think discourages Pacific people from being physically active? What do you think are the main factors that engage Pacific people in physical activity? As a Pacific person yourself, what enables or prevents you from being physically active? What type/mode of physical activity do you think Pacific people are most interested in? Can you think of how culture may facilitate or potentially hinder Pacific people's engagement in physical activity? How do you think gender influences Pacific people's involvement in physical activity? There does not seem to be much literature I have noticed on what engages men specifically in physical activity. Why do you think this is? What do you think motivates Pacific Islanders to be physically active? Lack of motivation seems to be a barrier for Pacific people in the literature. How do you think this can be overcome?

text to be identified that could be coded and grouped into initial themes. Discussions then with the third member of the research team (CH) who, although not of Pacific heritage, had worked with extensively with Pacific peoples, allowed for refinement and finalisation of the themes. Finally, PE presented our findings at a Pacific research show-case day, which both the local Pacific community and some of our participants attended. Our findings were well received, providing a level of verification.

RESULTS

Five academics and tutors of Pacific Island heritage (2 male, 3 female, age range 30–45 years) with an interest in physical activity and self-management for Pacific peoples, were interviewed. Three participants were based in Dunedin, one in Gisborne and one in Samoa. To ensure anonymity of our participants in a small sample within a small population, we have chosen not to provide further demographic details.

Three themes were developed through the analysis and are summarised in Table 2 and discussed below. The predominant theme was *Centrality of community*, and the other two themes were *Physical activity is something you do* and *It depends on the 'environment'*. *Centrality of community* depicts the crucial role the community plays in enabling physical activity, in that its centrality can discourage people from being individually active, or conversely employed to enable physical activity engagement, the process facilitated by how physical activity is perceived. If *Physical activity is something you do,* in other words is viewed as

Table 2

Summary of Themes as Barriers or Facilitators to Physical Activity for Pacific Peoples

Barrier or Facilitator	Centrality of community	Physical activity is something you do	It depends on the 'environment'		
			Physical	Social	Personal
Barrier	Having commitments that contribute to the community Collectivist mindset may cause individuals to prioritise their own health less The use of technology such as pedometers is individualistic and not community-oriented so may not be appropriate in Pacific settings	Definition or perception of what physical activity is Physical activity is just for losing weight The media can change people's perception of physical activity Physical activity is just for fit people A barrier for males is the idea that group exercise is just for females Physical activity is not a priority	Unsafe physical environment No setting for physical activity. No organised sport, for example Westernisation, where the environment has more convenience with food and transport and technology, for example	Lack of role models Lack of support from family and friends Being uncomfortable doing physical activity with the opposite gender (culture)	Lack of time Socioeconomic status /money/financial stress Limited access to resources Low confidence/fear of injury/shyness/low self-efficacy Lack of expertise Lack of motivation Weight/self-image
Facilitator	Performing physical tasks that are going to help the collective Group activities that everyone in the community can be involved in, including all-inclusive exercise classes and team sports The idea of being healthy to contribute to the community Facebook groups can provide an online community for organisational purposes	Doing the type of physical activity that is enjoyable and valued Realising physical activity can be fun and social More education and awareness around what physical activity is and the benefits to not just the individual, but the collective as well	Exploring culture and history may help to facilitate physical activity Areas people are comfortable with Physical setting like a class or tournament	Role models/elders/ church leaders who promote physical activity and health Group physical activity, including classes Workplaces that are supportive and prioritise health Families who value physical activity	Socioeconomic status People make the most of what they have with the resources they have Weight/self-image can be a motivating factor to becoming healthier

an add-on to your daily life, as articulated in the second theme, then intentional engagement may not be as successful. If, however, physical activity is perceived as something embedded in everyday life, particularly integral to everyday community life, then engagement in physical activity might increase incidentally. The third theme, *It depends on the 'environment'*, shows how contingent physical activity participation is on whether or not the community influence and perceptions of physical activity occur within a supportive environment. These themes are discussed in more detail below illustrated with participant quotes.

Theme 1: Centrality of community

"I have community obligations so I can't do as much physical activity as I want, but I want to do physical activity so that I can contribute to my community" (Participant 3). The importance of community was central to all interviews. As the quote above illustrates, the influence of community is complex because it can both enable or limit engagement in physical activity. As our participants articulated, while community is an important part of culture for many Pacific people, physical activity engagement does not necessarily hold the same value.

Centrality of community as a barrier

Barriers emerging from the *Centrality of community* theme were having community commitments and having a collectivist mindset, where the individual does not take priority. Participants emphasised that community is central to many Pacific cultures and looking after the family often takes precedence to looking after oneself. Hence, 'self' management of health through physical activity is not culturally important to many Pacific people, as explained by Participant 2:

> People prioritising things other than their own personal physical wellbeing and that's sort of last on the list. Once they have hit all of these other things that need to be done, then I will do that. And I think it's very easy to do when you have a collectivist mindset.

Participant 2 elaborates further on how Pacific communities can be critical of physical activity done for self-good:

> An analogy in a Western sense is those guys that spend all of their time in the gym and they are really preening and you give them the side eye and they are sort of like aw look at you, that must take you all day to look like that. And it's kind of that kind of energy of you're really into yourself aren't you, but taken to a much lesser degree of look at you going and doing that thing, when actually you haven't done this for your aunty and you know, you're not doing this for your church and it's a little bit of that side eye energy of if you are doing particular things that are seen to be selfish.

Approaches to encourage individual health behaviour change are most likely not feasible or acceptable in Pacific communities, as Participant 3 explains:

> It's very individualistic, so yeah that's something that we talked about with e-cessation with smoking and what not. It comes to one person's phone. But um if you are going to do something, I think everyone around you needs to be involved with it as well. … it is trying to figure out how to create community from what you're doing, where you're part of something. Whereas if you're just like it's my phone, I need to go walk, like you detach from everything that you're around just to do what you need to do. Which is opposite to what is ideal in Pacific settings.

Centrality of community as a facilitator

Community-oriented physical activity was considered the strongest facilitator for physical activity engagement with all participants mentioning either group physical activity within the community or physically working the land to contribute to the community.

Community can act as a support network in managing health, which also links to the supportive environments theme, hence the predominance of this theme, described by Participant 2 below.

> I just think our families are incredibly busy serving their communities and their families and the expectations are very high around what they will be doing for each other which I think is a strength and a weakness. So, the weakness is that individuals might not be looking after their own health. The strength is that if you can activate that collective to everyone watching each other's health.

Another idea suggested by participants was one of encouraging people to be physically active to help them live healthier lives, so they can better provide for their family and community. In a similar vein, enabling people to be incidentally physically active in ways that will help contribute to their collective, in terms of the type of 'work they do', was another recommendation, elucidated by Participant 1:

> I think there is a social structure in the Islands that means that people are physically active in the Islands in activities that link directly back to the community. As in when you're gardening you are gardening for the sake of contributing to the community, to feeding the family. … They're not individual tasks, even though they are performed individually, they link to a sense of community.

Theme 2: Physical activity is something you do

Participants talked of how Pacific people form their perspectives and attitudes towards physical activity from what they have been exposed to in the past. Participants explained that physical activity is often not considered a priority in Pacific culture and that there are other things, like family and community, that tend to come first. Thereby there was agreement that Pacific peoples' thoughts and beliefs around physical activity tend to either put them off or engage them further.

Physical activity is something you do as a barrier

In many ways physical activity was perceived as additional, as opposed to something that is part of daily life. As Participant 5 explains:

> I think the perception of physical activity is something that you do, it's not something that's integrated very well into life. And I think Samoans see physical activity as something extra and as something optional to their day to day life.

Participants said that the way physical activity is defined, and the value placed on physical activity are barriers to engagement. They spoke of how people tend to think group exercise is for females, which can end up being a barrier for males to participate. Further, the idea that physical activity is only for fit people and people who want to lose weight is also a barrier. All interviewees mentioned that there is a spectrum or a dichotomy where people were either fit or sedentary. The way physical activity is perceived in the media shapes common views around physical activity that are not always helpful. The way physical activity is perceived by many is what acts as a barrier. If physical activity is considered as an extra to daily chores, not enjoyable or perceived as too hard, it may not be sustainable. As explained by Participant 3: "I think physical activity and exercise are synonymous with being strenuous at this stage … They just need to be headband on, put the tights on and go for it" (Participant 3).

Participants spoke of how Pacific people used to be physically active in the sense of collecting food and living off the land. Now there is so much convenience, it seems that being physically active in this way has become less integrated into the lives of many Pacific people, something additional:

> But now we are all so motorised now and we all have phones and we all hang around the blue Sky Tower which is like the Wi-Fi tower … people don't want to be doing that sort of work because we know what's available now and we have so much convenience everywhere. So, like our starchy vegetables, we now have rice. (Participant 3)

Participants explained that a common view of why people become physically active is something that you do to lose weight. There seems to be less emphasis put on people viewing physical activity to change health values such as blood glucose and cholesterol levels, for example. If physical activity is associated with losing weight and the individual does not place a value on losing weight, this can act as a barrier to change: "A lot of times we always think that when we exercise, we want to lose weight you know it's all about losing weight but that's not the point" (Participant 4).

Physical activity is something you do as a facilitator

Pacific peoples' engagement in physical activity can be facilitated by their perception of how they enjoy the activity they are doing and realising it can be something they find fun and social. Participants 1 and 4 explain how social sport/games and dance can facilitate physical activity.

> Yeah. And it's often quite diffusing after busy days in the plantation, or you know, it's a great way to expel some energy, have fun with each other, lots of mockery and laughter and that becomes a bit of a hub of the village. (Participant 1)

> I guess for our way of dancing its very natural to us, like anyone can do it if you're from the Cook Islands because we all grew up doing it so we see that as something physical that we are doing. (Participant 4)

Theme 3: It depends on the 'environment'

We learnt that the 'environment', in its wider sense, be it physical, social or personal environments, can facilitate or hinder engagement in physical activity for Pacific people. It was explained that while the physical environment acted as a barrier in terms of lack of safe places to be active, the lack of a supportive social environment appeared to be a more important barrier. Lack of role models and lack of support from families and friends seemed to play, as explicated by our participants, a part in Pacific people being unable to maintain physical activity routines. Further to this, the personal 'environment' that individuals occupied also influenced physical activity engagement. These findings are elaborated on below.

Barriers and facilitators of the physical environment

Examples provided of barriers in the physical environment included an unsafe setting, or lack of a setting, for physical activity. One participant explained how 'Westernisation' of the environment in the Islands has resulted in more 'convenience' living and ultimately less 'need' to be active. Conversely, facilitators for the physical environment included having a setting that was both comfortable and culturally appropriate where physical activity can take place. Participant 1 describes:

> So, there is something about the environment that either facilitates physical activity or people don't feel safe to or whatever it is or it's not set up to. So, I think linked in with the social economics, are people probably living in environments that aren't that safe.

When there is a physical setting conducive to physical activity, and Pacific peoples feel comfortable, there is more likely to be engagement as a result of this. "Really areas that people are comfortable with. So, if they are going there anyway, and you're just like AND we have a class then they will just do it as well" (Participant 3).

Facilitators and barriers of the social environment

The social environment is just as important as the physical environment when it comes to enabling physical activity participation. Cited examples of facilitators in the social environment included having role models or authority figures promoting physical activity and health, group activity, and supportive families and workplaces. The barriers were the opposite where lack of role modelling and lack of support from family and friends prevented physical activity.

> There can be a lot of judgment when it comes to making lifestyle choices, so sometimes you get like there's a possibility of you becoming mocked when you start to care about your health which is very very interesting to me. Like in my head if you're taking steps to improve your health that's a good thing, but I see it time and time again when people start to eat right and will start to exercise and they are teased about it and it discourages them from engaging, because who likes being mocked for doing something that they like? (Participant 5)

Having cultural components incorporated into physical activity was seen as a way to facilitate engagement through the social environment, whether that be the inclusion of family, traditions like dance or preparation of food, or potentially single gender group sessions. Single gender physical activity sessions may reduce the barrier of discomfort in being active with the opposite gender, which seemed to be a cultural barrier, as Participant 5 explains:

> I think that ah females are a lot more likely to exercise with females and males are a lot more likely to exercise with

> males. There is a bit of a separation between groups, and I think that might be because of culture, where it feels kind of weird to be in that vulnerable space with your body, with members of the opposite gender.

Authority figures or role models such as church ministers, elders and employers play an important role in the social environment to promote health and were seen to have huge potential in improving engagement in physical activity for Pacific peoples. Participant 1 elucidates:

> One of my criticisms of particularly church leaders, is that they don't necessarily model what a healthy lifestyle can look like. And there are traditional proverbs, there is a proverb that says 'the chief doesn't overeat' and that's an ancient proverb that kind of outlined that back then chiefs were really quite disciplined about their, I guess, the harmony of their body and their mind and their spirit. Which was probably, something that we have certainly lost. I think we only have to look at church leaders to see that they are often largely overweight and got a number of health conditions, so I think they have a role to play in terms of modelling um the fact that physical health isn't disconnected from spiritual health and wellbeing and mental health and wellbeing.

Facilitators and barriers of the personal environmental factors

Personal environmental factors stated by participants as barriers to physical activity engagement included lack of time, low confidence, lack of expertise, lack of motivation, weight/self-image and low socioeconomic status. Conversely, socioeconomic status and motivation to be healthier were facilitators for physical activity.

Lack of time was considered by participants to be a barrier for Pacific people. This often related to the commitments people had to the community, but also regarding improving their financial status: "Ah I don't have time for exercise because sometimes it's family commitments, I don't really know what the English word is for fa'alavelave but it's just like an important event for families you know" (Participant 5).

Low confidence, low self-efficacy, low motivation and lack of expertise can all be barriers to physical activity for people of Pacific heritage, illustrated below by Participant 4:

> I choose to do it whereas for my husband; he is Samoan, he was physically active when he was younger, a lot younger but now he's a lot older now and he kind of stopped, like he lost interest, um he just don't have that motivation anymore, maybe because of the weight that he is carrying.

Socioeconomic status was considered both a barrier and a facilitator. Regardless of socioeconomic status being low for many, participants said that Pacific people will make the most of opportunities and work with the resources they have if they have the will to be active. This is explicated by Participant 1:

> I think it's hard to look past the social and economic determinants of health, because they impact the degree to which the accessibility of opportunities for physical participation or physical activity … They will be playing rugby with a coke bottle, a plastic coke bottle, or a coconut husk. So, I think there is that desire to want to be active and competitive and um socialise, in whatever way they can and with whatever resources they can.

DISCUSSION

This study explored what academics and tutors of Pacific heritage perceive may facilitate Pacific people to be physically active. Knowing the benefits of physical activity as a holistic approach to managing non-communicable diseases is beneficial to understand how we can improve engagement of Pacific people.

Pacific people's sense of community is central to most Pacific cultures and this extends to values placed on health and, in respect to our study, physical activity engagement. As explained by our participants, while this sense of community may limit individual choices of physical activity participation, engagement may be enhanced by appealing to the collective responsibility for all to engage in health endeavours such as being active together for the good of the community. This finding is not new, having been highlighted previously in studies in which physical inactivity was related to prioritising community wellbeing over individual health and the necessity for a community-orientated approach (Hardin, 2015; Siefken et al., 2014). It is a finding, however, that may be more prominent in societies that value collectivism such as Pacific and Māori communities (Warbrick et al., 2016). Heard et al. (2017) listed the 10 universally common barriers to adults being physically inactive: lack of time, inconvenience, lack of infrastructure, low motivation, low confidence, lack of enjoyment, boredom, lack of self-management skills, fear of being injured and lack of support. While these factors were also found to be barriers in our study, community wellbeing as such does not feature in this list.

Clearly defining what physical activity is, and the benefits of physical activity, for not only the individual but the whole collective, is something that may help motivate Pacific people to be active. Kolt et al. (2006) identified motivation and education as a barrier for older Tongans to be physical active. Currently, 'physical activity' appears to be considered synonymous with being exhausting, and it is often the 'not knowing what to do to be active' that may act as a major barrier. Assisting Pacific people to understand the wide scope of what constitutes physical activity, for example, going for a walk with the family or vegetable gardening, can be more beneficial for health than they realise. Group exercise and community gatherings that involve dancing, team sports (such as volleyball) and having fun are other options that might appeal to Pacific people as forms of physical activity. Given the apparent misconceptions about what being physically active is, there is clearly scope to capitalise on these types of activities that incidentally increase physical activity participation as opposed to encouraging intentional physical activity (e.g., increase frequency and amount of step counts related to walking). Ensuring approaches to physical activity education and motivation are culturally appropriate has been long stressed and thus it is beholden on those working in this space to understand the populations they are working with (Belza et al., 2004; Conn et al., 2013).

Another complex barrier to physical activity engagement is insufficient support from family members, with the collective's perceptions of physical activity preventing improvements in physical activity behaviours, even if the individual wishes and intends to become more active. Including the whole family in group activities and involving role models, such as church and community leaders, in physical activity pursuits is necessary to help extend the message. The importance of the role of leaders in delivering health messages in Pacific communities, particularly that of church leaders or health experts of the same ethnic group as the targeted community, has been previously acknowledged (Kolt et al., 2006; Look et al., 2012; World Health Organization, 2017).

Findings from this research provide suggestions that physiotherapists, and anyone, working to help improve physical activity participation for Pacific people may want to consider. When providing or suggesting Pacific peoples with physical activity programmes, consider the influence of community and collectivism on the individual. Incorporating family, whānau and kōpu tangata throughout the process, as well as community leaders, to consider community-type activities that will benefit the community (not the individual per se) and are fun, traditionally and community based (such as dance) may be an appropriate approach.

Applying Yardley's (2000) quality evaluation to our research, we were sensitive to context by recognising our limited understanding of Pacific culture and requesting guidance from the University of Otago's Va'a o Tautai and focusing on the perceptions of academics and tutors of Pacific heritage as opposed to Pacific community members to whom we had not first developed relationships of trust and openness. Further to this, as part of our reflexivity, in discussion we acknowledged how our perceptions might influence the data collection and analysis. Limitations to the completeness of our data collection, analysis and interpretation included the semantic nature of our data analysis; the level of our cultural knowledge precluding deeper latent analysis; and that the data collected was not specific to the New Zealand context and looked at Pacific people as a collective. From the five participants interviewed, two were of Cook Island descent and three of Samoan descent. Pacific people, especially in New Zealand are diverse in their customs and cultures and it is difficult to characterise everyone as 'Pasifika' (Capstick et al., 2009). As a result, future research should aim for ethnic specific data to better determine barriers and facilitators for specific ethnic groups. Although the research team were guided by the philosophies of Talanoa research methodology, we were cognisant of our limitations and that only one member of the team was of Pacific heritage. Future research should be conducted by researchers of Pacific heritage and with more experience and authenticity in Talanoa research. Further to this, the research should extend to exploring the views of other Pacific leaders and community groups. Finally, we consider that our research is important, in that as physiotherapists we need to be cognisant of the communities we work with to ensure our support and encouragement is appropriate and relevant, and here we have elucidated some clinical guidance that may be of value for physiotherapists when working with Pacific communities.

CONCLUSION

This study explored the perceptions of Pacific academics and tutors with an interest in physical activity as to facilitators and barriers to physical activity engagement for Pacific people. *Centrality of community* was a prominent theme that spoke to the high value placed on collectivism and communitarianism by Pacific communities, which may limit individual choices of physical activity participation but facilitate physical activity through collective responsibility for all to engage in health endeavours. Mobilising a community response to participation in physical activity by motivating through improved understanding of the health benefits of physical activity for the community as a whole, role modelled and championed by community leaders (such as church leaders), and choosing activity programmes that are group- and community-based, fun and social occasions may be optimal facilitators. Approaches that target the individual, both in health benefits and individually based activities, may be less successful.

KEY POINTS

1. In Pacific communities, the high value placed on collectivism and communitarianism may limit individual choices of physical activity participation but facilitate physical activity through collective responsibility for all to engage in health endeavours such as being active together.
2. To facilitate people of Pacific heritage living in New Zealand into physical activity physiotherapists should consider culturally- and community-based group activity programmes rather than focus on programmes that enable the individual.
3. Working alongside community leaders, such as church leaders, may help further the importance of physical activity engagement for health benefits.

DISCLOSURES

Funding source: Paige Enoka was funded by New Zealand Health Research Council Pacific Health Research Summer Studentship. There are no conflicts of interest that may be perceived to interfere with or bias this study.

PERMISSIONS

Ethical approval was gained from the University of Otago Ethics Committee (SOP-EC-2020-07). All participants interviewed gave signed informed consent prior to participating.

No other permissions were required.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the five participants and Associate Professor Rose Richards of Va'a o Tautai, Division of Health Sciences, University of Otago for her guidance and support.

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Physical Activity in the Acute Hospital Following Elective Lower Limb Joint Arthroplasty

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ABSTRACT

The objective of this study was to quantify physical activity undertaken by patients in the acute setting following elective lower limb joint replacement and determine the relationship between physical activity and hospital outcomes (length of stay [LOS] and discharge destination). This prospective observational study included 74 adults with osteoarthritis who underwent lower limb arthroplasty (total hip replacement n = 38, total knee replacement n = 36). Participants were fitted with an accelerometer and inclinometer-based device (activPAL3™) post-operatively prior to first mobilisation for the duration of the acute hospital admission. Physical activity data collected were steps, sit-to-stand transitions and upright time (standing and stepping). The relationship between each physical activity variable and hospital outcomes was calculated using logistic regression (for discharge destination) and linear regression (for LOS). Potential confounding factors considered in multivariable models included age, sex, body mass index, Risk Assessment Prediction Tool, American Society of Anesthesiologists Score and surgical procedure. Analyses for the relationship with these outcomes used physical activity data from day two as these comprised the largest dataset for a single day. Participants' mean (SD) age was 67 (10) years and 53% were female. Participants performed a median (IQR) of 136 (50–294) steps, 17 (11–75) transitions and 52 (32–94) upright minutes per day. All physical activity variables were significantly negatively associated with LOS (steps p = 0.016, transition p = 0.025, upright time p = 0.024). There was a significant association between discharge to inpatient rehabilitation for steps (p = 0.010) and transitions (p = 0.005). Participants undergoing elective lower limb arthroplasty engaged in low levels of post-operative physical activity during hospitalisation. Lower levels of physical activity on post-operative day two were associated with discharge to inpatient rehabilitation and a longer total hospital LOS.

Kirk, A. G., Burge, A. T., Ekegren, C. L., Liew, S. M., & Kimmel, L. A. (2022). Physical activity in the acute hospital following elective lower limb joint arthroplasty. *New Zealand Journal of Physiotherapy, 49*(3), 42–49. https://doi.org/10.15619/NZJP/50.1.05

Key Words: Arthroplasty, Exercise, Inpatients, Length of Stay, Patient Discharge, Sedentary Lifestyle

INTRODUCTION

Osteoarthritis (OA) is the most common condition leading to total hip replacement (THR) and total knee replacement (TKR) in Australia and New Zealand (Australian Institute of Health and Welfare, 2020; Ministry of Health, 2019). Although these procedures are performed to restore joint function, relieve pain and improve quality of life, research has shown that patients undergoing elective lower limb arthroplasty do not meet recommended physical activity guidelines six months post-operatively (Harding et al., 2014). Previous research has also shown a reduction in total physical activity in the first few weeks following THR and TKR compared to pre-operative activity (Luna et al., 2019). Similarly, patients with higher variation in daily physical activity (i.e., peaks in highs and lows of daily activity patterns) in the acute setting have increased post-operative pain and longer acute hospital length of stay (LOS) following THR and TKR (Hayashi et al., 2018).

Studies using accelerometry have shown that patients hospitalised in acute medical or surgical wards are highly inactive (Baldwin et al., 2017). Low levels of physical activity during hospital admission have been associated with adverse outcomes including institutionalisation and death (Brown et al., 2004). Furthermore, in hospitalised older adults, increased walking in the acute hospital significantly reduced the risk of 30-day readmission (Fisher et al., 2016). Specifically, for each 100 step increase in daily step count, readmission rate was reduced by 10% (Fisher et al., 2016).

Historically, 'bed rest' was usual practice following orthopaedic surgery but recent evidence in people with hip fracture supports the need for early and frequent physical activity in the acute period to improve health outcomes and reduce hospital LOS (Kimmel et al., 2016). There is also growing evidence that fast-track THR and TKR pathways, including engagement in early mobilisation, can shorten LOS, reduce post-operative complications (e.g., venous thromboembolism [VTE]) and improve patient satisfaction (Glassou et al., 2014; Husted et al., 2010; Malviya et al., 2011; Martinez-Velilla et al., 2016; Schneider et al., 2009). Furthermore, previous research suggests patients with better pre-operative physical function may undertake higher levels of physical activity in the early post-operative setting and achieve higher physical function at six months following TKR (Takamura et al., 2021). However, there are no previous studies reviewing the association between physical activity levels in the acute setting and hospital outcomes following THR or TKR. This association is particularly important to investigate in people undergoing joint replacement, given the potential for extended hospital stays and costly rehabilitation admissions. Inpatient rehabilitation following TKR has significantly higher costs compared to community-based rehabilitation with no improvement in patient outcomes (Naylor et al., 2017), suggesting strategies to enable discharge home should be adopted. Therefore, the aims of this study were to:

1. Quantify physical activity undertaken by patients in the acute setting following elective lower limb joint replacement; and
2. Determine the relationship between physical activity and hospital outcomes (LOS and discharge destination).

METHODS

Participants and setting

This was a prospective observational study undertaken at the Alfred, a tertiary metropolitan hospital in Melbourne, Australia. All patients on the elective orthopaedic surgery list were screened for inclusion during two recruitment periods (April to August 2018, June to September 2019). A break in recruitment occurred due to investigator leave. Potential study participants were approached by one of the investigators pre-operatively on the day of surgery or day one post-operatively, prior to first mobilisation and provided with study information. All study participants provided written informed consent prior to participation.

Patients were eligible for inclusion if they had OA and were admitted for an elective primary THR or TKR. Patients were excluded from the study if they had rheumatoid arthritis or were admitted with a traumatic injury, were living in a nursing home, were allergic to adhesive tape, were unable to consent for themselves (e.g., dementia), were non-English speaking or had an intra-operative complication resulting in non-weight-bearing status. This study was approved by the Alfred Human Research Ethics Committee (registration approval number 76/18).

Procedures

All THRs were performed using a lateral or posterior approach. The most common prosthesis used for THR was the Exeter Hip System and for TKR was the Genesis II Total Knee System. Participants received post-operative care as per local clinical practice guidelines, which commenced day one post-operatively and aimed for early independence with transfers and mobility. Physiotherapy involved individualised lower limb exercises and gait retraining at least daily, seven days per week. For each physiotherapy visit, the treating clinician recorded details of the session including time of day, patient position (i.e., resting in bed or sitting in a chair), highest level of mobility (including level of assistance, gait aid and distance mobilised) and complications (e.g., cardiovascular instability, anaemia, patient fall).

Routinely-collected participant characteristics, extracted from the medical record included age, sex, body mass index (BMI) classification (normal 18.5 to 24.99 kg/m^2, overweight 25 to 29.99 kg/m^2, obese ≥ 30 kg/m^2) (World Health Organization, 2020) and American Society of Anesthesiologists (ASA) score, a five-category physical status classification system for overall pre-operative medical co-morbidities used to predict perioperative risks (Mayhew et al., 2019). Furthermore, operative details (including procedure, type of anaesthetic), use of femoral nerve block (in addition to anaesthetic type), post-operative complications (e.g., cardiovascular instability, intraoperative fracture and anaemia), total hospital LOS (including acute admission and inpatient rehabilitation) and discharge destination (home, inpatient rehabilitation) were recorded.

Physical activity measurement and processing

For the purpose of this study, the term 'physical activity' is used to describe total number of steps, sit-to-stand transitions and time upright (standing and stepping), measured using the activPAL3™, a triaxial accelerometer and inclinometer-based device (PAL Technologies Limited, Glasgow, UK). The activPAL3™ has been validated for collecting step counts across a wide range of walking speeds, including slow speeds and while using gait aids (Harrington et al., 2011; Ryan et al., 2006; Treacy et al., 2017). The activPAL3™ was applied once the patient reached the ward from theatre (day 0) and remained in place until the day of hospital discharge. The device was placed inside a disposable waterproof pocket and adhered to the non-operated thigh using the same tape used for the post-surgical wound dressing. This did not interfere with any daily activities or procedures, including showering or sleeping.

Activity data were downloaded using proprietary software (PAL Technologies software: research edition, version 7.2.38). For inclusion, participants needed to provide at least one full post-operative 'day' of data (24 hr period of data from 00:00 to 23:59). Physical activity occurring during the 'waking day' was reported. The 'waking day' was defined *a priori* as the 16 hr period from 06:00 to 22:00 to reflect the time period in which physical activity would usually be undertaken on an acute inpatient ward (Patterson et al., 2005). Physiotherapy intervention time was recorded to enable calculations of the proportion of physical activity undertaken during physiotherapy compared to physical activity undertaken at other times during the 'waking day'.

Data analyses

Data analyses were undertaken using commercial software (SPSS 26.0 software, SPSS Inc., Chicago, USA). Continuous participant and surgical characteristics were summarised using means and standard deviations (SD), or medians and interquartile ranges

(IQR), according to distribution. Categorical data were expressed as frequencies and percentages. Physical activity data for all participants were expressed as the median (IQR) according to post-operative day. The proportion of physical activity undertaken during physiotherapy sessions was expressed as a percentage of the total amount of physical activity undertaken during the waking day.

We investigated the association between physical activity variables (step count, transitions and upright time) and hospital outcomes (discharge destination and LOS) using logistic regression for discharge destination and linear regression for LOS. These analyses used the day two dataset as this comprised the largest dataset for all activity measures. Because LOS and day two physical activity data (steps, transitions and upright time) were skewed, these data were natural log-transformed prior to modelling. Potential confounding factors considered in multivariable models included age, sex, BMI, Risk Assessment Prediction Tool (RAPT), ASA and surgical procedure. Factors significantly associated with the physical activity variable and hospital outcome ($p < 0.2$), were included in multivariable models. While ASA score did not meet our criteria for inclusion in the multivariate models, previous research has shown ASA score to be a strong confounding factor to LOS and discharge destination (Kimmel et al., 2011); therefore, ASA score was included in the multivariate model. Adjusted log odds ratios and 95% confidence intervals (CI) were calculated for the relationship between log-transformed physical activity values and discharge destination. Given that the explanatory variables for the discharge destination models were log transformed, and both explanatory and outcome variables for LOS models were log transformed, outputs were back transformed into clinically relevant values using the methods outlined in Appendices A–C. In alignment with recommendations for sample size in relation to independent variables (IVs) in multiple regressions (20 + 5[IVs]) (Khamis & Kepler, 2010), our final sample exceeded the minimum number of respondents required in the model with the highest number of covariates (20 + (5 × 5) = 45).

RESULTS

Flow of participants through the study

A total of 80 patients were approached to participate in the study and only one patient declined. Therefore, 79 participants were included. Valid activPAL3™ data were available for 74 participants. Two participants removed the device prior to discharge from hospital and the device did not record data for a further three participants. No adverse events occurred.

Pre-operative and surgical characteristics of participants are presented in Table 1. The sample was balanced according to sex (females 53%, males 47%) and procedure (THR 51%, TKR 49%). The majority of participants were classified as obese (65%). Most participants were discharged home (n = 52, 70%) and their median (IQR) LOS was 5 (4–6) days, while the remaining 22 participants (30%) were transferred to inpatient rehabilitation with a total median (IQR) LOS (acute + inpatient rehabilitation) of 16 (13–22) days.

Table 1

Pre-operative and Surgical Characteristics of Participants

Characteristic	All participants		Discharge destination				Procedure			
			Home		Inpatient rehabilitation		THR		TKR	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Age (years), mean (SD)	67 (10)		65 (9)		73 (10)		67 (11)		67 (10)	
Total	74		52	70	22	30	38	51	36	49
Female	39	53	26	50	13	59	16	42	23	64
Body mass index classification (kg/m²)										
Normal (18.5–24.9)	4	5	4	8	0	0	3	8	1	3
Overweight (25.0–29.9)	22	30	17	33	5	23	12	32	10	28
Obese (≥ 30.0)	48	65	31	60	17	77	23	60	25	69
Procedure										
THR	38	51	30	58	8	36				
TKR	36	49	22	42	14	64				
ASA score										
1 or 2	29	39	24	46	5	23	15	39	14	39
3 or 4	45	61	28	54	17	77	23	61	22	61
Type of anaesthesia										
General	43	58	31	60	12	55	23	61	20	56
Spinal	31	42	21	40	10	45	15	39	16	44
Femoral nerve block	6	8	4	8	2	9	1	3	5	14

Note. ASA = American Society of Anaesthesiologists; THR = total hip replacement; TKR = total knee replacement.

Post-operative physical activity

During the acute hospital admission, participants demonstrated a daily median (IQR) step count of 136 (50–294) steps, median (IQR) transitions of 17 (11–75) and 52 (32–94) upright minutes. Physical activity increased daily during the acute admission, with the most activity undertaken on day four with a median (IQR) of 251 (34–575) steps, 21 (13–33) transitions and 69 (31–119) minutes upright. Particularly on post-operative days one to three, a high proportion of physical activity occurred during physiotherapy (Table 2).

Unadjusted and adjusted relationships between physical activity variables hospital outcomes (discharge destination and LOS) can be found in Tables 3 (discharge destination) and 4 (LOS). There was a significant association between discharge destination and each of steps and transitions. For every 50% increase in either steps or transitions the probability of discharge to inpatient rehabilitation decreased by 5%. There was a significant association between all physical activity variables (steps, transitions and upright time) and LOS. For every 50% increase in steps, transitions and upright time, there was a decrease in LOS (days) by 4.56%, 7.79% and 6.66%, respectively.

Table 2

Physical Activity During the 'Waking' Day and Proportion Undertaken During Physiotherapy According to Post-operative Day

Post-operative day	Patients with complete 24hr data	Step count		Sit-to-stand transitions		Time upright (min)	
	n (%)	*Mdn* (IQR)	% during physiotherapy	*Mdn* (IQR)	% during physiotherapy	*Mdn* (IQR)	% during physiotherapy
Day 1	41 (55)	12 (4–63)	28	7 (3–11)	38	14 (5–45)	36
Day 2	73 (99)	80 (34–272)	22	16 (9–27)	21	46 (23–93)	25
Day 3	51 (69)	148 (48–318)	17	17 (9–27)	13	50 (26–92)	18
Day 4	32 (43)	251 (34–575)	20	21 (13–33)	17	69 (31–119)	18

Table 3

Association Between Physical Activity and Discharge to Inpatient Rehabilitation

Physical activity variable	Home discharge	IPR discharge	Unadjusted log *OR* (95% CI)	*p*	Adjusted log *OR* (95% CI)	*p*
	Mdn (IQR)					
Log steps	142 (37–379)	22 (3–109)	0.51 (0.32, 0.82)	0.006	0.46 (0.26, 0.83) [a]	0.010
Log transitions	19 (11–28)	11 (4–20)	0.50 (0.25, 1.01)	0.054	0.49 (0.30, 0.81) [b]	0.005
Log upright time (min)	59 (27–106)	39 (13–523)	0.59 (0.33, 1.06)	0.078	0.64 (0.34, 1.21) [c]	0.171

Note. IPR = inpatient rehabilitation.

[a] Adjusted for age, body mass index, American Society of Anesthesiologists score and procedure. [b] Adjusted for body mass index and American Society of Anesthesiologists. score. [c] Adjusted for body mass index and Risk Assessment Prediction Tool score.

Table 4

Association Between Physical Activity and Log Length of Stay (Days)

Physical activity variable	Unadjusted β (standard error)	*p*	Adjusted β (standard error)	*p*
Log steps	–0.17 (0.04)	< 0.001	–0.11 (0.04) [a]	0.016
Log transitions	–0.21 (0.09)	0.019	–0.20 (0.09) [b]	0.025
Log upright time (min)	–0.19 (0.07)	0.009	–0.17 (0.07) [c]	0.024

[a] Adjusted for age, body mass index and American Society of Anesthesiologists score. [b] Adjusted for body mass index and American Society of Anesthesiologists score. [c] Adjusted for body mass index and Risk Assessment Prediction Tool score

DISCUSSION

The aims of this study were to quantify physical activity undertaken in the acute setting following lower limb arthroplasty and determine the relationship between activity levels and hospital outcomes. The hospital outcomes (LOS and discharge destination) reported in this study were consistent with outcomes for usual care of THR and TKR patients across Australia and New Zealand hospitals (Hart et al., 2021). Within the acute hospital, participants engaged in low levels of physical activity following elective lower limb arthroplasty. Lower levels of physical activity on day two post-operatively were associated with discharge to inpatient rehabilitation and a longer total hospital LOS after accounting for potential confounders.

The median daily step count (136 steps) completed by our participants falls short of current recommended guidelines for older adults and special populations (i.e., those with chronic diseases), i.e., moderate intensity exercise to be undertaken three days per week during at least 10 min bouts (of 1000 steps each) to equate to 150 min per week, in addition to activities of daily living (Tudor-Locke et al., 2011). Similarly, the limited upright minutes achieved by our participants suggests a large amount of sedentary time in the acute post-operative period. The World Health Organization recommends that older adults should limit the time spent sedentary, replacing sedentary time with physical activity of any sort (Bull et al., 2020). The median step count was also considerably lower than other hospitalised post-surgical or acutely ill patients (Barkley et al., 2019; Bennett et al., 2016; Floegel et al., 2018; Kaplan et al., 2019; King et al., 2019; Rice et al., 2020; Tonosaki, 2012). Although a gradual increase in physical activity occurred during the acute stay, participants remained highly inactive on the day of discharge. For participants discharged home, the highest median number of steps per day was 281 (IQR 142–675). Considering 70% of participants in this study discharged directly home, this low level of activity may present a significant problem for managing activities of daily living in the community. Although services and support can be provided following discharge from acute care, the physical activity levels in our population were far inferior to recommended levels for older adults to safely access community sites such as banks, pharmacies and supermarkets (Salbach et al., 2014). In addition to encouraging more frequent engagement in physical activity throughout the course of the day, elective arthroplasty patients should be challenged to mobilise further in order to ensure safe community access on discharge, particularly those living alone. Research suggests even a few weeks of sedentary behaviour and physical inactivity in previously healthy adults can have an immediate impact on overall health (Convertino, 1997; Ferrando et al., 1996) and are linked to many chronic diseases (Bellettiere et al., 2017; Biswas et al., 2015; Woodcock et al., 2011). The lack of physical activity and abundance of sedentary time in our participants may increase the risk of future chronic health conditions if these behaviours become embedded. Previous research has demonstrated that, following elective lower limb arthroplasty, patients may remain inactive for up to six months (Harding et al., 2014). However, further research is required to determine if the observed lack of physical activity in the acute setting is linked to longer term outcomes.

The significant association between all physical activity variables and hospital LOS highlights the importance of assessing physical activity levels as part of routine inpatient care, as engagement in early and regular post-operative physical activity within hospital settings was associated with improved hospital-based outcomes. This is particularly important given longer hospital LOS has been associated with increased complication rates such as VTE, urinary retention and infection (Hauck & Zhao, 2011). Furthermore, each additional night in hospital increases the risk of adverse drug reactions and infection, as well as increasing healthcare costs (Hauck & Zhao, 2011). Our study has shown that LOS decreased by between 4.59% and 7.79% for every 50% increase in physical activity levels. Additionally, for every 50% increase in steps or transitions the probability of discharge to inpatient rehabilitation decreased by 5%. Patients who required an inpatient rehabilitation admission spent an average of 16 days in rehabilitation, which places a financial burden on the healthcare system and can expose patients to significant hospital-based harms. Whether increasing a patient's physical activity in hospital can reduce the risk of discharge to inpatient rehabilitation is unknown and further experimental research is needed. Earlier mobilisation (i.e., on the day of surgery) by a physiotherapist may be a potential option to increase physical activity and reduce rehabilitation admissions (Yakkanti et al., 2019). Our study also showed that up to 38% of total physical activity is undertaken during physiotherapy sessions. Encouraging physical activity outside physiotherapy sessions is also needed and may improve hospital outcomes, such as reducing both LOS and complications. Increasing patient physical activity within the acute setting could be achieved by enabling participation in unsupervised activity (e.g., bedside exercises) or encouraging patients to engage in meaningful goal-directed activities on the ward (e.g., walking to the bathroom or kitchen).

A strength of this study was that continuous objective physical activity data was collected throughout the acute inpatient admission. Furthermore, the age, sex, BMI and ASA score of the study cohort were comparable to national normative values for arthroplasty patients (Australian Orthopaedic Association National Joint Replacement Registry, 2019). Although two participants removed the activPAL3™ devices, no adverse events were observed. This study did not investigate the amount of physical activity undertaken following discharge from acute care and further research during this period would facilitate our understanding of the impact of acute and sub-acute physical activity on long-term outcomes. A limitation of this study is that it was undertaken in a large tertiary public hospital with strict post-operative protocols and priorities, which may differ in other institutions. Therefore, these results may not be generalisable to other settings. Further, as this study was observational, only association was shown and causality cannot be confirmed. In addition, while we adjusted for key confounding factors such as ASA score and the RAPT, we were unable to adjust for other potentially important confounding factors, such as frailty or psychosocial factors, which may have also affected the relationship between physical activity and outcome. Finally, we included procedure (THR or TKR) as a potential confounder in our multivariable models; however, we were underpowered to examine THR and TKR groups separately.

CONCLUSION

The results of this study highlight the importance of increasing physical activity in the acute setting following lower limb arthroplasty. Further strategies to enable early post-operative physical activity, including day-of-surgery mobilisation with a physiotherapist and encouraging patients to engage in goal-directed activities on the ward, may enable increased physical activity and thus may reduce hospital LOS and inpatient rehabilitation admissions.

KEY POINTS

1. This study demonstrates that participants undergoing elective lower limb arthroplasty engaged in low levels of post-operative physical activity during the acute setting.
2. The amount of physical activity undertaken was far less than other hospitalised patient groups and falls short of the recommended activity levels for older and special patient groups.
3. This study shows that lower levels of physical activity during the acute setting, particularly on day two post-operatively, were significantly associated with discharge to inpatient rehabilitation and a longer total hospital LOS.

DISCLOSURES

Asher Kirk was the recipient of the Alfred Health Physiotherapy Research Fellowship to enable preparation of the article. There are no conflicts of interest that may be perceived to interfere with or bias this study.

PERMISSIONS

Ethical approval for this study was granted from Alfred Human Research Ethics Committee (project number 76/18). All participants provided their written consent to participate in this research.

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Appendix A

METHODOLOGY FOR BACK-TRANSFORMATION OF LOG-TRANSFORMED VARIABLES

Discharge destination models

To interpret the log odds ratios for each of the physical activity variables, marginal effects were calculated, whereby for every 1% increase in the physical activity variable, the probability of discharge home was increased/decreased by x, whereby x is the 'margin' from the marginal effects model (Dimitriy, 2015).

Length of stay models

Adjusted coefficients and standard errors were calculated for the relationship between log-transformed physical activity values and log-transformed LOS. Given that both predictors and outcome were log transformed, and therefore proportional to one another, results were interpreted by considering a 50% increase in physical activity equivalent to an x% increase/decrease in LOS (days) where x = 1.50 to the power of the beta coefficient for the log physical activity variable (Ford, 2018).

Appendix B

FULL OUTPUT FOR MULTIVARIABLE MODEL OF THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND DISCHARGE TO INPATIENT REHABILITATION

Covariate	Adjusted log *OR* (95% CI)	*p*
Log steps	0.46 (0.26, 0.83)	0.010
Age	0.94 (0.23, 3.92)	0.941
BMI	2.20 (0.49, 9.96)	0.305
ASA score		
1–2 (reference)	1	0.335
3–4	2.06 (0.47, 8.92)	
Procedure		
THR (reference)	1	0.026
TKR	5.76 (1.23, 26.80)	
Log transitions	0.49 (0.30, 0.81)	0.05
BMI	2.32 (0.56, 9.35)	0.237
ASA score		
1–2 (reference)	1	0.173
3–4	2.37 (0.68, 8.17)	
Log upright time (min)	0.64 (0.34, 1.21)	0.171
BMI	1.50 (0.52, 4.32)	0.448
RAPT	0.72 (0.56, 0.94)	0.014

Note. ASA = American Society of Anesthesiologists; BMI = body mass index; RAPT = Risk Assessment Prediction Tool; THR = total hip replacement; TKR = total knee replacement.

Appendix C

FULL OUTPUT FOR MULTIVARIABLE MODEL OF THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND LOS

Covariate	Adjusted β (standard error)	*p*
Log steps	–0.11 (0.04)	0.016
Age	0.17 (0.13)	0.210
BMI	0.15 (0.11)	0.170
ASA score		
1–2 (reference)	1	0.407
3–4	0.11 (0.13)	
Log transitions	–0.20 (0.09)	0.025
BMI	0.11 (0.11)	0.345
ASA score		
1–2 (reference)	1	0.102
3–4	0.24 (0.14)	
Log upright time (min)	–0.17 (0.07)	0.024
BMI	0.10 (0.11)	0.358
RAPT	–0.07 (0.03)	0.020

Note. ASA = American Society of Anesthesiologists; BMI = body mass index; RAPT = Risk Assessment Prediction Tool score.

THANK YOU NZJP REVIEWERS!

We would like to take this opportunity to thank all of the reviewers who completed reviews of manuscripts for the *New Zealand Journal of Physiotherapy* in 2021. We truly appreciate your time, willingness and expertise in contributing to the peer review process, and your thoughtful comments and recommendations which assist our decision-making and improve the quality of published papers. We could not publish our journal without you!

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