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PHYSIOTHERAPY NEW ZEALAND
Kōmiri Aotearoa

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PHYSIOTHERAPY NEW ZEALAND
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Guiding Occupational Health Physiotherapy into the Future

What is an occupational health physiotherapist?

Occupational health (OH) is an area of work that aims to promote and maintain the highest degree of physical, mental, and social wellbeing of workers in all occupations (International Labour Organization, 2003). An OH physiotherapist is a qualified physiotherapist with expertise in preventing and managing work-related injuries and illnesses. Occupational health physiotherapists work with individuals and organisations to identify and eliminate occupational hazards in the workplace, and also promote and maintain the health and wellbeing of workers. They can work independently or within interdisciplinary teams to meet the needs of workers and stakeholders (McAulay et al., 2023).

What do OH physiotherapists do?

The responsibilities of OH physiotherapists positively impact work, workers, workplaces, tasks, and systems. The tasks undertaken by workers can expose them to various physical, psychological, and environmental demands, which can have either positive or negative effects on their health. Occupational health physiotherapists operate in diverse settings, utilising their extensive understanding of these factors to actively mitigate risks and enhance the overall wellbeing of workers. These initiatives can be categorised as both proactive and reactive in nature. They encompass activities such as designing systems, enhancing posture and movement for sedentary roles, offering equipment recommendations, and suggesting methods to reduce the load, frequency, or duration of manual tasks. Wellbeing initiatives aimed at fostering positive workplace health can vary based on specific workplace requirements and the expertise of the clinician. They may include initiatives involving cultural shifts within organisations, revamping work design, developing policies and procedures, and conducting training sessions.

In addition to their preventive efforts, OH physiotherapists play a crucial role in facilitating the return of injured workers to their jobs. They provide support and help manage the expectations of both workers and workplaces to improve confidence and return to work outcomes (Christopherson et al., 2022). Their services encompass personalised rehabilitation as well as the development and support of safe and sustainable return-to-work programmes. Occupational health physiotherapists collaborate closely with organisations to enhance the efficiency and safety of work task performance, ultimately benefitting workplace culture, productivity, efficiency, and profitability. Their role is characterised by a high degree of autonomy, offering flexibility and versatility in terms of work hours and environments.

Where do OH physiotherapists work?

Occupational health physiotherapists operate across a diverse spectrum of work settings, ranging from physically demanding roles in industries such as forestry, manufacturing, health, agriculture, and construction to more sedentary or light roles within corporate offices, laboratories, or automated production facilities. With a multifaceted role where the primary objective is the prevention of injuries and illnesses within the workplace, work can range from computer-based policy development to instructing workers on the shop floor.

Rather than confining themselves solely to clinical intervention after injuries occur, OH physiotherapists strive to be proactive. Consequently, OH physiotherapists extend their reach far beyond the confines of a clinic. Armed with a skill set that encompasses risk management, injury prevention, systems analysis, and fostering a positive workplace culture, they become integral assets to any organisation.

How are OH physiotherapists unique?

There are many professions working in the field of OH, all with different and overlapping areas of expertise. As well as being able to undertake workplace assessments, deliver workplace health and safety training, provide consulting services, and oversee rehabilitation and return-to-work programmes, OH physiotherapists can provide diagnosis, prognosis, treatment, and work capacity certification.

OH physiotherapists have expertise in human movement analysis to understand the tasks and loads to which people are exposed and can use this knowledge to help reduce the risk of work-related injuries. An OH physiotherapist applies their understanding of specific workplace dynamics and the complex interaction between these factors.

Why are guidelines required?

To date, OH physiotherapists working in Aotearoa New Zealand have lacked clarity and guidance around defining their unique skills, attributes, and potential career pathway. Therefore, to address this, a working group of seven OH physiotherapists has collaborated for over 18 months to create a practical guide for clinical, professional, and promotional purposes. The guidelines were disseminated at the Occupational Health Symposium (Harvey et al., 2023a) and recently published (Harvey et al., 2023b).

Feedback and consultation were sought from international and local industry experts, as well as the Physiotherapy Board of New Zealand and Tae Ora Tinana. These guidelines are designed to complement the Physiotherapy Board of New Zealand's physiotherapy thresholds document, which outlines the key roles and competencies for a physiotherapist practising in Aotearoa New Zealand (Physiotherapy Board of New Zealand, 2023). The International Federation of Physiotherapists working in Occupational Health and Ergonomics (IFPOHE), a subgroup of World Physiotherapy, was consulted to ensure this document has maximal credibility and consistency to support the profession's growth both nationally and internationally (International Federation of Physiotherapists working in Occupational Health and Ergonomics, 2023).

OH physiotherapy in Aotearoa New Zealand: Practice guidelines highlights

The newly released guidelines outline the varying skills an OH physiotherapist can develop as they progress through their career within both core and complementary areas of practice. The guidelines describe different aspects of OH physiotherapy such as professional and ethical practice, communication, self-directed learning and reflection, collaboration, being an educator, and leadership and management skills. The guidelines outline how these skills may progress and develop over time and demonstrate what these skills look like in practice with case study examples. The guidelines also provide links to relevant legislation, standards, and acts, and outline essential knowledge and working relationships within OH physiotherapy. This enables easy access to key information, promoting high-quality practice for all OH physiotherapists. The goal is for the OH physiotherapy profession to thrive in Aotearoa New Zealand. We envisage these guidelines will help navigate OH physiotherapy into a bright future.

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REFERENCES

Christopherson, R. M., Fadyl, J. K., & Lewis, G. N. (2022). Return-to-work expectations and workplace supports in New Zealand: Injured workers' perspectives. *Disability Rehabilitation,* 44(5), 702–709. https://doi.org/10.1080/09638288.2020.1776775

Harvey, D., Longworth, J., Mcintosh, C., Meys, S., Moffett, J., Newburn, G. & Wilson, M. (2023a, September 16). *Occupational health physiotherapy Aotearoa New Zealand: Practice guidelines* [Conference presentation]. Occupational Health Symposium, Auckland, New Zealand. https://pnz.org.nz/Attachment?Action=Download&Attachment_id=3406

Harvey, D., Longworth, J., Mcintosh, C., Meys, S., Moffett, J., Newburn, G. & Wilson, M. (2023b). *Occupational health physiotherapy in Aotearoa New Zealand. Practice guidelines*. Physiotherapy New Zealand.

International Federation of Physiotherapists working in Occupational Health and Ergonomics (2023). *About the speciality group.* https://world.physio/subgroups/occupational-health-ergonomics

International Labour Organization (2003, December 9–12). *Thirteenth session of the Joint ILO/WHO Committee on Occupational Health*. Geneva. https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_110478.pdf

McAulay, L., Fadyl, J., & Terry, G. (2023). Effective teams in vocational rehabilitation: An exploration of complexities and practice in Aotearoa-New Zealand. *Journal of Occupational Rehabilitation, 33*(3), 518–527. https://doi.org/10.1007/s10926-022-10089-w

Physiotherapy Board of New Zealand. (2023). *Physiotherapy thresholds*. https://www.physioboard.org.nz/standards/physiotherapy-thresholds

Evaluating the Benefits of the MOVE Mentoring Programme to Mentors and Early Career Physiotherapists

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ABSTRACT

The purpose of this study was to evaluate the benefits of a structured mentoring programme for new graduate physiotherapists, which included standardised mentor training. Thirty new graduate physiotherapists from Aotearoa New Zealand were matched with registered physiotherapist mentors located outside their workplace but working in the same clinical practice area. All mentors completed a standardised 3 hr mentor training. Four mentoring sessions were conducted by Zoom over 4 months. Mentees and mentors completed pre- and post-mentoring surveys and participated in post-mentoring focus groups for review and elaboration of data. All participants reported benefits from the mentoring process. Most mentors had no previous mentor training and found the 3 hr programme valuable for improving their confidence and skills. Mentees reported improvements in confidence and motivation and highlighted the benefits of having a mentor outside the workplace to discuss potentially sensitive issues. The main challenges for mentees related to them taking the lead in the process due to feeling unsure what to bring to mentoring sessions so early in their career. This study highlighted both the benefits and challenges of structured mentoring for early career physiotherapists and mentors in Aotearoa New Zealand.

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Key Words: Competence, Education, Health Workforce, Mentoring, Physiotherapists

INTRODUCTION

Across Australia and Aotearoa New Zealand, the intake of students into university-based physiotherapy programmes has steadily increased to meet projected workforce demands. However, job satisfaction and retention of early career physiotherapists are of growing concern (Bacopanos & Edgar, 2016; Mulcahy et al., 2010; Reid & Dixon, 2018).

Poor retention has been attributed to new graduates having unrealistic expectations, a lack of peer support and mentoring, limited career pathways, and inadequate exposure to the full range of clinical settings during training. The result is that many report feeling unprepared to manage the workload, complexity, and psychosocial care of patients (Arkwright et al., 2018; Atkinson & McElroy, 2016; Bacopanos & Edgar, 2016; Kennedy et al., 2021; Reid & Dixon, 2018; Wells et al., 2021).

While Aotearoa New Zealand physiotherapy training providers report skills and competence are adequate, it is acknowledged that students may get insufficient variety in clinical placement offerings and have less effective communication skills, making patient/client interactions more difficult (Kennedy et al., 2021). In addition, while nearly half of new graduates enter private practice, many have limited experience as students in this setting (Health Workforce Australia, 2014; Kennedy et al., 2021; Pretorius et al., 2016; Reid & Dixon, 2018).

Professional supervision has been promoted to provide ongoing learning and support to physiotherapists (Butler & Thornley, 2014). It involves scheduled, protected time for a practitioner to discuss any aspect of their practice, facilitated by a respected colleague (Davys & Beddoe, 2021).

Among the challenges associated with professional supervision is the lack of consensus on the definition and inconsistent use of language, with the terms professional supervision and clinical supervision often used interchangeably (Holder et al., 2020; Snowdon et al., 2015). While it is valued as a clinical governance and professional support strategy by health professionals in rural settings (Ducat & Kumar, 2015), it is not seen as a normal part of physiotherapy private practice culture (Holder et al., 2020). As such it would be difficult to implement professional supervision in physiotherapy without broader knowledge, training, and acceptance across the profession.

In contrast, mentoring is recognised as important for early career health professionals as it can help build competence, confidence, improve decision-making, productivity, career satisfaction, clinical outcomes, workload, stress management, and provide networking opportunities (Buning & Buning, 2019; Davies et al., 2016; Williams et al., 2019; Yoon et al., 2017).

Mentoring is defined as:

> A learning relationship, involving the sharing of skills, knowledge, and expertise between a mentor and mentee through developmental conversations, experience sharing, and role modelling. The relationship may cover a wide variety of contexts and is an inclusive two-way partnership for mutual learning that values differences. (European Mentoring and Coaching Council (n.d.).

Mentors need to be patient, open-minded, approachable, kind, reassuring, willing to listen, and able to provide direct guidance (Buning & Buning, 2019; Forbes et al., 2021). The role of a mentor is multifactorial and should include goal setting, teaching, role modelling, provision of feedback, and development of coping strategies (Loosveld et al., 2020). In addition, the process of mentoring should be collaborative, individualised, and adaptable to meet mentee needs (Forbes et al., 2021). The quality of the mentoring experience will depend on factors such as the matching process, the skills and training provided, as well as the receptivity and motivation of the mentee (Buning & Buning, 2019). Consequently, the purpose of this study was to evaluate the benefits of a 4-month structured mentoring programme for new graduate physiotherapists (mentees) and their mentors that included mentor training (Williams et al., 2022; Yoon et al., 2017).

METHODS

A qualitative descriptive methodology was utilised for this research (Sandelowski, 2000). The first author (AC) is a physiotherapist with over 30 years of experience in private practice. AC is actively involved in mentoring colleagues and regularly delivers professional development training to physiotherapists at all levels. She has firsthand experience of the knowledge and skill gaps, as well as the lack of confidence among early career physiotherapists.

The second author (MP) is a physiotherapist and professional certified coach with over 30 years of experience in health professional education including curriculum design, delivery, and evaluation. MP was keen to participate in this research based on feedback from her clients about the growing need to build the confidence and competence of new graduates and junior staff.

A key driver for both authors was anecdotal evidence that, while many Aotearoa New Zealand physiotherapists are engaged in mentoring roles, there is limited information available about the quality of the mentoring experience and what, if any, training is provided.

Mentees

Thirty-three new graduate physiotherapists were recruited from fourth-year student electronic noticeboards at two physiotherapy schools in Aotearoa New Zealand in November 2021 (AUT University and the University of Otago). Participants were eligible if they graduated in the 6 months prior to start of the project (February 2022).

Mentors

Expressions of interest were sought for mentors through advertising within established physiotherapy networks in Aotearoa New Zealand and Australia including professional social media group pages, professional email lists, and word-of-mouth referrals. Potential mentors were eligible if they held a current Aotearoa New Zealand or Australian annual practising certificate and were based in Aotearoa New Zealand or Australia at the time of the study.

Fifty-six physiotherapists registered interest in being a mentor and 43 completed a 3 hr mentor training session via Zoom as a pre-requisite for involvement in the programme.

The 'MOVE' mentoring programme

The training was developed by MP and focused on:

1. Exploring the role of a mentor.
2. Creating a quality relationship.
3. Establishing a mentoring agreement and mentee development plan.
4. Exploring mentoring methods (coach, support, teach, delegate).
5. Ethical considerations and dealing with challenges.

A summary of the MOVE mentoring process is provided in Figure 1. As part of the training, mentors were encouraged to adopt a specific, structured approach to each mentoring session that was coined "MOVE" to reflect the following four components:

1. **M**ap out the goal for the session.
2. **O**ptions should be identified with mentee.
3. **V**erify with mentee their next steps.
4. **E**valuate the session.

The MOVE structure provided mentors with a framework they could utilise for the mentoring process and encouraged a consistent approach. This was considered important as mentoring practice is influenced by personal beliefs and, in general, mentors have their own unique ways of working (Loosveld et al., 2020).

As part of the training, mentors and mentees were provided with guides that explained the stages of mentoring, expectations, useful questions, and included a mentoring agreement, a mentee development plan, and a mentoring session agenda. These templates were included as resources to guide the mentoring process, which was conducted via video conference using Zoom. Online mentoring has proven to be valuable for novices in physiotherapy (Westervelt et al., 2018).

Both mentors and mentees provided written consent to participate in the study and ethical approval for the project was granted from the New Zealand Ethics Committee (reference number, NZEC21_55).

The matching process

Mentees were matched with mentors based on information provided in a commencement survey (Appendices A and B). The matching process prioritised the following areas:

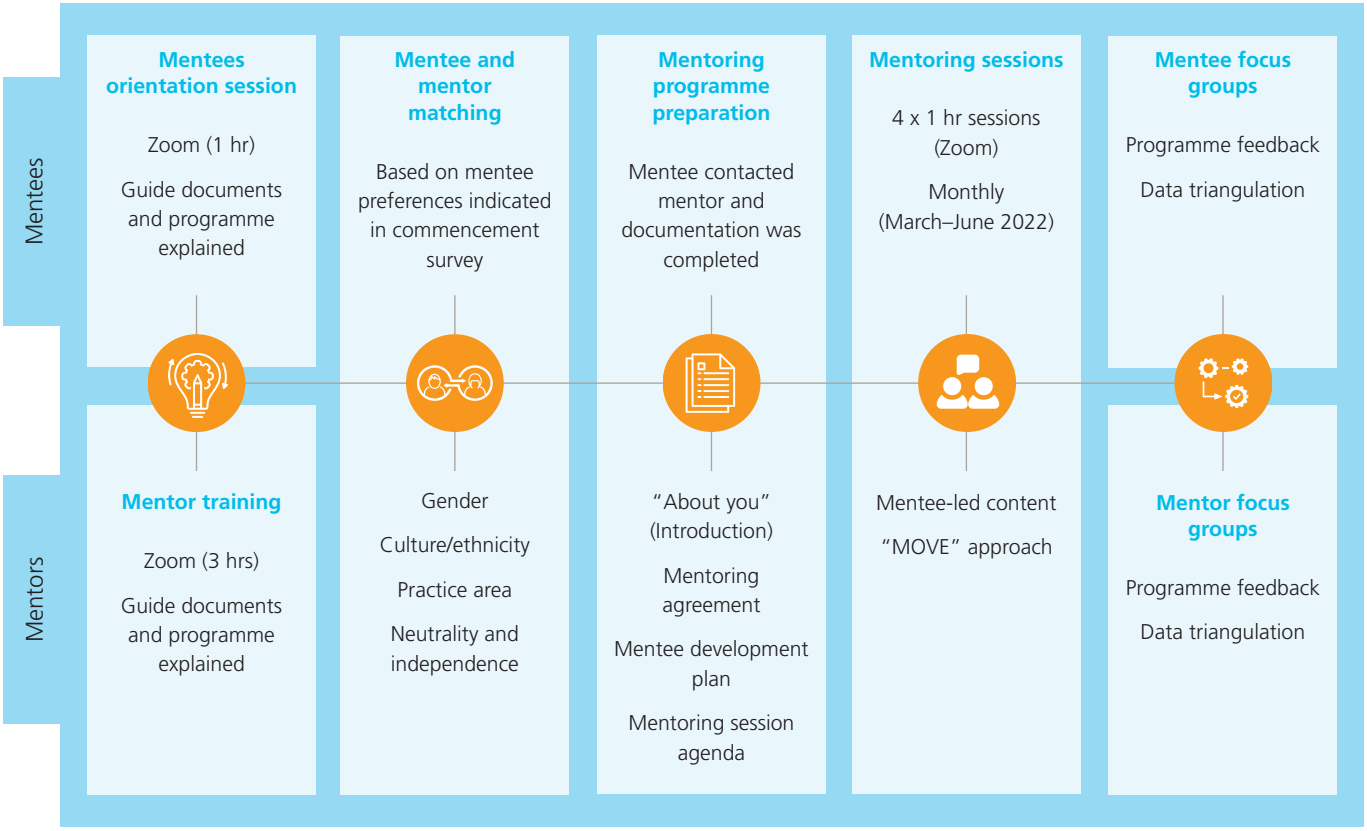
- Gender and cultural/ethnicity preferences.
- Practice area.
- Neutrality and independence, so neither party was working with, or for, the other party or had any influence over their employment status.

Mentoring sessions

Mentees were responsible for initiating contact to commence mentoring. One session was scheduled per month between March and June 2022 (a total of four mentoring sessions). The content of the sessions was at the discretion of the mentee.

Figure 1

Summary of the MOVE Mentoring Process



At the conclusion of the mentoring programme, mentees and mentors were invited to participate in a focus group debrief session (1.5 hr) to provide feedback on the programme and to assist with the triangulation of survey data.

Data analysis

De-identified data from open questions in the post-mentoring surveys were analysed thematically using inductive content analysis (Elo & Kyngäs, 2008). This process was primarily completed by the second author coding the data provided in the written responses to identify key ideas and create themes. The next step involved engaging mentors and mentees in separate audio-recorded focus group meetings via Zoom. The purpose of these meetings was not to seek congruence or agreement of themes but rather to enable participants to review and ascribe meaning to their input (Varpio et al., 2017). In addition, transcription of this data ensured direct quotes from participants were available to explain the findings. If participants were unable to attend one of the two focus-group meetings scheduled for each cohort, they were given the opportunity to review the information and provide written feedback. For all questions that utilised a five-point Likert rating scale, the mean was calculated.

RESULTS

Demographics

Thirty mentors and mentees completed the MOVE mentoring programme (Tables 1 and 2). Three mentees dropped out of the study. Reasons for dropouts are provided in Figure 2. Of the 30 mentees who completed the study, 29 completed four mentoring sessions. Follow-up surveys were completed by nearly all mentors (93%) and mentees (83%), and 80% of mentors and 63% of mentees attended focus group sessions (Figure 2).

Matching

Mentees were matched with a mentor based on clinical practice area with mentoring sessions occurring remotely with mentors based outside their geographic location. This was an ethical requirement of the study to maintain mentee confidentiality and minimise the possibility of employer influence.

Three mentees working in hospital settings could not be matched to their clinical practice area due to insufficient mentors recruited from hospital-based settings. All three mentees were matched with mentors from private practice settings and remained in the study. Although these three mentees found the mentoring process beneficial, two indicated that the lack of a matched mentor from their clinical practice

Table 1

Descriptive Statistics for Mentees and Mentors (N = *30)*

Characteristic	Mentees		Mentors	
	n [a]	%	*n* [a]	%
Age, years, *M* (*SD*), range	25 (5), 22–45		43.7 (9.8), 25–64	
Gender				
Male	6	20.0	10	33.0
Female	24	80.0	20	67.0
Ethnicity				
New Zealand European/Pākehā	20	67.0	23	77.0
Asian (not further defined)	3	10.0	1	3.0
European (not further defined)	3	10.0	0	0
New Zealand Māori	2	6.5	1	3.0
Chinese	2	6.5	2	7.0
Indian			2	7.0
Other			1	3.0
Practice area				
Private practice (*musculoskeletal)	24	80.0	22	73.0
*District health board/hospital	5	17.0	2	7.0
Don't know	1	3.0		
Other			6	20.0

[a] Unless indicated otherwise.

Table 2

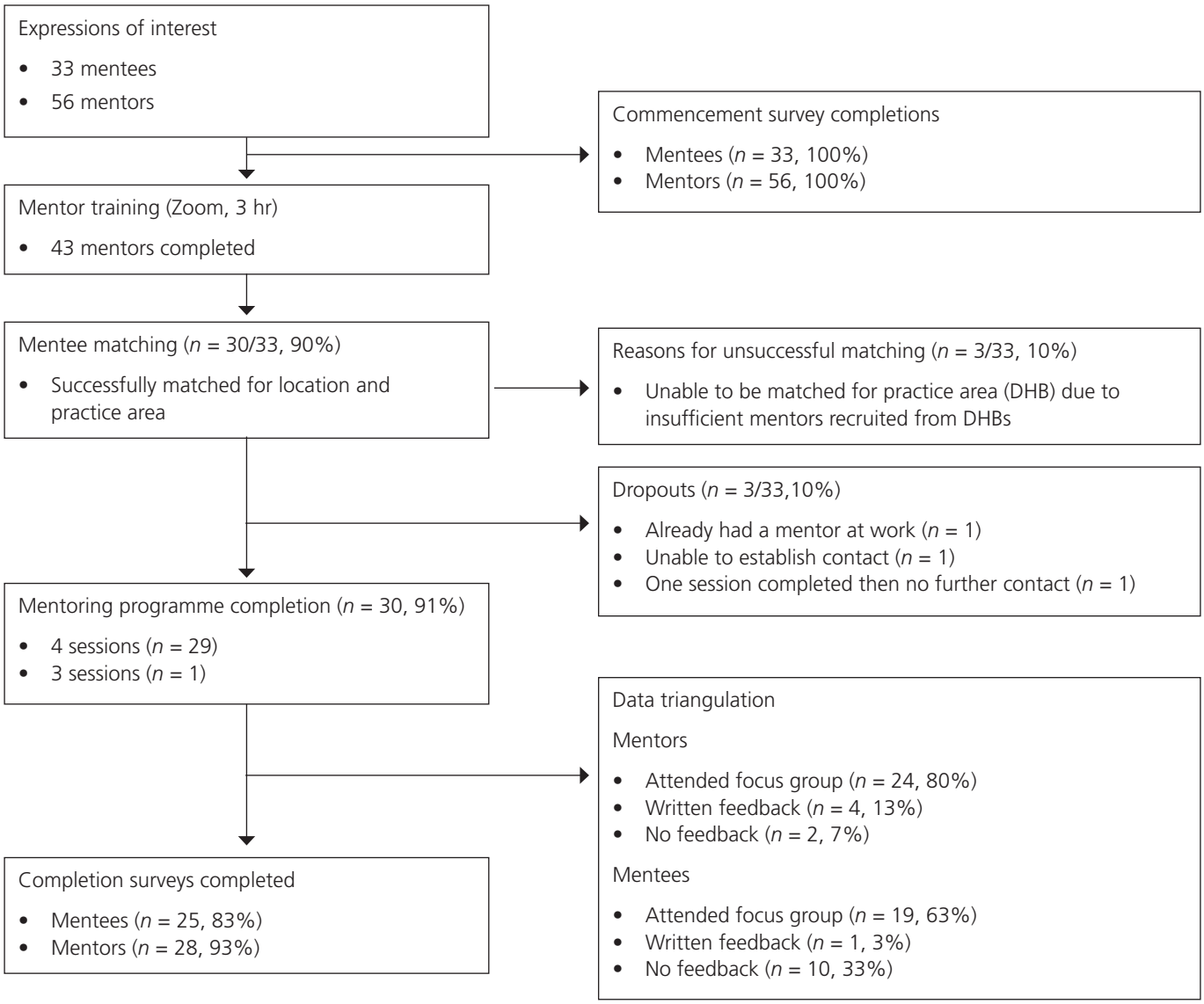
Mentors' Experience, Qualifications, and Background (N = *30)*

Demographic	*n* [a]	%
Years in practice, *M* (*SD*), range	21.4 (10.5), 3–44	
Highest qualification		
Bachelor's degree	5	17
Post-graduate certificate	2	7
Post-graduate diploma	12	40
Master's degree	11	37
Registered scope of practice		
General scope	29	97
Advanced practitioner/titled	1	3
Previous mentoring experience		
Yes	14	47
No	16	53
Previous mentor training		
Yes	6	20
No	24	80

[a] Unless indicated otherwise.

Figure 2

Flowchart of Participants in the Study



Note. DHB = district health board.

setting (hospital) affected their experience. Specifically, one mentee stated, "The mentoring did not add much value to my practice as it could only be very generic mentoring". The second mentee said, "I found it difficult to get specific advice because my mentor hasn't had experience in my role".

Mentees were asked about gender and cultural preferences for mentor matching at the beginning of the study. None of the mentees indicated a preference for either of these variables initially. However, in the focus group session, two mentees who coincidentally were matched with a mentor of the same culture (Asian) indicated there was value in working with someone who understood their culture and the challenges they faced integrating into the Aotearoa New Zealand healthcare system.

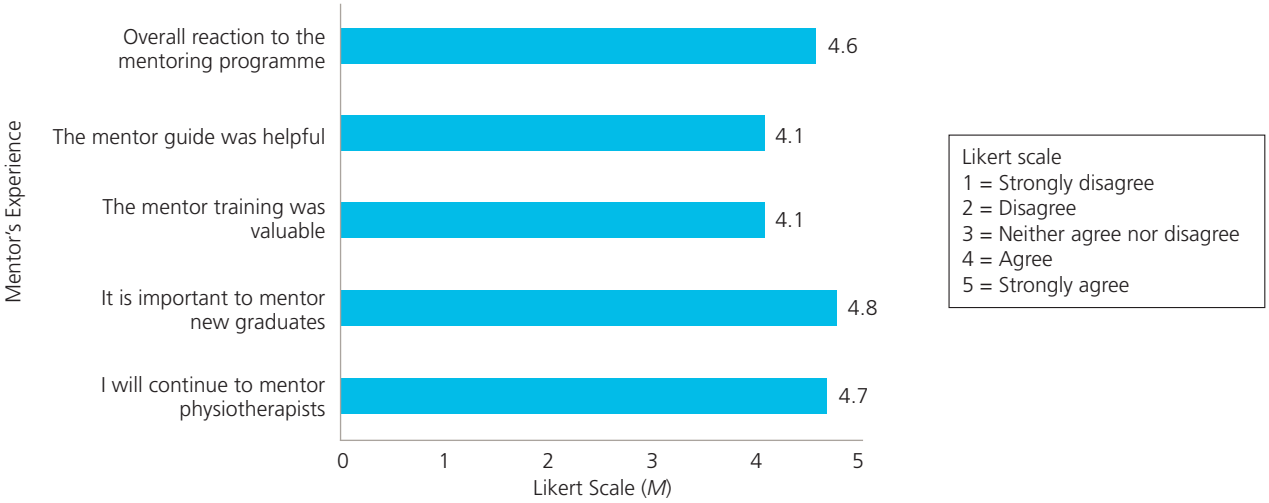
Benefits for mentors

There was overwhelming support for the mentoring programme from the mentors who participated. Mentors highlighted the importance of mentoring for new graduates and indicated commitment to continuing to mentor (Figure 3).

Despite almost half of the mentor group having had previous mentoring experience, 80% of them had never had any formal training as a mentor. The training provided prior to the mentoring programme was said to be valuable, with mentors stating it gave them more confidence in their mentoring ability. The electronic guide and supporting documents were said to be helpful to the process (Figure 3). The key benefits to mentors were related to skill development, gaining a better

Figure 3

Mean Scores Relating to the Mentors' Experience



understanding of new graduates, and the opportunity to share knowledge and skills.

The main areas of skill development identified by 60% of mentors were reflective practice, teaching, coaching, communication, and giving feedback. One mentor reported that, "learning the art of coaching, asking open questions, reflective listening skills" was a key benefit. Another stated:

> It (the training) helped me to make sure I was not just teaching the mentee. To make sure I asked more open-ended questions and guided them in accessing their own knowledge and giving confidence that they knew the answer. It helped me to think about what questions I asked the mentee so that I could try to help them in all areas not just clinical.

Getting a better understanding of new graduates was identified as a key benefit by 29% of the mentors. One mentor said, "It gave me a greater understanding of the pressures that new grads are under and led me to offering the new graduate in my clinic more support". Another found it helpful by "gaining some insight into the experience and thought process of new graduate/early career physiotherapist especially about the views of their career goals/aspiration, professional identity as a physiotherapist and barriers/drivers of professional development".

Sharing knowledge and skills was identified as a benefit of the mentoring process by 18% of mentors. One mentor said, "It was rewarding to me to share what I felt were really basic skills, but they meant a lot to the mentee". Another benefitted from the opportunity to help their mentee, saying, "I enjoyed the training we received and the opportunity to help a new graduate develop their knowledge and skills in what I consider to be a pretty tough environment for a new graduate at the present time".

Benefits for mentees

The mentees responded positively to the mentoring programme and on average rated the importance of mentoring and likelihood of seeking ongoing mentoring as 4.8 out of 5. The topics most frequently covered during mentoring sessions were professional development, clinical cases, clinical reasoning, patient, and workplace communication. Mentees most valued receiving constructive feedback from their mentors and appreciated the approach and expertise provided (Figure 4).

The main benefits of the mentoring programme for mentees were in two key areas. Personal and professional development was identified by all (100%) of the mentees as a key benefit of the mentoring process. One mentee said, "improving my confidence, broadening my knowledge, feeling more supported, making me feel inspired" was one of the most beneficial aspects. Another stated:

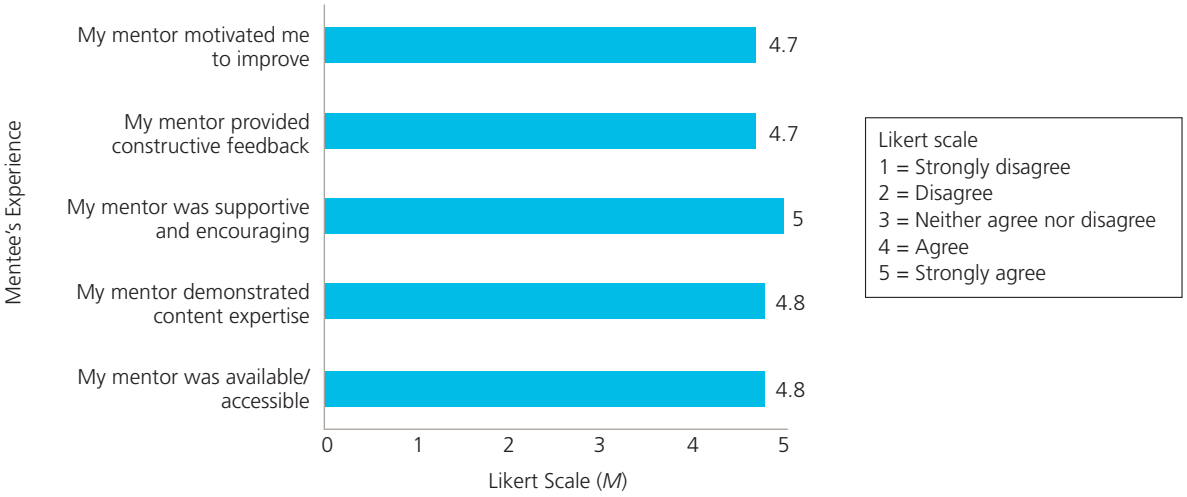
> I felt like my mentor really supported me and was so approachable that she was able to reassure me as well as challenge me to become the best physiotherapist I could and provide the best care for my clients. She had so many tips and tricks and such a broad range of expertise that made it so lovely to be guided by her. She supplied resources that were helpful and really listened to and provided helpful ideas. She simplified physiotherapy and the questions I had about it as a career and how to get the most out of this career.

The second area of benefit was the independence of the mentor, which was identified by 64% of mentees. Having a mentor who was independent of their workplace made mentees feel more comfortable asking questions and expressing thoughts and opinions without fear of judgement from an employer or line manager. One mentee said, "I could talk pragmatically and honestly about career progressions, pay scales, and workplace logistics/dynamics, which I wouldn't feel as comfortable discussing with physios or managers already in my company". Another indicated:

> It was amazing to have another professional opinion from an experienced physiotherapist aside from the clinical directors in my own clinic. It was also great to be able to ask a professional about questions that I may not want to ask my own boss/clinical mentor.

Figure 4

Mean Scores Relating to the Mentees' Experience



Challenges

The main challenge identified by mentors and mentees was scheduling mutually convenient meeting times. In addition, those mentees matched with a mentor in a different practice area noted this was not ideal as it limited discussion of certain issues.

The challenges identified by mentors (one-off comments) included:

- a lack of confidence in their own mentoring skill level
- dealing with a mentee facing personal or professional issues
- the limitations of virtual meetings

The challenges identified by mentees (one-off issues) included:

- a lack of confidence to take the lead in the mentoring process
- commencing a new job, so being unclear about what to bring to mentoring
- feeling unsure regarding whether physiotherapy was the right profession

DISCUSSION

There is a growing body of literature that supports the benefits of mentoring for early career physiotherapists, particularly those working in private practice (Davies et al., 2016; Forbes et al., 2021; Wells et al., 2021; Westervelt et al., 2018). Mentoring and support of early career physiotherapists are important for the retention of graduates, job satisfaction, the quality of physiotherapy service, enhancing clinical outcomes, and the future of the physiotherapy profession (Australian Physiotherapy Association, 2013; Davies et al., 2016; Naidoo, 2006; Williams et al., 2022). Our results support previous research with universal agreement on the importance and value of mentoring in both mentee and mentor groups.

Our study explored the benefits of the MOVE mentoring programme to both mentors and mentees using remote mentoring methods over a 4-month period. Few previous studies have included standardised mentor training and only a small number investigated the benefits to the mentors of their involvement in the mentoring process.

Mentors

Despite almost half of the mentor group indicating they had previously been engaged in a mentor role, 80% had no previous mentor training and reported limited confidence in their mentoring skills at the beginning of the study. A lack of confidence in their own skill level was a key challenge raised by mentors in this study. The mentors found the training provided prior to commencing mentoring gave them more confidence in their mentoring ability. After the programme, mentors specifically noted improvement in their reflective practice, communication, and feedback skills (Buning & Buning, 2019; Johnson, 2002). The importance and value of training for mentors has also been identified by other researchers (Buning & Buning, 2019; Westervelt et al., 2018). Despite mentor training being an important factor in the quality of the mentoring experience (Buning & Buning, 2019; Johnson, 2002), only 20% of mentors in this study had previous exposure to this form of professional development. With mentoring being recognised as an increasingly important part of early career development, the physiotherapy profession may need to explore ways of improving access to mentor training for the benefit of both mentees and mentors.

Many physiotherapists are appointed to "mentoring" roles in the workplace by virtue of their longevity in the workplace, or by volunteering. However, it is unclear whether the role of a mentor is always clearly defined in these relationships. Consequently, it is possible that physiotherapists working as mentors may adopt more of a "preceptorship" role, which is a short-term, defined, clinically focused arrangement that may have an evaluative component. By contrast, mentorship is a longer-term, formative arrangement focused on building capability to facilitate personal and professional development that is not limited to clinical skill development (Gerhart, 2012).

Based on the results of this study, mentoring roles appear to be common in the workplace; however, in our cohort, previous mentor training was lacking. Given the importance placed on mentoring, particularly for early career physiotherapists, consideration should be given to clearly defining "mentoring" in the workplace and providing adequate training on key mentoring skills including non-clinical skills to optimise the experience for both mentors and mentees. This echoes the call by others to improve the training, policies, and implementation frameworks of supervision, and ensure agreed definitions and functions of different types of support across allied health professions (Ducat & Kumar, 2015).

Mentors were able to empathise with the issues facing new graduates and willingly shared their knowledge and skills to help mentees navigate their challenges. These results echo previously reported mentor benefits from a large Canadian study in which mentors also cited improvement in knowledge base, critical thinking, a sense of fulfilment, and the promotion of personal and professional development because of their mentoring experience (Yoon et al., 2017).

Almost all mentors indicated they would be likely to continue mentoring as they felt that it is important for early career physiotherapists. The physiotherapy profession has a problem with the retention of physiotherapists, with many leaving the profession either in the first two years or between 4–6 years post-graduation (Reid & Dixon, 2018). Mentoring roles provide an opportunity for physiotherapists with some experience to "give back" and obtain a sense of personal and professional fulfilment (Yoon et al., 2017). In addition, it provides motivation to upskill in competencies that are now required for registration under advanced practitioner and specialist scope of practice that may assist their own career pathway (Physiotherapy Board of New Zealand, 2018). Mentoring opportunities supported by training to enhance confidence and mentoring skills may thus contribute to improved retention of physiotherapists in the profession.

Mentees

All of the mentees who submitted the completion questionnaire reported benefits of the mentoring process including improved motivation, encouragement, advice, support, and increased confidence, which is supported by the findings of others (Buning & Buning, 2019; Westervelt et al., 2018). One of the challenges raised by a mentee was being "unsure whether physiotherapy is the right profession for me". Mentoring in this context may be invaluable to identify and work through specific issues that help the mentee make an informed decision about their career, which may improve retention of early career physiotherapists in the profession (Reid & Dixon, 2018).

Having a mentor who is independent of the clinical setting was reported to be important by 64% of the mentees in the completion survey, despite many already having an assigned mentor within their workplace. This underscores the benefit of engaging early career physiotherapists in an externally run mentoring programme where the mentor is impartial, has no conflict of interest, and can focus on the identified needs of the mentee. As such, mentees are more likely to feel comfortable to raise issues such as pay and work conditions and any ongoing gaps in their knowledge or skills without fear of judgement or adverse consequences related to career progression and remuneration. This is endorsed by Buning and Buning (2019) who noted that in an employer-led mentoring programme, the structure and process may have an organisational bias, rather than a primary focus on the developmental needs of mentees.

In contrast, others have promoted the value of in-house support and mentoring for new graduates due to improved treatment outcomes and factors such as the ease of direct, in-person contact with structured education sessions during work hours (Chipchase et al., 2022; Forbes et al., 2021; Williams et al., 2019). Williams et al. (2022) found that on-site mentoring in the mentees' clinical environment provided familiarity, comfort, peer support, and adequate reflection time, and all these factors were reported to contribute to optimal outcomes in musculoskeletal clinical practice.

While in-house mentoring in the workplace may enhance clinical outcomes, the results of our study suggest there may be aspects of personal and professional development the mentee does not feel comfortable raising with a workplace-based mentor. As such, there is a case for a mixed model involving external, independent mentoring as well as workplace-based, clinical "preceptorship" for early career physiotherapists to ensure optimal development of both clinical and non-clinical competencies.

Mentee challenges

Challenges raised by mentees during the process included a lack of confidence to take the lead in the mentoring process and being unclear about what to bring to mentoring sessions. This raises important issues relating to the timing and structure of mentoring sessions for new graduates. The value of mentee-led sessions is self-determination; however, it can take some time to develop the level of confidence to take on this responsibility, so it is helpful if mentors are willing and able to lead, if necessary, when commencing mentoring. This further reinforces the value of mentor training that covers different roles in the mentoring process, such as teaching, coaching, counselling, and facilitating learning. This enables a flexible mentoring approach that is adaptable to meet mentee needs.

The matching process

Matching of mentees and mentors based on clinical practice area seems to be an important factor in positive mentoring experiences. Two of the three hospital-based mentees who were not able to be matched with hospital-based mentors reported that the mentoring process was affected as it was difficult to discuss context-specific issues. Studies from medicine have found that randomly assigning mentors and mentees may result in a less beneficial interaction and the matching process should be natural with engagement ideally "in person" to facilitate a more meaningful relationship (Johnson, 2002). In physiotherapy, Buning and Buning (2019) reported value in matching based on personality assessment or similarities in work schedule, location, age, learning styles, or training.

Although no mentees in this study initially indicated a preference for cultural matching, several mentees post-mentoring specifically noted benefits of unintended matching with a mentor of the same culture. The ability to share

experiences of relocation and reintegration into a different society and culture was valuable to these mentees.

Despite mentees in this study being assigned to mentors without in-person contact, as all meetings were conducted remotely via Zoom, all mentees reported positive mentoring experiences. This supports the findings of Westervelt et al. (2018) and suggests that remote meetings with appropriate matching can be successful, especially where small and geographically remote practices may lack the staff resources to offer workplace-based mentoring.

LIMITATIONS

The duration of the mentoring process was 4 months with a maximum of four mentoring sessions, which may be insufficient time to develop a meaningful mentee–mentor relationship. Despite this, all mentees reported benefits from the process. Longer periods would be required to get an accurate measure of mentoring outcomes. All sessions were conducted by Zoom with mentors who were not based in the same city as the mentee. While traditionally mentoring sessions are conducted in person (Yoon et al., 2017), our results did not identify any significant disadvantage in using a remote model of mentoring and all mentees reported benefits from the process.

CONCLUSION

Both mentors and mentees reported benefits from a 4-month, remote, structured mentoring process. Mentees improved in motivation and confidence and found it valuable to have a mentor independent of their workplace but found it difficult to take the lead early in the mentoring process. Mentors rated the training valuable and reported improvements in reflective practice, communication, and feedback skills. Given the value and importance placed on mentoring in physiotherapy, it would be worthwhile to ensure mentors are adequately trained for their role; that the developmental needs of mentees are the primary focus of any mentoring programme; and that minimum matching criteria should include clinical practice area.

KEY POINTS

1. Mentor training is important to build skills and confidence, because, while many physiotherapists are engaged in mentoring, few have received any formal training.
2. Clear and agreed definitions and frameworks are needed for different support roles across health professions, including supervision and mentoring.
3. When matching mentors with mentees, one important consideration should be to ensure they work in the same clinical setting.
4. Mentees perceived real value in being assigned a mentor who was independent of their workplace, as this provided opportunities for open discussion of potentially sensitive issues such as workplace remuneration and conditions.
5. Mentoring of early career physiotherapists has a positive impact on their motivation and confidence, which in turn can benefit clinical outcomes, job satisfaction, and retention within the profession.

DISCLOSURES

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

PERMISSIONS

The study was approved by the New Zealand Ethics Committee (Application: NZEC21_55) and informed consent was obtained from all study participants.

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CONTRIBUTIONS OF AUTHORS

Design, conceptualisation, methodology, writing the original draft, reviewing and editing, AC and MP; project administration and mentor, mentee recruitment and matching, AC; development of the MOVE mentoring programme methodology, mentor training, mentee focus groups and analysis, MP.

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REFERENCES

Arkwright, L., Edgar, S., & Debenham, J. (2018). Exploring the job satisfaction and career progression of musculoskeletal physiotherapists working in private practice in Western Australia. *Musculoskeletal Science and Practice*, *35*, 67–72. https://doi.org/10.1016/j.msksp.2018.03.004

Atkinson, R., & McElroy, T. (2016). Preparedness for physiotherapists in private practice: Novices identify key factors in an interpretive description study. *Manual Therapy*, *22*, 116–121. https://doi.org/10.1016/j.math.2015.10.016

Australian Physiotherapy Association. (2013, August). *In practice 2025: Final report*. https://australian.physio/sites/default/files/tools/InPractice_2025.pdf

Bacopanos, E., & Edgar, S. (2016). Identifying the factors that affect the job satisfaction of early career Notre Dame graduate physiotherapists. *Australian Health Review*, *40*(5), 538–543. https://doi.org/10.1071/ah15124

Buning, M. M., & Buning, S. W. (2019). Beyond supervised learning: A multi-perspective approach to outpatient physical therapy mentoring. *Physiotherapy Theory and Practice*, *35*(3), 243–258. https://doi.org/10.1080/09593985.2018.1443183

Butler, S., & Thornley, L. (2014). Presenting the case for all physiotherapists in New Zealand to be in professional supervision. *New Zealand Journal of Physiotherapy*, *42*(1), 42–46. https://nzjp.org.nz/nzjp/article/view/76

Chipchase, L., Papinniemi, A., Dafny, H., Levy, T., & Evans, K. (2022). Supporting new graduate physiotherapists in their first year of private practice with a structured professional development program; A qualitative study. *Musculoskeletal Science and Practice*, *57*, 102498. https://doi.org/https://doi.org/10.1016/j.msksp.2021.102498

Davies, J. M., Edgar, S., & Debenham, J. (2016). A qualitative exploration of the factors influencing the job satisfaction and career development of physiotherapists in private practice. *Manual Therapy*, *25*, 56–61.

Davys, A., & Beddoe, L. (2021). *Best practice in professional supervision: A guide for the helping professions*. Jessica Kingsley Publishers.

Ducat, W. H., & Kumar, S. (2015). A systematic review of professional supervision experiences and effects for allied health practitioners working in non-metropolitan health care settings. *Journal of Multidisciplinary Healthcare*, *8*, 397–407. https://doi.org/10.2147/jmdh.S84557

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

European Mentoring and Coaching Council. (n.d). *Mentoring*. https://www.emccglobal.org/leadership-development/leadership-development-mentoring/

Forbes, R., Lao, A., Wilesmith, S., & Martin, R. (2021). An exploration of workplace mentoring preferences of new-graduate physiotherapists within Australian practice. *Physiotherapy Research International*, *26*(1), e1872. https://doi.org/https://doi.org/10.1002/pri.1872

Gerhart, L. A. (2012). Mentorship: A new strategy to invest in the capital of novice nurse practitioners. *Nurse Leader*, *10*(3), 51–53. https://www.nurseleader.com/article/S1541-4612(11)00265-5/fulltext

Health Workforce Australia. (2014). *Australia's health workforce series: Physiotherapists in focus*.

Holder, L., Windross, K., & Kayes, N. M. (2020). The tipping point for engagement in professional supervision by physiotherapy private practitioners. *New Zealand Journal of Physiotherapy*, *48*(1), 29–36. https://doi.org/10.15619/NZJP/48.1.04

Johnson, B. (2002). The intentional mentor: Strategies and guidelines for the practice of mentoring. *Professional Psychology: Research and Practice*, *33*(1), 88–96. https://doi.org/10.1037/0735-7028.33.1.88

Kennedy, E., Bax, J., Blanchard, P., Drinkwater, K., Dysart, A., Horan, K., Jina, R., Leaming, A., Lee, P., Lepine, G., Jackson, D., & George, A. (2021). Clients and conditions encountered by final year physiotherapy students in private practice. A retrospective analysis. *Physiotherapy Theory and Practice*, 3027–3036. https://doi.org/10.1080/09593985.2021.1975340

Loosveld, L. M., Van Gerven, P. W. M., Vanassche, E., & Driessen, E. W. (2020). Mentors' beliefs about their roles in health care education: A qualitative study of mentors' personal interpretative framework. *Academic Medicine*, *95*(10), 1600–1606. https://doi.org/10.1097/acm.0000000000003159

Mulcahy, A. J., Jones, S., Strauss, G., & Cooper, I. (2010). The impact of recent physiotherapy graduates in the workforce: A study of Curtin University entry-level physiotherapists 2000–2004. *Australian Health Review*, *34*(2), 252–259. https://doi.org/10.1071/AH08700

Naidoo, N. (2006). The role and importance of mentoring in physiotherapy. *South African Journal of Physiotherapy*, *62*(3), 1–5.

Physiotherapy Board of New Zealand. (2018). *Physiotherapy standards framework*. https://www.physioboard.org.nz/standards

Pretorius, A., Karunaratne, N., & Fehring, S. (2016). Australian physiotherapy workforce at a glance: A narrative review. *Australian Health Review*, *40*(4), 438–442. https://doi.org/10.1071/ah15114

Reid, A., & Dixon, H. (2018). *M4king sen5e of 7he numbers. Analysis of the physiotherapy workforce*. BERL. https://pnz.org.nz/Folder?Action=View%20File&Folder_id=1&File=PNZ%20Workforce%20Issues%20December%202018.pdf

Sandelowski, M. 2000. Whatever happened to qualitative description? *Research in Nursing & Health, 23*(4), 334–340. https:10.1002/1098-240x(200008)23:4<334::aid-nur9>3.0.co;2-g

Snowdon, D. A., Millard, G., & Taylor, N. F. (2015). Effectiveness of clinical supervision of physiotherapists: A survey. *Australian Health Review*, *39*(2), 190–196. https://doi.org/10.1071/ah14020

Varpio, L., Ajjawi, R., Monrouxe, L. V., O'Brien, B. C., & Rees, C. E. (2017). Shedding the cobra effect: Problematising thematic emergence, triangulation, saturation and member checking. *Medical Education*, *51*(1), 40–50. https://doi.org/10.1111/medu.13124

Wells, C., Olson, R., Bialocerkowski, A., Carroll, A., Chipchase, L., Reubenson, A., Scarvell, J. M., & Kent, F. (2021). Work readiness of new graduate physical therapists for private practice in Australia. Academic faculty, employer, and graduate perspectives. *Physical Therapy and Rehabilitation Journal*, *101*(6), pzab078. https://doi.org/10.1093/ptj/pzab078

Westervelt, K. C., Hing, W., McGovern, M., Banks, L., Carney, C., Kunker, K., Magoon, A., Sibold, J., & Crane, L. (2018). An online model of international clinical mentoring for novice physical therapists. *Journal of Manual & Manipulative Therapy*, *26*(3), 170–180. https://doi.org/10.1080/10669817.2018.1447789

Williams, A., Phillips, C., & Rushton, A. (2022). Exploration of mentor and mentee perspectives of a mentored clinical practice programme to improve patient outcomes in musculoskeletal physiotherapy. *PLoS One, 17*(8), e0272728. https://doi.org/10.1371/journal.pone.0272728

Williams, A., Rushton, A., Lewis, J. J., & Phillips, C. (2019). Evaluation of the clinical effectiveness of a work-based mentoring programme to develop clinical reasoning on patient outcome: A stepped wedge cluster randomised controlled trial. *PLoS One, 14*(7), e0220110. https://doi.org/10.1371/journal.pone.0220110

Yoon, L., Campbell, T., Bellemore, W., Ghawi, N., Lai, P., Desveaux, L., Quesnel, M., & Brooks, D. (2017). Exploring mentorship from the perspective of physiotherapy mentors in Canada. *Physiotherapy Canada*, *69*(1), 38–46. https://doi.org/10.3138/ptc.2015-52

Appendix A

MENTOR COMMENCEMENT SURVEY

Pilot Project

Please complete your details below. This information will be used for the purposes of matching you with a mentee, and for data collection and analysis. Your data will remain confidential. All identifying information will be removed before data analysis.

*Required

1. First name *
2. Last name *
3. Date of birth: *
4. Email *
5. Contact phone number *
6. Ethnicity *
   - ◯ New Zealand Māori
   - ◯ New Zealand European/Pākehā
   - ◯ Pacific Island
   - ◯ European (not further defined)
   - ◯ Chinese
   - ◯ Indian
   - ◯ Asian (not further defined)
   - ◯ Other
   - ◯ Prefer not to say
7. How many years of physiotherapy practice experience do you have? *
8. What qualifications do you hold? (Select all that apply). If "other", please specify. *
   - ◯ Diploma/Bachelor of physiotherapy
   - ◯ Postgraduate certificate
   - ◯ Postgraduate diploma
   - ◯ Masters degree in physiotherapy
   - ◯ PhD

   Other: _____
9. What is your registered scope of physiotherapy practice? *
   - ◯ General scope
   - ◯ Advanced practitioner
   - ◯ Titled (Australia)
   - ◯ Specialist
   - ◯ Other: _____
10. What is/was your main area of clinical practice? *
    - ◯ Private practice (musculoskeletal)
    - ◯ Private practice (other)
    - ◯ DHB/hospital rotation work
    - ◯ Educational institution
    - ◯ Sports physiotherapy
    - ◯ Residential care
    - ◯ Cardiorespiratory
    - ◯ Neurology
    - ◯ Pain
    - ◯ Hand therapy
    - ◯ Occupational health
    - ◯ Pelvic health
    - ◯ Paediatrics
    - ◯ Older adult health
    - ◯ Other _____
11. What city are you located in? *
12. Have you ever participated in any formal mentor training? *
    - ◯ Yes
    - ◯ No
13. If you answered "Yes" to the question above, please describe the training including the number of hours of training you received.

    _____

    _____

    _____

14. Please rate your skills in the following areas: *

	Not at all skilled	Slightly skilled	Somewhat skilled	Moderately skilled	Extremely skilled
Active listening	◯	◯	◯	◯	◯
Providing constructive feedback	◯	◯	◯	◯	◯
Establishing a relationship based on trust	◯	◯	◯	◯	◯
Utilising different communication styles	◯	◯	◯	◯	◯
Identifying different learning styles	◯	◯	◯	◯	◯
Identifying and managing expectations	◯	◯	◯	◯	◯
Establishing realistic goals	◯	◯	◯	◯	◯
Motivating others	◯	◯	◯	◯	◯
Building the confidence of others	◯	◯	◯	◯	◯
Developing the knowledge and skills of others	◯	◯	◯	◯	◯

15. What do you see as your key strengths as a mentor? *

16. Is there anything you would like your mentee to know that might help you tobuild a successful relationship? e.g., Your preferred communication style.

Appendix B

MENTEE COMMENCEMENT SURVEY

Pilot Project

Please complete the form below. This should take approx. 5 minutes. This information will be used for the purposes of matching you with a mentor, and for data collection and analysis. Your data will remain confidential. All identifying information will be removed before data analysis.

*Required

1. First name *
2. Last name *
3. What is your gender? *

   Mark only one oval.

   - ◯ Male
   - ◯ Female
   - ◯ Prefer not to say
   - ◯ Other:
4. Date of birth: *
5. Email *
6. Contact phone number *
7. Ethnicity *

   - ◯ New Zealand Māori
   - ◯ New Zealand European/Pākehā
   - ◯ Pacific Island
   - ◯ European (not further defined)
   - ◯ Chinese
   - ◯ Indian
   - ◯ Asian (not further defined)
   - ◯ Other
   - ◯ Prefer not to say
8. Please state the reason(s) you are interested to participate in this study. *

   _____

   _____
9. What city are you located in?

   _____
10. Zoom will be our preferred platform for mentee-mentor meetings. How confident are you in using Zoom? *

	1	2	3	4	5	
Not confident at all	◯	◯	◯	◯	◯	Extremely confident

11. What area of practice will you be working in 2022? *
    Check all that apply.

    - ◯ Private practice (musculoskeletal)
    - ◯ Private practice (other)
    - ◯ DHB/hospital rotation work
    - ◯ Educational institution
    - ◯ Sports physiotherapy
    - ◯ Residential care
    - ◯ Cardiorespiratory
    - ◯ Neurology
    - ◯ Pain
    - ◯ Hand therapy
    - ◯ Occupational health
    - ◯ Pelvic health
    - ◯ Paediatrics
    - ◯ Older adult health

    Other: _____
12. For Māori physiotherapists only: If you are a Māori physiotherapist, do you wish to be paired with a Māori mentor?
    Mark only one oval.

    - ◯ Yes
    - ◯ No
    - ◯ I have no preference and am happy to be paired with any mentor.

13. Do you have a gender preference for your mentor? *

- ◯ Male
- ◯ Female
- ◯ I don't have a preference

14. To assist in matching mentors with mentees, please indicate if there are any specific areas where you feel you may need support, and feel free to add an area under "Other". Please select ALL that apply. *

- ◯ Professional and ethical practice
- ◯ Communication (patient, colleagues, including health records/documentation)
- ◯ Collaboration (e.g., interprofessional practice, working in teams)
- ◯ Self-directed and lifelong learning (developing PD plans, sourcing information, learning in the workplace)
- ◯ Education (teaching principles, facilitating learning)
- ◯ Management/Leadership
- ◯ No specific area
- ◯ Other _____

15. What are the top THREE (3) things you would like to achieve from mentoring?*

_____

_____

_____

16. Is there anything you would like your mentor to know that might help you to build a successful relationship? e.g., your preferred communication style.

_____

_____

_____

Concurrent Validity of Clinical Balance Tests and Falls Risk for Older Adults with Cognitive Impairment

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ABSTRACT

Older adults with cognitive impairment frequently have reduced balance and are at high risk for falling. We investigated the concurrent validity of the Physiological Profile Assessment (PPA) and the Timed Up and Go (TUG) test with computerised posturography in 13 older adults (mean (*SD*) age, 80 (8) years) with mild-to-moderate cognitive impairment (mean (*SD*) Mini-Mental State Examination score, 19 (9)). Spearman's rho demonstrated moderately good positive correlation between PPA (muscle strength) and posturography rising index (r_s = 0.699, p = 0.01) and posturography mediolateral sway during eyes open standing on a foam surface (r_s = 0.604, p = 0.04); good negative correlations between PPA anteroposterior sway (eyes closed) and posturography sway velocity (eyes open) standing on foam (r_s = –0.745, p = 0.01) and Romberg ratios of PPA and posturography (r_s = –0.698, p = 0.02); moderately good positive correlations between TUG and posturography (left step quick turn *time;* left turn *sway*; r_s = 0.548, p = 0.04; 0.646, p = 0.02); and good-to-excellent negative correlation between TUG and posturography (rising index r_s = –0.719, p = 0.01). Both tests appear valid measures of balance in older adults with mild-to-moderate cognitive impairment; however, we suggest both are used.

Mesbah, N., Perry, M., Hill, K. D., Manlapaz, D., & Hale, L. (2023). Concurrent validity of clinical balance tests and falls risk for older adults with cognitive impairment. *New Zealand Journal of Physiotherapy, 51*(2), 188–198. https://doi.org/10.15619/nzjp.v51i3.277

Key Words: Balance, Cognitive Impairment, Concurrent Validity, Falls Risk, Older Adults, Postural Stability

INTRODUCTION

Older adults with cognitive impairment frequently have reduced balance and are at high risk for falling (Allali et al., 2017). Cognitive impairment in older adults forms part of the syndrome of dementia, an overarching term for a clinical syndrome "characterised by progressive cognitive decline that interferes with the ability to function independently" (Duong et al., 2017, p. 118). Changes in cognition, function, and behaviour vary greatly between those living with dementia and are insidiously progressive, starting with mild cognitive impairment typically not assigned a diagnosis (Duong et al., 2017). A major concern for older adults living with dementia is that of falling, with an increased falls risk of two to three times that of older adults without cognitive impairment and an annual falls rate of around 60% (Allali et al., 2017; Goldup, 2017).

Risk factors for falling associated with dementia include poorer executive function and visuospatial scores, use of centrally acting medications, high number of medications, psychiatric comorbidities, such as anxiety or depression, and reduced mobility and balance (Goldup, 2017). Further to this, postural stability and balance have been shown to be impaired in older adults with mild to moderate Alzheimer's disease (AD), the most common type of dementia, with decreasing visual input and ability to concentrate on multiple tasks found to particularly impact postural stability (Mesbah et al., 2017). Some aforementioned risk factors are unmodifiable; however, exercise and/or physical activity has shown promise to reduce the rate of falls in people with dementia, theorised to mediate falls risk by reducing the rate of physical decline through maintaining

or improving balance and mobility (Goldup, 2017). Arguably, addressing balance and mobility concerns is likely to be more effective before cognitive decline progresses. Interventions targeting balance and mobility, commonly prescribed and delivered by physiotherapists, are therefore recommended but require appropriate clinical measures of outcome, with demonstrated properties of validity, reliability, utility, and safety (Suttanon et al., 2011).

Several measurement tools have been recommended for evaluation of balance in older adults with dementia. These tools include both clinical tools such as the Timed Up and Go (TUG) test (Goldup, 2017; Mesbah et al., 2017; Suttanon et al., 2011) and one component of the Physiologic Profile Assessment (PPA) (Lord et al. 2003), and laboratory-based tools like computerised posturography (Lorbach et al., 2007). While the advantage of clinical balance tests is their ease of execution, their variable execution and subjective scoring systems can render these tools sub-optimal (Jacobs et al., 2006; Munhoz et al., 2004). As such, a clinical outcome measure of balance provides a limited understanding of postural instability. The advantages of laboratory-based tests, such as computerised posturography are their objectivity and detailed results that can guide clinical management (Chaudhry et al., 2011), but their limitations include poor accessibility, cost, time to set up and administer, and size of the equipment.

Many authors consider laboratory measures, such as computerised posturography, to be the "gold standard" (Versi, 1992) in measuring balance due to their reliable, comprehensive, and objective measurement (Dodd et al., 2003; Furman et al., 1994; Ionescu et al., 2005; Mancini & Horak, 2010; Trueblood et al., 2018). Indeed, the NeurocomTM force plate tests of the modified Clinical Test of Sensory Interaction on Balance, Walk Across (step width, step length parameters), and sit to stand (rising index parameter) demonstrated excellent retest reliability ($ICC_{3,1}$ ranging from 0.75 to 0.91) in 14 older people with mild to moderate AD (Suttanon et al., 2011). Such measures, however, are not readily available in a physiotherapy community or primary health care setting, nor are practical or easily transportable, and can be time consuming to execute.

The types of outcome measures used to evaluate balance in older populations with dementia were found in a published systematic review to be inconsistent across studies (Mesbah et al., 2017). A more consistent approach to outcome measures used to evaluate changes of balance has been recommended (Howe et al., 2011). Although a consensus statement on tools and measures most useful to evaluate balance in adult populations has been published (Sibley et al., 2015), the applicability of this to older adults with dementia is unclear (Sibley et al., 2015). For populations with dementia, it is recommended that outcome measures should be quick to execute and instructions easy for the person being tested to follow (Horak, 2006).

Two clinically applied measurement tools of falls risk including balance, the PPA and the TUG, potentially meet the requirements of being "quick to execute" and "easy to follow instructions" and have been shown to have reasonable reliability in older adults with cognitive impairment. For example, the TUG's retest reliability in 14 older people with mild to moderate AD was moderately high (intraclass correlation coefficient ($ICC_{3,1}$) = 0.5 and 0.7) (Suttanon et al., 2011). The PPA demonstrated a range of test-retest reliability data in 21 older adults with mild to moderate AD: excellent for high- and low-contrast visual acuity, contrast sensitivity, knee extension strength, coordinated stability, and maximal balance range tests (ICCs 0.78–0.90); fair-to-good for tactile sensitivity, ankle dorsiflexion strength, hand reaction time, sway on foam with eyes closed, and the overall falls risk score (ICCs 0.43–0.75), but poor for proprioception, foot reaction time, sway on floor (eyes open and closed), and sway on foam with eyes open (ICCs 0.18–0.39) (Lorbach et al., 2007).

In addition to reliability, a further clinometric property of outcome measurement to consider is that of concurrent validity. This construct measures how tests compare against a criterion or "gold standard" test. The aim of this study was to evaluate the concurrent validity of the PPA and the TUG tests with computerised posturography in older adults with cognitive impairment. If found to be concurrently valid, the TUG and the PPA could be used as valid measures of falls risk and balance in older adults with dementia in a community or clinical setting when computerised posturography was not available or impractical to use.

METHODS

Study design, recruitment, and study setting

This cross-sectional study was approved by the University of Otago Human Ethics Committee (reference number, H14/035). Participants were recruited through community advertisement such as newsletters distributed by the local Alzheimer's association. Volunteers contacted the primary researcher (NM) and were screened for eligibility by telephone. Information sheets and consent forms were then sent (by post or email) to potentially eligible participants. Testing occurred at two sites, at a university-based balance clinic and at a local rest home that offered a day care out-reach programme specifically for older adults with dementia living in the community.

Participants

Participants with the following criteria were included: (a) aged 65 years or older, (b) mild to moderate severity of cognitive impairment based on the Mini-Mental State Examination (MMSE) score ≥ 10 but ≤ 28/30 (Folstein et al., 1975; Ries et al., 2010; Shigemori et al., 2010), (c) community dwelling, (d) self-reported ability to understand verbal instruction sufficiently to safely undergo postural stability testing (Mozley et al., 1999), (e) independently mobile for a distance of at least 5 m (with or without walking devices), and (f) able to self-consent to participate (determining this ability was guided by steps outlined by the United Kingdom's Alzheimer's Society (Alzheimer's Society, 2023). Participants with cardiac and neurological impairments that would prevent them from doing the testing were excluded.

Procedure

Following the recruitment process, participants were provided with an appointment for testing. Participants were encouraged to have a support person accompany them. The participant was provided with an opportunity to ask questions and was then

asked to sign consent. All tests were conducted by NM and assisted by a research assistant (DM).

The following processes then took place:

1. Collection of self-reported (or support person proxy reported) demographic data: age, gender, marital status, ethnicity, height, weight, education level, duration of having memory loss, medical status, number of falls in the past 12 months, and medications. In this study, a fall was defined as "an unexpected event in which the person comes to rest inadvertently on the ground, floor, or other lower level" (Lamb et al., 2005, p. 1618).
2. Testing of cognitive function using the MMSE (Folstein et al., 1975). The MMSE is divided into two sections. The first section requires verbal responses to test orientation, memory, and attention; 21 is the maximum score. The second section tests the ability of an individual to name, follow verbal and written commands, write a sentence spontaneously, and copy a complex polygon similar to a Bender-Gestalt figure; 9 is the maximum score (Folstein et al., 1975). The score range has been divided into normal (27–30), mild (18–26), moderate (10–17), and severe (< 10) cognitive function (Folstein et al., 1975). For this study, and given the variability of cut-off in the literature, a cut-off ≥ 10 and ≤ 28/30 was employed to indicate mild to moderate severity of cognitive impairment (Folstein et al., 1975; Ries et al., 2010; Shigemori et al., 2010). A license for use of the MMSE was obtained for this study.
3. Each participant was then tested using computerised posturography using the Neurocom long plate (0.5 m x 1.5 m) (Neurocom Balance Master, Neurocom International Inc., USA), the PPA and the TUG. These tests were carried out in a random order assigned by a computerised random programme and are described below.

Tests

The protocol for testing was based on the standardised procedures published for each test and standardised instructions were used with each participant. Each test was demonstrated to the participant before the actual test was performed to increase their understanding of it. The score of the PPA and TUG performance were recorded on the study scoring sheet. Data from the posturography testing were computer generated, thus the scores were saved in a PDF file downloaded from the computer linked to the posturography system.

Computerised posturography using the long-plate equipment

Five tests were undertaken on the computerised posturography using the NeuroCom International Balance Manager System™ (the long-plate equipment) (Neurocom Balance Master, Neurocom International Inc., USA): (a) modified Clinical Test of Sensory Interaction on Balance (mCTSIB), (b) sit to stand, (c) step quick turn (to the left and the right), (d) walk across, and (e) limits of stability. The tests were first demonstrated to participants. The key elements in the instructions were the use of simple commands with cues and gestures provided when necessary. The testing procedures followed those used by Suttanon et al. (2011) and are briefly described in Table 1.

PPA

The PPA was developed by Lord and colleagues (2003) from Neuroscience Research Australia, to evaluate balance and risk of falling among older adults (Lord et al., 2003). The PPA measures five components: (a) postural sway: performed under four sensory conditions of eyes open or eyes closed on both a firm surface and a foam surface, (b) hand reaction time, (c) quadriceps muscle strength, (d) knee joint proprioception, and (e) vision edge contrast sensitivity. The details of the execution of the PPA can be found in Lord et al. (2003) but are briefly described in Table 1.

TUG test

The TUG, as described by the developers, can be used as a descriptive tool, providing information about an individual's balance, gait speed, and functional ability (Podsiadlo & Richardson, 1991), and as such was used in this study to measure balance and falls risk. This test has been shown to be feasible and reliable to use with older adults with mild to moderate dementia, despite the multi-step instructional nature of this test (Goldup, 2017; Mesbah et al., 2017; Suttanon et al., 2011). The shorter the time to complete the task the better the functional balance (Mancini & Horak, 2010). This test is described in Table 1.

Data analysis

SPSS software Windows version 23 (IBM Corporation, United States of America) was used to analyse the data. Descriptive analysis was used to calculate means, standard deviations, and the range of the continuous data, and percentage was used for categorical data.

Concurrent validity between the PPA, the TUG, and the computerised posturography was calculated using the Spearman rank order correlation (r_s) because all values violated the assumption of normality and linearity. As there are similarities and differences between the characteristics of balance evaluated by the three chosen tests, and none have a composite score of balance per se, concurrent validity between variables from within each test that had similar properties were correlated, as shown in Table 2. The strength of correlation coefficient was categorised according to the criteria by Portney and Watkins (2015): $r_s \geq 0.75$ demonstrated a good to excellent relationship, 0.50–0.75 moderate to good, 0.25–0.50 fair, and < 0.25 represented little or no relationship (Portney & Watkins, 2015; Portney & Watkins, 2000). The significance level was set at $p < 0.05$.

For the balance evaluation in the eyes open and eyes closed condition, the Romberg ratio (on firm and foam surface) was calculated by dividing the score of eyes closed with that of eyes open (Fujita et al., 2005) for both the PPA and computerised posturography sway. A value exceeding 1.0 indicates a greater amount of postural sway during the eyes closed condition (Tjernström et al., 2015). Romberg's ratio assesses visual dependency in postural stability and indicates the proprioceptive contribution to postural stability (Tjernström et al., 2015).

Table 1

Brief Description of Tests Used in this Study

Description of tests
Computerised posturography using the long-plate equipment
Modified Clinical Test of Sensory Interaction on Balance (mCTSIB): This test was used to measure postural sway under four sensory conditions: (a) eyes open and (b) eyes closed while standing on (c) a firm surface and (d) a foam surface; each participant undertook three trials, standing still for 10 s on each of the four test conditions. The smaller the sway velocity, the greater the stability. The best result from each test was used for statistical analysis (Suttanon et al., 2011).
Sit to stand: The sit to stand test measures the ability of the participant to stand up from a seated position without losing balance. The participant was asked to sit on a box that was placed at the centre of the measurement platform with the knees positioned in 90° flexion. On seeing a visual cue generated by the computer the participant had to stand up and hold a standing position for 5 s. Three trials were undertaken and the best score for each variable measured during this task was computed for statistical analysis. The outcome variables from this test were: (a) weight transfer time (s), (b) rising index (%), and (c) sway velocity (degree/s) (Suttanon et al., 2011).
Step quick turn: This is a test of stability during turning, measured in turn time (s) and turn sway (degree/s). The participant takes two steps then turns to one direction (left or right) and returns to the starting position. Performance was evaluated based on turning to both sides (left and right). The best measures of turn time (s) and turn sway (degree/s) were reported for turning in both directions from three trials in each direction and were used for analyses. The short turn time and low sway score indicate high stability (Suttanon et al., 2011).
Walk across: Walk across is a test of walking at a comfortable speed across the long plate. The measurements taken were step width (cm), step length (cm), and walking speed (cm/s). Step width is an indication of the size of the person's base of support. A smaller score indicates better postural stability. Completing the task quickly indicates longer step lengths were used, which is indicative of a better performance (Suttanon et al., 2011).
Limits of stability: Limits of stability (LOS) is a test of moving in eight directions as fast as possible towards to match the cursor of the individual's movement with that of a shifting target displayed on a screen. The measurements taken were speed and oscillation of weight shift (movement of centre of gravity within the body's LOS). All eight directions were tested once. The outcome variables include: (a) reaction time (s), is the time between the trigger signal to move (the centre of gravity) and the beginning of execution of movement. A low score indicates good performance; and (b) movement velocity (degree/s), that is, the average speed of centre of gravity movement. A low score indicates good performance (Suttanon et al., 2011).
Physiological Profile Assessment
Postural sway: Participants stand with feet together either on a firm floor or on a medium-density foam rubber mat (15 cm thick) for 30 s. The degree of body sway is measured using a swaymeter (a 40 cm long rod with a vertically mounted pen at its end is attached to the participant's waist). The pen tip is located on a square paper positioned on a height-adjustable table. As the person sways, the movement is recorded visually by the pen on a sheet of millimetre graph paper. The test is performed with eyes open and closed. The total sway (number of square millimetre squares traversed by the pen) and anteroposterior and mediolateral sway are recorded.
Edge contrast sensitivity: Assessed with the Melbourne Edge Test. Participants are presented with a card with 20 circular patches with visually reducing contrast variability and the participant is scored on their ability to accurately identify the orientation of the lowest contrast patch. This contrast sensitivity is measured in decibel units (1 dB = 10log10 contrast).
Proprioception: Assessed in sitting with the participant's eyes closed. An acrylic panel marked with a protractor is placed between the participant's feet and the participant is asked to lift one foot and then match the position of this foot with the other foot. The difference in alignment between the position of the two great toes is measured in degrees. An average of five attempts is recorded.
Maximum isometric muscular strength of the quadriceps: Measured in sitting on a specially provided chair using a spring-loaded dynamometer attached to the participant's ankle and the chair. The average of 3 trials is recorded in kg.
Timed Up and Go (TUG) test
The *TUG* (Podsiadlo and Richardson, 1991) was used to measure dynamic postural stability. This test timed the duration (s) for the participant to stand up from a standard chair without an arm rest, walk 3 m at their usual pace, turn, walk back and sit down again in the chair. Participants may use a walking device as necessary, but this use needs to be recorded and the device used in subsequent testing (Shumway-Cook et al., 2000).

Table 2

Matching of Similar Variable of the Three Tests for Purposes of Correlation Analysis

Test	Variables evaluating various aspects of balance and falls risk				
Computerised posturography using the long-plate equipment	mCTSIB	Sit to stand	Step quick turn	Walk across	Limits of Stability
PPA	Postural sway. (1) eyes open; (2) eyes closed on a firm surface or a foam surface	Quadriceps muscle strength. An important prerequisite to achieve the motor task of sit to stand			
TUG test	–	TUG includes sit to stand	TUG includes turning	TUG includes walking	–

Note. mCTSIB = modified Clinical Test of Sensory Interaction on Balance; PPA = Physiological Profile Assessment; TUG = Timed Up and Go test.

RESULTS

Participants

Demographic data for the 13 participants (7 male, 6 female) are reported in Table 3. Included participants had a mean (*SD*) age of 80 (8) (range 71–94) years and a mean (*SD*) MMSE of 19 (9) (range 14–28) points. Ten participants were recruited from a day care programme that specifically catered for older adults with dementia and three participants via the local Alzheimer's Society newsletter. Three participants had diagnoses of dementia (one with AD, two with fronto-temporal lobe dementia). A history of falls in the previous year was self-reported by four participants and confirmed by their support person. One participant used a walking stick during the TUG, walk across, and step quick turn tests. One participant could not perform the walk across and step quick turn tests due to failure of the testing equipment at the time of their test.

The computerised posturography limits of stability test was only carried out on six (46%) participants as those with a history of falling declined to complete the test as they felt apprehensive of falling. One participant did not complete the PPA as she was anxious about falling and declined to participate in the last four aspects of the PPA test. There were no other safety incidents reported during or after the tests. Missing data were thus due to participants being unable to complete a test due to their concern for their safety. In these instances, the test was stopped immediately and was noted as "unable to complete".

Concurrent validity assessment

Tables 4–6 illustrate the results of the correlation coefficients of the PPA and the TUG against variables from computerised posturography, namely, mCTSIB, sit to stand, step quick turn, and walk across tests.

Concurrent validity of the Physiological Profile Assessment

To assess the concurrent validity of the PPA, the sway and quadriceps muscle strength variables were compared with tasks of a similar nature performed using computerised posturography (Tables 4 and 5). Spearman's rho indicated the presence of moderate to good positive correlation between muscle strength (PPA) and the rising index (computerised posturography) (r_s = 0.699, p = 0.01, n = 12), and mediolateral sway during eyes open standing on foam (PPA) and sway velocity during eyes open standing on foam surface (computerised posturography) (r_s = 0.604, p = 0.04, n = 12). There were good negative correlations between anteroposterior sway during eyes closed standing on foam (PPA) and sway velocity during standing on foam with eyes open (computerised posturography) (r_s = –0.745, p = 0.01, n = 12) and Romberg ratio between PPA and computerised posturography (r_s = –0.698, p = 0.02, n = 12). The other variables did not significantly correlate (p > 0.05).

Concurrent validity of the TUG test

Similarly, to assess the concurrent validity of the TUG, performance of the test was compared with tasks of a similar nature performed using computerised posturography. Table 6 reports the results of concurrent validity between the TUG and step quick turn, sit to stand, and walk across tests. Moderate to good positive correlations were found between the TUG and the step quick turn *time* turn to left (computerised posturography) (r_s = 0.548, p = 0.04, n = 12) and step quick turn *sway* to left (computerised posturography) (r_s = 0.646, p = 0.02, n = 11). Good to excellent negative correlation was found between the TUG and rising index (computerised posturography) (r_s = –0.719, p = 0.01, n = 13). The other variables did not significantly correlate (p > 0.05).

DISCUSSION

In this study, the PPA and the TUG were shown to have moderate to excellent concurrent validity compared to the criterion test of computerised posturography in older adults with mild to moderate cognitive impairment. Four pairs of variables demonstrated concurrent validity. However, as not all variables between the PPA and the TUG correlated with comparable items of the computerised posturography, we suggest that both the PPA and the TUG may be required to evaluate balance and falls risk in older adults with self-reported memory loss in a clinical setting.

Thirteen older adults aged 71 to 94 years were recruited, with self-reported memory loss. Although a confirmed diagnosis of dementia would have been ideal, only three participants had confirmed dementia and the diagnoses of the other participants remained unconfirmed. Due to recruitment difficulties, participants were selected based on self-report of memory loss as opposed to confirmed diagnostic criteria. Subsequent

Table 3

*Demographics and Health Status Characteristics of Participants (*N = *13)*

Characteristic	*M* (*SD*)	Range	*n*	%
Age, years	80 (8)	71–94		
Male			7	54
Height, m	1.6 (1.6)	1.4–1.9		
Weight, kg	73.9 (13.0)	41.0–93.0		
Education				
High school			10	75
Tertiary diploma/degree			2	17
Other			1	8
MMSE [a]	19 (9)	14–28		
Diagnosis				
Confirmed dementia diagnosis			3	23
Corrective lenses				
Bifocal			11	85
No visual correction			2	15
History of fall				
No fall			9	69
One-time fall			4	31
Number of medical conditions [b]				
0			4	31
1			4	31
2			2	15
≥ 3			3	23
Number of medications		0–4		
Use of walking aids			1	8

Note: MMSE = Mini-Mental State Examination; TUG = Timed Up and Go test.

[a] *n* = 11, 2 participants did not have recent MMSE scores. [b] Medical conditions included hypertension, heart disease, lung disease, depression, diabetes, musculoskeletal and history of stroke.

testing of participants with the MMSE, however, confirmed that eight participants did indeed have mild to moderate cognitive impairment (mean (*SD*) 20 (3), range 14–24). Thus, the findings of this study, while not reflecting specific diagnostic conditions (such as AD or a specific dementia), are representative for older adults with mild to moderate cognitive impairment, with the caveat that the identification of mild to moderate cognitive impairment was solely from the Mini Mental State Examination. This test has demonstrated high sensitivity (87% sensitivity) to measure cognitive impairment among older adults with dementia in residential care, hospital, or presenting at memory/dementia clinics, albeit in older adults with more cognitive impairments than participants in the current study (Folstein et al., 1985; Tombaugh et al., 1992). Targeting older adults with mild to moderate cognitive decline potentially enables concerns with balance and mobility to be addressed more effectively than when cognitive decline has progressed to more advanced levels.

This study demonstrated that participants who had stronger quadriceps muscles as measured by the PPA and were faster at completing the TUG had higher force generation from their lower legs when standing up (as measured by computerised posturography). Previous studies have evaluated the relationship of muscle strength and the sit to stand task in older adults (Lord et al., 2002; Kwan et al., 2011; Schenkman et al., 1996). For instance, among 280 community-dwelling older adults aged 65 years and above, quadriceps muscle strength was found to significantly influence ($p < 0.001$, $r_s = 0.231$) the performance of the TUG (Kwan et al., 2011). This finding is not surprising given that in sit to stand, a common daily living activity (Millington et al. 1992), the quadriceps muscles are required to generate the force to initiate the extension phase of sit to stand (Corrigan & Bohannon, 2001; Miyoshi et al., 2005).

The moderate correlation found between the TUG with the time taken and amount of sway during a turning task measured by computerised posturography was expected, but that this correlation was only significant for turning to the left was not. Turning plays a role in many upright physical activities (Lenoir et al., 2006). Turning requires asymmetrical limb movement and, through changes in the execution of knee flexion-extension and ankle dorsi-plantarflexion, the inside limb is theorised to be functionally shorter than the outside limb (Dite & Temple, 2002). The inside foot is subject to a prolonged stance phase and a

Table 4

Spearman Rank Correlation (r_s) Between Sway (Physiological Profile Assessment) and Sway in AP and ML Direction (mCTSIB From Computerised Posturography)

PPA		mCTSIB			
		Firm surface		Foam surface	
		EO SV	EC SV	EO SV	EC SV
Firm surface					
EO sway AP	r_s	0.320	–0.176	–0.291	0.056
	p	0.31	0.58	0.36	0.86
	n	12	12	12	12
EO sway ML	r_s	0.386	0.302	0.303	–0.555
	p	0.22	0.34	0.34	0.06
	n	12	12	12	12
EC sway AP	r_s	–0.484	–0.043	–0.355	0.291
	p	0.11	0.90	0.26	0.36
	n	12	12	12	12
EC sway ML	r_s	0.040	0.107	–0.267	0.039
	p	0.90	0.74	0.40	0.91
	n	12	12	12	12
Foam surface					
EO sway AP	r_s	0.018	–0.438	–0.229	0.181
	p	0.96	0.16	0.48	0.57
	n	12	12	12	12
EO sway ML	r_s	0.604*	0.463	0.011	–0.364
	p	0.04	0.13	0.97	0.25
	n	12	12	12	12
EC sway AP	r_s	–0.327	–0.219	–0.745**	0.354
	p	0.30	0.49	0.01	0.26
	n	12	12	12	12
EC sway ML	r_s	–0.104	–0.046	–0.399	–0.028
	p	0.75	0.89	0.20	0.93
	n	12	12	12	12

Note: AP = anteroposterior; EC = eyes closed; EO = eyes open; mCTSIB = modified Clinical Test of Sensory Interaction on Balance; ML = mediolateral; PPA = Physiological Profile Assessment; SV = sway velocity.

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

10% increase in vertical force in the posteromedial section of the foot compared to straight-line walking (Peyer et al., 2017). In the current study, leg dominance may explain this difference, but unfortunately leg dominance data were not collected. Future research should measure and analyse direction of turn related to the dominant and non-dominant leg.

For the correlation between sway items between the PPA and the modified clinical test of sensory interaction, on balance, the main tests were those of upright standing on foam with eyes open and closed. Given the similarities of these two tests, the poor correlation was unexpected, with only three variables demonstrating a significant correlation (mediolateral sway [eyes open, standing on foam]; PPA anteroposterior sway [eyes closed] and posturography sway velocity [eyes open] standing on foam, and Romberg ratio). The differing density of the foam (supplied by the license company as part of the test equipment) used to stand on between the two tests could account for this. The foam used in the computerised posturography may have higher elasticity, thus causing more sway. Patel et al. (2008) reported on the elasticity of the foam used in their test (with foam categorised by their elastic modulus as firm, medium, and soft) and found that there was more variance in ankle torque when standing on more elastic foam (Patel et al., 2008). Standing on a foam (high elasticity) surface is thought to amplify postural stability sway by reducing the reliability of somatosensory input from cutaneous mechanoreceptors on the base of the feet and by changing the efficiency of ankle torque (Perry et al., 2000). The amount of compression explains this

Table 5

Spearman Rank Correlation (r_s) Between the Romberg Ratio and Muscle Strength Components of the PPA and the mCTSIB and Sit to Stand Components of Computerised Posturography

PPA		Computerised posturography Romberg ratio (mCTSIB)			
		Firm surface		Foam surface	
Romberg ratio (firm surface)	r_s	0.135		–0.113	
	p	0.68		0.74	
	n	12		11	
Romberg ratio (foam surface)	r_s	0.191		–0.698*	
	p	0.55		0.02	
	n	12		11	
		Sit to stand			
		WTT	RI	SV	LRWS
Muscle strength	r_s	0.554	0.699*	–0.323	–0.189
	p	0.06	0.01	0.31	0.56
	n	12	12	12	12

Note: LRWS = left right weight symmetry; mCTSIB = modified Clinical Test of Sensory Interaction on Balance; PPA = Physiological Profile Approach; RI = rising index; SV = sway velocity; WTT = weight transfer time.

*Correlation is significant at the 0.05 level (2-tailed).

Table 6

Spearman Rank Correlation (r_s) Between Timed Up and Go and Computerised Posturography's Step Quick, Sit to Stand and Walk Across Tests

Variable		Step quick turn				Sit to stand				Walk across			
		TTL	TTR	TSL	TSR	WTT	RI	SV	LRWS	SW	SL	WS	LRS
Timed up and go	r_s	0.584*	0.245	0.646*	0.491	–0.022	–0.719**	–0.409	–0.264	0.124	–0.470	–0.470	0.109
	p	0.04	0.47	0.02	0.13	0.94	0.01	0.17	0.38	0.69	0.25	0.11	0.74
	n	12	11	11	11	13	13	13	13	13	13	13	12

Note: LRS = left right walk symmetry; LRWS = left right weight symmetry; RI = rising index; SL = step length; SV = sway velocity; SW = walk step width; TSL = turn sway left; TSR = turn sway right; TTL = turn time left; TTR = turn time right; WS = walk speed; WTT = weight transfer time.

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

theory; if the compression of the foam surface that has low elasticity was large, participants would be able to feel some of the hard surface (i.e., floor) beneath the foam, thus the accuracy of sensory information from the mechanoreceptors on the base of the feet may increase (Patel et al., 2008), and therefore stability is increased. Even though Patel's study was conducted among healthy adults aged 19 to 43 years (Patel et al., 2008), the suggestion that different foam elasticity might give rise to the different results in the performance of postural stability may account for our findings.

The precision limitation of the sway measure by the PPA could be another reason for the lack of significant correlation, as measuring the distance of trajectory of the sway measure is done "manually" using the graph paper provided and may introduce error. It is now recommended to use the new software of the PPA that directly digitally measures the distance during the test (https://www.neura.edu.au/, Prince of Wales Medical Research Institute, Randwick, Sydney, NSW, Australia). Notwithstanding, our finding was dissimilar to that of a previous study that measured the validity of measuring postural sway with the sway meter device of the PPA compared to that measured by a force plate (Sturnieks et al., 2011). Sturnieks et al. (2011) found moderate to good correlations between the sway meter and the force plate sway measures across all four conditions (r = 0.560–0.865): eyes open and eyes closed standing on firm surface; and eyes open and eyes closed standing on foam surface. Although their study suggested the sway meter has good agreement with the force plate centre of pressure (COP) measures for anterior-posterior (r > 0.743)

and medio-lateral displacement ($r > 0.692$), it was conducted among 29 older adults without neurological problems, aged 71 to 83 years (mean = 78, *SD* = 3), with a mean (*SD*) MMSE score of 27.8 (1.7) (Sturnieks et al., 2011). The difference of the populations might explain the variance in results.

The TUG did not show any significant agreement with the walk across test measured by computerised posturography. The nature of the test might explain this discrepancy. While performing the TUG, a participant may need to accelerate and decelerate twice, while transferring positions, and before and after turning, while the walk across only requires one acceleration–deceleration execution. The earlier construction of the TUG by Podsiadlo and Richardson (1991) showed good correlation between time score in the TUG and gait speed. However, this study was conducted among older patients with no more than mild cognitive impairment (mean MMSE = 28) referred to a day hospital (Podsiadlo & Richardson, 1991), many of whom had reduced overall functional capacity (participants had history of stroke (38%), Parkinson's disease (17%) and osteoarthritis (15%)). In a study by Wall et al. (2000), the researchers suggested isolating each component of the TUG to further investigate which functional component was impaired. These authors measured the time taken at six points: sit to stand, gait initiation, walk, turn around, walk again, slow down, stop, and sit down. It might be that the components of turning and standing up are compromised among older adults with cognitive impairment, thus increasing the time taken to complete these tasks, explaining the findings of a significant correlation between the TUG and the step quick turn test.

Participants had difficulty in completing two of the computerised posturography tests: (a) eyes closed standing on the foam, and (b) the limits of stability test in all eight directions. This is not surprising as these two tests are particularly challenging for individuals' postural stability (Suttanon et al., 2011), the first because of the limited sensory information available to the participant during the test procedure, and the second because it involves moving towards outer points of stability for an individual. The value of the computerised posturography limits of stability test for use with older adults with cognitive impairment is, however, debatable as participants with a history of falling in our study declined to do the test due to fear of falling. Suttanon et al. (2011) investigated 14 older adults with similar cognitive impairment and all their participants were able to complete the same limits of stability test; however, only four of the 14 had a history of falling.

Study limitations

The findings of this study need to be interpreted within the context of its limitations. The first limitation was its small sample size; this was because recruitment of participants using our study's "mild-to-moderate impairment" eligibility criteria proved challenging. Although the low recruitment may partly be due to the small overall population in the region where the data collection was done (approximately 130,000), it may also be due to possibly eligible older adults' denial of potential cognitive problems and potential diagnosis, and thus failure to volunteer for our study (Cohen et al., 1984). This leads to the second limitation, that of heterogeneity of the population. Our sample was heterogeneous in that it likely included people with AD, other forms of dementia, frontotemporal, and cognitive impairment. We minimised the exclusion criteria to maximise participant recruitment, a strategy recommended when there are limited resources (Hardy et al., 2009). A third limitation was not collecting leg dominance data, which would have assisted evaluation and interpretation of the turn data.

CONCLUSION

The results of this study showed that the PPA and the TUG had moderate to excellent concurrent validity compared to the criterion test of computerised posturography in older adults with mild to moderate cognitive impairment. However, as not all variables between the PPA and the TUG correlated with comparable items of the computerised posturography, we suggest that both the PPA and the TUG may be required to evaluate balance and falls risk in older adults with mild to moderate cognitive impairment in a clinical setting. Recognising the limitations of the current study, further exploration is needed of clinical-based outcome measures to use with older adults with mild to moderate cognitive impairment.

KEY POINTS

1. Older adults with cognitive impairments frequently have balance impairments and thus are at a high risk for falling.
2. The types of outcome measures used to evaluate balance in cognitively impaired older populations vary across studies.
3. For cognitively impaired populations, it is recommended that outcome measures should be quick to execute and instructions easy for the person being tested to follow.
4. This study suggests that the Physiological Profile Assessment and the Timed Up and Go test might be practical to use in combination to measure balance in older people with mild to moderate cognitive impairment.

DISCLOSURES

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The authors have no conflicts of interest.

PERMISSIONS

No permissions were required.

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CONTRIBUTIONS OF AUTHORS

Design, conceptualisation, and methodology, NM and LH; formal analysis, NM; data curation, NM and LH; writing—original draft preparation, NM; writing—review and editing, NM, LH, MP, KH, and DM; funding acquisition, NM.

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REFERENCES

Allali, G., Launay, C. P., Blumen, H. M., Callisaya, M. L., De Cock, A.-M., Kressig, R. W., Srikanth, V., Steinmetz, J.-P., Verghese, J., Beauchet, O., & Biomathics Consortium. (2017). Falls, cognitive impairment, and gait performance: Results from the GOOD Initiative. *Journal of the American Medical Directors Association, 18*(4), 335–340. https://doi.org/10.1016/j.jamda.2016.10.008

Alzheimer's Society. (2023). *Assessing the mental capacity of a person with dementia*. https://www.alzheimers.org.uk/get-support/legal-financial/assessing-mental-capacity-dementia

Chaudhry, H., Bukiet, B., Ji, Z., & Findley, T. (2011). Measurement of balance in computer posturography: Comparison of methods – a brief review. *Journal of Bodywork and Movement Therapies, 15*(1), 82–91. https://doi.org/10.1016/j.jbmt.2008.03.003

Cohen, D., Kennedy, G., & Eisdorfer, C. (1984). Phases of change in the patient with Alzheimer's dementia: A conceptual dimension for defining health care management. *Journal of the American Geriatrics Society, 32*(1), 11–15. https://doi.org/10.1111/j.1532-5415.1984.tb05143.x

Corrigan, D., & Bohannon, R. W. (2001). Relationship between knee extension force and stand-up performance in community-dwelling elderly women. *Archives of Physical Medicine and Rehabilitation, 82*(12), 1666–1672. https://doi.org/10.1053/apmr.2001.26811

Dite, W., & Temple, V. A. (2002). Development of a clinical measure of turning for older adults. *American Journal of Physical Medicine and Rehabilitation, 81*(11), 857–866. https://doi.org/10.1097/00002060-200211000-00010

Dodd, K., Hill, K., Haas, R., Luke, C., & Millard, S. (2003). Retest reliability of dynamic balance during standing in older people after surgical treatment of hip fracture. *Physiotherapy Research International, 8*, 93–100. https://doi.org/10.1002/pri.276

Duong, S., Patel, T., & Chang, F. (2017). Dementia: What pharmacists need to know. *Canadian Pharmacists Journal, 150*(2), 118–129. https://doi.org/10.1177/1715163517690745

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Folstein, M. F., Anthony, J. C., Parhad, I., Duffy, B., & Gruenberg, E. M. (1985). The meaning of cognitive impairment in the elderly. *Journal of the American Geriatrics Society, 33*(4), 228–235. https://doi.org/10.1111/j.1532-5415.1985.tb07109.x

Fujita, T., Nakamura, S., Ohue, M., Fujii, Y., Miyauchi, A., Takagi, Y., & Tsugeno, H. (2005). Effect of age on body sway assessed by computerized posturography. *Journal of Bone and Mineral Metabolism, 23*(2), 152–156. https://doi.org/10.1007/s00774-004-0554-7

Furman, J. M. (1994). Posturography: Uses and limitations. *Baillieres Clinical Neurology, 3*(3), 501–513.

Goldup, H. (2017). Falls prevention in dementia: Literature review. *Journal of Dementia, 2*(1), 105.

Hardy, S. E., Allore, H., & Studenski, S. A. (2009). Missing data: A special challenge in aging research. *Journal of the American Geriatrics Society, 57*(4), 722–729. https://doi.org/10.1111/j.1532-5415.2008.02168.x

Horak, F. B. (2006). Postural orientation and equilibrium: What do we need to know about neural control of balance to prevent falls? *Age and Ageing, 35*(Suppl 2), ii7–ii11. https://doi.org/10.1093/ageing/afl077

Howe, T. E., Rochester, L., Neil, F., Skelton, D. A., & Ballinger, C. (2011). Exercise for improving balance in older people. *Cochrane Database of Systematic Reviews.* https://doi.org/10.1002/14651858.CD004963.pub3

Ionescu, E., Dubreuil, C., & Ferber-Viart, C. C. (2005). Physiological changes in balance control of adults aged 20 to 60 years assessed with Equitest. *Annales d'Oto-Laryngologie et de Chirurgie Cervico-faciale, 122*(5), 231–235. https://doi.org/10.1016/s0003-438x(05)82354-0

Jacobs, J. V., Horak, F. B., Tran, V., & Nutt, J. G. (2006). Multiple balance tests improve the assessment of postural stability in subjects with Parkinson's disease. *Journal of Neurology, Neurosurgery and Psychiatry, 77*(3), 322–326. https://doi.org/10.1136/jnnp.2005.068742

Kwan, M. M.-S., Lin, S.-I., Chen, C.-H., Close, J. C., & Lord, S. R. (2011). Sensorimotor function, balance abilities and pain influence Timed Up and Go performance in older community-living people. *Aging Clinical and Experimental Research, 23*(3), 196–201. https://doi.org/10.1007/BF03324960

Lamb, S. E., Jørstad-Stein, E. C., Hauer, K., & Becker, C., & Prevention of Falls Network Europe and Outcomes Consensus Group (2005). Development of a common outcome data set for fall injury prevention trials: The Prevention of Falls Network Europe consensus. *Journal of the American Geriatrics Society, 53*(9), 1618–1622. https://doi.org/10.1111/j.1532-5415.2005.53455.x

Lenoir, M., Van Overschelde, S., De Rycke, M., & Much, E. (2006). Intrinsic and extrinsic factors of turning preferences in humans. *Neuroscience Letters 393*(2–3),179–183. https://doi.org/10.1016/j.neulet.2005.09.061

Lorbach, E. R., Webster, K. E., Menz, H. B., Wittwer, J. E., & Merory, J. R. (2007). Physiological falls risk assessment in older people with Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders, 24*(4), 260–265. https://doi.org/10.1159/000107101

Lord, S. R., Menz, H. B., & Tiedemann, A. (2003). A physiological profile approach to falls risk assessment and prevention. *Physical Therapy, 83*(3), 237–252.

Lord, S. R., Murray, S. M., Chapman, K., Munro, B., & Tiedemann, A. (2002). Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 57*(8), M539–M543. https://doi.org/10.1093/gerona/57.8.m539

Mancini, M., & Horak, F. B. (2010). The relevance of clinical balance assessment tools to differentiate balance deficits. *European Journal of Physical Rehabilitation Medicine, 46*(2), 239–248.

Mesbah, N., Perry, M., Hill, K. D., Kaur, M., & Hale, L. (2017). Postural stability in older adults with Alzheimer disease. *Physical Therapy, 97*(3), 290–309. https://doi.org/10.2522/ptj.20160115

Millington, P. J., Myklebust, B. M., & Shambes, G. M. (1992). Biomechanical analysis of the sit-to-stand motion in elderly persons. *Archives of Physical Medicine and Rehabilitation, 73*(7), 609–617.

Miyoshi, K., Kimura, T., Yokokawa, Y., Cheng, G. A., Fujiwara, T., Yamamoto, I., & Kondo, Y. (2005). Effect of ageing on quadriceps muscle strength and on the forward shift of center of pressure during sit-to-stand movement from a chair. *Journal of Physical Therapy Science, 17*(1), 23–28.

Mozley, C. G., Huxley, P., Sutcliffe, C., Bagley, H., Burns, A., Challis, D., & Cordingley, L. (1999). 'Not knowing where I am doesn't mean I don't know what I like': Cognitive impairment and quality of life responses in elderly people. *International Journal of Geriatric Psychiatry, 14*(9), 776–783. https://doi.org/10.1002/(SICI)1099-1166(199909)14:9<776::AID-GPS13>3.0.CO;2-C

Munhoz, R., Li, J.-Y., Kurtinecz, M., Piboolnurak, P., Constantino, A., Fahn, S., & Lang, A. (2004). Evaluation of the pull test technique in assessing postural instability in Parkinson's disease. *Neurology, 62*(1), 125–127. https://doi.org/10.1212/wnl.62.1.125

Patel, M., Fransson, P.-A., Lush, D., & Gomez, S. (2008). The effect of foam surface properties on postural stability assessment while standing. *Gait and Posture, 28*(4), 649–656. https://doi.org/10.1016/j.gaitpost.2008.04.018

Perry, S. D., McIlroy, W. E., & Maki, B. E. (2000). The role of plantar cutaneous mechanoreceptors in the control of compensatory stepping reactions evoked by unpredictable, multi-directional perturbation. *Brain Research, 877*(2), 401–406. https://doi.org/10.1016/s0006-8993(00)02712-8

Peyer, K. E., Brassey, C. A., Rose, K. A., & Sellers, W. I. (2017). Locomotion pattern and foot pressure adjustments during gentle turns in healthy subjects. *Journal of Biomechanics, 60*, 65–71. https://doi.org/10.1016/j.jbiomech.2017.06.025

Podsiadlo, D., & Richardson, S. (1991). The timed "Up & Go": A test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society, 39*(2), 142–148. https://doi.org/10.1111/j.1532-5415.1991.tb01616.x

Portney, L. G., & Watkins, M. P. (2000). *Foundations of clinical research: Applications to practice* (2nd ed.). Prentice Hall Health.

Portney, L. G., & Watkins, M. P. (2015). *Foundations of clinical research: Applications to practice* (3rd ed.). FA Davis Company.

Ries, J. D., Drake, J. M., & Marino, C. (2010). A small-group functional balance intervention for individuals with Alzheimer disease: A pilot study. *Journal of Neurologic Physical Therapy, 34*(1), 3–10. https://doi.org/10.1097/NPT.0b013e3181d00f2e

Schenkman, M., Hughes, M. A., Samsa, G., & Studenski, S. (1996). The relative importance of strength and balance in chair rise by functionally impaired older individuals. *Journal of the American Geriatrics Society, 44*(12), 1441–1446. https://doi.org/10.1111/j.1532-5415.1996.tb04068.x

Shigemori, K., Ohgi, S., Okuyama, E., Shimura, T., & Schneider, E. (2010). The factorial structure of the Mini Mental State Examination (MMSE) in Japanese dementia patients. *BMC Geriatrics, 10*, 36. https://doi.org/10.1186/1471-2318-10-36

Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the Timed Up and Go Test. *Physical Therapy, 80*(9),896–903. https://doi.org/10.1093/ptj/80.9.896

Sibley, K. M., Howe, T., Lamb, S. E., Lord, S. R., Maki, B. E., Rose, D. J., Scott, V., Stathokostas, L., Straus, S. E, & Jaglal, S. B. (2015). Recommendations for a core outcome set for measuring standing balance in adult populations: A consensus-based approach. *PLoS One, 10*(3), e0120568. https://doi.org/10.1371/journal.pone.0120568

Sturnieks, D. L., Arnold, R., & Lord, S. R. (2011). Validity and reliability of the Swaymeter device for measuring postural sway. *BMC Geriatrics, 11*, 63. https://doi.org/10.1186/1471-2318-11-63

Suttanon, P., Hill, K. D., Dodd, K. J. & Siad, S. M. (2011). Retest reliability of balance and mobility measurements in people with mild to moderate Alzheimer's disease. *International Psychogeriatrics, 23*(7), 1152–1159. https://doi.org/10.1017/S1041610211000639

Tjernström, F., Björklund, M., & Malmström, E.-M. (2015). Romberg ratio in quiet stance posturography – Test to retest reliability. *Gait and Posture, 42*(1), 27–31. https://doi.org/10.1016/j.gaitpost.2014.12.007

Tombaugh, T. N., & McIntyre, N. J. (1992). The Mini-Mental State Examination: A comprehensive review. *Journal of the American Geriatrics Society, 40*(9), 922–935. https://doi.org/10.1111/j.1532-5415.1992.tb01992.x

Trueblood, P. R., Rivera, M., Lopez, C., Bentley, C., & Wubenhorst, N. (2018). Age-based normative data for a computerized dynamic posturography system that uses a virtual visual surround environment. *Acta Oto-Laryngologica, 138*(7), 597–602, https://doi.org/10.1080/00016489.2018.1429653

Versi, E. (1992). "Gold standard" is an appropriate term. *British Medical Journal, 305*(6846), 187. https://doi.org/10.1136/bmj.305.6846.187-b

Wall, J. C., Bell, C., Campbell, S., & Davis, J. (2000). The Timed Get-Up-and-Go test revisited: Measurement of the component tasks. *Journal of Rehabilitation Research and Development, 37*(1), 109–113.

The Understanding Persistent Pain Where it ResiDes Study of Low Back Pain Cohort Profile

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ABSTRACT

Despite chronic low back pain (LBP) being considered a biopsychosocial condition for diagnosis and management, few studies have investigated neurobiological risk factors thought to underpin the transition from acute to chronic LBP. The aim of this research is to describe the methodology, compare baseline characteristics between acute LBP participants and pain-free controls, and compare LBP participants with or without completed follow-up. One hundred and twenty individuals experiencing acute LBP and 57 pain-free controls were recruited to participate in the Understanding persistent Pain Where it ResiDes (UPWaRD) study. Neurobiological, psychological, and sociodemographic data were collected at baseline, and at 3 and 6 months. Ninety-five participants (79%) provided outcome data at 3-month follow-up and 96 participants (80%) at 6 months. Compared to controls, LBP participants in the UPWaRD cohort were older, had a higher BMI, a higher prevalence of comorbidities, and higher medication usage. Higher depression, anxiety and stress, lower pain self-efficacy, and higher pain catastrophising during acute LBP were correlated with higher 6-month pain and disability. This cohort provides novel and significant opportunities to increase understanding of neurobiological risk factors of LBP. Future findings endeavour to provide new targets for treatment and prevention of chronic LBP. Additional priorities include exploring epigenetic and proteomic biomarkers of poor LBP outcome.

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Key Words: Acute to Chronic, Demographic, Low Back Pain, Neurobiological, Psychological, Social

INTRODUCTION

The worldwide monthly prevalence of low back pain (LBP) is approximately 23%, with 83% of the world's population experiencing LBP at least once during their lifetime (Hoy et al., 2012; Manchikanti et al., 2014). The clinical course of LBP is complex, with many people reporting ongoing pain and disability 1 year following an acute episode (Costa et al., 2012; Henschke et al., 2008; Kongsted et al., 2015). LBP is a leading cause of disability worldwide (Vos et al., 2017) and associated with substantial economic burden, with $135 billion spent on low back and neck pain in the US in 2017 (Dieleman et al., 2020). Despite the scale of the problem, identifying those with acute LBP who are at risk of chronic or recurrent symptoms remains challenging.

Most cases of LBP have no identifiable pathoanatomical cause or clear nociceptive source that could explain chronic symptoms (Maher et al., 2017). This has led to a focus on the identification of psychological, social, and demographic risk factors to explain the transition to chronic LBP (Ardakani et al., 2019). Unfortunately, risk factors such as pain intensity, disability, psychological distress, smoking, and physical inactivity explain only some of the variance in LBP outcome (Hartvigsen et al., 2018; Kent & Keating, 2008; Lin et al., 2011; Shiri et al., 2010).

Investigation of biological risk factors in the development of chronic pain has been limited. Although some data are beginning to show that systemic inflammation and pain sensitivity interact with psychological features (Klyne et al., 2018; Klyne et al., 2019), the role of several other biological risk factors has not been investigated. The Understanding persistent Pain Where it ResiDes longitudinal cohort study (UPWaRD) aimed to recruit and follow a cohort of adults living in Australia who experienced an acute episode of LBP. The primary aim, as reported a priori in the study protocol (Jenkins et al., 2019), was to use this cohort to identify neurobiological, psychological, and sociodemographic risk factors that predict future LBP outcome. The neurobiological risk factors selected for investigation in the protocol were those with a putative link to the development of aberrant cortical and spinal neuroplasticity, hypothesised to explain why some individuals develop chronic pain after an acute episode.

In this paper we present a cohort profile. Cohort profiles describe the rationale, methodology, baseline data, and future plans of a longitudinal cohort study. A cohort profile bridges the gap between study protocol and results, providing readers with an honest experience of conducting the cohort study, potentially facilitating collaboration (Ebrahim, 2004).

Therefore, the overarching aim of this paper is to present a cohort profile for the UPWaRD study. Specifically, this paper addresses the aims of a cohort profile through (a) describing the design, participant recruitment, and measurement procedures of the UPWaRD study; (b) comparing baseline characteristics of the cohort (health, sociodemographic, psychological, and lifestyle factors) between individuals with or without acute LBP; (c) describing the recovery trajectories (pain and disability) of individuals with acute LBP over a period of 6 months; and (d) reporting future plans for data obtained within this cohort.

METHODS

Study design

The UPWaRD study was a multicentre, prospective, longitudinal, cohort trial of people with acute (within 6 weeks of pain onset) LBP, and pain-free controls, with 3- and 6-month follow-up. The study received funding from the National Health and Medical Research Council of Australia (Grant ID, 1059116). All study procedures were approved by the Human Research Ethics Committees of Western Sydney University (H10465) and Neuroscience Research Australia (SSA:16/002) and in accordance with the Helsinki Declaration of 1975, as revised in 1983. All participants provided written, informed consent for participation in the study and its related procedures.

Recruitment and follow-up

Participants were recruited through flyers around university campuses and the local community, social media posts, local hospitals in South Eastern Sydney and South Western Sydney Local Health Districts, New South Wales, Australia, primary care practitioners (e.g., GPs and physiotherapists), and newspaper advertisements. Screening was conducted via email and phone. Potential participants who contacted the research team or were referred from a practitioner were contacted over the phone within 24 hr to discuss the study purpose and methodology. Participants were then sent a detailed participant information sheet and screening form via email. Participants who returned the screening form were considered "screened" and any reason for exclusion was documented.

Acute LBP participants were eligible if they experienced pain in the region of the lower back, superiorly bounded by the thoracolumbar junction and inferiorly by the gluteal fold (Müller et al., 2019). Pain must have been present for more than 24 hours and persisted for less than 6 weeks following a period of at least 1 month pain-free (De Vet et al., 2002; Müller et al., 2019; Stanton et al., 2008; Williams et al., 2014). Participants remained eligible if they reported a previous history of LBP. As we sought to identify predictors of recovery from an acute episode of LBP, regardless of the history of LBP, inclusion of strictly first episode LBP was not required to achieve our study aims. Given the prevalence of LBP in the community and the identification that most LBP is recurrent, the generalisability of a strictly first episode LBP cohort would also be questionable. All participants with pain referred beyond the inferior gluteal fold underwent a physical examination by a trained physiotherapist (study staff) to identify any sensory or motor deficit of the lower extremity. Participants with suspected lumbosacral radiculopathy characterised by the presence of weakness, loss of sensation, or loss of reflexes associated with a particular nerve root, or a combination of these, were excluded (Lin et al., 2014). Individuals who presented with suspected serious spine pathology (e.g., fracture, tumour, cauda equina syndrome), other major diseases/disorders (e.g., schizophrenia, chronic renal disorder, multiple sclerosis), a history of spine surgery, or any other chronic pain conditions were excluded. As transcranial magnetic stimulation (TMS) was an important variable measured in the UPWaRD study, all participants were additionally screened for contraindications to the use of TMS (as described by Keel et al. (2001).

Exclusion criteria for pain-free controls were LBP within the past 12 months, previous history of spine surgery, any other chronic pain conditions, other major diseases/disorders, or contraindications to the use of TMS. Pain-free participants were carefully screened to ensure they were pain-free prior to study enrolment and at the time of baseline testing.

Data collection

Participants completed a laboratory testing session and a battery of questionnaires (online or in person) at baseline, 3, and 6 months. All variables were measured in a standardised order for all participants and four assessors performed all laboratory sessions between Western Sydney University, Campbelltown Campus, or Neuroscience Research Australia. Duration of assessment of all variables was approximately 2.5 hr. Measures were collected within the domains of health (e.g., weight), sociodemographic (e.g., cultural diversity), psychological (e.g., depression, catastrophising, self-efficacy), clinical (Keele StarT Back Screening Tool), neurobiological (e.g., electroencephalography), biological (serum biomarkers), pain processing (e.g., pressure pain sensitivity), and lifestyle (e.g., physical activity – International Physical Activity Questionnaire). Detailed description of all measures obtained in the UPWaRD Cohort and their methodology is described in Appendix A, Table A1. This table includes details of which measures were added after registration/protocol publication. Pain-free controls were followed up at 3 and 6 months to allow comparison of neurobiological and psychological variables between participants with and without LBP, and allow assessment of measurement stability across baseline, 3, and 6 months in pain-free individuals (Cunningham et al., 2021).

In brief, neurobiological measures were selected based upon a theoretical association between cortical and spinal plasticity and the development of chronic LBP and supporting evidence from cross-sectional studies (Baumbauer et al., 2020; Flor et al., 1997; Hayden et al., 2009; Linton, 2000; Schabrun et al., 2017; Tsao et al., 2011). For psychological measures, three questionnaires were used to assess specific aspects of psychological status with evidence of relevance to the development of chronic LBP: the 21-Item Depression, Anxiety and Stress Scales Questionnaire (DASS-21) (Antony et al., 1998; Parkitny et al., 2012), the 13-item Pain Catastrophizing Scale (PCS) (Sullivan et al., 1995), and 10-item Pain Self-Efficacy Questionnaire (PSEQ) (Nicholas, 2007). A commonly used clinical prediction tool, The Keele StarT Back Screening Tool was also administered among LBP participants at baseline assessment (Hill et al., 2008). Sociodemographic, environmental, and lifestyle factors were selected based on the Australasian Electronic Persistent Pain Outcomes Collaboration minimum dataset recommendations (Tardif et al., 2017). Guidelines for that minimum dataset were first developed in 2011 by an expert team, consisting of members of the Faculty of Pain Medicine of the Australian and New Zealand College of Anaesthetists, Australian Pain Society, and New Zealand Pain Society. Participants were free to seek and utilise any treatment, and data were collected on healthcare utilisation and medication consumption. No form of treatment or advice was provided within this study.

Average pain intensity over the week preceding baseline and follow-up assessment was self-reported by participants using the 11-point numerical rating scale (NRS) anchored with "no pain" at 0 and "worst pain possible" at 10. Disability was assessed using the 24-point Roland Morris Disability Questionnaire (RMDQ) on the day of baseline and follow-up testing. An item receives a score of 1 if it is applicable to the respondent or 0 if it is not, with a total range of 0 (no disability) to 24 (severe disability) (Roland & Morris, 1983).

Sample size

Sample size for the primary study aim (i.e., to determine whether cortical reorganisation, an individual's capacity for neuroplasticity, central sensitisation, psychosocial factors, and their possible interaction, predict LBP outcome) was initially calculated (pre study commencement) based on an assumption the prediction model would include 17 candidate predictors, five a priori interactions, and nine sociodemographic variables. Allowing for 10% loss to follow-up, a power of 80% with a 5% level of significance and a medium effect size, a sample size of 264 participants was required. Once data collection commenced, a slower than expected rate of participant recruitment made the target sample size unachievable. On this basis, the sample size calculation for the primary aim was revised using the rule of thumb that 10 subjects per variable are required to adequately power a linear regression model (Harrell Jr, 2015) and a minimum of five events per candidate variable is required for logistic regression analysis (Vittinghoff & McCulloch, 2007) resulting in a required sample size of 120 individuals with acute LBP. Prior to the completion of data collection and analysis, the UPWaRD study was registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12619000002189) and the protocol for the primary study aim was published (Jenkins et al., 2019). Both documents include description of the revised sample size calculation and this sample size (n = 120) was achieved as planned.

Statistical analyses

Statistical Package for the Social Sciences software (version 27; IBM Corp) was used for all analyses in this study. Statistical significance was accepted at $p \leq 0.05$ and all analyses were conducted on complete cases, with missing data described in Appendix A, Table A2. First, the distribution of individual variables was inspected using histograms. Continuous data are presented as mean and standard deviation (normally distributed) or median and interquartile range (non-normally distributed), and categorical data presented as number and percentage.

To explore potential differences in LBP recovery trajectories at 3 and 6 months, participants were divided into three sub-groups based on standardised criteria: (a) unresolved LBP if participants reported an increase or no change in pain intensity (NRS) and disability (RMDQ) from baseline, or a pain NRS score of ≥ 7/10, corresponding with severe pain (Boonstra et al., 2016); (b) partially resolved LBP if participants reported a decrease in pain and/or disability from baseline (≥ 1-point reduction on NRS and/or RMDQ from baseline scores); or (c) resolved LBP if participants reported no pain and disability (NRS and RMDQ = 0) at follow-up (Boonstra et al., 2016; Klyne et al., 2018).

Comparisons were made between participants who did or did not complete follow-up, and between participants with or without LBP using independent samples t-test, non-parametric

Mann-Whitney *U* test and Fisher's exact test for normally distributed, non-normally distributed, and categorical data, respectively. Spearman's rank correlation coefficients and the corresponding bootstrapped and bias-corrected 95% confidence intervals were used to determine whether depression and anxiety (DASS-21), pain catastrophising (PCS) or pain self-efficacy (PSEQ) were correlated with 6-month pain intensity (NRS) or disability in the UPWaRD LBP participants. A one-way multivariate analysis of variance (MANOVA) was used to compare differences in moderate and vigorous physical activity minutes at baseline, 3 months, and 6 months between pain-free controls, participants with resolved LBP or participants with partially or unresolved LBP.

RESULTS

Participant recruitment

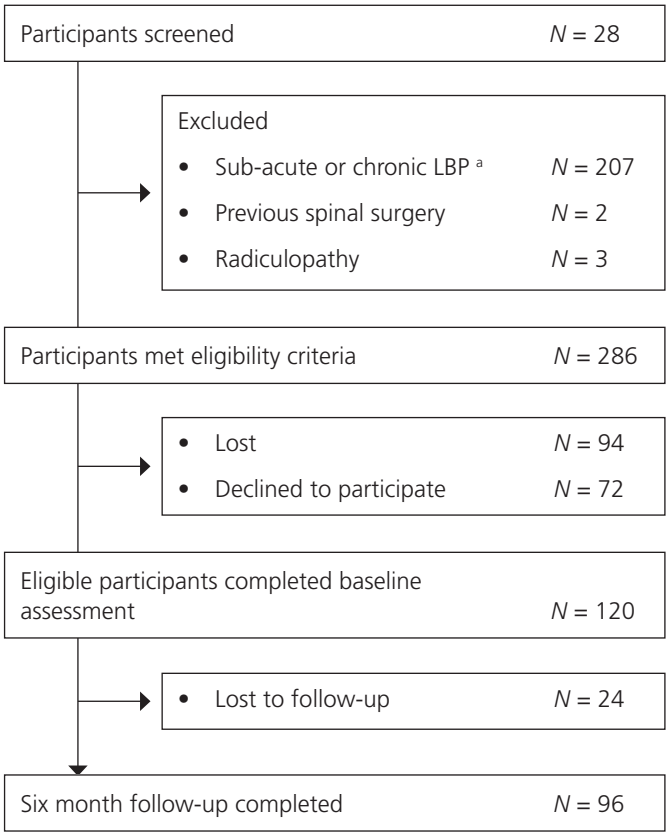
Between 14 April 2015 and 25 July 2019, 498 participants who presented with LBP were screened and 120 participants were included in the cohort (Figure 1; mean age 39 (*SD* 15) years; range = 21–83 years, female:male sex = 59:61). Two hundred and seven participants (41.5%) were ineligible because they had chronic LBP, two participants were excluded because they had previous spinal surgery, and three were excluded because physical examination by the study investigator suggested a diagnosis of lumbosacral radiculopathy. Of the 286 eligible participants, 94 (32.9%) failed to respond to contact attempts organising baseline assessment and 72 (25.2%) declined participation after reviewing the study information sheet. Baseline data were obtained on average 2.4 (*SD* 1.4) weeks (range 1 day–6 weeks) after the onset of acute LBP.

Between October 2016 and February 2019, 57 pain-free controls who reported no current or prior LBP during the 12 months preceding study entry, and with age and sex distribution similar to the UPWaRD LBP cohort were recruited (mean age 35 (*SD* 14) years; range = 19–68 years, female:male sex = 28:29) (Table 2).

Participant attrition

Of the 120 eligible acute LBP participants who were enrolled in the study and provided baseline data, 95 (79%) provided outcome data at the 3-month follow-up and 96 (80%) at 6 months. Missing follow-up cases were due to participants failing to respond to multiple contact attempts to schedule their laboratory assessment within a 1 month time window of their 3- or 6-month follow-up date. At 3- and 6-month follow up, 15 (16%) of the 95 LBP participants and 12 (13%) of the 96 LBP participants declined assessment of all laboratory measures, respectively. These participants agreed to complete questionnaire data, and, thus, remained in the cohort. The number of participants who provided valid data for each of the 3- and 6-month questionnaire-based items are shown in Appendix A, Table A2. Of the 57 control participants, follow-up was completed in 43 (75%) at 3 months and 39 (68%) at 6 months. Reasons for participant attrition among controls were (a) only consented to single laboratory testing session (n = 7); (b) withdrew from the study due to intolerance of laboratory testing and/or duration of the testing protocol (n = 4); (c) no reason given (n = 6); or (d) developed LBP (n = 1).

Figure 1
UPWaRD Low Back Pain Cohort Flow Diagram



[a] defined as LBP lasting for longer than 6 weeks and/or an LBP episode preceded by a period of less than 1 month without pain.

Participants with higher DASS depression (p = < 0.01), DASS anxiety (p = 0.03), and DASS stress (p = < 0.01) scores and lower PSEQ (p = 0.02) scores were less likely to complete the 3-month follow-up. At 6 months, participants who did not complete follow-up reported higher rates of pain affecting their work (p = 0.04), pain interference with their usual work (p = 0.03), pain interference with their walking (p = 0.04), and pain interference with their relations (p = 0.04). Higher levels of self-reported moderate physical activity time per day (p = 0.03) and lower PSEQ scores (p = 0.04) were also observed in participants who did not attend their 6-month follow-up appointment (Table 1).

Pain and disability recovery trajectories

Overall, mean NRS scores of pain intensity for participants with LBP decreased (p < 0.001) from 4.3 (*SD* 1.9) at baseline to 2.3 (*SD* 2.3) at 3 months, remaining stable at 6 months (M = 2.3, *SD* = 2.2). Disability scores (RMDQ) decreased (p < 0.001) from a median score of 5.0 (IQR = 2.0–8.3) at baseline to a median score of 2.0 (IQR = 0.0–5.0) at 3 months, and a median score of 1.0 (IQR = 0.0–4.0) at 6 months. Reporting unresolved LBP at 3 months was not significantly associated with experiencing unresolved LBP at 6 months (p = 0.21). Conversely, partially resolved (p = 0.01) and resolved (p < 0.001) LBP status at 3 months was significantly associated with 6-month partially resolved and resolved LBP status, respectively. Twenty-four

Table 1

Comparison of Baseline Characteristics Between Participants with LBP Who Did (FU), and Did Not (NFU), Complete 3- and 6-month Follow-up

Characteristic	Summary statistics					
	3 months		*p*	6 months		*p*
	FU (*n* = 95)	NFU (*n* = 25)		FU (*n* = 96)	NFU (*n* = 24)	
Health						
Age (years), *Mdn* [IQR]	34 [28–55]	34 [28–41]	0.51	32 [28–55]	38 [30–49]	0.45
Height (cm), *M* (*SD*)	173.0 (10.8)	175.1 (11.1)	0.39	172.5 (10.9)	175.6 (10.7)	0.24
Weight (kg), *M* (*SD*)	77.7 (19.4)	81.9 (15.0)	0.38	77.9 (19.1)	80.1 (17.7)	0.62
Sex: Female, *n* (%)	51 (51)	8 (40)	0.47	51 (53)	8 (33)	0.08
Body mass index (kg/m^2), *Mdn* [IQR]	23.7 [21.6–29.4]	24.9 [22.5–31.6]	0.30	23.7 [21.6–30.2]	24.7 [22.5–29.1]	0.61
Comorbidities: Yes, *n* (%)	31 (32)	6 (30)	1.00	30 (32)	7 (32)	0.87
Previous LBP: Yes, *n* (%)	73 (75)	18 (90)	0.07	72 (77)	19 (86)	0.32
Health care usage: Yes, *n* (%)	56 (57)	11 (58)	1.00	51 (54)	16 (73)	0.10
Medication usage: Yes, *n* (%)	55 (56)	8 (42)	0.32	53 (44)	10 (46)	0.36
Sociodemographic, *n* (%)						
Cultural diversity: Yes	44 (45)	9 (50)	0.80	40 (43)	13 (62)	0.11
Education: Secondary school/below	14 (14)	5 (25)	0.19	16 (17)	3 (14)	0.73
Employment: Full/part time	72 (73)	13 (65)	0.59	69 (73)	16 (67)	0.56
Compensation: Yes	3 (3)	1 (5)	0.51	3 (3)	1 (5)	0.74
Sickness benefits: Yes	0 (0)	1 (5)	0.16	1 (1)	0 (0)	0.62
Pain affected work: Yes	28 (29)	9 (47)	0.12	26 (27)	11 (50)	0.04
Psychological, *Mdn* [IQR]						
DASS depression	2.0 [0.0–6.0]	14.0 [4.0–18.0]	< 0.01	2.0 [0.0–8.0]	8.0 [0.0–15.0]	0.77
DASS anxiety	2.0 [0.0–6.0]	5.0 [1.5–12.5]	0.03	2.0 [0.0–6.0]	2.0 [0.0–10.0]	0.15
DASS stress	6.0 [2.0–15.0]	14.0 [18.0–24.0]	< 0.01	6.0 [2.0–16.0]	12 [7.5–20.0]	0.10
Self-efficacy (PSEQ), *Mdn* [IQR]	50.5 [40.0–57.0]	41.0 [27.0–52.0]	0.02	51.0 [40.0–57.0]	45.0 [32.0–52.0]	0.04
Catastrophising (PCS), *Mdn* [IQR]	8.0 [2.8–14.3]	12.0 [6.0–19.0]	0.13	8.0 [3.0–16.0]	12.0 [7.0–16.0]	0.14
Pain (Numerical Rating Scale), *M* (*SD*) [a]						
Worst pain	6.3 (1.9)	6.7 (1.9)	0.41	6.4 (1.9)	6.6 (1.8)	0.62
Least pain, *Mdn* [IQR]	2.0 [0.0–4.0]	2.0 [1.0–3.0]	0.71	2.0 [1.0–4.0]	2.0 [1.0–3.0]	0.79
Average pain	4.2 (2.0)	4.7 (1.5)	0.24	4.2 (2.0)	4.6 (1.3)	0.25
Current pain	3.0 (2.2)	3.5 (2.0)	0.37	3.0 (2.2)	3.5 (1.9)	0.42
Pain (Brief Pain Inventory), *M* (*SD*) [a]						
Pain interference: Activity	4.5 (2.9)	5.4 (3.1)	0.25	4.4 (2.8)	5.7 (3.0)	0.06
Pain interference: Mood	4.0 (3.0)	5.1 (2.3)	0.14	4.0 (2.9)	5.0 (2.6)	0.15
Pain interference: Walking	3.3 (3.0)	4.6 (2.5)	0.08	3.3 (2.9)	4.6 (2.5)	0.04
Pain interference: Usual work	4.1 (3.0)	5.2 (2.8)	0.13	4.0 (2.9)	5.5 (2.9)	0.03
Pain interference: Relations, *Mdn* [IQR]	1.0 [0.0–5.0]	2.0 [1.0–5.0]	0.17	1.0 [0.0–4.0]	2.0 [1.0–6.0]	0.04
Pain interference: Sleep	3.8 (3.1)	4.6 (2.5)	0.30	3.9 (3.0)	4.0 (2.8)	0.86
Pain interference: Enjoyment	3.9 (3.1)	4.3 (2.9)	0.63	3.8 (3.1)	4.5 (2.9)	0.31
Disability						
Disability (RMDQ), *Mdn* [IQR]	5.0 [2.0–8.0]	5.0 [3.0–10.0]	0.74	5.0 [2.0–8.0]	6.0 [3.0–10.0]	0.28
Clinical						
StartBack score, *n* (%)						
Low risk	67 (73)	15 (63)	0.56	66 (70)	16 (73)	0.71
Medium risk	20 (22)	7 (29)		23 (24)	4 (18)	
High risk	5 (5)	2 (8)		5 (5)	2 (9)	
Lifestyle (IPAQ), *Mdn* [IQR] [a]						
Vigorous activity days/week	1.0 [0.0–3.0]	0.0 [0.0–3.0]	0.37	1.0 [0.0–3.0]	1.0 [0.0–3.3]	0.76
Vigorous activity time/day (min)	30.0 [0.0–67.5]	0.0 [0.0–60.0]	0.31	30.0 [0.0–60.0]	20.0 [0.0–67.5]	0.69
Moderate activity days/week	2.0 [0.0–4.0]	2.0 [0.0–3.3]	0.34	2.0 [0.0–4.0]	2.5 [2.0–4.0]	0.22
Moderate activity time/day (min)	37.5 [0.0–90.0]	25.0 [0.0–120.0]	0.90	30.0 [0.0–60.0]	60.0 [11.5–195.0]	0.03
Days/week walking ≥ 10 min	7.0 [5.0–7.0]	7.0 [3.0–7.0]	0.50	7.0 [5.0–7.0]	7.0 [2.0–7.0]	0.28
Walking time/day (min)	60.0 [28.9–120.0]	37.5 [20.0–60.0]	0.31	60.0 [30.0–120.0]	37.5 [18.8–60.0]	0.12
Sitting time/day (min), *M* (*SD*)	297.4 (172)	270.6 (192.4)	0.58	294.6 (171.5)	288.0 (193.1)	0.88

Note. DASS = 21-item depression anxiety stress subscale; FU = completed follow-up; IQR = interquartile range; LBP = low back pain; NFU = did not complete follow-up; PCS = pain catastrophising scale; PSEQ = Pain Self-efficacy Questionnaire. Baseline variable (characteristic) summary statistics compared between LBP participants who did, and did not follow-up, at 3- and 6-month time-points using *t* tests (continuous data, normally distributed), Mann-Whitney U tests (continuous data, not normally distributed), or Fisher's exact test (categorical data).

[a] Except where indicated.

(25.0%) LBP participants were completely recovered and 60 (62.5%) were partially recovered after 6 months. Twelve (12.5%) participants LBP were unresolved at 6 months (Table 2).

Health-related characteristics

Compared to controls, LBP participants were slightly older, had a higher body mass index (BMI), a higher prevalence of comorbidities, and higher medication usage (Table 3). The most reported comorbidities among participants with LBP were depression/anxiety (*n* = 12, 29.3%), hypertension (*n* = 9, 22.0%), and asthma (*n* = 5, 12.2%). Among controls, six comorbidities were self-reported: vision impairment (*n* = 1), hypothyroidism (*n* = 1), osteoporosis (*n* = 1), prolactinoma (*n* = 1), mild depression/anxiety not requiring intervention (*n* = 1), and heart disease (*n* = 1). The most frequently used medication within the control group was a contraceptive (*n* = 4). Types of health care utilised by LBP participants were allied health (*n* = 59, 50.4%), GPs (*n* = 30, 25.6%), diagnostic tests (*n* = 13, 11.1%), and specialist physicians (*n* = 5, 4.3%). During the follow-up period, three (2.6%) participants presented to their local emergency department because of their LBP but none were admitted to hospital. Among participants experiencing an acute episode of LBP, 55 (46.6%) did not use any medication and two (1.7%) did not specify their medication use. Eighteen (15.3%) used nonsteroidal anti-inflammatories and 19 (16.1%) used acetaminophen. Seven (5.9%) LBP participants were prescribed opioids and three (2.5%) were prescribed benzodiazepines. Nine (7.6%) LBP participants were taking anti-depressant medication for the management of co-existing depressive symptoms. Three (2.5%) LBP participants were prescribed an anti-convulsant. No LBP participants in the UPWaRD cohort received an epidural steroid injection. Thirty-three participants with LBP were taking medication not related to pain (e.g., anti-hypertensive or oral contraceptives).

Sociodemographic characteristics

Fifty-three (46.1%) LBP participants and 30 (56.6%) pain-free controls identified as culturally diverse. Only one participant with LBP was receiving a sickness benefit (0.9%) at the time of baseline testing and four (3.4%) were receiving compensation

Table 2

UPWaRD LBP Cohort Pain and Disability Outcomes At 3- and 6-month Follow-up

Classification	3 months		6 months		*p*
	n	%	*n*	%	
Unresolved recurrent or chronic LBP	16	16.8	12	12.5	0.21
Partially resolved recurrent or chronic LBP	57	60.0	60	62.5	0.01
Resolved	22	23.2	24	25.0	< 0.001

Note. LBP = low back pain. Summary statistics compared between 3- and 6-month time points using Fisher's exact test. LBP outcome within the UPWaRD Cohort was dichotomised at 3 and 6 months using standardised criteria defined as: (a) unresolved – increase or no change in pain intensity (numerical rating scale, NSR) and disability (Roland Morris disability questionnaire, RMDQ) from baseline, or a pain NRS score of ≥ 7/10; (b) partially resolved – decrease in pain and/or disability from baseline (≥ 1-point reduction on NRS and/or RMDQ from baseline scores); (c) resolved – no pain and disability (NRS and RMDQ = 0) at follow-up.

Table 3

Baseline Demographic and Health-related Characteristics of the UPWaRD Cohort

Health-related characteristic	Summary statistics		*p*
	LBP (*n* = 120)	Control (*n* = 57)	
Age (years), *Mdn* [IQR]	34 [28–53]	31 [25–40]	0.02
Height (cm), *M* (*SD*) [a]	173.1 (10.9)	170.6 (8.2)	0.10
Weight (kg), *M* (*SD*) [a]	78.3 (8.8)	69.0 (13.7)	< 0.001
Sex: Female, *n* (%)	59 (49)	28 (49)	0.56
Comorbidities: Yes, *n* (%)	37 (32)	6 (11)	< 0.01
Previous LBP: Yes, *n* (%)	91 (78)	2 (4.0)	< 0.001
Health care usage: Yes, *n* (%)	67 (57)	NA	NA
Medication usage: Yes, *n* (%)	63 (53)	12 (21)	< 0.001
Body mass index (kg/m^2), *Mdn* (IQR)	24.2 [21.7–29.8]	22.5 [21.2–25.8]	0.01

Note. IQR = interquartile range; LBP = low back pain, NA = not applicable. Summary statistics compared between LBP and control participants using *t* test (continuous data, normally distributed), Mann-Whitney *U* test (continuous data, not normally distributed), or Fisher's exact test (categorical data).

[a] Welch's *t*-test was performed.

related to their LBP. Thirty-seven (31.6%) LBP participants reported pain that was affecting their occupation. Table 4 outlines the education and occupational status of the UPWaRD cohort.

Psychological characteristics

DASS depression scores were higher at baseline in acute LBP participants compared with pain-free controls ($p = 0.01$). Although the median total DASS-21 scores appeared higher at baseline in the acute LBP participants compared with pain-free controls, the distributions overlapped and did not differ significantly ($p = 0.13$; Table 5). PCS and PSEQ scores were not obtained at baseline from pain-free participants; however, the median scores for these measurements among LBP participants are presented in Table 5.

Table 6 reports correlations between psychological variables of interest and 6 month pain (NRS) and disability (RMDQ) in the LBP cohort (NRS). All psychological variables at baseline displayed a statistically significant correlation with 6-month pain intensity and disability.

Lifestyle characteristics

Compared to pain-free controls, participants in the UPWaRD LBP cohort engaged in lower levels of vigorous and moderate physical activity in the week preceding their first laboratory session ($p < 0.05$; Table 7). Among the complete cases, there was no difference in moderate physical activity minutes between groups (controls, resolved LBP, partially or unresolved LBP) at 3-month follow-up ($F_{6, 176} = 0.96$, $p = 0.45$; Wilks' $\lambda = 0.94$, $\eta p^2 = 0.03$), and a similar result was observed at 6-month follow-up ($F_{6, 174} = 1.25$, $p = 0.28$; Wilks' $\lambda = 0.92$, $\eta p^2 = 0.04$). Vigorous physical activity minutes among complete cases also did not differ between groups at 3 months ($F_{6, 192} = 0.85$, $p = 0.53$; Wilks' $\lambda = 0.95$, $\eta p^2 = 0.03$), or at 6 months ($F_{6, 192} = 0.86$, $p = 0.52$; Wilks' $\lambda = 0.95$, $\eta p^2 = 0.03$).

DISCUSSION

LBP is a heterogenous condition (Hoy et al., 2010) and contributors to pain chronicity and disability are multifactorial (Hartvigsen et al., 2018). This cohort profile highlights that LBP participants were slightly older, had a higher average BMI, and participated in lower levels of vigorous and moderate physical activity in the week preceding baseline testing than their pain-free counterparts. Although this might be expected for individuals with pain, a recent systematic review, including individuals free from chronic LBP at study inception, suggests lower levels of moderate (1–3 times per week), or vigorous/high (≥ 3–4 times per week) leisure physical activity may increase the risk of developing chronic LBP (Shiri & Falah-Hassani, 2017). A significant causal relationship has recently been identified between BMI and back pain development (Elgaeva et al., 2019).

An important finding of the cohort profile presented here was that over 50% of the UPWaRD LBP cohort utilised at least one form of health care because of their LBP episode, most commonly, allied health (e.g., physiotherapist, chiropractor)

Table 4

Education and Occupational Status of Participants Enrolled in the UPWaRD Study

Sociodemographic characteristic	LBP		Control	
	n	%	*n*	%
Education				
Some secondary school or less	7	5.9	0	0.0
Completed secondary school	12	10.2	11	19.6
Certificate III/IV	5	4.2	11	19.6
Diploma	31	26.3	0	0.0
Bachelor's degree	37	31.4	16	28.6
Post-graduate degree	26	22.0	18	32.1
Not specified	2	1.7	1	1.8
Occupational status				
Full-time employment	50	43.1	17	38.6
Part-time employment	31	26.7	12	27.3
Studying	12	10.3	10	22.7
Volunteer	2	1.7	0	0.0
Unemployed/prolonged absence due to pain	5	4.3	0	0.0
Unemployed not due to pain	1	0.9	0	0.0
Retraining/limited hours	2	1.7	2	4.5
Home duties	3	2.6	0	0.0
Retired	8	6.9	3	6.8
Not specified	5	4.2	13	22.8

Note. LBP = low back pain. Certificate III/IV corresponds to the Australian Qualifications Framework Level 3 and 4 and provides the knowledge and skills required to undertake skilled work or further learning across a range of contexts.

Table 5

Baseline Psychological Characteristics of the UPWaRD Cohort

Psychological characteristic	Summary statistics				*p*
	LBP (*n* = 120)		Control (*n* = 57)		
	Mdn	IQR	*Mdn*	IQR	
DASS total	16.0	4.0–28.0	10.0	4.0–22.0	0.13
DASS depression item	2.0	0.0–10.0	2.0	0.0–4.0	0.01
DASS anxiety item	2.0	0.0–6.0	2.0	0.0–4.0	0.12
DASS stress item	8.0	2.0–16.0	8.0	4.0–12.0	0.37
PCS	8.0	3.0–15.5	NA		NA
PSEQ	48.0	37.5–56.0	NA		NA

Note. DASS = 21-item depression anxiety stress subscale; IQR = interquartile range; LBP = low back pain; NA = not applicable; NRS = numerical rating scale; PCS = pain catastrophising scale; PSEQ = pain self-efficacy questionnaire. Summary statistics compared between LBP and control participants using Mann-Whitney *U* test (continuous data, not normally distributed).

Table 6

Spearman's Correlation Coefficients Between Measures of Baseline Psychological Status and 6-month Pain and Disability

Characteristic	Spearman's correlation coefficient (BCa 95% CI)				
	DASS	PSEQ	PCS	NRS	RMDQ
DASS	–	–0.67 (–0.78, –0.51)	0.68 (0.55, 0.78)	0.42 (0.27, 0.57)	0.44 (0.25, 0.61)
PSEQ		–	–0.59 (–0.73, –0.40)	–0.36 (–0.53, –0.18)	–0.37 (–0.54, –0.19)
PCS			–	0.37 (0.19, 0.54)	0.40 (0.20, 0.57)
NRS				–	0.68 (0.55, 0.79)
RMDQ					–

Note. BCa = Bias-corrected and accelerated; CI = confidence interval; DASS = 21-item depression anxiety stress subscale; PCS = pain catastrophising scale; PSEQ = pain self-efficacy questionnaire; RMDQ = Roland Morris disability questionnaire. Spearman's correlation coefficients and the corresponding 95% confidence intervals were estimated with 1000 bootstrap samples and are bias-corrected and accelerated.

Table 7

Baseline Physical Activity Levels of the UPWaRD Cohort Based on the International Physical Activity Questionnaire

Lifestyle-related characteristic	Summary statistics				*p*
	LBP (*n* = 120)		Control (*n* = 57)		
	Mdn [a]	IQR	*Mdn* [a]	IQR	
Vigorous activity days/week		0.0–3.0	2.0	1.0–4.0	0.01
Vigorous activity time/day (min)	30.0	0.0–60.0	60.0	20.0–90.0	0.01
Moderate activity days/week	2.0	0.0–4.0	3.0	2.0–5.0	0.01
Moderate activity time/day (min)	30.0	0.0–90.0	60.0	30.0–120.0	0.02
Days/week walking ≥ 10 min	7.0	4.0–7.0	7.0	5.0–7.0	0.15
Walking time/day (min)	45.0	25.0–120.0	60.0	30.0–120.0	0.16
Sitting time/day (min), *M* (*SD*)	293.4 (174.8)		291.0 (205.1)		0.94

Note. IQR = interquartile range; LBP = low back pain. Comparisons made between LBP and control participants using *t* test (continuous data, normally distributed) or Mann-Whitney *U* test (continuous data, not normally distributed).

[a] Unless indicated otherwise.

or general practitioners. Notably, 11% of the UPWaRD LBP cohort underwent diagnostic imaging for their acute LBP episode, 6% received opioids for management of their LBP symptoms, and 4% received a specialty consultation (e.g., spinal surgeon). Routine use of diagnostic imaging, opioid medication, and specialist consultation in the absence of serious pathology is not recommended for acute LBP (Oliveira et al., 2018). As all participants in the UPWaRD cohort were carefully screened for the presence of serious pathology and signs of lumbosacral radiculopathy, this finding is likely to represent care that is discordant with current clinical practice guidelines. The observation of discordant care is consistent with studies of individuals with acute LBP presenting to Australian emergency departments (Machado et al., 2018). A recent prospective cohort study identified a linear relationship between guideline discordant care and increased risk of transition to chronicity (Stevans et al., 2021).

Previous research has linked psychological risk factors with the transition from acute to chronic LBP (Linton, 2000; Pincus et al., 2002). Psychological risk factors (i.e., depression, anxiety and stress, pain catastrophising, and pain self-efficacy beliefs) assessed in the UPWaRD acute LBP cohort at baseline were comparable to those of the pain-free participants, a finding that has been observed in previous comparable cohorts (Pengel et al., 2007). However, among the UPWaRD acute LBP participants, higher levels of depression, anxiety and stress, higher pain catastrophising, and lower pain self-efficacy at baseline were correlated with higher 6-month pain intensity and disability (Table 6). Systematic reviews of 13 LBP cohorts report similar findings, with depression and catastrophising consistently identified as significant risk factors for poor LBP outcome (Pinheiro et al., 2016; Wertli et al., 2014).

On average, LBP participants included in the UPWaRD cohort demonstrated a significant reduction in pain and disability between baseline and 3 months, yet no significant change in pain intensity and disability from the 3- to 6-month assessment. This is typical of LBP studies. A meta-analysis of 33 discrete cohorts identified a comparable recovery trajectory (Costa et al., 2012). Further, the UPWaRD LBP cohort reported similar recovery rates to other acute LBP cohorts (Klyne et al., 2020). At 6 months, 12 (12.5%) LBP participants in the UPWaRD cohort reported worse pain and disability from baseline or severe pain (NRS $\geq$ 7), 60 (62.5%) participants reported less pain and disability compared to baseline, and 24 (25%) participants reported no pain or disability. In the cohort described by Klyne and colleagues (2020), 15 (15.5%) participants reported worse or severe LBP, 66 (68.0%) reported less pain and disability, and 16 (16.5%) reported no pain or disability at 6-month follow-up. Similar rates of ongoing LBP at 6-month follow-up have been reported in other LBP cohorts (Baumbauer et al., 2020; Baliki et al., 2012; Müller et al., 2019).

The cohort profile presented here provides a transparent foundation for future longitudinal analyses; however, the UPWaRD study is not without limitations. Although missing data are inevitable in longitudinal trials, the presence of incomplete cases does represent a threat to the depth of the results. The UPWaRD cohort profile reports similar rates of missing data to most recent prospective cohort studies examining biological risk factors during an acute LBP episode (Klyne et al., 2020; Müller et al., 2019; Vachon-Presseau et al., 2016). Most missing data in this cohort occurred after the first laboratory session, and many baseline characteristics, with some exceptions, were similar between those who did and did not return for follow-up. Study attrition was likely due to inclusion of a high burden of laboratory measures that some participants found difficult to tolerate, and the time commitment involved in the study. In this cohort, individuals who were lost to follow-up at 3 or 6 months reported, at baseline, higher levels of depression, anxiety, stress, and pain catastrophising, higher pain interference, higher levels of moderate physical activity, and occupational difficulties due to pain. Future longitudinal cohort studies might benefit from considering this finding and implementing targeted, innovative methods to reduce attrition in participants with similar baseline characteristics.

Difficulties were experienced with recruitment, highlighted by the revised sample size and time taken to recruit the required number of LBP participants. Similar difficulties with recruitment have been reported by other groups conducting experimental LBP cohort studies (Klyne et al., 2020; Müller et al., 2019). Cohort studies conducted alongside randomised trials of new treatments appear to have greater recruitment success (Stevans et al., 2021) and this may be an important consideration for future LBP cohort study designs.

Another important limitation to consider is that pain and disability outcome measures for the UPWaRD LBP cohort were assessed over the week preceding the 3- and 6-month follow-up assessment. Consequently, it is not possible to determine whether the presence of pain and disability at 6 months follow-up reflects chronic LBP (i.e., pain that had persisted since the acute episode) or chronic recurrent LBP (i.e., a new episode of LBP following a pain-free period). This is acknowledged in our classification of the presence of LBP at 3- and 6-month follow-up (i.e., chronic or recurrent LBP). More frequent assessment of pain and disability over the course of the follow-up period (e.g., weekly/second weekly would allow evaluation of differing recovery trajectories (Costa et al., 2021; Klyne et al., 2018; Kongsted et al., 2015).

This cohort has already been used to investigate neurobiological risk factors underpinning transition from acute to chronic LBP, and how these factors are confounded (Jenkins et al., 2022) or interact with sociodemographic and psychosocial variables (Jenkins et al., 2023). Priorities for future research using data collected within the UPWaRD cohort include exploring proteomic and epigenetic biomarkers of poor LBP outcome, and assessing if psychological risk factors mediate 6-month LBP outcome. These research questions will be reported as secondary analyses of the UPWaRD study data. Both national and international collaborations have been formed to address these research questions. UPWaRD cohort data could be combined with other national or international cohorts that have collected similar data increasing confidence in the study findings reported. The UPWaRD team welcomes collaboration and research proposals.

CONCLUSION

This manuscript reports a cohort profile for the UPWaRD study.

Overall, the UPWaRD LBP cohort represents a generalisable sample of participants experiencing an acute episode of LBP within the community, many of whom seek and utilise treatment. Psychological risk factors (i.e., higher depression, anxiety and stress, higher pain catastrophising, and lower pain self-efficacy) assessed during acute LBP were correlated with higher pain and disability at 6 months. Participants experiencing acute LBP were older, had a higher BMI, and participated in lower levels of moderate and vigorous physical activity during an acute LBP episode compared with pain-free control participants. Participants who did not complete follow-up at 3 and 6 months had higher psychological distress, higher pain interference, higher levels of moderate physical activity, and reported occupational difficulties due to pain.

KEY POINTS

1. This cohort profile details the methodology used within the UPWaRD study to investigate a diverse range of neurobiological risk factors longitudinally.
2. Demographic, psychological, and social data described within this cohort profile can allow confounder adjustment or modelling of plausible interactions between biopsychosocial risk factors.
3. Baseline data described in this cohort profile suggest psychological risk factors were correlated with higher pain and disability at 6 months and participants experiencing acute LBP were older, had a higher BMI, and participated in lower levels of physical activity during an acute LBP episode compared with pain-free control participants.

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PERMISSIONS

All study procedures were approved by the Human Research Ethics Committees of Western Sydney University (H10465) and Neuroscience Research Australia (SSA:16/002) and in accordance with the Helsinki Declaration of 1975, as revised in 1983. All participants provided written, informed consent for participation in the study and its related procedures.

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REFERENCES

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the depression anxiety stress scales in clinical groups and a community sample. *Psychological Assessment*, *10*(2), 176–181. https://doi.org/10.1037/1040-3590.10.2.176

Ardakani, E. M., Leboeuf-Yde, C., & Walker, B. F. (2019). Can we trust the literature on risk factors and triggers for low back pain? A systematic review of a sample of contemporary literature. *Pain Research and Management*, *2019*, 6959631. https://doi.org/10.1155/2019/6959631

Arendt-Nielsen, L., Brennum, J., Sindrup, S., & Bak, P. (1994). Electrophysiological and psychophysical quantification of temporal summation in the human nociceptive system. *European Journal of Applied Physiology and Occupational Physiology*, *68*(3), 266–273. https://doi.org/10.1007/BF00376776

Babiloni, C., Babiloni, F., Carducci, F., Cincotti, F., Rosciarelli, F., Rossini, P. M., Arendt-Nielsen, L., & Chen, A. C. (2001). Mapping of early and late human somatosensory evoked brain potentials to phasic galvanic painful stimulation. *Human Brain Mapping*, *12*(3), 168–179. https://doi.org/10.1002/1097-0193(200103)12:3%3C168::aid-hbm1013%3E3.0.co;2-o

Baliki, M. N., Petre, B., Torbey, S., Hermann, K. M., Huang, L., Schnitzer, T. J., Fields, H. L., & Apkarian, A. V. (2012). Corticostriatal functional connectivity predicts transition to chronic back pain. *Nature Neuroscience*, *15*(8), 1117–1119. https://doi.org/10.1038/nn.3153

Baumbauer, K. M., Ramesh, D., Perry, M., Carney, K. B., Julian, T., Glidden, N., Dorsey, S. G., Starkweather, A. R., & Young, E. E. (2020). Contribution of COMT and BDNF genotype and expression to the risk of transition from acute to chronic low back pain. *The Clinical Journal of Pain, 36*(6), 430–439. https://doi.org/10.1097/AJP.0000000000000819

Bibikova, M., Barnes, B., Tsan, C., Ho, V., Klotzle, B., Le, J. M., Delano, D., Zhang, L., Schroth, G. P., Gunderson, K. L., Fan, J.-B., & Shen, R. (2011). High density DNA methylation array with single CpG site resolution. *Genomics*, *98*(4), 288–295. https://doi.org/10.1016/j.ygeno.2011.07.007

Boonstra, A. M., Stewart, R. E., Köke, A. J., Oosterwijk, R. F., Swaan, J. L., Schreurs, K. M., & Schiphorst Preuper, H. R. (2016). Cut-off points for mild, moderate, and severe pain on the numeric rating scale for pain in patients with chronic musculoskeletal pain: Variability and influence of sex and catastrophizing. *Frontiers in Psychology*, *7*, 1466. https://doi.org/10.3389/fpsyg.2016.01466

Chang, W.-J., Buscemi, V., Liston, M. B., McAuley, J. H., Hodges, P. W., & Schabrun, S. M. (2019). Sensorimotor cortical activity in acute low back pain: A cross-sectional study. *The Journal of Pain, 20*(7), 819–829. https://doi.org/10.1016/j.jpain.2019.01.006

Clarke, S. M., Henry, H. M., Dodds, K. G., Jowett, T. W., Manley, T. R., Anderson, R. M., & McEwan, J. C. (2014). A high throughput single nucleotide polymorphism multiplex assay for parentage assignment in New Zealand sheep. *PloS One*, *9*(4). https://doi.org/10.1371/journal.pone.0093392

Costa, L., Maher, C. G., Hancock, M. J., McAuley, J. H., Herbert, R. D., & Costa, L. O. (2012). The prognosis of acute and persistent low-back pain: A meta-analysis. *CMAJ*, *184*(11), E613–E624. https://doi.org/10.1503/cmaj.111271

Costa, N., Smits, E., Kasza, J., Salomoni, S., Ferreira, M., Sullivan, M., & Hodges, P. W. (2021). ISSLS prize in clinical science 2021: What are the risk factors for low back pain flares and does this depend on how flare is defined? *European Spine Journal*, 30, 1089–1097 https://doi.org/10.1007/s00586-021-06730-6

Cunningham, C. N., Jenkins, L. C., Chang, W.-J., McAuley, J. H., & Schabrun, S. M. (2021). Relative and absolute reliability of somatosensory evoked potentials in response to non-noxious electrical stimulation of the paraspinal muscles in healthy participants at an interval of 3-months. *International Journal of Neuroscience*, 133(1), 103–109. https://doi.org/10.1080/00207454.2021.1893722

De Vet, C. W. H., Heymans, W. M., Dunn, M. K., Pope, P. D., van der Beek, J. A., Macfarlane, J. G., Bouter, M. L., & Croft, R. P. (2002). Episodes of low back pain: A proposal for uniform definitions to be used in research. *Spine*, *27*(21), 2409–2416. https://doi.org/10.1097/01.BRS.0000030307.34002.BE

Desmeules, J. A., Cedraschi, C., Rapiti, E., Baumgartner, E., Finckh, A., Cohen, P., Dayer, P., & Vischer, T. L. (2003). Neurophysiologic evidence for a central sensitization in patients with fibromyalgia. *Arthritis & Rheumatism*, *48*(5), 1420–1429. https://doi.org/10.1002/art.10893

Dieleman, J. L., Cao, J., Chapin, A., Chen, C., Li, Z., Liu, A., Horst, C., Kaldjian, A., Matyasz, T., Scott, K. W., Bui, A. L., Campbell, M., Duber, H. C., Dunn, A. C., Flaxman, A. D., Fitzmaurice, C., Naghavi, M., Sadat, N., Shieh, P., . . . Murray, C. J. L. (2020). US health care spending by payer and health condition, 1996-2016. *JAMA*, *323*(9), 863–884. https://doi.org/10.1001/jama.2020.0734

Diers, M., Koeppe, M. C., Diesch, M. E., Stolle, M. A., Hölzl, M. R., Schiltenwolf, M. M., van Ackern, K., & Flor, H. (2007). Central processing of acute muscle pain in chronic low back pain patients: An EEG mapping study. *Journal of Clinical Neurophysiology*, *24*(1), 76–83. https://doi.org/10.1097/01.wnp.0000241093.00844.0e

Ebrahim, S. (2004). Cohorts, infants and children. *International Journal of Epidemiology*, *33*(6), 1165–1166. https://doi.org/10.1093/ije/dyh368

Elgaeva, E. E., Tsepilov, Y., Freidin, M. B., Williams, F. M., Aulchenko, Y., & Suri, P. (2019). ISSLS prize in clinical science 2020. Examining causal effects of body mass index on back pain: A Mendelian randomization study. *European Spine Journal*, *29*(4), 686–691. https://doi.org/10.1007/s00586-019-06224-6

Flor, H., Braun, C., Elbert, T., & Birbaumer, N. (1997). Extensive reorganization of primary somatosensory cortex in chronic back pain patients. *Neuroscience Letters*, *224*(1), 5–8. https://doi.org/10.1016/S0304-3940(97)13441-3

Harrell Jr, F. E. (2015). *Regression modeling strategies: With applications to linear models, logistic and ordinal regression, and survival analysis*. Springer.

Hartvigsen, J., Hancock, M. J., Kongsted, A., Louw, Q., Ferreira, M. L., Genevay, S., Hoy, D., Karppinen, J., Pransky, G., Sieper, J., Smeets, R. J., & Underwood, M; on behalf of the Lancet Low Back Pain Series Working Group. (2018). What low back pain is and why we need to pay attention. *The Lancet*, *391*(10137), 2356–2367. https://doi.org/10.1016/S0140-6736(18)30480-X

Hayden, J., Chou, R., Hogg-Johnson, S., & Bombardier, C. (2009). Systematic reviews of low back pain prognosis had variable methods and results—Guidance for future prognosis reviews. *Journal of Clinical Epidemiology*, *62*(8), 781–796 e781. https://doi.org/10.1016/j.jclinepi.2008.09.004

Henschke, N., Maher, C. G., Refshauge, K. M., Herbert, R. D., Cumming, R. G., Bleasel, J., York, J., Das, A., & McAuley, J. H. (2008). Prognosis in patients with recent onset low back pain in Australian primary care: Inception cohort study. *BMJ, 337*(7662), a171. https://doi.org/10.1136/bmj.a171

Hill, J. C., Dunn, K. M., Lewis, M., Mullis, R., Main, C. J., Foster, N. E., & Hay, E. M. (2008). A primary care back pain screening tool: Identifying patient subgroups for initial treatment. *Arthritis Care & Research*, *59*(5), 632–641. https://doi.org/10.1002/art.23563

Homan, R. W., Herman, J., & Purdy, P. (1987). Cerebral location of international 10–20 system electrode placement. *Electroencephalography and Clinical Neurophysiology*, *66*(4), 376–382. https://doi.org/10.1016/0013-4694(87)90206-9

Hoy, D., Bain, C., Williams, G., March, L., Brooks, P., Blyth, F., Woolf, A., Vos, T., & Buchbinder, R. (2012). A systematic review of the global prevalence of low back pain. *Arthritis and Rheumatism*, *64*(6), 2028–2037. https://doi.org/10.1002/art.34347

Hoy, D., Brooks, P., Blyth, F., & Buchbinder, R. (2010). The epidemiology of low back pain. *Best Practice & Research Clinical Rheumatology*, *24*(6), 769–781. https://doi.org/10.1016/j.berh.2010.10.002

Jenkins, L. C., Chang, W.-J., Buscemi, V., Liston, M., Skippen, P., Cashin, A. G., McAuley, J. H., & Schabrun, S. M. (2022). Low somatosensory cortex excitability in the acute stage of low back pain causes chronic pain. *The Journal of Pain*, *23*(2), 289–304. https://doi.org/10.1016/j.jpain.2021.08.003

Jenkins, L. C., Chang, W.-J., Buscemi, V., Liston, M., Toson, B., Nicholas, M., Graven-Nielsen, T., Ridding, M., Hodges, P. W., & McAuley, J. H. (2019). Do sensorimotor cortex activity, an individual's capacity for neuroplasticity, and psychological features during an episode of acute low back pain predict outcome at 6 months: A protocol for an Australian, multisite prospective, longitudinal cohort study. *BMJ Open*, *9*(5), e029027. https://doi.org/10.1136/bmjopen-2019-029027

Jenkins, L. C., Chang, W.-J., Buscemi, V., Liston, M., Humburg, P., Nicholas, M., Graven-Nielsen, T., Hodges, P. W., McAuley, J. H., & Schabrun, S. M. (2023). Cortical function and sensorimotor plasticity are prognostic factors associated with future low back pain after an acute episode: The Understanding persistent Pain Where it ResiDes prospective cohort study. *Pain*, *164*(1), 14–26. https://doi.org/10.1097/j.pain.0000000000002684

Keel, J. C., Smith, M. J., & Wassermann, E. M. (2001). A safety screening questionnaire for transcranial magnetic stimulation. *Clinical Neurophysiology, 112*(4), 720. https://doi.org/10.1016/S1388-2457(00)00518-6

Kent, P. M., & Keating, J. L. (2008). Can we predict poor recovery from recent-onset nonspecific low back pain? A systematic review. *Manual Therapy*, *13*(1), 12–28. https://doi.org/10.1016/j.math.2007.05.009

Klyne, D., Barbe, M., Hoorn, W., & Hodges, P. (2018). ISSLS prize in clinical science 2018: Longitudinal analysis of inflammatory, psychological, and sleep-related factors following an acute low back pain episode—The good, the bad, and the ugly. *European Spine Journal*, *27*(4), 763–777. https://doi.org/10.1007/s00586-018-5490-7

Klyne, D. M., Moseley, G. L., Sterling, M., Barbe, M. F., & Hodges, P. W. (2019). Are signs of central sensitization in acute low back pain a precursor to poor outcome? *The Journal of Pain*, *20*(8), 994–1009. https://doi.org/10.1016/j.jpain.2019.03.001

Klyne, D. M., Schmid, A. B., Moseley, G. L., Sterling, M., & Hodges, P. W. (2015). Effect of types and anatomic arrangement of painful stimuli on conditioned pain modulation. *Journal of Pain*, *16*(2), 176–185. https://doi.org/10.1016/j.jpain.2014.11.005

Klyne, D. M., van den Hoorn, W., Barbe, M. F., Cholewicki, J., Hall, L. M., Khan, A., Meroni, R., Moseley, G. L., Nicholas, M., O'Sullivan, L., Park, R., Russell, G., Sterling, M., & Hodges, P. W. (2020). Cohort profile: Why do people keep hurting their back? *BMC Research Notes*, *13*(1), 538. https://doi.org/10.1186/s13104-020-05356-z

Kongsted, A. P., Kent, P. P., Hestbaek, L. P., & Vach, W. P. (2015). Patients with low back pain had distinct clinical course patterns that were typically neither complete recovery nor constant pain. A latent class analysis of longitudinal data. *The Spine Journal*, *15*(5), 885–894. https://doi.org/10.1016/j.spinee.2015.02.012

Lee, P. H., Macfarlane, D. J., Lam, T. H., & Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition Physical Activity*, *8*, 115.

Lin, C.-W. C., McAuley, J. H., Macedo, L., Barnett, D. C., Smeets, R. J., & Verbunt, J. A. (2011). Relationship between physical activity and disability in low back pain: A systematic review and meta-analysis. *Pain*, *152*(3), 607–613. https://doi.org/10.1016/j.pain.2010.11.034

Lin, C.-W., Verwoerd, A. J. H., Maher, C. G., Verhagen, A. P., Pinto, R. Z., Luijsterburg, P. A. J., & Hancock, M. J. (2014). How is radiating leg pain defined in randomized controlled trials of conservative treatments in primary care? A systematic review. *European Journal of Pain*, *18*(4), 455–464. https://doi.org/10.1002/j.1532-2149.2013.00384.x

Linton, J. S. (2000). A review of psychological risk factors in back and neck pain. *Spine*, *25*(9), 1148–1156. https://doi.org/10.1097/00007632-200005010-00017

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the depression anxiety stress scales* (2nd ed.). Psychology Foundation of Australia.

Machado, G. C., Rogan, E., & Maher, C. G. (2018). Managing non-serious low back pain in the emergency department: Time for a change? *Emergency Medicine Australasia*, *30*(2), 279–282. https://doi.org/10.1111/1742-6723.12903

Maher, C., Underwood, M., & Buchbinder, R. (2017). Non-specific low back pain. *The Lancet*, *389*(10070), 736–747. https://doi.org/10.1016/S0140-6736(16)30970-9

Manchikanti, L., Singh, V., Falco, F. J., Benyamin, R. M., & Hirsch, J. A. (2014). Epidemiology of low back pain in adults. *Neuromodulation: Technology at the Neural Interface*, *17*(Suppl 2), 3–10. https://doi.org/10.1111/ner.12018

Müller, M., Curatolo, M., Limacher, A., Neziri, A. Y., Treichel, F., Battaglia, M., Arendt-Nielsen, L., & Jüni, P. (2019). Predicting transition from acute to chronic low back pain with quantitative sensory tests—A prospective cohort study in the primary care setting. *European Journal of Pain*, *23*(5), 894–907. https://doi.org/10.1002/ejp.1356

Nicholas, M. K. (2007). The pain self-efficacy questionnaire: Taking pain into account. *European Journal of Pain*, *11*(2), 153–163. https://doi.org/10.1016/j.ejpain.2005.12.008

O'Connell, N. E., Maskill, D. W., Cossar, J., & Nowicky, A. V. (2007). Mapping the cortical representation of the lumbar paravertebral muscles. *Clinical Neurophysiology*, *118*(11), 2451–2455. https://doi.org/10.1016/j.clinph.2007.08.006

Oliveira, C. B., Maher, C. G., Pinto, R. Z., Traeger, A. C., Lin, C.-W. C., Chenot, J.-F., van Tulder, M., & Koes, B. W. (2018). Clinical practice guidelines for the management of non-specific low back pain in primary care: An updated overview. *European Spine Journal*, *27*(11), 2791–2803. https://doi.org/10.1007/s00586-018-5673-2

Parkitny, L., McAuley, J. H., Walton, D., Costa, L. O. P., Refshauge, K. M., Wand, B. M., Di Pietro, F., & Moseley, G. L. (2012). Rasch analysis supports the use of the depression, anxiety, and stress scales to measure mood in groups but not in individuals with chronic low back pain. *Journal of Clinical Epidemiology*, *65*(2), 189–198. https://www.jclinepi.com/article/S0895-4356(11)00188-0/fulltext

Pengel, L. H., Refshauge, K. M., Maher, C. G., Nicholas, M. K., Herbert, R. D., & McNair, P. (2007). Physiotherapist-directed exercise, advice, or both for subacute low back pain: A randomized trial. *Annals of Internal Medicine*, *146*(11), 787–796. https://doi.org/10.7326/0003-4819-146-11-200706050-00007

Pincus, T., Burton, A. K., Vogel, S., & Field, A. P. (2002). A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine*, *27*(5), E109–E120. https://doi.org/10.1097/00007632-200203010-00017

Pinheiro, M. B., Ferreira, M. L., Refshauge, K., Maher, C. G., Ordoñana, J. R., Andrade, T. B., Tsathas, A., & Ferreira, P. H. (2016). Symptoms of depression as a prognostic factor for low back pain: A systematic review. *The Spine Journal*, *16*(1), 105–116. https://doi.org/10.1016/j.spinee.2015.10.037

Roland, M., & Morris, R. (1983). A study of the natural history of back pain: Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine*, *8*(2), 141–144. https://doi.org/10.1097/00007632-198303000-00004

Sandoval, J., Heyn, H., Moran, S., Serra-Musach, J., Pujana, M. A., Bibikova, M., & Esteller, M. (2011). Validation of a DNA methylation microarray for 450,000 CpG sites in the human genome. *Epigenetics*, *6*(6), 692–702. https://doi.org/10.4161/epi.6.6.16196

Schabrun, M. S., Elgueta-Cancino, L. E., & Hodges, W. P. (2017). Smudging of the motor cortex is related to the severity of low back pain. *Spine*, *42*(15), 1172–1178. https://doi.org/10.1097/BRS.0000000000000938

Schabrun, S. M., Jones, E., Elgueta Cancino, E. L., & Hodges, P. W. (2014). Targeting chronic recurrent low back pain from the top-down and the bottom-up: A combined transcranial direct current stimulation and peripheral electrical stimulation intervention. *Brain Stimul*ation, *7*(3), 451–459. https://doi.org/10.1016/j.brs.2014.01.058

Shiri, R., & Falah-Hassani, K. (2017). Does leisure time physical activity protect against low back pain? Systematic review and meta-analysis of 36 prospective cohort studies. *British Journal of Sports Medicine*, *51*(19), 1410–1418. https://doi.org/10.1136/bjsports-2016-097352

Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. (2010). The association between smoking and low back pain: A meta-analysis. *The American Journal of Medicine*, *123*(1), 87. e7–e35. https://doi.org/10.1016/j.amjmed.2009.05.028

Skljarevski, V., & Ramadan, N. M. (2002). The nociceptive flexion reflex in humans – review article. *Pain*, *96*(1), 3–8. https://doi.org/10.1016/S0304-3959(02)00018-0

Stanton, T. R., Henschke, N., Maher, C. G., Refshauge, K., Latimer, J., & McAuley, J. H. (2008). After an episode of acute low back pain, recurrence is unpredictable and not as common as previously thought. *Spine*, *33*(26), 2923–2928 https://doi.org/10.1097/BRS.0b013e31818a3167

Stevans, J. M., Delitto, A., Khoja, S. S., Patterson, C. G., Smith, C. N., Schneider, M. J., Freburger, J. K., Greco, C. M., Freel, J. A., & Sowa, G. A. (2021). Risk factors associated with transition from acute to chronic low back pain in US patients seeking primary care. *JAMA Network Open*, *4*(2), e2037371. https://doi.org/10.1001/jamanetworkopen.2020.37371

Sullivan, M. J., Bishop, S. R., & Pivik, J. (1995). The Pain Catastrophizing Scale: Development and validation. *Psychological Assessment*, *7*(4), 524–532. https://doi.org/10.1037/1040-3590.7.4.524

Tardif, H., Arnold, C., Hayes, C., & Eagar, K. (2017). Establishment of the Australasian electronic persistent pain outcomes collaboration. *Pain Medicine*, *18*(6), 1007–1018. https://doi.org/10.1093/pm/pnw201

Tsao, A. H., Danneels, W. L., & Hodges, W. P. (2011). ISSLS prize winner: Smudging the motor brain in young adults with recurrent low back pain. *Spine*, *36*(21), 1721–1727. https://doi.org/10.1097/BRS.0b013e31821c4267

Vachon-Presseau, E., Tétreault, P., Petre, B., Huang, L., Berger, S. E., Torbey, S., Baria, A. T., Mansour, A. R., Hashmi, J. A., Griffith, J. W., Comasco, E., Schnitzer, T. J., Baliki, M. N., & Apkarian, A. V. (2016). Corticolimbic anatomical characteristics predetermine risk for chronic pain. *Brain*, *139*(7), 1958–1970. https://doi.org/10.1093/brain/aww100

Vittinghoff, E., & McCulloch, C. E. (2007). Relaxing the rule of ten events per variable in logistic and Cox regression. *American Journal of Epidemiology*, *165*(6), 710–718. https://doi.org/10.1093/aje/kwk052

Vos, T., Abate, K. H., Abbafati, C., Abbas, K. M., Abd-Allah, F., Abdulkader, R. S., Abdulle, A. M., Abera, S. F., Abu-Raddad, L. J., Adetokunboh, O., Afshin, A., Agarwal, S. K., Aggarwal, R., Agrawal, A., Agrawal, S., Ahmadieh, H., Ahmed, M. B., Aichour, A. N., Aichour, I., . . . Criqui, M. H; GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. (2017). Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet*, *390*(10100), 1211–1259. https://doi.org/10.1016/s0140-6736(17)32154-2

Wertli, M. M., Eugster, R., Held, U., Steurer, J., Kofmehl, R., & Weiser, S. (2014). Catastrophizing—A prognostic factor for outcome in patients with low back pain: A systematic review. *The Spine Journal*, *14*(11), 2639–2657. https://doi.org/10.1016/j.spinee.2014.03.003

Willer, J. C. (1977). Comparative study of perceived pain and nociceptive flexion reflex in man. *Pain (Amsterdam)*, *3*(1), 69–80. https://doi.org/10.1016/0304-3959(77)90036-7

Williams, C. M., Maher, C. G., Latimer, J., McLachlan, A. J., Hancock, M. J., Day, R. O., & Lin, C.-W. C. (2014). Efficacy of paracetamol for acute low-back pain: A double-blind, randomised controlled trial. *The Lancet*, *384*(9954), 1586–1596. https://doi.org/10.1016/S0140-6736(14)60805-9

Appendix A

Table A1

Detailed Description of Measures Collected in the UPWaRD Study

Measure	Description	Assessed in		Units/range
		LBP	Control	
Health				
Age, height [a], weight [a], sex [b]	Self-reported age, height, weight, sex	✓	✓	Years, cm, kg, male/female
BMI [a]	Weight (kg) divided by height^2 (cm)	✓	✓	Numerical
Comorbidities [a, b]	Self-selected comorbid conditions other than LBP from a list (including "other")	✓	✓	Yes/no, type
Health care usage [a]	Self-reported health care usage from a list including GP, medical specialist, health professionals other than doctors, emergency department, hospital admission, and diagnostic tests	✓	✓	Frequency, type
Medication usage [a]	Self-reported medication usage	✓	✓	Dosage, frequency, type
Previous LBP [b]	Self-reported previous incidence(s) of LBP	✓	✓	Yes/no
Sociodemographic				
Cultural diversity [a, b]	Each participant was asked the question: "How do you define your identity, in ethnic or cultural terms?" If the participant identified a cultural or ethnic background other than "English", "Caucasian", or "Australian" they were considered culturally and linguistically diverse for the purpose of this study.	✓	✓	Type
Education level [a, b]	Self-selected highest education level from a list (e.g., primary school, completed secondary school, post-graduate degree).	✓	✓	Type
Employment status [a]	Self-selected employment status from a list (e.g., full-time paid employment, studying, retired).	✓	✓	Type
Impending compensation [a]	Self-reported impending or current compensation case related to the LBP episode.	✓		Yes/no, type
Sickness benefits [a]	Self-reported sickness benefits associated with the participants' LBP episode.	✓		Yes/no
Pain affected work [a]	Self-reported pain affected work hours or whether pain affects the type of work the respondent can complete.	✓		Yes/no
Psychological				
21-item depression, anxiety and stress subscale (DASS-21) (Lovibond & Lovibond, 1995)	Questionnaire: Evaluates symptoms of depression, anxiety and tension-stress. Consists of 21 items with responses quantified on a four-point Likert scale ranging from 0 ("not at all") to 3 ("applied to me very much, or most of the time"). Yields a total score as well as three subscale scores: DASS-depression (low positive affect), DASS-anxiety (psychological hyper-arousal), and DASS-stress (e.g., tension or irritability).	✓	✓	0–63: Higher score = higher distress along the three axes of depression, anxiety, and stress Subscales: depression (0–21; ≥ 11 = severe), anxiety (0–21; ≥ 8 = severe), stress (0–21; ≥ 13 = severe)
Pain self-efficacy questionnaire (PSEQ) (Nicholas, 2007)	Questionnaire: evaluates an individual's confidence in their ability to perform a range of functional activities while in pain. Consists of 10 items. Respondents rate how confident they are in performing each item using a seven-point Likert scale.	✓		0–60: Higher score = higher self-efficacy beliefs

Measure	Description	Assessed in		Units/range
		LBP	Control	
Pain catastrophising scale (PCS) (Sullivan et al., 1995)	Questionnaire: evaluates thoughts and feelings related to catastrophic cognitions when in pain. Consists of 13 items with responses quantified on a five-point Likert scale ranging from 0 ("not at all") to 4 ("all the time"). Yields a total score as well as three subscales: magnification (3 items), rumination (4 items), and helplessness (6 items).	✓		0–52: Higher score = higher pain catastrophising Subscales: magnification (0– 12), rumination (0– 16), helplessness (0– 24)
Clinical				
The Keele StarT Back Screening Tool (SBT) (Hill et al., 2008) [a, b]	Questionnaire: The SBT is a brief, validated tool, designed to screen patients presenting to primary care with acute LBP. Respondents select if they agree or disagree with the first eight items (e.g., "my back pain spread down my leg(s) at some point in the last 2 weeks"), then rate the overall bothersomeness of their LBP using a five-point Likert scale from ("0 = not at all") to 4 ("extremely").	✓		Respondents reporting a score of 0–3 are classified as low-risk and those reporting scores of ≥ 4 overall as medium-risk. Respondents are considered at high-risk of a worse outcome if they score 4 or 5 in the distress subscale score (questions 5–9)
Neurobiological				
Sensory evoked potentials (electroencephalography recording, SEPs)	Laboratory measure: SEPs were assessed based on our previous work demonstrating reliability of this measure in healthy participants (Cunningham et al., 2021). Participants were seated comfortably in a chair with eyes closed. Electroencephalographic SEPs were recorded using gold-plated cup electrodes positioned over the primary sensory cortex contralateral to the side of worst pain for LBP participants, or contralateral to the dominant hand in healthy controls, and referenced to Fz using the International 10/20 System (Homan et al., 1987). A constant current stimulator delivered two blocks of 500 non-noxious electrical stimuli through a single bipolar electrode positioned 3 cm lateral to the L3 spinous process, ipsilateral to the side of the worst LBP, or dominant hand for healthy controls. Individual SEP traces were manually inspected and averaged for analysis. Distinct SEP components are thought to reflect sensory afferent processing within the human cortex and the area under the rectified curve for each component was a candidate predictor reported a priori in the study protocol (N_{80} – primary sensory cortex excitability, N_{150} – secondary sensory cortex excitability, P_{260} – anterior cingulate cortex excitability (Babiloni et al., 2001; Diers et al., 2007; Flor et al., 1997)).	✓	✓	Latency (ms), Area under the rectified curve (μV)

Measure	Description	Assessed in		Units/range
		LBP	Control	
Corticomotor excitability	Laboratory measure: The corticomotor response to transcranial magnetic stimulation (TMS) was assessed using an established mapping paradigm and based on our previous work (Chang et al., 2019; O'Connell et al., 2007; Schabrun et al., 2014; Tsao et al., 2011). Participants sat comfortably in a chair and electrodes were placed on the paraspinal muscles 3 cm lateral to the spinous process of L3 and 1 cm lateral to the spinous process of L5 (Noraxon USA Inc, Arizona, USA). Participants were fitted with a tight-fitting cap, marked with a 6 x 7 cm grid oriented to the vertex. Single-pulse, monophasic stimuli (Magstim 200 stimulator/7 cm figure-of-eight coil; Magstim Co. Ltd. Dyfed, UK) was then delivered over M1 contralateral to the side of the worst LBP, starting at the vertex. For healthy controls, M1 contralateral to the dominant hand was stimulated. Five stimuli were delivered over each site on the grid with an inter-stimulus interval of 6 s at 100% of maximum stimulator output. Participants maintained activation of their paraspinal extensor muscles to 20 ± 5% of their EMG recorded during a maximum voluntary contraction throughout the stimulation with constant feedback of real-time EMG displayed on a monitor. Parameters calculated from the normalised motor cortical maps are described in the study protocol (Jenkins et al., 2019).	✓	✓	Map volume (cm^2) Centre of gravity (cm)
Brain derived neurotrophic factor (BDNF) genotype and serum concentration [b]	Laboratory measure: Buccal swabs were taken on the day of baseline testing (Isohelix DNA Isolation Kit) and immediately frozen and stored at –80°C. Genomic DNA samples were polymerase chain reaction amplified and sequenced by the Australian Genome Research Facility. Genotyping was performed as recommended by the manufacturer with reagents included in the iPLEX Gold SNP genotyping kit (Agena) and the software and equipment provided with the MassARRAY platform (Agena) (Clarke et al., 2014). BDNF serum concentration was analysed using the same methodology as described for analysing serum cytokine levels. Cartridge limits of detection for BDNF serum concentration were 5.25 pg/ml and samples below this level were allocated a value of zero.	✓	✓	Genotype: Met/Met, Met/Val, Val/Val Serum concentration: pg/mL
Biological				
Serum cytokines [a]	Laboratory measure: Serum concentrations of IL-1β, IL-2, IL-4, IL-6, IL-8. IL-10, IL-15, TNF, CRP, TGF-β1. Peripheral venous blood was drawn, clotted (30 min, room temperature), and separated by centrifugation (2500 rpm, 15 min). Serum samples were pipetted into 50 µL aliquots and stored at -80°C until analysis. After thawing, concentrations of each biomarker were determined using "high-sensitive" enzyme-linked immunosorbent assays (ELISA, Protein Simple, CA, USA). Samples were loaded into the cartridge according to a standard procedure provided by the manufacturers and immunoassay scans processed with no user activity. Built in cartridge limits of detection for each biomarker were as follows: (1) IL-1β: 0.064 pg/ml; (2) IL-2: 0.18 pg/ml; (3) IL-4: 0.16 pg/ml; (4) IL- 6: 0.26 pg/ml; (5) IL-8: 0.08 pg/ml; (6) IL-10: 0.14 pg/ml; (7) 1L-15: 0.19 pg/ml; (8) TNF: 0.278 pg/ml; (9) CRP: 1.24 pg/ml; (10) TGF-β1: 5.29 pg/ml. Zero was allocated for values below the reported sensitivity of the test.	✓	✓	pg/mL

Measure	Description	Assessed in		Units/range
		LBP	Control	
Serum proteomic profile [a]	Serum samples for a subgroup of 60 participants with acute LBP were prepared by digesting 3µl of serum (57µg ul-1 +/-7µg) in 50µl of 50mM AMBIC, 2M urea, 10mM DTT at pH 8 using trypsin at 25°C for 16 hours in a 1:100 enzyme to protein ratio. Serum peptides were fractionated using hydrophobic interaction chromatography (HILIC) according to the manufacturer's protocol (PolyLC Inc, MD, USA). Digested and fractionated peptides were reconstituted in 5µL 0.1% formic acid and separated by nano-LC using an Ultimate 3000 HPLC and autosampler (Dionex, Amsterdam, Netherlands). The QExactive (Thermo Electron, Bremen, Germany) mass spectrometer was run in DDA mode. Proteins were identified from the Uniprot database. Protein identifications were accepted if they could be established at less than 5% FDR and contained at least two identified peptides.			Spectral count, normalised by total ion count
Genome-wide DNA methylation [a, b]	Buchal swabs obtained from the cheek of participants on the day of baseline testing were used to prepare genomic DNA for a subgroup of 60 participants with acute LBP (Isohelix DNA Isolation Kit). Samples were immediately frozen at -80°C and stored. Samples were sent to Australian Genome Research Facility (Melbourne node) where they underwent quality assessment using QuantiFluor. The samples were then normalised to approximately 250ng of DNA in 45µL and bisulfite converted with Zymo EZ-96 DNA Methylation kit (Zymo Research, Orange, CA). DNA was whole-genome amplified, enzymatically fragmented, purified, and applied to the Illumina MerthylationEPIC BeadChips (Illumina, San Diego, CA) according to the Illumina methylation protocol (Bibikova et al., 2011; Sandoval et al., 2011). Beadchips were scanned using the Illumina HiScan SQ and the methylation score for each CpG was represented as a β value according to the fluorescent intensity ratio.	✓		Type: Differentially methylated genes
Pain processing				
Pressure pain sensitivity [a]	Laboratory measure: Pressure pain thresholds (PPT) were assessed using a hand help pressure algometer (Somedic, Hörby, Sweden, probe size 1cm^2) at three distinct sites: (1) the site of worst LBP (side of most pain on palpation); (2) 3 cm lateral to the L3 spinous process on the less painful side of the lower back; and (3) the thumbnail bed (PPT) of the hand contralateral to worst LBP. For pain-free controls, PPTs were measured 3 cm lateral to the L3 spinous process bilaterally and over the thumbnail bed of the dominant hand. Pressure was applied at a rate of 40 kPa/s and participants used a hand-held trigger to indicate when the sensation of pressure first changed to one of pain. Three measures were made at each site and averaged for analysis.	✓	✓	PPT (kPa, higher score = higher threshold to pressure pain)

Measure	Description	Assessed in		Units/range
		LBP	Control	
Heat pain sensitivity [a]	Laboratory measure: Heat pain thresholds were measured (Thermal Sensory Analyzer, TSA-2001, Q-Sense-CPM, Medoc Ltd, Ramat Yishai, Israel). A 30 x 30 mm Peltier-based thermode was placed on the skin and HPT measured at three sites: (1) site of worst LBP, (2) the opposite side of the lumbar region, and (3) the ventral aspect of the forearm on the side of worst pain. For pain-free controls, HPTs were measured 3 cm lateral to the L3 spinous process bilaterally and over the ventral aspect of the forearm of the dominant hand. The temperature started at 32°C and increased at a rate of 0.5° C/s. Participants were instructed to push a button when the sensation of heat first changed to one of pain. Three measures were made at each site and the average at each site used for analyses.	✓	✓	HPT (°C, higher score = higher threshold to heat pain)
Descending pain modulation [a]	Laboratory measure: Assessed using an established conditioned pain modulation (CPM) paradigm (Klyne et al., 2015). PPT was used as the test stimulus (TS) and noxious heat (1° C > HPT) as the conditioning stimulus (CS). Participants completed two trials in random order separated by a 15-min break: (Trial 1) TS at the site of worst LBP and CS on the opposite forearm; (Trial 2) TS at the ipsilateral forearm of worst LBP and CS on the low back opposite to the side of worst pain. In pain-free controls the TS for Trial 1 was the lower back at the level of L3 ipsilateral to the dominant hand and CS on the opposite forearm. For Trial 2, the TS was applied to the forearm of the dominant hand and CS on the low back at the level of L3 opposite the side of TS. Three consecutive PPTs were measured before the application of heat (TS_1). Noxious heat was then applied and maintained for the duration of the test, with three consecutive PPTs re-measured 30 s post heat application (TS_2). Participants were instructed to rate their pain on a numerical rating scale (0–100) at 0 s, 30 s and immediately following the final PPT measurement. Pain scores were maintained between 50 and 80/100 during testing. The test stimulus was adjusted by 1° C as required to achieve a pain score within this range. The CPM response was calculated as TS_2 minus TS_1.	✓	✓	CPM (kPa, > 0 = pain inhibition, < 0 = deficient pain inhibition)
Nociceptor flexor withdrawal reflex (NFR) [a]	Laboratory measure: The NFR was recorded from the biceps femoris muscle on the side of worst LBP (or matched side in pain-free controls). Electrical stimuli were delivered to the sural nerve within the retro-malleolar pathway according to a +/- 20 s variable interval schedule. The NFR threshold was determined as the lowest stimulator intensity that elicited a reflex (4 mA increase until reflex detected, then 2 mA decrease until reflex absent). The stimulus intensity was then set at 120% of the NFR threshold and five trials recorded. The NFR was identified as the multiphasic response occurring 90–200 ms after each stimulus (Arendt-Nielsen et al., 1994; Desmeules et al., 2003; Skljarevski & Ramadan, 2002; Willer, 1977).	✓	✓	Amplitude (mV) Latency (ms)

Measure	Description	Assessed in		Units/range
		LBP	Control	
Lifestyle				
International Physical Activity Questionnaire (IPAQ) (Lee et al., 2011) [a]	Questionnaire including seven items evaluating health-related physical activity. Respondents report the volume of physical activity performed over the previous week, including vigorous activity (activities that make breathing much harder than normal), moderate activity (activities that make breathing somewhat harder than normal), walking, and sitting time.		✓	Higher score = higher physical activity (refer to scoring manual for calculating and interpreting MET scores and activity categories)

Note. BDNF = Brain derived neurotrophic factor; CRP = C–reactive protein; EMG = electromyography; IL–1β = interleukin–1 beta; IL–2 = interleukin–2; IL–4 = interleukin–4; IL–6 = interleukin–6; IL–8 = interleukin–8; IL–10 = interleukin–10; 1L–15 = interleukin–15; LBP = low back pain; kPa = kilo Pascal; M1 = primary motor cortex; Met = Methionine; MET = metabolic equivalent of task; SEP = sensory evoked potentials; TGF–β1 = transforming growth factor beta–1; TMS = transcranial magnetic stimulation; TNF = tumour necrosis factor; Val = Valine.

[a] Indicates measure is additional to those reported in the trial registration and study protocol.

[b] Indicates measure was only collected at baseline assessment. All other measures were collected at baseline, 3, and 6 months.

Table A2

Number of Baseline and Follow-up LBP Participants Who Provided Valid Data for All Questionnaire Items

Measure	*N*		
	Baseline (*n* = 120)	3 months (*n* = 100)	6 months (*n* = 96)
Demographic and health			
Age (years)	120	NA	NA
Height (cm)	111	NA	NA
Weight (kg)	114	73	77
Sex	120	NA	NA
BMI (kg/m^2)	111	73	76
Comorbidities	117	NA	NA
Previous LBP	116	NA	NA
Health care usage	117	95	96
Medication usage	118	95	96
Sociodemographic			
Cultural diversity	115	NA	NA
Education	118	NA	NA
Employment status	119	95	93
Impending compensation	118	NA	NA
Sickness benefits	110	83	76
Pain affected work	117	95	96
Pain and disability			
Brief pain inventory short form	118	95	96
Roland-Morris Disability Questionnaire	118	95	96
Lifestyle			
International Physical Activity Questionnaire	116	95	96

Note. LBP = low back pain; NA indicates questionnaire data was not reassessed at 3- and 6-month follow-up.

Corticosteroid Injections for Non-spinal Musculoskeletal Conditions: Consideration of Local and Systemic Adverse Drug Reactions and Side Effects

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ABSTRACT

Following specialist training, physiotherapists in some countries, such as the United Kingdom and Norway perform landmark, and ultrasound guided, soft tissue and joint injections for a wide range of musculoskeletal conditions. Whether they inject or not, physiotherapists may wish to recommend injections, and people requiring care commonly seek physiotherapists' opinions on injection therapy. Globally, there has been a substantial increase in the use of corticosteroid injections to treat musculoskeletal conditions. Those performing injections or providing advice need be cognisant of the possible harms of the procedures and communicate this information sensitively to those considering the procedures. This review synthesises evidence for local and systemic adverse reactions and side effects related to corticosteroid injections in the treatment of non-spinal musculoskeletal conditions. Multiple databases including PubMed, Medline, PEDro, and Cinahl were searched, and all levels of evidence were included if they added to the review. Serious adverse events appear to be rare, possibly in part due to under-reporting of side effects. Where available, suggestions for minimising risk and aftercare have been made. As substantial gaps in the evidence were found, areas for further research are suggested and a decision-making tool is included to facilitate whether to proceed to injection, proceed with precaution, or no injection.

Bilsborough Smith, C., Baker, D., Botchu, R., Cairns, M., Chester, R., Dean, B., Mast, R., & Lewis, J. (2023). Corticosteroid injections for non-spinal musculoskeletal conditions: Consideration of local and systemic adverse drug reactions and side effects. *New Zealand Journal of Physiotherapy*, *51*(3), 217–232. https://doi.org/10.15619/nzjp.v51i3.363

Key Words: Corticosteroid Injections, Local Reactions, Musculoskeletal, Non-spinal, Side Effects

INTRODUCTION

Corticosteroid injections (CSI) are commonly used in the management of musculoskeletal conditions involving symptoms related to joints and soft tissues in both athletic and non-athletic populations. In the United Kingdom (UK) physiotherapists, rheumatologists, radiologists, pain specialists, nurses, sports and exercise doctors, and orthopaedic surgeons perform injections as either image or landmark guided interventions. Although the use of CSIs is increasing, knowledge of their effectiveness in musculoskeletal pain conditions, together with associated adverse events and side effects, remains equivocal (Stout et al., 2019). Adverse drug reactions cost the UK National Health Service (NHS) £446 million a year (Patton & Borshoff, 2018) and in the United States of America (USA) approximately USD $30.1 billion dollars (Sultana et al., 2013).

The aim of this paper was to support shared decision making by clinicians and patients by synthesising evidence for local and systemic adverse reactions and side effects related to CSIs in the management of upper and lower limb musculoskeletal conditions.

METHODS

A formal search strategy was not used and is acknowledged as a possible limitation of the study. Eight co-authors contributed and performed a search that was designed to cover their area of expertise. Systematic reviews with and without meta-analysis, randomised and pseudo-randomised trials, cohort studies, case control, cases series, and case studies published in the English language were considered. Both retrospective and prospective evidence were included. Search terms included "corticosteroid injection", "adverse reaction/event", "side effect", and "musculoskeletal condition(s)". Databases searched were Scopus, Web of Science, PubMed, Medline, DOAJ, PEDro, and Cinahl. Eligibility for inclusion was the administration of a CSI used to treat non-spinal musculoskeletal conditions, either as a stand-alone treatment, or compared to another intervention, where adverse events and/or side effects were reported. Exclusion included CSIs for spinal and non-musculoskeletal conditions.

FINDINGS

The information extracted from the papers included in this manuscript is presented in the following sections, and includes *the pharmacology of corticosteroids*, *history of injections*, *definitions of side and adverse effects*, and *descriptions of local and systemic adverse drug reactions and side effects*.

The pharmacology of corticosteroids

The adrenal glands are endocrine glands, located above the kidneys and are involved in the production of hormones. The outer adrenal cortex produces three corticosteroid hormones (steroidogenesis): (i) mineralocorticoids that regulate blood pressure and electrolyte balance, (ii) androgens that are involved in reproduction, and (iii) glucocorticoids that regulate functions including glucose metabolism, cognition, skeletal growth, and inflammation (Ramamoorthy & Cidlowski, 2016). The term glucocorticoid is a synthesised word: **glu**cose + **cor**tex + ster**oid**. The circadian release of glucocorticoids is regulated by the hypothalamic–pituitary–adrenal axis. Cortisol is a human glucocorticoid and functions to increase blood sugar and suppress the immune system. Its release is increased in response to stress and low blood-glucose. Sustained high levels of cortisol may lead to an allostatic load (McEwen & Stellar, 1993) and is associated with multiple health concerns. Synthetic cortisol is known as hydrocortisone and a range of synthetic glucocorticoids are among the most widely prescribed drugs worldwide (Ramamoorthy & Cidlowski, 2016). The action of glucocorticoids is mediated by the intracellular glucocorticoid receptor (IGR) and once bound to this receptor mediates myriad effects (Ramamoorthy & Cidlowski, 2016). Several mechanisms have been proposed that lead to a reduction in inflammation including inhibition of pro-inflammatory genes that encode cytokines and cell adhesion (Cruz-Topete & Cidlowski, 2015). However, glucocorticoids can also induce a pro-inflammatory response, suggesting their action is very complex and not yet fully understood (Cruz-Topete & Cidlowski, 2015).

History of injections

From the 1600s the term injection was used to describe the process of driving a fluid into a body using a purpose-built tool. As such, the first to perform injections were Indigenous or First Nation populations who used blowpipes to *inject* poisons. Christopher Wren is credited with fashioning a "syringe" from a quill and bladder to inject dogs with alcohol and opium in the 17th century. In 1807 the Edinburgh Medical and Surgical dictionary defined a syringe as "A well-known instrument, serving to imbibe or suck in a quantity of fluid and afterwards expel the same with violence. A syringe is used for transmitting injections into cavities or canals." In the 20th century references relating to injections of salvarsan (arsphenamine) for syphilis (1911), heroin for non-medical use (1925), and analgesics for musculoskeletal pain conditions (1944) were published.

Steinbrocker (1944) reported:

> Analgesic therapy with procaine hydrochloride … is being widely employed in a variety of painful disorders and has established its effectiveness in many of them. Its field of usefulness has been steadily extended recently, particularly in acute and chronic musculoskeletal conditions—fibrositis (myositis), bursitis, neuritis and some arthritides. Although every practitioner or student of these diseases must encounter some apparently suitable patients whose stubborn symptoms fail to respond to procaine or alcohol block, confusing differences in therapeutic results have been recorded by various investigators. The mere insertion of a needle somewhere in the region of pain, without introducing analgesic solutions, also has been reported to give frequent lasting relief (p. 397).

Murnaghan and McIntosh (1955) described further uncertainty regarding CSI, as no differences in outcome for people diagnosed with painful shoulders injected with hydrocortisone (n = 24) or lignocaine (n = 27) were reported. They concluded it was doubtful whether hydrocortisone has any special effect. Despite this uncertainty, corticosteroid injections became widely used to treat athletes in the 1960s (Nicols, 2005).

Injection therapy principally involves corticosteroid in isolation or in combination with anaesthetic. Naturally occurring cortisone and manufactured corticosteroids have a pharmacological effect by inhibiting granular tissue formation, ground substance

sulfation, fibroblast and blood vessel formation, and collagen tissue repair (Nicols, 2005).

Data from the National Health Service (NHS, UK) suggest that approximately 800,000 prescriptions for injectable corticosteroids are dispensed annually. The shoulder, accounting for over one-third of injections, is the most common region injected and the most common shoulder injection (72% of all shoulder injections) is for rotator cuff-related shoulder pain (Cook et al., 2018).

Due to the cost, uncertainty, short-lived clinical benefit, and potential harms, high numbers of injections are of concern (Cook et al., 2018; Hoffmann et al., 2020; Mohamadi et al., 2017). For example, randomised clinical trial results suggest worse outcomes at one year for CSI in the treatment of tennis elbow when compared to placebo (Coombes et al., 2013). Intra-articular CSI at the time of knee arthroscopy increases the risk of post-operative infection (Kohls et al., 2022), and early findings suggest that CSI for knee osteoarthritis may contribute to worsening of the condition as reported in MRI scans (Bharadwaj, 2022) and radiography (Darbandi, 2022).

Definitions of adverse events, adverse reactions, and side effects

Following the review of the included literature, adverse events, adverse reactions, and side effects were defined and are presented in Table 1.

Adverse drug reactions and side effects

Following the review of the included literature, adverse drug reactions and side effects were extracted and formatted into two tables. Table 2 details *local* adverse drug reactions and side effects, and Table 3 details *systemic* adverse drug reactions and side effects.

Other systemic effects

Myopathy

Myopathy refers to a clinical disorder of skeletal muscle. Two forms, acute and chronic, were discussed in the literature. *Chronic steroid myopathy* typically affects the proximal lower limbs (Minetto et al., 2011) and to a lesser extent the bulbar and respiratory muscles (Haran et al., 2018). Glucocorticoid-induced myopathy was first described in 1932 in people diagnosed with Cushing's syndrome (Pereira & Freire de Carvalho, 2011). The pathogenesis is complex as glucocorticoids have a catabolic effect on muscle, negatively impacting on protein synthesis and increasing protein catabolism resulting in muscle atrophy (Pereira & Freire de Carvalho, 2011). Daily doses more of than 40 to 60 mg/day of prednisone or its equivalent can induce clinically important weakness within two weeks (Paik, 2022). Muscle weakness is also a sign of adrenal insufficiency and overall steroid dosage should be accounted for.

Acute steroid myopathy (ASM) is very rare (fewer than 20 cases have been reported in literature), but needs to be considered as a plausible adverse effect of steroid injection therapy as it could occur with dosages normally used to treat musculoskeletal conditions (Haran et al., 2018). ASM is unpredictable, heterogeneous and can develop 1–3 days after a single 1mg Betamethasone intramuscular injection (Sun & Chu, 2017). The withdrawal of corticosteroids leads to gradual full recovery over several weeks in most patients (Haran et al., 2018). Before

Table 1

Definitions of Adverse Events, Adverse Reactions, and Side Effects

Term	Definition
Adverse event	An *adverse event* is an iatrogenic incident that results in harm (mild, moderate) to an individual because of a medical procedure (assessment or intervention).
Serious adverse event	A *serious adverse event* occurs when the iatrogenic incident results in severe and life-threatening harm, hospitalisation, prolongation of existing hospitalisation, significant disability or incapacity, or death.
Adverse drug reaction	An *adverse drug reaction* (ADR) has been defined as "A response to a drug that is noxious and unintended and that occurs at doses normally used for prophylaxis, diagnosis, or treatment of disease, or for modification of physiological function" (Tan et al., 2014, p. 2). An ADR may be a known effect, or a new and previously unrecognised effect of a drug (Medicines and Healthcare Products Regulatory Agency, 2006). An ADR may occur *locally* at the site of the injection, (e.g., hypopigmentation and subcutaneous fat, muscle atrophy following a wrist injection), distally, away from the site of the injection (e.g., increased intraocular pressure following intra-articular knee injection), or *systemically* (e.g., hyperglycaemia in people with diabetes mellitus following intra-articular steroid injections) (Taliaferro et al., 2018).
Side effect	The term *adverse reaction*, also known as *toxic effect* or *side effect*, refers to an unwanted effect experienced by an individual, caused by the drug (Aronson & Ferner, 2005). A *side effect* is defined as: Any unintended effect of a pharmaceutical product occurring at doses normally used in humans which is related to the pharmacological properties of the medicine. Such effects may be either positive or negative. Such effects may be well-known and even expected and may require little or no change in patient management.

Table 2

Local Adverse Drug Reactions and Side Effects

Local adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
Tendon rupture (rotator cuff full thickness tear)	Triamcinolone acetate 40mg	Shoulder	17% (66% with a pre-existing partial thickness tear)	Prospective, open label clinical trial (Ramírez et al., 2014)	CS-induced tendon rupture may be associated with suppression of tenocyte activity and collagen synthesis (Wong et al., 2004). Tendon rupture associated with local and systemic CS (Kotnis et al., 1999). Ruptures reported in the Achilles, long head of biceps, extensor digitorum, and patellar tendons (Halpern et al., 1977). 17% of 53 participants without evidence of FTRCTs who received 40 mg triamcinolone acetate for subacromial pain developed FTRCTs in one week; the majority (66%) occurred in the presence of a PTT pre-injection (Ramírez et al., 2014). Lack of blinding between the ultrasonographer and the participants may have confounded the findings. Triamcinolone acetonide may be related to more structural defects and ruptures than methylprednisolone. In addition, ruptures may be related to multiple injections at a site (Nicols, 2005). Definitive causation has not been demonstrated.
Cartilage thinning	Triamcinolone acetate 40mg (every 3 months over 2 years)	Knee joint	Not stated	Randomised, placebo, double blind clinical trial (McAlindon et al., 2017)	Urinary crosslinked C-telopeptide of type II collagen (uCTX-II), associated with degenerative cartilage breakdown, is a biomarker found in urine and provides valuable information of the effects of corticosteroids on cartilage (Klocke et al., 2018). The certainty by which CSI are associated with cartilage damage is equivocal and opposing findings have been published. Following a single dose of 40 mg triamcinolone acetonide, uCTX-II levels were reduced at three weeks when compared to a saline group, suggesting a protective effect of corticosteroid on cartilage (Klocke et al., 2018). This is supported by a systematic review of human and animal in-vitro studies, reporting that after low doses of CSI (2–3 mg to 8–12 mg), cartilage cells were synthesised and degenerative enzymes inhibited (Wernecke et al., 2015). CS may reduce the rate of degenerative changes in osteoarthritic joints where inflammation is part of the degenerative process (Ayral et al., 2005). In higher doses corticosteroids may induce chondrocyte apoptosis, decrease cell viability, suppress the expression of matrix proteins, or promote calcium pyrophosphate dihydrate crystals formation that may accelerate cartilage degeneration (Zeng et al., 2019). A systematic review concluded that higher and more sustained exposure (> 3mg/dose or 18–24 mg/cumulative dose) was associated with gross cartilage damage and chondrotoxicity in human and animal in-vitro studies (Wernecke et al., 2015). Following sustained and repeated CSI, a reduction in joint space on MRI scan was found in the CS group compared to patients injected with saline (McAlindon et al., 2017). It is important to note that following the injection, the decrease in knee pain across the treatment groups did not significantly differ.

Local adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
					Higher dose, more frequently administered injections may lead to progression of osteoarthritis as radiographic changes correlate with increased pain and loss of function (Hill et al., 2007; Shah et al., 2019; Van Spil et al., 2015) and may increase the risk of progression to total knee replacement (Liu et al., 2018; Zeng et al., 2019). Confounding variables are likely to exist in such studies and it is worth considering the contribution of phenotype in relation to osteoarthritis disease progression. For example, as body mass index, sedentary lifestyle, sex, ethnicity, age, pain, and diet are risk factors associated with arthritis (Karsdal et al., 2015; Musumeci et al., 2015). Limiting the frequency of injections has been advocated (Walker-Bone et al., 2004), but this appears to be based on professional opinion as opposed to definitive research evidence (Douglas, 2012). Current recommendations are that injections should be limited to once every 3–4 months and not exceed 3–4 injections per year (National Institute for Health and Care Excellence, 2017) (Lane & Thompson, 1997; Neustadt, 2006).
Infection/septic arthritis	Not stated	Not stated	1:3,000–1:100,000	Survey (Baima & Isaac, 2008 Narrative review (Peterson & Hodler, 2011; Shah et al., 2019 Retrospective cohort (Charalambous et al., 2003; Holland et al., 2012)	Bacterial or septic arthritis is a rare but potentially catastrophic complication following CSI (Shah et al., 2019), with a 15% mortality rate. In survivors, impairment of joint function occurs in up to 50% of cases (Charalambous et al., 2003). Early symptoms may include severe local pain, heat, swelling, feeling systemically unwell, temperature, nausea, dizziness, and fatigue. Faulty aseptic technique is probably the main cause (Holland et al., 2012; von Essen & Savolainen, 1989), but may occur due to hormonal activation of a previously quiescent infection (von Essen & Savolainen, 1989). Staphylococcus aureus is most implicated (Charalambous et al., 2003; Provenzano et al., 2018). Pre-injection blood screening may be relevant for some patients. Pre-injection screening for previous joint surgery, pre-existing joint disease, particularly rheumatoid arthritis as the immune system is already compromised, diabetes mellitus, the presence of prosthetic or osteosynthetic material, skin defect or infection, advanced age, and immunosuppressive medication (Kaandorp et al., 1995) is essential.
Post-injection pain (PIP)	Depomedrone 40 or 80 mg	Shoulder Trigger finger DeQuervain's tenosynovitis	1–81%	Systematic review (Brinks et al., 2010). Prospective cohort (Fawi et al., 2017) Randomised controlled clinical trial (Goldfarb et al., 2007)	PIP is a self-limiting increase in pain (+/- swelling) by 2 or more points on a 10-point VAS (Goldfarb et al., 2007; Peterson & Hodler, 2011; Shah et al., 2019). Proposed mechanisms may include steroid microcrystals (Shah et al., 2019) and a reaction caused by the "rapid intracellular ingestion of the microcrystalline steroid ester" (Berger & Yount, 1990, p. 1286). Acidity of the injection may result in short-term inflammation, pain, and crystal induced synovitis (Goldfarb et al., 2007). PIP may also be due to physical trauma to tissues during the procedure, nocebo, insufficient post procedure relative rest, and natural history. To minimise PIP, analgesics, non-pharmacological pain relief methods, and avoidance of strenuous activities should be considered for at least 48 hr after an injection.

Local adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
Subcutaneous fat atrophy	Triamcinolone acetate 10–40 mg	De Quervain's tenosynovitis Tennis elbow	1.5–40%	Systematic review (Brinks et al., 2010)	Subcutaneous fat and skin atrophy (lipoatrophy) and hypopigmentation are considered serious adverse reactions following a corticosteroid injection into soft tissue. Lymphatic spread of corticosteroid into the dermal and epidermal tissues has been hypothesised as the mechanism (Evans & McGibbon, 2002; Nanda et al., 2006), but the definitive cause remains unknown. Lipoatrophy has been reported with methylprednisolone acetate injections (Beyzadeoglu et al., 2011), but may be more common in high doses of corticosteroids and with triamcinolone acetonide due to its larger molecular size and longer half-life (Kim, Lee et al., 2015). Fat atrophy usually affects more superficial regions such as the wrist, hand, elbow, ankle, and foot. The incidence of post-injection fat atrophy has been reported between 0.6%–40% (Brinks et al., 2010; Kim, Lee et al., 2015). It usually appears within two weeks to 4 months (Ghunawat & Sarkar, 2018; Green et al., 2019; Liang & McElroy, 2013; Park et al., 2013; Wang, 2017), and typically (but not always) resolves within 6–30 months (Ghunawat & Sarkar, 2018; Green et al., 2019; Kim, Lee et al., 2015; Martins et al., 2019; Park et al., 2013).
Hypopigmentation	Triamcinolone acetate 10 mg	De Quervain's tenosynovitis Tennis elbow	1.3–4%	Systematic review (Brinks et al., 2010)	Hypopigmentation is characterised by a lightening in skin colour, mostly affecting the peripheral cutaneous regions possibly due to thinner dermal layers. It affects 1–4% of adults (Papadopoulos & Edison, 2009; Park et al., 2013), and is more noticable in people with darker skin colour (Ghunawat & Sarkar, 2018). It is proposed that steroids inhibit prostaglandins or cytokines involved in melanin production (Gupta et al., 2006). Re-pigmentation occurs as melanocytes are downregulated (Green et al., 2019). Strategies to reduce fat atrophy and hypopigmentation include: The use of CS with smaller molecular size and shorter half-life such as methylprednisolone. Using triamcinolone acetate for deep structures such as the knee and shoulder joints (Kim, Lee et al., 2015; Liang & McElroy, 2013; Park et al., 2013). A RCT comparing USGI to a landmark guided injection for DeQuervain's tenosynovitis found fewer cases of hypopigmentation in the USGI group (Roh et al., 2018). Compression over the injection site to reduce the chances of steroid "leaking" along the needle track may also reduce the risk (Papadopoulos & Edison, 2009; Park et al., 2013).

Note. CS = corticosteroid; CSI = corticosteroid injections; FTRCT = full thickness rotator cuff tear; MRI = magnetic resonance imaging; PTT = partial thickness tears; RCT = randomised controlled trial; USGI = ultrasound guided injection; VAS = visual analogue scale.

considering a corticosteroid injection, clinicians are advised to consider no injection where there is a history of long-term steroid use.

Glaucoma

Glaucoma is associated with loss of vision due to raised pressure on the optic nerve. The condition is a leading cause of blindness globally, and in the UK approximately 2% of the population over 40 years of age have glaucoma. Corticosteroids increase intraocular pressure (IOP), cause optic disc cupping, optic nerve atrophy, and glaucomatous visual field loss (Tripathi et al., 1999) and corticosteroid-induced glaucoma following corticosteroid injection (Schäcke et al., 2002). In patients with established glaucoma, a further dangerous increase of the intraocular pressure due to corticosteroid therapy may often be problematic (Schäcke et al., 2002). Symptoms include sudden onset of blurred vision leading to unexpected short-term blurred vision or vision loss, with potential irreversible loss of vision.

Increased IOP typically returns to normal after 2–4 weeks but can persist for over 12 months (Spaeth et al., 1977). Approximately 18–36% of the general population show a moderate increase of 5mm Hg or more IOP after topical administration of corticosteroids with 5–6% of the general population, and 46–92% of patients with primary open-angle glaucoma (POAG), experiencing a significant and potentially damaging rise in IOP after topical glucocorticoid administration (Tripathi et al., 1999).

One suggestion to explain the mechanism by which corticosteroids may lead to worsening signs of glaucoma is exposure to corticosteroids in vitro show increases in ocular cell size and production of a glycoprotein myocilin that may lead to primary open angle glaucoma (POAG) (Tamm, 2002). The heterogeneous nature of the response of corticosteroid-induced ocular hypertension indicates that other factors could have a possible role. Elevated IOP has been noted in patients with Cushing's syndrome secondary to adrenal adenoma, carcinoma, or adrenal hyperplasia (Huschle et al., 1990). First-degree relatives of patients with POAG, diabetes, high myopia, and with connective tissue diseases (especially rheumatoid arthritis) are more likely to develop increased IOP after corticosteroid treatment than the normal population (Manjiani et al., 2015). If symptoms of visual disturbances, especially bilateral blurred vision, are experienced, an urgent medical or ophthalmologist referral is mandatory (Manjiani et al., 2015).

Glaucoma may affect people of all ages, but is more common in older people, and is more common in people of Afro-Caribbean, Afro-American, Hispanic, and African descent. It is more common in near-sighted people and people with high blood pressure, thin corneas, and diabetes. For people at higher risk, or for people over the age of 50 years, an eye examination (if not conducted recently) to exclude glaucoma should be considered prior to a CSI.

DISCUSSION

This review has highlighted a series of diverse side effects and adverse events that are associated with corticosteroid injections for musculoskeletal joint and soft tissue injections. These are presented in Tables 2 and 3. The review has also highlighted the paucity and incomplete nature of knowledge surrounding this practice. The global healthcare community needs to address this, and Table 3 offers non-exhaustive suggestions for research to address these deficits.

The review revealed shortcomings in our knowledge with respect to short-, medium-, and long-term consequences of CSI injection therapy. This should be presented to patients considering injection therapy as part of the shared decision-making process. Table 4 details information that should be discussed with patients considering an injection for rotator cuff-related shoulder pain as part of this process.

Based on the information generated in this review, a clinical decision-making tool was developed to support clinicians in their decision to proceed to injection, proceed with caution (and possibly consider other interventions first), or not to inject. This is presented as an algorithm in Figure 1.

CONCLUSION

There has been an exponential increase in the use of corticosteroid injections to treat musculoskeletal conditions. This has not kept pace with knowledge necessary to inform clinicians and those considering injections on the potential benefits and possible harms, which include local and systemic adverse drug reactions and side effects. Our cumulative knowledge is predominantly based upon studies considered to be of high risk of bias, retrospective analyses, case studies, and systematic reviews synthesising inadequate primary data. Serious adverse events appear to be rare, but this may be due to under-reporting of side effects. There is unquestionably a definitive lack of understanding of the depth and breadth of local adverse drug reactions. This poses a dilemma for clinicians wanting to reach a balanced clinical decision as to whether the benefits of an injection outweigh harm. This needs to be addressed and clinicians recommending and providing injection therapy have a duty of care to fill the large voids in our knowledge.

We advocate that prior to a CSI an in-depth health history should be undertaken with a focus on existing comorbidities such as diabetes and previous or concurrent steroid use. Screening for systemic infection, glaucoma, a history of mental illness, and diabetes, must be included. We recommend providing the Steroid Emergency Card following a third injection within a 12-month period (NHS, 2020).

KEY POINTS

1. Local and systemic adverse drug reactions and side effects are associated with corticosteroid injections for musculoskeletal conditions involving the upper and lower limbs.
2. Intended benefits and potential harms need to be communicated with people considering these procedures.
3. Shared decision-making supports people considering corticosteroid injections to understand the intended benefits and potential harms associated with the procedures.
4. This review has clearly illustrated substantial deficits in knowledge relating to most aspects of injection therapy for non-rheumatological musculoskeletal conditions. These should be addressed in RCTs and large cohort studies and require international collaboration.

Table 3

Systemic Adverse Drug Reactions and Side Effects

Systemic adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
Elevated blood glucose	Methylprednisolone/80 mg Triamcinolone hexacetonide/ 20 mg or Triamcinolone acetate/40 mg	Subacromial region in people with diabetes Knee osteoarthritis in people with diabetes	100%	Prospective case study (Aleem, 017) Prospective controlled study (Habib & Miari, 2011)	CS reduce cell wall sensitivity to insulin by blocking insulin receptor sites, resulting in the cell wall becoming temporarily insulin resistant causing a rise in blood glucose levels (BGL) (Hwang & Weiss, 2014). HbA1c is a measure of BGL over a 3-month period (Kim, Schroeder et al., 2015) and a HbA1c < 7 mg/dL is indicative of well controlled diabetes (Hwang & Weiss, 2014). One study compared HbA1c in different diabetic groups and found that following an injection of 2 ml of 40 mg (80 mg) methylprednisolone acetate to the subacromial space, there was a mean rise in BGL of 38 mg/dL in the well-controlled diabetic group compared to 98 mg/dL in the poorly controlled group (Aleem, 2017). BGL were reported to increase (range 125 mg/dL to 320 mg/dL and in one instance increased to 518 mg/dL) in people with diabetes following CSI (Waterbrook et al., 2017). Elevated BGL may occur 2 hr post injection (Uboldi et al., 2009), but usually between 1 and 2 days post CSI (Moon et al., 2014; Twu et al., 2018), and return to baseline BGL after several days especially in those with poorly controlled diabetes (Aleem, 2017). Lower dose steroids were generally associated with a quicker return to baseline BGL (Patel et al., 2015; Twu et al., 2018). Patients with HbA1c > 7 mg/dL are at greater risk of hyperglycaemia and close monitoring is essential to reduce the chances of further diabetic impairment.
Adrenal suppression	Methylprednisolone/80 mg	Knee osteoarthritis	25%	Randomised controlled study (Habib et al., 2014)	Adrenal insufficiency (AI) occurs when the adrenal glands do not produce enough cortisol, which may be a consequence of oral, inhaled, or injected CS. Cortisol is a steroid hormone that helps the body respond to stress, control blood sugar levels and blood pressure, regulates metabolism, reduces inflammation, and aids with memory formulation. CS suppress the hypothalamic pituitary adrenal axis suppressing the adrenal glands to reduce production of adrenocorticotropic hormone leading to low levels of cortisol production (Stout et al., 2019). Characteristic clinical features of AI are unintentional weight loss, anorexia, postural hypotension, fatigue, muscle, and abdominal pain (Husebye et al., 2021). In the management of rheumatoid arthritis, 52.2% of patients had reduced adrenocorticotropic hormone levels when CS was administered by intra-articular injections and steroids administered via the nasal route for rheumatic disorders compared to 4.2% when administered nasally (Broersen et al., 2015). Nine out of 10 athletes had reduced cortisol levels 14 days after cortivazol/betamethasone injection (Duclos et al., 2007). Raised biomarkers relating to adrenal suppression were found in 25% of people 4 weeks after an injection of 80 mg methylprednisolone for knee osteoarthritis (Habib et al., 2014). A single knee injection of 40 mg methylprednisolone resulted in significantly reduced cortisol levels 24 hr post-injection and below normal levels at 72 hr (Lazarevic et al., 1995). The clinical significance of this remains unclear (Paragliola et al., 2017). Higher doses of depomedrone are associated with lower cortisol levels (Mader et al., 2005) and repeated intra-articular injections may lead to adrenal suppression particularly when the course of steroids ceases (Paragliola et al., 2017). Risk reduction includes a 30-day interval between injections (Johnston et al., 2015) and refraining from excessive heat, altitude, dehydration, over-exertion, trauma, or surgery post injection (Freire & Bureau, 2016).

Systemic adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
					Concomitant use of corticosteroids with anti-retroviral drugs such as ritonavir have resulted in cases of significant adrenal insufficiency (Husebye et al., 2021). Ritonavir blocks the enzyme pathway CYP3A4, which raises concentrations of medications that are metabolised using the same pathway, including corticosteroids (Wood et al., 2015). In some cases, injections were preceded by a course of inhaled steroids for chronic obstructive airways disease and the addition of the injected steroid caused the accumulation of steroid systemically (Alidoost et al., 2020). Clinicians are recommended to use a drug interaction checker such as that from the University of Liverpool (2023). Gradual steroid withdrawal is often the best management option (Husebye et al., 2021; Wood et al., 2015). The use of the "steroid emergency card" is advocated for those on long-term steroids receiving exogenous steroid injections (NHS, 2020).
Menstrual alterations	Triamcinolone acetate/40 mg	Frozen shoulder	24%	Randomised trial (Van der Windt et al., 1998)	Corticosteriods may initiate a negative feedback loop involving the hypothalamic–ovarian axis leading to a suppression of hormones (Gitkind et al., 2010). Triamcinolone acetonide appears to have a high affinity to progesterone receptors (Yoon & Lee, 2009) as depleted levels of dehydroepiandrosterone, testosterone, and oestradiol were found in blood serum analysis following an intra-articular injection of 20 mg triamcinolone hexacetonide for knee rheumatoid arthritis (Weitoft et al., 2008). Over 50% of premenopausal women reported a menstrual disturbance including longer duration of menses and increased blood flow after an injection for peripheral joint or soft tissue pain (Mens et al., 1998). Although there is a paucity of definitive data, one study reported that 16% of women reported changes in menses following an intra-articular shoulder injection of 40 mg triamcinolone (Van der Windt et al., 1998). A case series reported that post-menopausal women experienced bleeding between 9 and 19 days after shoulder, knee, or bursal injections with doses ranging from 10–40 mg triamcinolone acetate. Those between the ages of 45 to 64 years were more likely to report bleeding compared to the over 65-year age group (4.5/1000 ~ 3.3/1,000), which may be due to greater degree of atrophic endometrium in the older age group (Gowri, 2013). Information should be provided as those who experience menstrual alterations may not relate it to the CS injection and may seek specialist advice (Suh-Burgmann et al., 2013).
Facial flushing	Triamcinolone acetate/40 mg Triamcinolone acetate/40 mg or Triamcinolone hexacetonide/ 20 mg	Knee	12.5–40%	Prospective randomised trial Jacobs et al., 1991) Comment (Pattrick & Doherty, 1987)	Facial flushing is associated with erythema (and warmth) that affects the face and upper trunk (Pattrick & Doherty, 1987) and is a relatively minor complication of corticosteroid injections. It is thought to be histamine-mediated, or an immunoglobulin mediated mechanism (Everett et al., 2004) lasting last less than 24 hr post injection (Jacobs et al., 1991). Facial flushing may be more common following epidural injections but has been reported following intra-articular knee injections (Pattrick & Doherty, 1987) and after injections for frozen shoulder (Jacobs et al., 1991). In a case series of people who received an intra-articular steroid injection to the knee with 40 mg Triamcinolone acetonide, flushing occurred in 40% of the 130 consecutive patients (Pattrick & Doherty, 1987). The inconsistent data may reflect under-reporting, different injection sites, variations in medicine and dose, co-morbidites, disgnosis, and study methodology.

Systemic adverse drug reaction/side effect	Drug/dose	Region of injection/ condition	Incidence	Study type (reference)	Summary of findings
Hypersensitivity reactions	Methylprednisolone/80 mg	Knee/Achilles tendon/hand and wrist	Three case studies	Case study (Brandt et al., 2017)	Immediate and uncommon hypersensitivity reactions (HSR) including hives, urticaria, angioedema, and anaphylaxis are reported side effects following CSI. No single corticosteroid molecule structure has been identified as the exact cause, but it is likely the corticosteroid molecule combined with serum, tissue proteins, or enzymes forms an immunogenic steroid-protein-enzyme conjugate acting as the hapten against which the immunoglobin response is directed (Habib, 2009). Although rare there have been well-documented cases of hypersensitivity reactions to steroids where reactions to excipients such as parabens, metabisulfites, and anaesthetics were excluded (Karsh & Yang, 2003). HSR occurred several hr after an intra-articular injection of prednisolone acetate (Comaish, 1969) and a case was recorded of anaphylactic reaction after injection with triamcinolone (Karsh & Yang, 2003). Similarly, a sudden onset of sneezing, angioedema, tachycardia, and marked hypotension reaction was attributable to methylprednisolone after exclusion of other constituents (Mace et al., 1997). The medical records of patients with suspected immediate HSR over a 9-year period were analysed and 64 patients underwent investigations for suspected type I HSR post-injection. True immediate HSR were found in only 14% (n = 9) of patients via positive skin tests or drug provocation tests. Most confirmed cases were allergic to the inert substance used to bulk up or dilute a drug (Li et al., 2018) known as an excipient. Three patients injected with depomedrone who subsequently developed allergic reactions were allergic to the excipient macrogol (Brandt et al., 2017).
Neuropsychiatric symptoms	Methylprednisolone/80 mg	Hip osteoarthritis	1–60%	Case study (Fischer & Kim, 2019)	CS have been associated with neuropsychiatric symptoms that may manifest as mood elevation, insomnia, psychosis, delusions, anger, paranoia, depression, mania, delirium, confusion, disorientation, or hallucinations (Fischer & Kim, 2019). Symptoms are more common with higher dose oral medication but have been reported after a single transforaminal epidural steroid injection (Fischer & Kim, 2019) and after a single injection of 5 mg of dexamethasone and 0.25% of bupivacaine for genitofemoral neuralgia (Janes et al., 2019). Following CSI for musculoskeletal conditions, auditory and visual hallucinations, confusion and poor judgement, anger, agitation, paranoia, hostility, excitability, euphoria, and insomnia have been reported as have excessive spending and grandiose thoughts (Janes et al., 2019). Symptoms have been reported after injections of both methylprednisolone and triamcinolone with onset ranging from the day after the injection(s) to seven days post injection and resolution ranging from 72 hr to 10 days after onset (Fischer & Kim, 2019). Neuropsychiatric symptoms following systemic corticosteroid therapy have a reported prevalence of < 1% to 60%. The percentage of severe psychotic disturbances following intra-articular and soft tissue injections are uncertain, but the available literature would suggest they are rare. There may be a higher incidence in people with a history of neuropsychiatric disorders but there is some uncertainty surrounding this (Fischer & Kim, 2019). There appears to be a higher prevalence of neuropsychiatric disorders with higher doses of corticosteroid and a daily dose exceeding 40 mg prednisolone (Fischer & Kim, 2019). If applied to injection therapy, then single-dose procedures of 40 mg prednisolone, 32.5 mg methylprednisolone or triamcinolone and 6 mg dexamethasone should be considered (Fischer & Kim, 2019).

Note: AI = adrenal insufficiency; BGL = blood glucose levels; CS = corticosteroid; CSI = corticosteroid injections; HSR = hypersensitivity reactions

Table 3

Recommendations for Future Research

Recommendations
Cartilage thinning
Do CSIs lead to cartilage thinning?
If yes, at what doses and volumes, frequency of injections, which joints are more and less commonly affected, does the addition of anaesthetic magnify, decrease, or not change the effect of CS on cartilage thinning?
Does this occur in all joints, or are some more vulnerable than others?
If this does occur, is it reversible?
Tendon degeneration and ruptures
Do CSIs lead to increased tendon degeneration and ruptures?
If yes, at what doses and volumes, frequency of injections, which tendons are more and less commonly affected, does the addition of anaesthetic magnify, decrease, or not change the effect of corticosteroids on tendon degeneration and ruptures?
Does this occur in all tendons, or are some more vulnerable than others?
If degeneration does occur, is it reversible?
Does CSI lead to an increase in surgery, and, if yes, is the effect influenced by the addition of anaesthetic, and are some tendons more vulnerable than others?
Joint infection
Should blood tests be conducted routinely in all, some, or no people, before joint injections to reduce the risk of unmasking a subclinical infection?
Glaucoma
Should tests be conducted routinely in all, some, or no people, before CSI to determine if closed angle glaucoma is present?
Subcutaneous fat atrophy and hypopigmentation
Should sustained pressure be maintained for a specific duration to reduce the risk of this occurring?
Should superficial structures more at risk be injected under ultrasound guidance?

Note. CSI = corticosteorid injection.

Table 4

Information to Support Shared Decision Making Prior to Considering a Corticosteroid Injection for Rotator Cuff-related Shoulder Pain

	Information
1.	CSIs for rotator cuff-related shoulder pain appear to have a small and transient benefit from 4–8 weeks.
2.	After 8 weeks CSIs have same benefit as anaesthetic-only injections.
3.	There is no evidence that CSIs have greater benefit than anaesthetic-only injections in the medium to long term.
4.	Numbers needed to treat = 5 and benefit when pain reduced may only be mild.
5.	When they help, there is uncertainty as to why they reduce symptoms – reasons include natural improvement, placebo, and therapeutic effect of the medication.
6.	Corticosteroid and anaesthetic injections theoretically may accelerate tendon and cartilage degeneration.
7.	If you have had surgery a CSI may increase the risk of you requiring additional surgery.
8.	CSIs are not a quick or guaranteed fix, and their use needs to be kept to minimum.
9.	You should only consider a CSI if the pain is significantly impairing your sleep and daily function.
10.	Multiple CSIs are no more beneficial than a single injection.
11.	All medicines are associated with side effects and adverse effects, and you must be informed of these.
12.	CSIs are more likely to be associated with negative effects in certain health conditions. The actual risks are often not known, but people considering CSI need to be made aware of these.
13.	Encourage the question "Is there another management option, including wait and watch?"

Note. CSI = corticosteroid injection. Publications from which this information has been sourced include Cook et al. (2018), Cook and Lewis (2019), Hoffman et al. (2020), Hopewell et al. (2021), Mohamadi et al. (2017), and Traven et al. (2018).

DISCLOSURES

There are no conflicts of interest that may be perceived to interfere with or bias this study. The authors affirm that we have no financial affiliation (including research funding) or involvement with any commercial organisation that has a direct financial interest in any matter included in this manuscript.

PERMISSIONS

Christine Bilsborough Smith and Jeremy Lewis have given permission for the use of Figure 1. Ethical approval was not required.

CONTRIBUTIONS OF AUTHORS

Conceptualisation and methodology, CBS, and JL; formal analysis, investigation and data curation, CBS, DB, RB, BD, RM, and JL; writing – original draft preparation, CBS, and JL; writing – review & editing, CBS, DB, RB, MC, RC, BD, RM, and JL.

The authors included two UK consultant physiotherapists (CBS, JL) who both perform ultrasound guided musculoskeletal injections and one (JL) who is an independent non-medical prescriber. Two UK specialist advanced practice physiotherapists (DB, RM) who are both independent non-medical prescribers and perform ultrasound guided injections. BD is a UK consultant orthopaedic surgeon and academic, and RB is a UK consultant musculoskeletal radiologist.

Figure 1

Decision-making Tool for Corticosteroid Injections For Adult Musculoskeletal Conditions

Decision making tool for corticosteroid injections for adult musculoskeletal conditions

NB: This does not include considerations for anaesthetics

Step one: Assessment

Conduct a full patient interview and physical examination

This will facilitate an understanding of the clinical presentation, and progression of the condition. It will enable risks or contraindications for injection therapy to be identified. It will assist in understanding the patient's values, beliefs, and aspirations around injection therapy.

Step two: Screening

Contraindications	Tick if applies
Feeling unwell – Current infection	☐
Taking antibiotics	☐
Aged under 18 years	☐
Currently on steroid management	☐
Site of prosthesis	☐
Pregnant/possibly pregnant/breastfeeding	☐
Recent trauma to intended site of injection	☐
Follow pre- and post-vaccination guidelines	☐
Immunocompromised (e.g., cancer HIV, TB)	☐
Planned surgery in next 3 months	☐

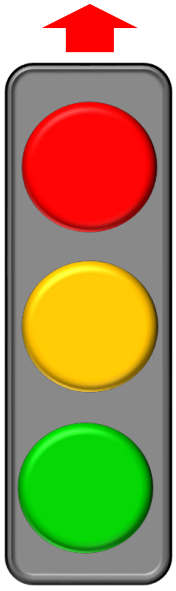
Any box ticked

No box ticked

Precautions	Tick if applies
Diabetes (Type 1/poorly controlled)	☐
Epilepsy	☐
Hypertension (assess if taking beta blockers)	☐
Currently on steroid treatment	☐
Adrenal insufficiency/Cushing's syndrome	☐
Bradycardia > 50 bpm	☐
Kidney function compromise	☐
Liver function compromise	☐
Myasthenia gravis	☐
Neurological conditions	☐
Glaucoma (closed angle)	☐
Follow pre- and post-vaccination guidelines	☐
Recent abdominal surgery	☐
≥3 steroid injections in past 12 months	☐

Any box ticked

No box ticked



DO NOT PROCEED

Consider other options such as physiotherapy management, activity modification, other pharmacological intervention, surgical opinion

SEEK GUIDANCE

If there is any degree of uncertainty, speak with the GP, consultant, rheumatologist, or other specialist. For example, contacting the patients ophthalmologist to determine if safe to proceed in the presence of closed angle glaucoma. The level of experience and degree of confidence a clinician has, may determine if and from whom guidance is sought. Following guidance, a decision to proceed or not proceed will be made.

PROCEED WITH INJECTION

Procced with the injection once a shared decision-making process has been completed and the patient is cognizant of the intended benefits, timeframes, harms, including side effects and potential adverse events

Step three: Shared decision making

Shared decision making

Shared decision making is at the centre of providing safe patient care. Discuss the risks and benefits where evidence is available. Ensure the patient is aware of alternatives including no treatment, no injection, and other management options. Patients should be aware of the side effects, adverse effects, and serious adverse effects of corticosteroid injections, as well as the limitations of the procedures which in some cases may be substantial.

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REFERENCES

Aleem, A. W. (2017). Blood glucose levels in diabetic patients following corticosteroid injections into the subacromial space of the shoulder. *Archives of Bone and Joint Surgery*, *5*, 315–321.

Alidoost, M., Conte, G. A., Agarwal, K., Carson, M. P., Lann, D., & Marchesani, D. (2020). Iatrogenic Cushing's syndrome following intra-articular triamcinolone injection in an HIV-infected patient on cobicistat presenting as a pulmonary embolism: Case report and literature review. *International Medical Case Reports Journal*, *13*, 229–235. https://doi.org/10.2147/IMCRJ.S254461

Aronson, J. K., & Ferner, R. E. (2005). Clarification of terminology in drug safety. *Drug Safety*, *28*(10), 851–870. https://doi.org/10.2165/00002018-200528100-00003

Ayral, X., Pickering, E. H., Woodworth, T. G., Mackillop, N., & Dougados, M. (2005). Synovitis: A potential predictive factor of structural progression of medial tibiofemoral knee osteoarthritis – Results of a 1 year longitudinal arthroscopic study in 422 patients. *Osteoarthritis Cartilage, 13*(5), 361–367. https://doi.org/10.1016/j.joca.2005.01.005

Baima, J., & Isaac, Z. (2008). Clean versus sterile technique for common joint injections: A review from the physiatry perspective. *Current Reviews in Musculoskeletal Medicine, 1*(2), 88–91. https://doi.org/10.1007/s12178-007-9011-2

Berger, R. G., & Yount, W. J. (1990). Immediate "steroid flare" from intraarticular triamcinolone hexacetonide injection: Case report and review of the literature. *Arthritis and Rheumatism*, *33*(8), 1284–1286. https://doi.org/10.1002/art.1780330833

Beyzadeoglu, T., Bekler, H., & Gokce, A. (2011). Skin and subcutanous fat atrophy after corticosteroid injection for medial epicondylitis. *Orthopedics*, *34*(8), 570–570. https://doi.org/10.3928/01477447-20110627-01

Bharadwaj, U. U, Link, T., Akkaya, Z., Joseph, G., Lynch, J., & Giesler, P. (2022). *Impact of intra-articular knee injections on the progression of knee osteoarthritis: Data from the osteoarthritis initiative (OAI) cohort* [conference presentation abstract]. Radiological Society of North America. https://press.rsna.org/timssnet/media/pressreleases/14_pr_target.cfm?id=2386

Brandt, N., Garvey, L. H., Bindslev-Jensen, U., Kjaer, H. F., Bindslev-Jensen, C., & Mortz, C. G. (2017). Three cases of anaphylaxis following injection of a depot corticosteroid with evidence of IgE sensitization to macrogols rather than the active steroid. *Clinical and Translational Allergy*, *7*, 2. https://doi.org/10.1186/s13601-016-0138-3

Brinks, A., Koes, B. W., Volkers, A. C., Verhaar, J. A., & Bierma-Zeinstra, S. M. (2010). Adverse effects of extra-articular corticosteroid injections: A systematic review. *BMC Musculoskeletal Disorders*, *11*, 206. https://doi.org/10.1186/1471-2474-11-206

Broersen, L. H., Pereira, A. M., Jorgensen, J. O., & Dekkers, O. M. (2015). Adrenal insufficiency in corticosteroids use: Systematic review and meta-analysis. *Journal of Clinical Endocrinology & Metabolism*, *100*(6), 2171–2180. https://doi.org/10.1210/jc.2015-1218

Charalambous, C. P., Zipitis, C. S., Kumar, R., Lipsett, P. A., Hirst, P., & Paul, A. (2003). Soft tissue infections of the extremities in an orthopaedic centre in the UK. *Journal of Infection*, *46*(2), 106–110. https://doi.org/10.1053/jinf.2002.1099

Comaish, S. (1969). A case of hypersensitivity to corticosteroids. *British Journal of Dermatology*, *81*(12), 919–925. https://doi.org/10.1111/j.1365-2133.1969.tb15974.x

Cook, T., Minns Lowe, C., Maybury, M., & Lewis, J. S. (2018). Are corticosteroid injections more beneficial than anaesthetic injections alone in the management of rotator cuff-related shoulder pain? A systematic review. *British Journal of Sports Medicine*, *52*(8), 497–504. https://doi.org/10.1136/bjsports-2016-097444

Cook, T., & Lewis, J. (2019). Rotator cuff-related shoulder pain: To inject or not inject? *Journal of Orthopaedic & Sports Physical Therapy, 49*(5), 289–293 https://www.jospt.org/doi/abs/10.2519/jospt.2019.0607

Coombes B, K., Bissett, L., Brooks, P., Khan, A., & Vicenzino, B. (2013). Effect of corticosteroid injection, physiotherapy or both on clinical outcomes in patients with unilateral lateral epicondylalgia. *JAMA*, *309*(5), 461–469. https://doi.org/10.1001/jama.2013.129

Cruz-Topete, D., & Cidlowski, J. A. (2015). One hormone, two actions: Anti- and pro-inflammatory effects of glucocorticoids. *Neuroimmunomodulation*, *22*(1–2), 20–32. https://doi.org/10.1159/000362724

Darbandi, A., Hormozian, S., Pooyan, A., Alipour, E., Zadeh, F, Z., Parham Pezeshk, P., & Chalian, M. (2022). *Medial joint space narrowing and Kellgren-Lawrence progression following intraarticular corticosteroid injections compared to hyaluronic acid injections and nontreated patients* [Conference presentation abstract]. Radiological Society of North America. https://press.rsna.org/timssnet/media/pressreleases/14_pr_target.cfm?id=2386

Douglas, R. J. (2012). Corticosteroid injection into the osteoarthritic knee: Drug selection, dose, and injection frequency. *International Journal of Clinical Practice, 66*(7), 699–704. https://doi.org/10.1111/j.1742-1241.2012.02963.x

Duclos, M., Guinot, M., Colsy, M., Merle, F., Baudot, C., Corcuff, J. B., & Lebouc, Y. (2007). High risk of adrenal insufficiency after a single articular steroid injection in athletes. *Medicine & Science in Sports & Exercise*, *39*(7), 1036–1043. https://doi.org/10.1249/mss.0b013e31805468d6

Evans, A. V., & McGibbon, D. H. (2002). Symmetrical hypopigmentation following triamcinolone injection for de Quervain's tenosynovitis. *Clinical and Experimental Dermatology*, *27*(3), 247–251. https://doi.org/10.1046/j.1365-2230.2001.09861.x

Everett, C. R., Baskin, M. N., Speech, D., Novoseletsky, D., & Patel, R. (2004). Flushing as a side effect following lumbar transforaminal epidural steroid injection. *Pain Physician*, *7*(4), 427–429.

Fawi, H. M. T., Hossain, M., & Matthews, T. J. W. (2017). The incidence of flare reaction and short-term outcome following steroid injection in the shoulder. *Shoulder Elbow, 9*(3), 188–194. https://doi.org/10.1177/1758573217693808

Fischer, M., & Kim, P. Y. (2019). Corticosteroid-induced psychosis after a single transforaminal epidural steroid injection. *WMJ*, *118*(2), 91–94. https://www.ncbi.nlm.nih.gov/pubmed/31532936

Freire, V., & Bureau, N. J. (2016). Injectable corticosteroids: Take precautions and use caution. *Seminars in Musculoskeletal Radiology*, *20*(5), 401–408. https://doi.org/10.1055/s-0036-1594286

Ghunawat, S. & Sarkar, R. (2018). Steroid-induced perilymphatic hypopigmentation: Response to tacrolimus. *Pigment International*, *5*(2), 114–116.

Gitkind, A. I., Shah, B., & Thomas, M. (2010). Epidural corticosteroid injections as a possible cause of menorrhagia: A case report. *Pain Medicine*, *11*(5), 713–715. https://doi.org/10.1111/j.1526-4637.2009.00775.x

Goldfarb, C. A., Gelberman, R. H., McKeon, K., Chia, B., & Boyer, M. I. (2007). Extra-articular steroid injection: Early patient response and the incidence of flare reaction. *Journal of Hand Surgery*, *32*(10), 1513–1520. https://doi.org/10.1016/j.jhsa.2007.08.002

Gowri, V. (2013). An unusual cause of postmenopausal bleeding. *BMJ Case Reports*, *2013*, bcr2012008500. https://doi.org/10.1136/bcr-2012-008500

Green, M. C., Tracey, M. S., & Trafeli, J. P. (2019). Treatment of corticosteroid-induced hypopigmentation using fractional carbon dioxide laser. *Dermotological Surgery, 45*(2), 298–300. https://doi.org/10.1097/DSS.0000000000001548

Gupta, A. K., Gover, M. D., Nouri, K., & Taylor, S. (2006). The treatment of melasma: A review of clinical trials. *Journal of the American Academy of Dermatology*, *55*(6), 1048–1065. https://doi.org/10.1016/j.jaad.2006.02.009

Habib, G., Jabbour, A., Artul, S., & Hakim, G. (2014). Intra-articular methylprednisolone acetate injection at the knee joint and the hypothalamic-pituitary-adrenal axis: A randomized controlled study. *Clinical Rheumatology*, *33*(1), 99–103. https://doi.org/10.1007/s10067-013-2374-4

Habib, G. S., & Miari, W. (2011). The effect of intra-articular triamcinolone preparations on blood glucose levels in diabetic patients: A controlled study. *Journal of Clinical Rheumatology, 17*(6), 302–305. https://doi.org/10.1097/RHU.0b013e31822acd7c

Habib, G. S. (2009). Systemic effects of intra-articular corticosteroids. *Clinical Rheumatology*, *28*(7), 749–756. https://doi.org/10.1007/s10067-009-1135-x

Halpern, A. A., Horowitz, B. G., & Nagel, D. A. (1977). Tendon ruptures associated with corticosteroid therapy. *Western Journal of Medicine*, *127*(5), 378–382. https://www.ncbi.nlm.nih.gov/pubmed/919538

Haran, M., Schattner, A., Kozak, N., Mate, A., Berrebi, A., & Shvidel, L. (2018). Acute steroid myopathy: A highly overlooked entity. *QJM: An International Journal of Medicine*, *111*(5), 307–311. https://doi.org/10.1093/qjmed/hcy031

Hill, C. L., Hunter, D. J., Niu, J., Clancy, M., Guermazi, A., Genant, H., Gale, D., Grainger, A., Conaghan, P., & Felson, D. T. (2007). Synovitis detected on magnetic resonance imaging and its relation to pain and cartilage loss in knee osteoarthritis. *Annals of the Rheumatic Diseases, 66*(12), 1599–1603. https://doi.org/10.1136/ard.2006.067470

Hoffmann, T. C., Lewis, J., & Maher, C. G. (2020). Shared decision making should be an integral part of physiotherapy practice. *Physiotherapy*, *107*, 43–49. https://doi.org/10.1016/j.physio.2019.08.012

Holland, C., Jaeger, L., Smentkowski, U., Weber, B., & Otto, C. (2012). Septic and aseptic complications of corticosteroid injections. An assessment of 278 cases reviewed by expert commissions and mediation boards from 2005 to 2009. *Deutsches Ärzteblatt International*, *109*(24), 425–430. https://doi.org/10.3238/arztebl.2012.0425

Hopewell, S., Keene, D. J., Marian, I. R., Dritsaki, M., Heine, P., Cureton, L., Dutton, S. J., Dakin, H., Carr, A., Hamilton, W., Hansen, Z., Jaggi, A., Littlewood, C., Barker, K. L., Gray, A., & Lamb, S. E. (2021). Progressive exercise compared with best practice advice, with or without corticosteroid injection, for the treatment of patients with rotator cuff disorders (GRASP): A multicentre, pragmatic, 2 x 2 factorial, randomised controlled trial. *The Lancet, 398*(10298), 416–428. https://www.compared.com/science/article/pii/S0140673621008461

Huschle, O. K., Jonas, J. B., Koniszewski, G., Buchfelder, M., & Fahlbusch, R. (1990). Glaucoma in central hypothalamic-hypophyseal Cushing syndrome. *Fortschritte Ophthalmologie*, *87*(5), 453–456. https://www.ncbi.nlm.nih.gov/pubmed/2177029

Husebye, E. S., Pearce, S. H., Krone, N. P., & Kämpe, O. (2021). Adrenal insufficiency. *The Lancet*, *397*(10274), 613–629. https://doi.org/10.1016/s0140-6736(21)00136-7

Hwang, J. L., & Weiss, R. E. (2014). Steroid-induced diabetes: A clinical and molecular approach to understanding and treatment. *Diabetes Metabolism Research and Reviews*, *30*(2), 96–102. https://doi.org/10.1002/dmrr.2486

Jacobs, L. G., Barton, M. A., Wallace, W. A., Ferrousis, J., Dunn, N. A., & Bossingham, D. H. (1991). Intra-articular distension and steroids in the management of capsulitis of the shoulder. *BMJ*, *302*(6791), 1498–1501. https://doi.org/10.1136/bmj.302.6791.1498

Janes, M., Kuster, S., Goldson, T. M., & Forjuoh, S. N. (2019). Steroid-induced psychosis. *Baylor University Medical Center Proceedings*, *32*(4), 614–615. https://doi.org/10.1080/08998280.2019.1629223

Johnston, P. C., Lansang, M. C., Chatterjee, S., & Kennedy, L. (2015). Intra-articular glucocorticoid injections and their effect on hypothalamic–pituitary–adrenal (HPA)-axis function. *Endocrine*, *48*(2), 410–416. https://doi.org/10.1007/s12020-014-0409-5

Kaandorp, C. J., Van Schaardenburg, D., Krijnen, P., Habbema, J. D., & van de Laar, M. A. (1995). Risk factors for septic arthritis in patients with joint disease. A prospective study. *Arthritis & Rheumatology*, *38*(12), 1819–1825. https://doi.org/10.1002/art.1780381215

Karsdal, M. A., Bihlet, A., Byrjalsen, I., Alexandersen, P., Ladel, C., Michaels, M., Andersen, J. R., Riis, B. J., Kraus, V., Bay-Jensen, A. C., & Christiansen, C. (2015). OA phenotypes, rather than disease stage, drive structural progression -- Identification of structural progressors from 2 phase III randomized clinical studies with symptomatic knee OA. *Osteoarthritis Cartilage, 23*(4), 550–558. https://doi.org/10.1016/j.joca.2014.12.024

Karsh, J., & Yang, W. H. (2003). An anaphylactic reaction to intra-articular triamcinolone: A case report and review of the literature. *Annals of Allergy Asthma & Immunology*, *90*(2), 254–258. https://doi.org/10.1016/S1081-1206(10)62151-5

Kim, I., Lee, H. L., & Lee, S.-S. (2015). Two cases of lipoatrophy after local corticosteroid injection. *Korean Journal of Clinical Neurophysiology*, *17*(2), 1084168. https://doi.org/10.14253/kjcn.2015.17.2.91

Kim, N., Schroeder, J., Hoffler, C. E., Matzon, J. L., Lutsky, K. F., & Beredjiklian, P. K. (2015). Elevated hemoglobin A1C levels correlate with blood glucose elevation in diabetic patients following local corticosteroid injection in the hand: A prospective study. *Plastic and Reconstructive Surgery*, *136*(4), 474e–479e. https://doi.org/10.1097/PRS.0000000000001624

Klocke, R., Levasseur, K., Kitas, G. D., Smith, J. P., & Hirsch, G. (2018). Cartilage turnover and intra-articular corticosteroid injections in knee osteoarthritis. *Rheumatology International, 38*(3), 455–459. https://doi.org/10.1007/s00296-018-3988-2

Kohls, M., Magnussen, R., Fitzpatrick, S., Kaeding, C., Flanigan, D., & Duerr, R. (2022). Intra-articular steroid injection at the time of knee arthroscopy increases risk of post-operative infection. *Knee Surgery, Sports Traumatology, Arthroscopy*, *30*(5), 1846–1853. https://doi.org/10.1007/s00167-021-06763-w

Kotnis, R. A., Halstead, J. C., & Hormbrey, P. J. (1999). Atraumatic bilateral Achilles tendon rupture: An association of systemic steroid treatment. *Journal of Accident & Emergency Medicine*, *16*(5), 378–379. https://doi.org/10.1136/emj.16.5.378

Lane, N. E., & Thompson, J. M. (1997). Management of osteoarthritis in the primary-care setting: An evidence-based approach to treatment. *American Journal of Medicine, 103*(6A), 25S–30S. https://doi.org/10.1016/s0002-9343(97)90005-x

Lazarevic, M. B., Skosey, J. L., Djordjevic-Denic, G., Swedler, W. I., Zgradic, I., & Myones, B. L. (1995). Reduction of cortisol levels after single intra-articular and intramuscular steroid injection. *American Journal of Medicine*, *99*(4), 370–373. https://doi.org/10.1016/s0002-9343(99)80183-1

Liang, J., & McElroy, K. (2013). Hypopigmentation after triamcinolone injection for de Quervain tenosynovitis. *American Journal of Physical Medicine & Rehabilitation*, *92*(7), 639. https://doi.org/10.1097/PHM.0b013e318269ebdc

Li, P. H., Wagner, A., Thomas, I., Watts, T. J., Rutkowski, R., & Rutkowski, K. (2018). Steroid allergy: Clinical features and the importance of excipient testing in a diagnostic algorithm. *Journal of Allergy and Clinical Immunology. In Practice, 6*(5), 1655–1661. https://doi.org/10.1016/j.jaip.2018.01.007

Liu, S.-H., Dubé, C. E., Eaton, C. B., Driban, J. B., McAlindon, T. E., & Lapane, K. L. (2018). Longterm effectiveness of intraarticular injections on patient-reported symptoms in knee osteoarthritis. *Journal of Rheumatology, 45*(9), 1316–1324. https://doi.org/10.3899/jrheum.171385

Mace, S., Vadas, P., & Pruzanski, W. (1997). Anaphylactic shock induced by intraarticular injection of methylprednisolone acetate. *Journal of Rheumatology*, *24*(6), 1191–1194.

Mader, R., Lavi, I., & Luboshitzky, R. (2005). Evaluation of the pituitary-adrenal axis function following single intraarticular injection of methylprednisolone. *Arthritis & Rheumatism*, *52*(3), 924–928. https://doi.org/10.1002/art.20884

Manjiani, D., Said, S., & Kaye, A. D. (2015). Transient glaucoma after an epidural steroid injection: A case report. *The Ochsner Journal*, *15*(1), 79–82.

Martins, N., Polido-Pereira, J., Caneira, M., & Fonseca, J. E. (2019). Treatment of persistent cutaneous atrophy after corticosteroid injection with fat graft. *Reumatología Clínica*, *15*(6), e122–e124. https://doi.org/10.1016/j.reuma.2017.09.002

McAlindon, T. E., LaValley, M. P., Harvey, W. F., Price, L. L., Driban, J. B., Zhang, M., & Ward, R. J. (2017). Effect of intra-articular triamcinolone vs saline on knee cartilage volume and pain in patients with knee osteoarthritis: A randomized clinical trial. *JAMA, 317*(19), 1967–1975. https://doi.org/10.1001/jama.2017.5283

McEwen, B. S., & Stellar, E. (1993). Stress and the individual. Mechanisms leading to disease. *Archives of Internal Medicine*, *153*(18), 2093–2101. https://doi.org/10.1001/archinte.1993.00410180039004

Medicines and Healthcare Products Regulatory Agency. (2006). *Annual report and accounts 2006/07*. TSO (The Stationery Office). https://www.gov.uk/government/publications/medicines-and-healthcare-products-regulatory-agency-annual-report-and-accounts-2006-07

Mens, J. M., Nico de Wolf, A., Berkhout, B. J., & Stam, H. J. (1998). Disturbance of the menstrual pattern after local injection with triamcinolone acetonide. *Annals of the Rheumatic Diseases, 57*(11), 700. https://doi.org/10.1136/ard.57.11.700

Minetto, M. A., Lanfranco, F., Motta, G., Allasia, S., Arvat, E., & D'Antona, G. (2011). Steroid myopathy: Some unresolved issues. *Journal of Endocrinological Investigation*, *34*(5), 370–375. https://doi.org/10.1007/BF03347462

Mohamadi, A., Chan, J. J., Claessen, F. M., Ring, D., & Chen, N. C. (2017). Corticosteroid injections give small and transient pain relief in rotator cuff tendinosis: A meta-analysis. *Clinical Orthopaedics and Related Research*, *475*(1), 232–243. https://doi.org/10.1007/s11999-016-5002-1

Moon, H. J., Choi, K. H., Lee, S. I., Lee, O. J., Shin, J. W., & Kim, T. W. (2014). Changes in blood glucose and cortisol levels after epidural or shoulder intra-articular glucocorticoid injections in diabetic or nondiabetic patients. *American Journal of Physical Medicine & Rehabilation*, *93*(5), 372–378. https://doi.org/10.1097/PHM.0000000000000001

Murnaghan, G.F., & McIntosh, D. (1955). Hydrocortisone in painful shoulder; A controlled trial. *Lancet, 269*(6894), 798–800. https://doi.org/10.1016/s0140-6736(55)92388-6

Musumeci, G., Aiello, F. C., Szychlinska, M. A., Di Rosa, M., Castrogiovanni, P., & Mobasheri, A. (2015). Osteoarthritis in the XXIst century: Risk factors and behaviours that influence disease onset and progression. *International Journal of Molecular Sciences, 16*(3), 6093–6112. https://doi.org/10.3390/ijms16036093

Nanda, V., Parwaz, M. A., & Handa, S. (2006). Linear hypopigmentation after triamcinolone injection: A rare complication of a common procedure. *Aesthetic Plastic Surgery*, *30*(1), 118–119. https://doi.org/10.1007/s00266-005-0131-z

National Institute for Health and Care Excellence (2017). *Corticosteroid, inflammatory disorders. Treatment summaries.* https://bnf.nice.org.uk/treatment-summaries/corticosteroids-inflammatory-disorders/

NHS. (2020, August 13). *Steroid emergency card to support early recognition and treatment of adrenal crisis in adults*. https://www.england.nhs.uk/2020/08/steroid-emergency-card-to-support-early-recognition-and-treatment-of-adrenal-crisis-in-adults/

Neustadt, D. H. (2006). Intra-articular injections for osteoarthritis of the knee. *Cleveland Clinic Journal of Medicine, 73*(10), 897–898, 901–904, 906–911. https://doi.org/10.3949/ccjm.73.10.897

Nicols, A. W. (2005). Complications associated with the use of corticosteroids in the treatment of athletic injuries. *Clinical Journal of Sports Medicine*, *15*(5), 370–375. https://doi.org/10.1097/01.jsm.0000179233.17885.18

Paik, J. (2022, May 31). *Glucocorticoid-induced myopathy*. Wolters Kluwer. https://www.uptodate.com/contents/glucocorticoid-induced-myopathy

Papadopoulos, P. J., & Edison, J. D. (2009). The clinical picture. Soft tissue atrophy after corticosteroid injection. *Cleveland Clinic Journal of Medicine*, *76*(6), 373–374. https://doi.org/10.3949/ccjm.76a.08096

Paragliola, R. M., Papi, G., Pontecorvi, A., & Corsello, S. M. (2017). Treatment with synthetic glucocorticoids and the hypothalamus-pituitary-adrenal axis. *International Journal of Molecular Sciences*, *18*(10), 2201. https://doi.org/10.3390/ijms18102201

Park, S.-K., Choi, Y. S., & Kim, H.-J. (2013). Hypopigmentation and subcutaneous fat, muscle atrophy after local corticosteroid injection. *Korean Journal of Anesthesiology*, *65*(Suppl 6), S59–S61. https://doi.org/10.4097/kjae.2013.65.6S.S59

Patel, A. A., Lekic, N., Fleming, M. E., Chen, D., Owens, P. W., & Askari, M. (2015). The effect of corticosteroid concentration on glycemic control in patients with diabetes mellitus. *The Journal of Hand Surgery*, *40*(9), e47–e48. https://doi.org/10.1016/j.jhsa.2015.06.080

Patton, K., & Borshoff, D. C. (2018). Adverse drug reactions. *Anaesthesia*, *73*(Suppl 1), 76–84. https://doi.org/10.1111/anae.14143

Pattrick, M., & Doherty, M. (1987). Facial flushing after intra-articular injection of steroid. *British Medical Journal (Clinical Research Education)*, *295*(6610), 1380. https://doi.org/10.1136/bmj.295.6610.1380

Pereira, R. M., & Freire de Carvalho, J. (2011). Glucocorticoid-induced myopathy. *Joint Bone Spine*, *78*(1), 41–44. https://doi.org/10.1016/j.jbspin.2010.02.025

Peterson, C., & Hodler, J. (2011). Adverse events from diagnostic and therapeutic joint injections: A literature review. *Skeletal Radiology*, *40*(1), 5–12. https://doi.org/10.1007/s00256-009-0839-y

Provenzano, D. A., Hanes, M. C., & Deer, T. R. (2018). Chapter 86. Interventional pain procedures and the risk of infection. In H. T. Benzon, S. N. Raja, S. S. Liu, S. M. Fishman, & S. P. Cohen (Eds.), *Essentials of pain medicine* (pp. 813–824.e813). Elsevier. https://doi.org/10.1016/b978-0-323-40196-8.00086-3

Ramamoorthy, S., & Cidlowski, J. A. (2016). Corticosteroids: Mechanisms of action in health and disease. *Rheumatic Diseases Clinics of North America*, *42*(1), 15–31, vii. https://doi.org/10.1016/j.rdc.2015.08.002

Ramírez, J., Pomés, I., Cabrera, S., Pomés, J., Sanmartí, R., & Cañete, J. D. (2014). Incidence of full-thickness rotator cuff tear after subacromial corticosteroid injection: A 12-week prospective study. *Modern Rheumatology*, *24*(4), 667–670. https://doi.org/10.3109/14397595.2013.857798

Roh, Y. H., Hong, S. W., Gong, H. S., & Baek, G. H. (2018). Ultrasound-guided versus blind corticosteroid injections for De Quervain tendinopathy: A prospective randomized trial. *Journal of Hand Surgery (European Volume)*, *43*(8), 820–824. https://doi.org/10.1177/1753193418790535

Schäcke, H., Döcke, W. D., & Asadullah, K. (2002). Mechanisms involved in the side effects of glucocorticoids. *Pharmacology & Therapeutics*, *96*(1), 23–43. https://doi.org/10.1016/s0163-7258(02)00297-8

Shah, A., Mak, D., Davies, A. M., James, S. L., & Botchu, R. (2019). Musculoskeletal corticosteroid administration: Current concepts. *Canadian Association of Radiologists Journal*, *70*(1), 29–36. https://doi.org/10.1016/j.carj.2018.11.002

Spaeth, G. L., Rodrigues, M. M., & Weinreb, S. (1977). Steroid-induced glaucoma: A. Persistent elevation of intraocular pressure B. Histopathological aspects. *Transactions of the American Ophthalmological Society*, *75*, 353–381. https://www.ncbi.nlm.nih.gov/pubmed/613525

Steinbrocker, O. (1944). Therapeutic injections in painful musculoskeletal disorders: with special reference to the saline-procaine test. *JAMA, 125*(6), 397–401. https://doi.org/10.1001/jama.1944.02850240007001

Stout, A., Friedly, J., & Standaert, C. J. (2019). Systemic absorption and side effects of locally injected glucocorticoids. *PM&R*, *11*(4), 409–419. https://doi.org/10.1002/pmrj.12042

Suh-Burgmann, E., Hung, Y.-Y., & Mura, J. (2013). Abnormal vaginal bleeding after epidural steroid injection: A paired observation cohort study. *American Journal of Obstetrics & Gynecology*, *209*(3), 206.E1–206.E6. https://doi.org/10.1016/j.ajog.2013.06.045

Sultana, J., Cutroneo, P., & Trifirò, G. (2013). Clinical and economic burden of adverse drug reactions. *Journal of Pharmacology & Pharmacotherapeutics*, *4*(Suppl 1), S73–S77. https://doi.org/10.4103/0976-500X.120957

Sun, L.-Y., & Chu, X.-L. (2017). Acute myopathy following intra-muscular injection of compound betamethasone: A case report. *Medicine*, *96*(34), e7474. https://doi.org/10.1097/MD.0000000000007474

Taliaferro, K., Crawford, A., Jabara, J., Lynch, J., Jung, E., Zvirbulis, R., & Banka, T. (2018). Intraocular pressure increases after intraarticular knee injection with triamcinolone but not hyaluronic acid. *Clinical Orthopaedics and Related Research*, *476*(7), 1420–1425. https://doi.org/10.1007/s11999.0000000000000261

Tamm, E. R. (2002). Myocilin and glaucoma: Facts and ideas. *Progress in Retinal and Eye Research*, *21*(4), 395–428. https://doi.org/10.1016/s1350-9462(02)00010-1

Tan, K., Petrie, K. J., Faasse, K., Bolland, M. J., & Grey, A. (2014). Unhelpful information about adverse drug reactions. *BMJ, 349*, g5019. https://doi.org/10.1136/bmj.g5019

Traven, S., Brinton, D., Simpson, K., Adkins, Z., Althoff, A., Palsis, J. A., & Slone, H. (2018). Shoulder injection prior to rotator cuff repair is associated with increased risk of subsequent surgery. *Orthopaedic Journal of Sports Medicine, 6*(7 Suppl 4). https://journals.sagepub.com/doi/abs/10.1177/232596711S00171

Tripathi, R. C., Parapuram, S. K., Tripathi, B. J., Zhong, Y., & Chalam, K. V. (1999). Corticosteroids and glaucoma risk. *Drugs & Aging*, *15*(6), 439–450. https://doi.org/10.2165/00002512-199915060-00004

Twu, J., Patel, N., Wolf, J. M., & Conti Mica, M. (2018). Impact of variation of corticosteroid dose, injection site, and multiple injections on blood glucose measurement in diabetic patients. *Journal of Hand Surgery*, *43*(8), 738–744. https://doi.org/10.1016/j.jhsa.2018.06.005

Uboldi, F., Carlo-Stella, N., Belloli, L., Massarotti, M., & Marasini, B. (2009). Glucose blood levels after intra-articular steroid injection in diabetic and non-diabetic patients. *Clinical Rheumatology*, *28*(4), 491–492. https://doi.org/10.1007/s10067-009-1091-5

University of Liverpool. (2023, August 16). *HIV drug interactions.* https://www.hiv-druginteractions.org/checker

Van der Windt, D. A., Koes, B. W., Devillé, W., Boeke, A. J., de Jong, B. A., Bouter, & L. M. (1998). Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: Randomised trial. *BMJ*, *317*(7168), 1292–1296. https://doi.org/10.1136/bmj.317.7168.1292

Van Spil, W. E., Nair, S. C., Kinds, M. B., Emans, P. J., Hilberdink, W. K., Welsing, P. M., & Lafeber, F. P. (2015). Systemic biochemical markers of joint metabolism and inflammation in relation to radiographic parameters and pain of the knee: Data from CHECK, a cohort of early-osteoarthritis subjects. *Osteoarthritis Cartilage, 23*(1), 48–56. https://doi.org/10.1016/j.joca.2014.09.003

von Essen, R., & Savolainen, H. A. (1989). Bacterial infection following intra-articular injection. A brief review. *Scandinavian Journal of Rheumatology*, *18*(1), 7–12. https://doi.org/10.3109/03009748909095397

Walker-Bone, K., Palmer, K. T., Reading, I., Coggon, D., & Cooper, C. (2004). Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. *Arthritis and Rheumatism, 51*(4), 642–651. https://doi.org/10.1002/art.20535

Wang, X. (2017). Hypopigmentation after local corticosteroid injection for de Quervain tenosynovitis. *International Journal of Clinical Dermatology*, *1*(2), 31–33. https://doi.org/10.11648/j.ijcd.20170102.14

Waterbrook, A. L., Balcik, B. J., & Goshinska, A. J. (2017). Blood glucose levels after local musculoskeletal steroid injections in patients with diabetes mellitus: A clinical review. *Sports Health*, *9*(4), 372–374. https://doi.org/10.1177/1941738117702585

Weitoft, T., Larsson, A., & Ronnblom, L. (2008). Serum levels of sex steroid hormones and matrix metalloproteinases after intra-articular glucocorticoid treatment in female patients with rheumatoid arthritis. *Annals of Rheumatic Diseases*, *67*(3), 422–424. https://doi.org/10.1136/ard.2007.081315

Wernecke, C., Braun, H. J., & Dragoo, J. L. (2015). The effect of intra-articular corticosteroids on articular cartilage: A systematic review. *Orthopaedic Journal of Sports Medicine, 3*(5), 2325967115581163. https://doi.org/10.1177/2325967115581163

Wong, M. W., Tang, Y. N., Fu, S. C., Lee, K. M., & Chan, K. M. (2004). Triamcinolone suppresses human tenocyte cellular activity and collagen synthesis. *Clinical Orthopaedics and Related Research, 421*, 277–281. https://doi.org/10.1097/01.blo.0000118184.83983.65

Wood, B. R., Lacy, J. M., Johnston, C., Weigle, D. S., & Dhanireddy, S. (2015). Adrenal Insufficiency as a result of Ritonavir and exogenous steroid exposure: Report of 6 cases and recommendation for management. *Journal of the International Association of Providers of AIDS Care*, *14*(4), 300–305. https://doi.org/10.1177/2325957414567681

Yoon, W. K., & Lee, J. S. (2009). Uterine bleeding in a postmenopausal women following epidural triamcinolone acetonide injection: A case report. *Korean Journal of Anesthesiology*, *57*(2), 225–227. https://doi.org/10.4097/kjae.2009.57.2.225

Zeng, C., Lane, N. E., Hunter, D. J., Wei, J., Choi, H. K., McAlindon, T. E., Li, H., Lu, N., Lei, G., & Zhang, Y. (2019). Intra-articular corticosteroids and the risk of knee osteoarthritis progression: Results from the osteoarthritis initiative. *Osteoarthritis Cartilage, 27*(6), 855–862. htpps://doi.org/10.1016/j.joca.2019.01.007

Factors Influencing Perception of, and Participation in, Pulmonary Telerehabilitation – A Scoping Review of the Literature

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ABSTRACT

Pulmonary rehabilitation (PR) is a high-value intervention for people living with a chronic respiratory disease. Uptake and completion of PR remains low, and telerehabilitation provides an alternative model for remotely delivering PR, which may improve the reach of this intervention. While telerehabilitation is safe and likely equivalent to centre-based PR, little is known about the barriers to participation in telerehabilitation to date. This scoping review aims to better understand the factors influencing perception of and participation in telerehabilitation for people living with a chronic respiratory disease. Scopus, MEDLINE, and CINAHL were searched between July 27 to November 23, 2022. Articles were screened, and those fulfilling inclusion criteria were extracted to a standard template. Extracted data were analysed using narrative synthesis. Twenty-seven studies met the inclusion criteria. People living with a chronic respiratory disease perceive telerehabilitation to be convenient and flexible, but technically challenging and lacking in contact with clinicians and peer support. The experiences from a small number of people who have participated in these programmes counter this with praise for the therapeutic relationship they developed with their clinician and the social support they received.

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Key Words: Barriers, Chronic Respiratory Disorders, Participation, Pulmonary Rehabilitation, Telerehabilitation, Uptake

INTRODUCTION

Pulmonary rehabilitation (PR) is a highly effective intervention in the management of chronic respiratory disorders (CRD). Despite the overwhelming evidence to support its effectiveness (McCarthy et al., 2015), uptake and completion of PR worldwide is low, with 8–50% of those referred never attending. Of those who do start PR, 10–32% do not complete the intervention (Keating et al., 2011). Barriers to attendance and completion have been widely investigated and include transport and travel (Fan et al., 2008), socioeconomic (Johnston & Williams, 2017), marital and social status (Young et al., 1999), and ethnicity (Candy et al., 2020; Spitzer et al., 2020). PR delivered remotely through technology has been proposed to improve access to care and may reduce the burden of attending centre-based programmes.

There are many different models for delivering pulmonary telerehabilitation, including telephone, videoconferencing (VC), and mobile/web-based applications (Bourne et al., 2017; Chaplin et al., 2017; Cox et al., 2018; Hansen et al., 2020; Holland et al., 2017; Tsai et al., 2017), some of which are synchronous (real time) and some asynchronous. A growing body of evidence evaluates some of these different models, including a recent Cochrane review by Cox et al. (2021), concluding that these telerehabilitation interventions are likely to be as safe and effective as traditional centre-based PR. However, the small number of studies, low sample sizes, and methodological heterogeneity make this a cautious conclusion (Cox et al., 2021). While telerehabilitation interventions have shown promising results, this form of PR has yet to be widely implemented in clinical practice in New Zealand (Candy et al., 2022). Studies involving telerehabilitation have reported challenges in recruiting participants as high numbers decline due, reportedly, to an intervention preference for in-person PR (Holland et al., 2017). There is a lack of information regarding which, if any, patients prefer telerehabilitation and different delivery modes.

Prior to this scoping review, we conducted a preliminary search of MEDLINE and the Cochrane Database of Systematic Reviews to determine the extent of the evidence regarding factors influencing participation in telerehabilitation, and no current systematic reviews or scoping reviews were identified. A scoping review was deemed necessary since telerehabilitation is an emerging field in PR. A range of information sources were required to provide information on the barriers to uptake, the perception of, and participation in remotely delivered PR. Scoping reviews allow consideration of a range of research evidence, including qualitative and non-clinical trial data, and allow summation of all existing data. This scoping review aimed to explore the factors impacting participation in PR telerehabilitation.

Review questions

The scoping review addressed three questions from available literature:

1. What factors influenced the uptake of PR delivered via telerehabilitation?
2. What were patient perceptions towards telerehabilitation?
3. What were the patient's experiences of participating in telerehabilitation?

METHODS

The scoping review followed the steps detailed in the Joanna Briggs Institute manual for conducting scoping reviews (Tricco et al., 2018). A protocol was developed prior to undertaking the review. An experienced librarian gave guidance on the search strategy.

Eligibility criteria

Due to the contemporary nature of telerehabilitation interventions, studies published from January 1, 2011 were included. Only studies published in English were included.

Participants

We included studies of adults (> 18 years of age) living with a CRD who are eligible for referral to PR (according to Australian and New Zealand PR Guidelines (Alison et al., 2017)) including chronic obstructive pulmonary disease (COPD), interstitial lung disease, asthma, bronchiectasis, and pre- and post-lung surgery.

Concept

Studies involving PR (as defined by the American Thoracic Society/European Respiratory Society (Spruit et al., 2013)), remotely delivered in the home via technology (telerehabilitation) were included. The technology included, but was not limited to, telephone, VC, and web-based interventions.

Context

Because we were interested in factors impacting willingness to participate in home-based telerehabilitation, we included studies that gathered end-users participation perceptions and actual experiences of participating.

Types of sources

We sought quantitative, qualitative studies and mixed method designs. The search strategy aimed to locate published material including non-peer reviewed sources such as editorials and conference proceedings.

Search strategy

An initial search of MEDLINE was undertaken to identify potential keywords for the full search strategy. The keywords contained in the titles and abstracts of potentially relevant studies were used to develop a full search strategy for Scopus, MEDLINE, and CINAHL. The search strategy was adapted for each included database (see Appendix A, Table A1). The reference list of all included sources of evidence was screened for any additional studies not identified by the initial search.

Screening, data extraction, and synthesis

All identified citations were uploaded into EndNote 20.4 and duplicates removed. Titles (and abstracts where available) were screened for assessment against the inclusion criteria by the primary author. After title and abstract screening, all relevant sources were retrieved in full, and their citation details imported into an Excel file. The full text of selected citations were assessed by the primary author (SC) to determine if they met the inclusion criteria.

Data were extracted from the included papers using a standard data extraction tool (Pollock et al., 2023), including author, date, country, study design, participant characteristics, PR concept, and outcomes of interest. Data were analysed in alignment with the research questions:

1. Factors influencing uptake of telerehabilitation in studies.
2. The patient perception of telerehabilitation (including willingness to participate).
3. The patient experience of participating in telerehabilitation.

Quantitative and qualitative data syntheses were undertaken. The quantitative data included counts of studies reporting uptake of remote PR. The number of participants declining participation was converted to rates and percentages, and, where possible, counts of reasons for declining across the studies were collated. Qualitative data reporting included descriptions of studies and delivery methods used. Themes relating to barriers and enablers derived from the qualitative studies have been reported through narrative synthesis (Lisy & Porritt, 2016). Data were first analysed by organising the studies based on the research question they addressed. Data were extracted by reading and collating the stated themes and subthemes, along with recording descriptions of themes with supporting quotes. The studies were then re-read to identify any other concepts or potential themes that may arise across the studies. The primary author grouped similar themes and then discussed and refined these with JR and DT until a consensus on final themes was reached. Final themes were grouped and reported as barriers and enablers to participation.

RESULTS

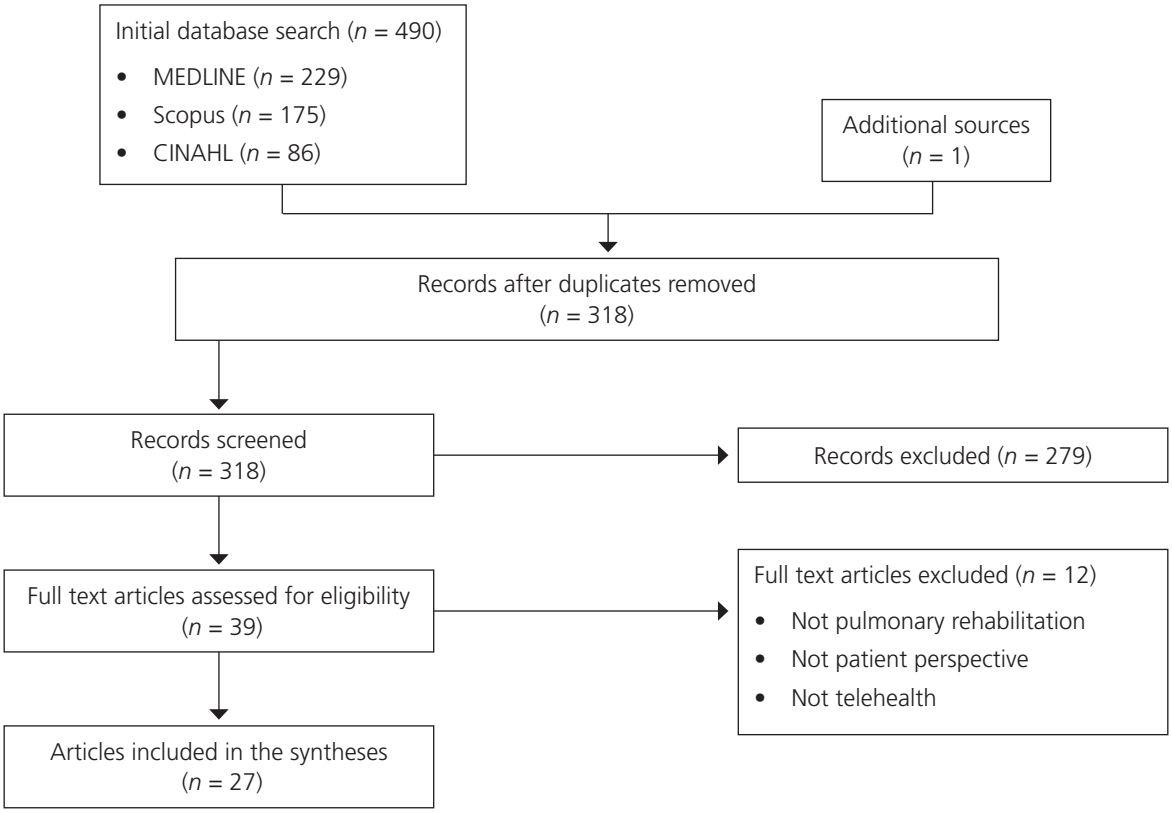
The initial search yielded a total of 490 potentially relevant papers. When duplicates were removed and titles/abstracts screened, 39 full papers were retrieved, of which 27 were included in the final analysis. Figure 1 details the flow of included and excluded studies.

Included studies

The review included 27 studies involving 2094 participants with sample sizes ranging from 10 to 254. The mean age of participants in the studies ranged from 54 to 73 years, and 48% of the participants across all the studies were female. Studies included people living with COPD (n = 19) or CRD (n = 7), and one study did not specify. Three different methods of remotely delivered home-based telerehabilitation were detailed in the studies: telephone support (n = 2), supervised group exercise and education using video conferencing facilities (n = 11), and web-based programmes (n = 11). A combination of differing modes of technology were described in two studies, and a further study did not describe the method of delivering telerehabilitation. The design of included studies were eight randomised control trials (RCT), seven non-randomised trials, four survey designs, and eight mixed methods studies (survey

Figure 1

Flow Diagram of Studies Included in Scoping Review



and interviews). The characteristics of the included studies can be seen in Appendix B, Table B1.

Uptake of telerehabilitation

Data on the uptake rate of telerehabilitation was extracted from both RCTs and non-randomised clinical trials but pooled separately. The reasons why participants did not participate are not clearly defined in all studies, and studies used different methodologies for recruitment, making direct comparison difficult.

Randomised control trials

A total of 3289 participants from eight RCTs were screened for inclusion in the RCTS, of which 2399 (73%) were either deemed ineligible or declined uptake (Appendix B, Table B2). In the seven studies that documented the number of patients who declined, six studies documented the reasons for declining. Five studies reported excluding between 4% and 26% of the participants screened due to patients' stated preference for centre-based rehabilitation and declining participation (Chaplin et al., 2017; Cox et al., 2018; Hansen et al., 2020; Holland et al., 2017; Tsai et al., 2017). Other reported reasons for declining telerehabilitation included lack of digital competence, not having a suitable home environment, or the perceived time commitment.

Non-randomised studies

Six observational studies were identified offering telerehabilitation to participants under different circumstances:

1. During the COVID pandemic when centre-based PR were closed (Grosbois et al., 2021; Lewis et al., 2021).
2. To bridge the gap to centre-based PR for patients with an acute exacerbation of COPD (Houchen-Wolloff et al., 2021).
3. While on PR waiting lists (Marquis et al., 2015; Simonÿ et al., 2019).

Across the included non-randomised studies, between 12 and 95% of the patients screened declined participation (Appendix B, Table B3).

Intention to participate in telerehabilitation

The intent or willingness of people living with a CRD to participate in telerehabilitation was explored in four studies (Almojaibel et al., 2020; Polgar et al., 2022; Seidman et al., 2017; Skibdal et al., 2022). Three studies surveyed current centre-based PR participants (Almojaibel et al., 2020; Polgar et al., 2022; Seidman et al., 2017) and one study surveyed participants after declining centre-based PR (Skibdal et al., 2022). Studies found those who wished to engage with telerehabilitation, perceived telerehabilitation would result in clinical benefits (Almojaibel, 2016; Almojaibel et al., 2021), had a higher education level (Seidman et al., 2017), and had greater familiarity with, and access to, digital devices (Seidman et al., 2017; Skibdal et al., 2022). The observation studies used different definitions of the telerehabilitation intervention to participants, which may have impacted the patient perception,

with one describing VC and the other via telephone, text messaging, or VC.

Participant preference

Two studies reported on the patient preference for how PR is delivered. Nolan et al. (2019) reported only 10% of participants opted for home-based PR when given the option of centre-based PR or home-based PR with weekly telephone calls. Chaplin et al. (2017) conducted a RCT comparing centre-based with web-based PR, but surveyed consented participants on their preference for centre-based or web-based PR prior to group randomisation; 38% stated a preference for the web-based PR intervention.

The patient perception of telerehabilitation

Data regarding patients' perception of telerehabilitation was gathered from people who had a range of prior experience and knowledge of centre-based PR; some had or were attending centre-based PR (Bairapareddy et al., 2021; Dobson et al., 2019; Inskip et al., 2018; Seidman et al., 2017), had been referred to PR (Polgar et al., 2022) or had declined PR (Dobson et al., 2019; Inskip et al., 2018; Skibdal et al., 2022). One study did not state participant's prior participation in centre-based PR (Alwashmi et al., 2020). None of the participants in any of the studies had prior experience with telerehabilitation.

Data were collated from five studies employing surveys, patient interviews, and focus groups. Participants in all the studies perceived telerehabilitation to be more convenient than centre-based PR with reduced time, travel, and financial burden. Synthesis of these studies identified several factors that appear to play a role in influencing the patient perception of telerehabilitation. These factors have been described as barriers and enablers and are discussed below and summarised in Table 1.

Perceived barriers to participation in telerehabilitation

Technical competence

Technical competence was reported by all studies as a perceived barrier to telerehabilitation with up to 39% of participants reporting they believed they would not have the necessary technical skills to partake in telerehabilitation (Alwashmi et al., 2020; Bairapareddy et al., 2021; Dobson et al., 2019; Inskip et al., 2018; Polgar et al., 2022). Age and education level were shown to be associated with technical confidence (Seidman et al., 2017; Skibdal et al., 2022).

Device and data access

An inability to access the required digital device and/or limited data access was reported as a perceived barrier to telerehabilitation (Alwashmi et al., 2020; Bairapareddy et al., 2021; Dobson et al., 2019; Polgar et al., 2022; Seidman et al., 2017). Four studies explored device access and found that the most ubiquitous device was a mobile phone, with ownership rates between 73% and 88% of the cohorts sampled (Almojaibel, 2016; Almojaibel et al., 2021; Alwashmi et al., 2020; Dobson et al., 2019; Seidman et al., 2017). However, the same studies showed smartphone ownership rates were 23–66%, with many participants reporting limited ability to use many of the functions the device provided. Two studies explored predictors of access to a device, and both found that smartphone ownership (like technical competence) was directly related to education level defined as beyond high school (Alwashmi et al., 2020; Seidman et al., 2017). In an implementation study conducted during the COVID-19 pandemic, 75% of the participants who transitioned to remotely delivered PR could not participate in VC classes due to lack of device access, and could only receive telephone support (Grosbois et al., 2021).

Supervision and contact with a healthcare professional

Direct contact with a clinician was discussed in seven reviewed studies (Alwashmi et al., 2020; Bairapareddy et al., 2021; Dobson et al., 2019; Inskip et al., 2018; Polgar et al., 2022; Seidman et al., 2017; Skibdal et al., 2022). A dominant theme in three studies was participants reporting a lack of supervision or contact with a clinician as a potential downside of telerehabilitation (Dobson et al., 2019; Seidman et al., 2017; Skibdal et al., 2022). Survey participants reported that while telerehabilitation might offer a more convenient way of communicating with their clinician, they thought the clinician may lack a good understanding of their health condition (Bairapareddy et al., 2021) or would prefer "in-person" contact with a physiotherapist (Seidman et al., 2017).

Peer support

Studies found that peer support and social connections were considered important components of centre-based PR, with the potential lack of peer support perceived a drawback to participation in telerehabilitation for many participants (Dobson et al., 2019; Inskip et al., 2018; Seidman et al., 2017; Skibdal et al., 2022). Pulmonary telerehabilitation delivered through group-based VC sessions may minimise the absence of peer support by allowing for sharing experiences of living with COPD (Skibdal et al., 2022).

Other barriers

The length of time a participant has lived with their CRD and the degree of symptom burden were identified as perceived barriers to participation (Almojaibel, 2016; Almojaibel et al., 2021; Skibdal et al., 2022). These studies suggested that the greater the duration and severity of the disease, the greater the perception of no benefit from telerehabilitation PR.

Language was reported as a potential barrier to participation in telerehabilitation, with the option of the intervention being delivered in other languages required in order to partake (Bairapareddy et al., 2021; Dobson et al., 2019; Houchen-Wolloff et al., 2021). In addition to these barriers, participants also reported caution around the security and privacy of data transmitted through technology potentially impacting their participation (Alwashmi et al., 2020; Bairapareddy et al., 2021; Dobson et al., 2019).

Perceived enablers to participation in telerehabilitation

Factors that were perceived to positively influence uptake of telerehabilitation were less commonly reported in the literature; however, understanding the benefits gained and the perceived usefulness of remote PR was shown to impact willingness to participate (Almojaibel et al., 2021; Alwashmi et al., 2020; Skibdal et al., 2022). Components participants wished to see included in telerehabilitation programmes were regular communication with a clinician (Bairapareddy et al., 2021;

Table 1

Barriers and Enablers to Uptake of Telerehabilitation in Studies

	Barriers and enablers	Author (date)											
		Almojaibel et al. (2021)	Alwashmi et al. (2020)	Bairapareddy et al. (2021)	Dobson et al. (2019)	Inskip et al. (2018)	Polgar et al. (2022)	Seidman et al. (2017)	Skibdal et al. (2022)	Chaplin et al. (2017)	Houchen-Wolloff et al. (2021)	Simonÿ et al. (2019)	Lewis et al. (2021)
Barriers	Technical competence of participant	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠
	Reduced interaction with healthcare professional		🟠	🟠	🟠	🟠	🟠	🟠	🟠				
	Lack of peer support/social interaction				🟠	🟠		🟠	🟠			🟠	
	Personal preference of participant		🟠		🟠		🟠		🟠	🟠	🟠		🟠
	Cultural/language			🟠	🟠						🟠		
	Access to a device and data		🟠	🟠	🟠			🟠					
	Privacy/security of health information		🟠	🟠	🟠								
	Lack of monitoring available (heart rate, SpO2)			🟠		🟠							
	Participant education level							🟠					
	Duration of CRD	🟠											
	Space/environment/equipment									🟠			
	Impact of co-morbidities									🟠	🟠		
Enablers	Perceived usefulness	🟢	🟢						🟢				
	Ease of use		🟢		🟢								
	Availability of technical support		🟢										
	Less burden compared with centre-based			🟢	🟢			🟢	🟢				
	Flexible/timing				🟢			🟢	🟢				
	Family involvement				🟢								
	Cultural considerations	🟢											
	Feeling safe in own environment								🟢				
	Receiving feedback and monitoring				🟢	🟢							

Note. CRD = chronic respiratory disease; SpO2 = peripheral oxygen saturations.

🟢 = enabler; 🟠 = barrier.

Skibdal et al., 2022), and monitoring and feedback on their rehabilitation performance (Dobson et al., 2019; Inskip et al., 2018).

Experiences of participation in telerehabilitation

Eight studies explored the patient experience of participating in telerehabilitation. Data were collected through interviews (Benzo et al., 2021; Burkow et al., 2018a; Houchen-Wolloff et al., 2021; Lahham et al., 2018a; Tsai et al., 2016; Whittaker et al., 2021), focus group (Hoaas et al., 2016), and questionnaires (Benzo et al., 2021; Hoaas et al., 2016; Tsai et al., 2016). The models of delivery of PR used were telephone calls (Lahham et al., 2018b), VC (Benzo et al., 2021; Burkow et al., 2015; Hoaas et al., 2016; Simonÿ et al., 2019; Tsai et al., 2016), and web-based models (Houchen-Wolloff et al., 2021; Whittaker et al., 2021). The web-based models allowed participants to complete PR independently at a time convenient to them, and allowed patient-initiated interactions with clinicians, with one of the programmes offering individual VC consultations with a clinician (Houchen-Wolloff et al., 2021). Across eight studies, 178 participants reported their experiences of participating in telerehabilitation, with study sample sizes ranging from 10 to 78 participants. The mean ages of participants ranged from 55 to 69 years and 52% of participants across the studies were female. Some participants had previously attended centre-based PR and others had never attended centre-based PR. Two studies included participants who started but did not complete telerehabilitation. In nearly all the studies (n = 7/8) exploring participation in telerehabilitation, the technical equipment was provided for participants, with the remaining study requiring participants to use their own device (Whittaker et al., 2021). See Appendix B, Table B4 for characteristics of studies included.

Telerehabilitation participants across all studies reported health benefits from the intervention and high levels of acceptability and usability when taking part in telerehabilitation. The key themes emerging from the studies reporting participants' experiences of being involved in telerehabilitation have been grouped as enablers and barriers.

Enablers

Communication with HCP

Five of the eight studies reported positive experiences with the communication and support they experienced from the attending clinician while using telerehabilitation (Benzo et al., 2021; Burkow et al., 2018b; Hoaas et al., 2016; Lahham et al., 2018a; Tsai et al., 2016). This positive feedback was reported predominantly in programmes that included individual phone or VC consultations (Burkow et al., 2018b; Hoaas et al., 2016; Lahham et al., 2018a) but also for one of the group VC programmes (Tsai et al., 2016). Clinician contact was reported to be associated with improved participation (Lahham et al., 2018a) and increased health benefits (Tsai et al., 2016). The regular clinician contacts reportedly facilitated safe completion of the programme (Hoaas et al., 2016). Two studies providing optional clinician consultations reported low rates of uptake of the consult (Bourne et al., 2017; Chaplin et al., 2017), which prompted the recommendation that these consultations should be scheduled and structured, rather than optional and patient led (Simonÿ et al., 2019).

Feeling supported

A theme of patients feeling supported with their health condition during telerehabilitation was reported in many of the studies. Participants reported support came from clinicians (Benzo et al., 2021), family and friends (Lahham et al., 2018a; Whittaker et al., 2021), and other participants in VC-based programmes (Burkow et al., 2015). Group-based education sessions enabled sharing of ideas and challenges between participants (Burkow et al., 2015). One web-based study allowed family members to register for the programme along with the person living with a respiratory condition, resulting in important benefits for both the family and participant (Whittaker et al., 2021). The study undertaken by Whittaker et al. (2021) also used personalised and tailored text messaging to inform, encourage, and support participants, and this messaging was perceived as being supportive by participants.

Flexibility

A frequently reported key enabler of participation in telerehabilitation was the flexibility it provided. It allowed those with daytime commitments, such as paid employment, to participate (Hoaas et al., 2016; Lahham et al., 2018a; Tsai et al., 2016; Whittaker et al., 2021). This flexibility in training time was an important component in allowing commitment to the exercise routine (Lahham et al., 2018a).

Reduced burden

Most participants across the studies reported a reduction in burden associated with telerehabilitation, which allowed participation in PR without the expense of travel and parking (Lahham et al., 2018a; Tsai et al., 2016), and reduced the time and fatigue participants associated with travelling (Burkow et al., 2018b; Hoaas et al., 2016; Tsai et al., 2016).

Monitoring and feedback

Different tools for monitoring participants during telerehabilitation were described in studies. These included activity monitors to gather data on steps taken (Benzo et al., 2021; Burkow et al., 2015; Lahham et al., 2018a; Whittaker et al., 2021), and providing pulse oximeters for data on peripheral oxygen saturations and heart rates. The data were monitored real-time via VC (Lewis et al., 2021; Tsai et al., 2016) or recorded in digital diaries (step count, observations, and symptoms) (Benzo et al., 2021; Burkow et al., 2015; Hoaas et al., 2016), and was available to both the participant and clinicians. Participants perceived the data differently; some reported the data as motivational and providing a learning opportunity (Hoaas et al., 2016; Houchen-Wolloff et al., 2021), while others did not wish to view their own data, but felt it was useful for their clinician (Burkow et al., 2015).

Barriers to participation

While most of the feedback was positive, participants reported aspects that made engaging in telerehabilitation challenging. Commencing the telerehabilitation programme was found to be a particularly difficult time due to their prolonged sedentary lifestyle (Lahham et al., 2018a), along with technical disruptions. While most participants reported the digital equipment was generally easy to use, internet disruptions impacted participation (Tsai et al., 2016), and there were reports of stress when the VC technology did not work (Hoaas et al., 2016), or difficulty

downloading and logging onto the app (Whittaker et al., 2021). One web-based application received feedback from participants that the programme was complex and technical challenges reduced their motivation or caused them to disengage entirely (Houchen-Wolloff et al., 2021).

Participants provided feedback that more variation in the exercise programme would have been beneficial, and options for adapting exercises when they were having a bad day or pain or weather limited participation (Hoaas et al., 2016; Lahham et al., 2018a; Whittaker et al., 2021). The barriers and enablers to participating in telerehabilitation are summarised in Table 2.

DISCUSSION

This scoping review has explored the literature on end-users' perceptions of telerehabilitation. This data informs our understanding of the barriers and enablers to telerehabilitation that are both anticipated and experienced by participants, and supports the need for future models to be developed through a process of co-design with potential end users to enhance the reach of PR.

This review found limited literature reporting the uptake of telerehabilitation in the clinical setting. Several pulmonary telerehabilitation studies involved randomisation, which dictates group allocation, and the studies frequently report patients' preference for centre-based rehabilitation as a reason for declining participation. It is acknowledged that recruitment to these studies was frequently from PR waitlists, with patients having an expectation of attending centre-based PR.

The most frequently reported barrier to telerehabilitation was technical competence with the devices used to deliver telerehabilitation. While this may change as technology becomes a more integral part of people's lives, the sequential surveys in the UK pre- and post-COVID have shown that despite the growing use of and confidence with technology, the appetite for telerehabilitation remains low and relatively unchanged (Polgar et al., 2020; Polgar et al., 2022). Competence with technology is associated with age, education level, and device access (Seidman et al., 2017; Skibdal et al., 2022), suggesting the possibility that providing telerehabilitation may widen the equity gap by promoting options that are not accessible to those who may need it the most. For example, a survey conducted in a UK inner city, high-poverty area showed that only 16% of people admitted to a hospital with a COPD exacerbation had computer access, and only 14% had internet access (Granger et al., 2018). A key feature of remote delivery is to reduce the burden associated with attending centre-based PR programmes and developers must ensure that those for whom this may be useful are not disadvantaged by lack of access to devices. Access to mobile phones appears most common; however, these are not always smartphones, and reports of internet data access are variable. Given the widespread ownership of mobile phones, it is the ideal device for delivery of PR.

Holland et al. (2021) recently suggested that the uptake of PR is influenced by perceptions of what participation in telerehabilitation might mean for people living with a CRD. For many participants, the perception of telerehabilitation is that it is technically challenging and beyond their digital skills. However, in participants who have completed telerehabilitation, technical challenges were retrospectively considered minor. Differing theoretical models consider the readiness to engage with technology and support these findings. For example, The Unified Theory of Acceptance and Use of Technology (Venkatesh, 2022) model suggests that the perceived likelihood of adopting the technology is dependent on the direct effect of four key constructs, namely performance expectancy, effort expectancy, social influence, and facilitating conditions. The use of such models can assist with understanding how we can facilitate uptake by employing strategies to assist participants to understand how the telerehabilitation programme works and the potential benefits to the participant. Many of the studies included in this review provided both equipment and significant technology support, which may have positively influenced the participant experience. Ensuring the allocation of such resources in telerehabilitation programmes may be an essential part of successful implementation. Including training and support as an opt-out rather than an opt-in model for telerehabilitation participants may enhance uptake and outcomes.

Developing a therapeutic relationship with attending clinicians has been shown to be important to people living with CRD. This review showed that a lack of supervision and direct contact with staff is a perceived barrier to participation in telerehabilitation. Studies of remotely delivered PR have used differing methodologies, making it challenging to compare and identify optimal models for telerehabilitation. For example, some web-based models use "stand-alone" models with no scheduled clinician contact, while others use weekly telephone coaching and supervised group exercise and education models. Despite this, communications with clinicians were identified as an important facet of programmes by participants. Many studies report remote communication as effective and as engaging as face to face (Benzo et al., 2021). It could be argued that participants have more individual and personalised communication with a clinician in telerehabilitation models than centre-based, where they are competing with other participants for attention. The optimal clinician contact time in telerehabilitation has not been determined, but future programmes should consider scheduled, structured consultations that may evolve over time with more support required at the start of the programme.

An important part of PR is developing a support network. In centre-based PR this network is developed with peers at the programme. Studies reported concerns that telerehabilitation would not be able to provide the same peer support as centre-based (Dobson et al., 2019; Inskip et al., 2018). However, participants who completed telerehabilitation reported feeling supported in different ways to those in centre-based PR. In remotely delivered group sessions using VC facilities, social support was reported as being received through other participants in the programme (Burkow et al., 2018b; Tsai et al., 2016). For telephone and web-based models this support was received from family and friends (Lahham et al., 2018a; Simonÿ et al., 2019; Whittaker et al., 2021), who often participated alongside the patient and became more aware of the participant's condition and how to best provide support. In developing telerehabilitation models, consideration of support

Table 2

Barriers and Enablers Experienced During Participation in Remotely Delivered Pulmonary Rehabilitation

	Barriers and enablers	Author (date)							
		Benzo et al. (2021)	Burkow et al. (2015)	Lahham et al. (2018b)	Hoaas et al. (2016)	Houchen-Wolloff et al. (2021)	Simonÿ et al.(2019)	Tsai et al. (2016)	Whittaker et al. (2021)
Barriers	Getting started			●					
	Variation and modification			●	●		●		●
	Technical challenges				●	●		●	●
	Not tailored								●
Enablers	Health benefits	●		●	●			●	●
	Interaction with healthcare professional	●	●	●	●		●		
	Feeling supported	●	●	●					●
	Usability of technology	●	●		●			●	
	Flexibility			●			●	●	
	Reduced burden								
	Feedback	●						●	

Note. ● = enabler; ● = barrier.

networks is vital and allowing for inclusion of family members appears beneficial.

CONCLUSION

PR is an effective and essential component in CRD management. While centre-based programmes have proven efficacy, they are not always accessible for all. Telerehabilitation can provide a flexible and convenient programme that can reduce the burden associated with accessing a centre-based programme while still maintaining a supportive and motivating environment.

Participants have preferences for how their healthcare is delivered. A range of delivery options is required to optimise the uptake and completion of PR. For some participants, concerns about digital competence, device access, or lack of perceived benefit can restrict participation in digital options. Services should consider adequate resourcing for new models of telerehabilitation to be implemented to allow inclusivity for all participants and provide sufficient training and support to overcome technical challenges. Developing a therapeutic relationship appears critical to programme success and strategies to enable this, such as regularly scheduled clinician interactions, must be considered to optimise the success of such programmes.

KEY POINTS

1. Providing information on expected benefits of telerehabilitation may improve the patient's perception.
2. Provision of devices and data may allow increased inclusivity.
3. Technical support should be provided for all participants.
4. Regular scheduled clinician contact points should be provided.

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PERMISSIONS

No permissions were required.

CONTRIBUTIONS OF AUTHORS

Design conceptualisation and methodology, SC, DT and JR; validation, SC, DT and JR; formal analysis, SC, DT and JR; data curation, SC, DT and JR; writing—original draft preparation SC, review and editing, SC, DT and JR; funding acquisition, SC and DT.

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REFERENCES

Alison, J. A., McKeough, Z. J., Johnston, K., McNamara, R. J., Spencer, L. M., Jenkins, S. C., Hill, C. J., McDonald, V. M., Frith, P., Cafarella, P, Brooke, M., Cameron-Tucker, H. L., Candy, S., Cecins, N., Chan, A. S., Dale, M. T., Dowman, L. M., Granger, C., Halloran, S. … on behalf of the Lung Foundation Australia and the Thoracic Society of Australia and New Zealand. (2017). Australian and New Zealand pulmonary rehabilitation guidelines. *Respirology*, *22*(4), 800–819. https://doi.org/10.1111/resp.13025

Almojaibel, A. A. (2016). Delivering pulmonary rehabilitation for patients with chronic obstructive pulmonary disease at home using telehealth: A review of the literature. *Saudi Journal of Medicine & Medical Sciences*, *4*(3), 164–171. https://doi.org/10.4103/1658-631X.188247

Almojaibel, A. A., Munk, N., Goodfellow, L. T., Fisher, T. F., Miller, K. K., Comer, A. R., Bakas, T., & Justiss, M. D. (2020). Health care practitioners' determinants of telerehabilitation acceptance. *International Journal of Telerehabilitation*, *12*(1), 43–50. https://doi.org/10.5195/ijt.2020.6308

Almojaibel, A. A., Munk, N., Goodfellow, L. T., Fisher, T. F., Miller, K. K., Comer, A. R., Bakas, T., & Justiss, M. D. (2021). Determinants of telerehabilitation acceptance among patients attending pulmonary rehabilitation programs in the United States. *Saudi Journal of Medicine & Medical Sciences*, *9*(3), 230. https://doi.org/10.4103/sjmms.sjmms_10_21

Alwashmi, M. F., Fitzpatrick, B., Davis, E., Farrell, J., Gamble, J.-M., & Hawboldt, J. (2020). Perceptions of patients regarding mobile health interventions for the management of chronic obstructive pulmonary disease: Mixed methods study. *JMIR mHealth and uHealth*, *8*(7), e17409. https://doi.org/10.2196/17409

Bairapareddy, K. C., Alaparthi, G. K., Jitendra, R. S., Prathiksha, Rao, P. P., Shetty, V., & Chandrasekaran, B. (2021). "We are so close; yet too far": Perceived barriers to smartphone-based telerehabilitation among healthcare providers and patients with chronic obstructive pulmonary disease in India. *Heliyon*, *7*(8), e07857. https://doi.org/10.1016/j.heliyon.2021.e07857

Benzo, R. P., Ridgeway, J., Hoult, J. P., Novotny, P., Thomas, B. E., Lam, N. M., Benzo, M. V., Kramer, K., & Seifert, S. (2021). Feasibility of a health coaching and home-based rehabilitation intervention with remote monitoring for COPD. *Respiratory Care*, *66*(6), 960–971. https://doi.org/10.4187/respcare.08580

Bourne, S., DeVos, R., North, M., Chauhan, A., Green, B., Brown, T., Cornelius, V., & Wilkinson, T. (2017). Online versus face-to-face pulmonary rehabilitation for patients with chronic obstructive pulmonary disease: Randomised controlled trial. *BMJ Open*, *7*(7), e014580.

Burkow, T. M., Vognild, L. K., Johnsen, E., Bratvold, A., & Risberg, M. J. (2018a). Promoting exercise training and physical activity in daily life: A feasibility study of a virtual group intervention for behaviour change in COPD. *BMC Medical Informatics and Decision Making*, *18*(1), 136. https://doi.org/10.1186/s12911-018-0721-8

Burkow, T. M., Vognild, L. K., Johnsen, E., Bratvold, A., & Risberg, M. J. (2018b). Promoting exercise training and physical activity in daily life: A feasibility study of a virtual group intervention for behaviour change in COPD. *BMC Medical Informatics and Decision Making*, *18*(1), 136. https://doi.org/10.1186/s12911-018-0721-8

Burkow, T. M., Vognild, L. K., Johnsen, E., Risberg, M. J., Bratvold, A., Breivik, E., Krogstad, T., & Hjalmarsen, A. (2015). Comprehensive pulmonary rehabilitation in home-based online groups: A mixed method pilot study in COPD. *BMC Research Notes*, *8*(1), 766. https://doi.org/10.1186/s13104-015-1713-8

Candy, S., Jepsen, N., Coomarasamy, C., Curry, J., Dodson, G., Pomelile, J., Versey, M., & Reeve, J. (2020). Patient characteristics and predictors of completion of a pulmonary rehabilitation programme in Auckland, New Zealand. *New Zealand Medical Journal*, *133*(1522), 30–41.

Candy, S., Reeve, J., Dobson, R., & Taylor, D. (2022). Characteristics of pulmonary rehabilitation programmes in New Zealand: A survey of practice prior to and during COVID-19. *New Zealand Medical Journal*, *135*(1550), 13–25.

Cerdán-de-Las-Heras, J., Balbino, F., Løkke, A., Catalán-Matamoros, D., Hilber, O & Bendstrup, E. (2021). Effect of a new tele-rehabilitation program versus standard rehabilitation in patients with chronic obstructive pulmonary disease. *Journal of Clinical Medicine*, 11(1), 11. https://doi.org.10.3390/jcm11010011

Chaplin, E., Hewitt, S., Apps, L., Bankart, J., Pulikottil-Jacob, R., Boyce, S., Morgan, M., Williams, J., & Singh, S. (2017). Interactive web-based pulmonary rehabilitation programme: A randomised controlled feasibility trial. *BMJ Open*, *7*(3), e013682. https://doi.org/10.1136/bmjopen-2016-013682

Cox, N. S., Dal Corso, S., Hansen, H., McDonald, C. F., Hill, C. J., Zanaboni, P., Alison, J. A., O'Halloran, P., Macdonald, H., & Holland, A. E. (2021). Telerehabilitation for chronic respiratory disease. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD013040.pub2

Cox, N. S., McDonald, C. F., Alison, J. A., Mahal, A., Wootton, R., Hill, C. J., Bondarenko, J., Macdonald, H., O'Halloran, P., Zanaboni, P., Clarke, K., Rennick, D., Borgelt, K., Burge, A. T., Lahham, A., Wageck, B., Crute, H., Czupryn, P., Nichols, A., & Holland, A. E. (2018). Telerehabilitation versus traditional centre-based pulmonary rehabilitation for people with chronic respiratory disease: Protocol for a randomised controlled trial. *BMC Pulmonary Medicine*, *18*(1), 71. https://doi.org/10.1186/s12890-018-0646-0

Dobson, R., Herbst, P., Candy, S., Brott, T., Garrett, J., Humphrey, G., Reeve, J., Tawhai, M., Taylor, D., Warren, J., & Whittaker, R. (2019). Understanding end-user perspectives of mobile pulmonary rehabilitation (mPR): Cross-sectional survey and interviews. *JMIR Formative Research*, *3*(4), e15466. https://doi.org/10.2196/15466

Fan, V. S., Giardino, N. D., Blough, D. K., Kaplan, R. M., Ramsey, S. D., & the NETT Research Group. (2008). Costs of pulmonary rehabilitation and predictors of adherence in the National Emphysema Treatment Trial. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *5*(2), 105–116. https://doi.org/10.1080/15412550801941190

Granger, C. L., Wijayarathna, R., Suh, E.-S., Arbane, G., Denehy, L., Murphy, P., & Hart, N. (2018). Uptake of telehealth implementation for COPD patients in a high-poverty, inner-city environment: A survey. *Chronic Respiratory Disease*, *15*(1), 81–84. https://doi.org/10.1177/1479972317707653

Grosbois, J.-M., Gephine, S., Le Rouzic, O., & Chenivesse, C. (2021). Feasibility, safety and effectiveness of remote pulmonary rehabilitation during COVID-19 pandemic. *Respiratory Medicine and Research*, *80*, 100846. https://doi.org/10.1016/j.resmer.2021.100846

Hansen, H., Bieler, T., Beyer, N., Kallemose, T., Wilcke, J. T., Østergaard, L. M., Frost Andeassen, H., Martinez, G., Lavesen, M., Frølich, A., & Godtfredsen, N. S. (2020). Supervised pulmonary tele-rehabilitation versus pulmonary rehabilitation in severe COPD: A randomised multicentre trial. *Thorax*, *75*(5), 413–421. https://doi.org/10.1136/thoraxjnl-2019-214246

Hoaas, H., Andreassen, H. K., Lien, L. A., Hjalmarsen, A., & Zanaboni, P. (2016). Adherence and factors affecting satisfaction in long-term telerehabilitation for patients with chronic obstructive pulmonary disease: A mixed methods study. *BMC Medical Informatics and Decision Making*, *16*, 26. https://doi.org/10.1186/s12911-016-0264-9

Holland, A. E., Cox, N. S., Houchen-Wolloff, L., Rochester, C. L., Garvey, C., ZuWallack, R., Nici, L., Limberg, T., Lareau, S. C., Yawn, B. P., Galwicki, M., Troosters, T., Steiner, M., Casaburi, R., Clini, E., Goldstein, R. S., & Singh, S. J. (2021). Defining modern pulmonary rehabilitation. An official American Thoracic Society workshop report. *Annals of the American Thoracic Society*, *18*(5), e12–e29. https://doi.org/10.1513/AnnalsATS.202102-146ST

Holland, A. E., Mahal, A., Hill, C. J., Lee, A. L., Burge, A. T., Cox, N. S., Moore, R., Nicolson, C., O'Halloran, P., Lahham, A., Gillies, R., & McDonald, C. F. (2017). Home-based rehabilitation for COPD using minimal resources: A randomised, controlled equivalence trial. *Thorax*, *72*(1), 57–65.

Houchen-Wolloff, L., Orme, M., Barradell, A., Clinch, L., Chaplin, E., Gardiner, N., & Singh, S. J. (2021). Web-based self-management program (SPACE for COPD) for individuals hospitalized with an acute exacerbation of chronic obstructive pulmonary disease: Nonrandomized feasibility trial of acceptability. *JMIR mHealth and uHealth*, *9*(6), e21728. https://doi.org/10.2196/21728

Inskip, J. A., Lauscher, H. N., Li, L. C., Dumont, G. A., Garde, A., Ho, K., Hoens, A. M., Road, J. D., Ryerson, C. J., & Camp, P. G. (2018). Patient and health care professional perspectives on using telehealth to deliver pulmonary rehabilitation. *Chronic Respiratory Disease*, *15*(1), 71–80. https://doi.org/10.1177/1479972317709643

Johnston, K. N., & Williams, M. T. (2017). Turning a challenge into an opportunity: Pulmonary rehabilitation and socioeconomic deprivation. *Thorax*, *72*(6), 493–494. DOI:10.1136/thoraxjnl-2016-209798

Keating, A., Lee, A., & Holland, A. E. (2011). What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review. *Chronic Respiratory Disease*, *8*(2), 89–99. https://doi.org/10.1177/1479972310393756

Lahham, A., McDonald, C. F., Mahal, A., Lee, A. L., Hill, C. J., Burge, A. T., Cox, N. S., Moore, R., Nicolson, C., O'Halloran, P., Gillies, R., & Holland, A. E. (2018a). Acceptability and validity of a home exercise diary used in home-based pulmonary rehabilitation: A secondary analysis of a randomised controlled trial. *Clinical Respiratory Journal*, *12*(6), 2057–2064. https://doi.org/10.1111/crj.12773

Lahham, A., McDonald, C. F., Mahal, A., Lee, A. L., Hill, C. J., Burge, A. T., Cox, N. S., Moore, R., Nicolson, C., O'Halloran, P., Gillies, R., & Holland, A. E. (2018b). Home-based pulmonary rehabilitation for people with COPD: A qualitative study reporting the patient perspective. *Chronic Respiratory Disease*, *15*(2), 123–130. https://doi.org/10.1177/1479972317729050

Lewis, A., Knight, E., Bland, M., Middleton, J., Mitchell, E., McCrum, K., Conway, J., & Bevan-Smith, E. (2021). Feasibility of an online platform delivery of pulmonary rehabilitation for individuals with chronic respiratory disease. *BMJ Open Respiratory Research*, *8*(1), e000880. https://doi.org/10.1136/bmjresp-2021-000880

Lisy, K., & Porritt, K. (2016). Narrative synthesis: Considerations and challenges. *JBI Evidence Implementation*, *14*(4), 201. https://doi.org/10.1097/01.XEB.0000511348.97198.8c

Marquis, N., Larivée, P., Saey, D., Dubois, M.-F., & Tousignant, M. (2015). In-home pulmonary telerehabilitation for patients with chronic obstructive pulmonary disease: A pre-experimental study on effectiveness, satisfaction, and adherence. *Telemedicine Journal and e-Health*, *21*(11), 870–879. https://doi.org/10.1089/tmj.2014.0198

McCarthy, B., Casey, D., Devane, D., Murphy, K., Murphy, E., & Lacasse, Y. (2015). Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database of Systematic reviews*. https://doi.org/10.1002/14651858.CD003793.pub3

Nolan, C. M., Kaliaraju, D., Jones, S. E., Patel, S., Barker, R., Walsh, J. A., & Man, W. (2019). Home versus outpatient pulmonary rehabilitation in COPD: A propensity-matched cohort study. *Thorax*, 75(10), 996–998. https://doi.org/10.1136/thoraxjnl-2018-212765

Polgar, O., Aljishi, M., Barker, R. E., Patel, S., Walsh, J. A., Kon, S. S., Man, W. D., & Nolan, C. M. (2020). Digital habits of PR service-users: Implications for home-based interventions during the COVID-19 pandemic. *Chronic Respiratory Disease*, *17*. https://doi.org/10.1177/1479973120936685

Polgar, O., Patel, S., Walsh, J. A., Barker, R. E., Ingram, K. A., Kon, S. S., Man, W. D., & Nolan, C. M. (2022). Digital habits of pulmonary rehabilitation service-users following the COVID-19 pandemic. *Chronic Respiratory Disease*, *19*. https://doi.org/10.1177/14799731221075647

Pollock, D., Peters, M. D. J., Khalil, H., McInerney, P., Alexander, L., Tricco, A. C., Evans, C., de Moraes, É. B., Godfrey, C. M., Pieper, D., Saran, A., Stern, C., & Munn, Z. (2023). Recommendations for the extraction, analysis, and presentation of results in scoping reviews. *JBI Evidence Synthesis*, *21*(3), 520–532. https://doi.org/10.11124/jbies-22-00123

Seidman, Z., McNamara, R., Wootton, S., Leung, R., Spencer, L., Dale, M., Dennis, S., & McKeough, Z. (2017). People attending pulmonary rehabilitation demonstrate a substantial engagement with technology and willingness to use telerehabilitation: A survey. *Journal of Physiotherapy*, *63*(3), 175–181. https://doi.org/https://doi.org/10.1016/j.jphys.2017.05.010

Simonÿ, C., Riber, C., Bodtger, U., & Birkelund, R. (2019). Striving for confidence and satisfaction in everyday life with chronic obstructive pulmonary disease: Rationale and content of the tele-rehabilitation programme >COPD-Life>>. *International Journal of Environmental Research and Public Health*, *16*(18), 3320. https://doi.org/10.3390/ijerph16183320

Skibdal, K. M., Emme, C., & Hansen, H. (2022). Listen to me! – A mixed-methods study of thoughts and attitudes towards participation in pulmonary telerehabilitation among people with severe and very severe COPD who declined participation in pulmonary rehabilitation. *Patient Preference and Adherence*, *16*, 2781–2798. https://doi.org/10.2147/PPA.S380832

Spitzer, K. A., Stefan, M. S., Priya, A., Pack, Q. R., Pekow, P. S., Lagu, T., Mazor, K. M., Pinto-Plata, V. M., ZuWallack, R. L., & Lindenauer, P. K. (2020). A geographic analysis of racial disparities in use of pulmonary rehabilitation after hospitalization for COPD exacerbation. *Chest*, *157*(5), 1130–1137. https://doi.org/10.1016/j.chest.2019.11.044

Spruit, M. A., Singh, S. J., Garvey, C., Zu Wallack, R., Nici, L., Rochester, C., Hill, K., Holland, A. E., Lareau, S. C., Man, W. D. C., Pitta, F., Sewell, L., Raskin, J., Bourbeau, J., Crouch, R., Franssen, F. M. E., Casaburi, R., Vercoulen, J. H., Vogiatzis, I., . . . Wouters, E. F. M. (2013). An official American thoracic society/European respiratory society statement: Key concepts and advances in pulmonary rehabilitation. *American Journal of Respiratory and Critical Care Medicine*, *188*(8), e13–e64. https://doi.org/10.1164/rccm.201309-1634ST

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D., Horsley, T., & Weeks, L. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Tsai, L. L. Y., McNamara, R. J., Dennis, S. M., Moddel, C., Alison, J. A., McKenzie, D. K., & McKeough, Z. J. (2016). Satisfaction and experience with a supervised home-based real-time videoconferencing telerehabilitation exercise program in people with chronic obstructive pulmonary disease (COPD). *International Journal of Telerehabilitation*, *8*(2), 27. https://doi.org/10.5195/ijt.2016.6213

Tsai, L. L. Y., McNamara, R. J., Moddel, C., Alison, J. A., McKenzie, D. K., & McKeough, Z. J. (2017). Home-based telerehabilitation via real-time videoconferencing improves endurance exercise capacity in patients with COPD: The randomized controlled TeleR Study. *Respirology*, *22*(4), 699–707. https://doi.org/10.1111/resp.12966

Venkatesh, V. (2022). Adoption and use of AI tools: A research agenda grounded in UTAUT. *Annals of Operations Research*, *308*, 641–652. https://doi.org/10.1007/s10479-020-03918-9

Whittaker, R., Dobson, R., Candy, S., Tane, T., Burrowes, K., Reeve, J., Tawhai, M., Taylor, D., Robertson, T., Garrett, J., Humphrey, G., Brott, T., Khan, S. R., Hu, F., & Warren, J. (2021). Mobile pulmonary rehabilitation: Feasibility of delivery by a mobile phone-based program. *Frontiers in Computer Science*, *3*, 546960. https://doi.org/10.3389/fcomp.2021.546960

Young, P., Dewse, M., Fergusson, W., & Kolbe, J. (1999). Respiratory rehabilitation in chronic obstructive pulmonary disease: Predictors of nonadherence. *European Respiratory Journal*, *13*(4), 855–859.

Appendix A

Table A1

Scoping Review Search Strategy

1	"COPD OR asthma OR bronchiectasis OR interstitial lung disease" OR "lung fibrosis" OR "chronic respiratory disease" OR "chronic lung disease"
2	Respiratory rehabilitation OR "pulmonary rehabilitation" OR "COPD rehabilitation" OR "lung rehabilitation" OR "respiratory therapy"
3	Telerehabilitation OR tele-rehabilitation OR mHealth OR "web based" OR smartphone OR App OR online OR telehealth OR "video conference" OR mobile OR home-based OR remote OR telephone
4	Barrier* OR enabler* OR challenge* OR uptake OR compliance OR adherence OR obstacle OR completion OR limitation* OR facilitator* OR success OR non-compliance OR attend OR attitude OR participation

Note. COPD = chronic obstructive pulmonary disease.

Appendix B

Table B1

Characteristics of Studies Included in the Review

Author (date) Country	Study design	Participants (*n*, diagnosis, age (mean (*SD*), sex)	PR concept	Report uptake data	Report intent/ willingness	Report barriers	Report enablers
Almojaibel et al. (2021) USA	Survey	134, diagnosis not stated 66 (10.7) years Female 50%	Willingness to participate in telerehabilitation	No	Yes	Yes	Yes
Alwashmi et al. (2020) Canada	Mixed methods, survey and interviews	77 COPD 65 years Female 60%	Perceptions of web-based PR	No	No	Yes	Yes
Bairapareddy et al. (2021) India	Survey	30 COPD 54 (12) years Female 20%	Perceptions of web-based PR	No	Yes	No	No
Benzo et al. (2021) USA	RCT and interviews	78 COPD 69 (8.1) years Female 53%	Participated in web-based and telephone calls	Yes	No	Yes	Yes
Bourne et al. (2017) UK	RCT	90 COPD 70 (8.6) years Female 35%	Web-based vs centre-based	Yes	No	No	No
Burkow et al. (2015) Norway	Mixed methods, survey and interview	10 COPD 62 years Female 50%	Participated in VC and phone calls	No	No	Yes	Yes
Cerdán-De-Las-Heras et al. (2022) Denmark	RCT	54 COPD 67 (10.2) years Female 43%	Web-based vs centre-based	Yes	No	Yes	No
Chaplin et al. (2017) UK	RCT	103 COPD 66 (8.1) years Female 31%	Web-based vs centre-based	Yes	Yes	Yes	No
Cox et al. (2021) Australia	RCT	142 COPD 68 (9) years Female 56%	VC vs centre- based	Yes	No	Yes	No
Dobson et al. (2019) New Zealand	Mixed methods, survey and interview	30 CRD 73% > 65 years Female 43%	Perceptions of web-based PR	No	No	Yes	Yes
Grosbois et al. (2021) France	Retrospective audit	105 CRD 63 years Female N/A	Telephone or VC vs no PR (COVID-19)	Yes	No	Yes	No
Hansen et al. (2020) Denmark	RCT	134 COPD 68 (9) years Female 55%	VC vs centre- based	Yes	No	Yes	No
Hoaas et al. (2016) Norway	Survey and focus group	10 COPD 55 years Female 50%	Participated in VC PR	No	No	Yes	Yes

Author (date) Country	Study design	Participants (*n*, diagnosis, age (mean (*SD*), sex)	PR concept	Report uptake data	Report intent/ willingness	Report barriers	Report enablers
Holland et al. (2017) Australia	RCT	166 COPD 69 (13) years Female 40%	Telephone vs centre-based	Yes	No	Yes	No
Houchen-Wolloff et al. (2021) UK	Feasibility; non-randomsied and interviews for select sample	100 COPD (AE) (*n* = 14 interviewed) 71 (9.3) years Female 45%	Web-based vs no PR	Yes	Yes	Yes	Yes
Inskip et al. (2018) Canada	Survey and focus groups	26 CRD 71 years Female 50%	Perceptions of telerehabilitation	No	No	Yes	Yes
Lewis et al. (2021) UK	Service evaluation	17 CRD 69 (11) years Female 50%	VC and telephone call	Yes	No	Yes	Yes
Marquis et al. (2015) Canada	Observational study	26 COPD 65 (7) years Female 58%	VC	Yes	Yes	No	No
Nolan et al. (2019) UK	Non-randomised trial	154 COPD 71 (9) years Female 52%	Telephone calls	Yes	Yes	No	No
Polgar et al. (2022) UK	Survey (x 2)	99 and 101 CRD 74 years Female 47%	Perceptions of web-based PR	No	Yes	Yes	No
Seidman et al. (2017) Australia	Survey	254 CRD 73 (10) years Female 59%	Perceptions of VC delivered PR	No	Yes	Yes	Yes
Simonÿ et al. (2019) Denmark	Non-empirical	15 COPD 62 years Female 47%	VC	Yes	No	Yes	Yes
Skibdal et al. (2022) Denmark	Mixed methods, survey and interviews	84 COPD survey, 9 COPD interviews 70 (9) years Female 53%	Perceptions of VC, telephone, or text messages	No	No	Yes	Yes
Tsai et al. (2017) Australia	RCT	37 COPD 73 (8) years Female 50%	VC vs centre- based	Yes	No	No	No
Tsai et al. (2016) Australia	Mixed methods, survey and interview	11 COPD 72 year Female 36%	Participated in VC PR	No	No	Yes	Yes
Whittaker et al. (2021) New Zealand	Feasibility study	26 CRD 70 years Female 50%	Participated in web-based PR	No	No	Yes	Yes

Note. AE = acute exacerbation, CRD = chronic respiratory disease, COPD = chronic obstructive pulmonary disease, N/A = not available, PR = pulmonary rehabilitation, RCT = randomised control trial, VC = videoconferencing.

Table B2

Number of Participants Screened, Excluded, or Declined in Randomised Control Trials of Telerehabilitation

Author (date)	Screened, *n*	Excluded, *n* (%)	Declined, *n*
Bourne et al. (2017)	163	73 (45%)	N/A
Cerdán-De-Las-Heras et al. (2021)	95	20 (21%)	21
Chaplin et al. (2017)	641	244 (38%)	294
Cox et al. (2021)	651	499 (77%)	246
Hansen et al. (2020)	1099	714 (65%)	251
Holland et al. (2017)	295	129 (44%)	67
Tsai et al. (2017)	128	91 (71%)	40
Benzo et al. (2021)	217	63 (29%)	33

Note. N/A = not applicable.

Table B3

Uptake of Telerehabilitation in Observational Studies

Author (date)	Screened, *n*	Uptake, *n* (%)
Grosbois et al. (2021)	65	57 (88%)
Houchen-Wolloff et al. (2021)	2080	100 (5%)
Lewis et al. (2021)	30	17 (57%)
Marquis et al. (2015)	77	26 (37%)
Simonÿ et al. (2019)	28	15 (54%)
Nolan et al. (2019)	1593	154 (10%)

Table B4

Characteristics of Studies Exploring the Participant Experiences with Remotely Delivered Pulmonary Rehabilitation

Author (year)	Sample size (*n*)	Age (years), *M* (*SD*)	PR delivery mode	Participant experience of PR		Participant digital literacy at baseline	Study provision of digital equipment
				No previous PR experience	Previously attended centre-based based PR		
Benzo et al. (2021)	78	69	VC			Not stated	Provided
Burkow et al. (2015)	10	62	VC	✓	✓	All regular computer users	Provided
Lahham et al. (2018b)	13	66	Telephone	✓	✓	N/A	N/A
Hoaas et al. (2016)	10	55	VC			8/10 used internet daily, 2 technology naive	Provided
Houchen-Wolloff et al. (2021)	14	71 (9)	Web-based	✓		Needed to be web literate and have email	Provided or used own
Simony et al. (2019)	15	62	VC			Not stated	Provided
Tsai et al. (2016)	11	72 (8)	VC	✓	✓	Not stated	Provided
Whittaker et al. (2021)	26	70	Web-based		✓	Not stated	Needed own mobile phone

Note. N/A = not applicable; PR = pulmonary rehabilitation; VC = video conferencing.

Designing, Implementing, and Evaluating a Framework for Managing Concussions in Aotearoa New Zealand Secondary Schools: A Study Protocol

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ABSTRACT

Adolescent concussions can potentially lead to cognitive and behavioural changes, affecting concentration and performance at school and in other activities. Although the Ministry of Education provides web-based guidelines for post-concussion student support, the implementation of these in the school setting is limited. Due to the complex school environment, a pragmatic methodology is needed to co-design implementation with relevant community stakeholders. We outline the protocol for designing and implementing a FRAmework for maNaging Concussions in New Zealand Secondary Schools (FRANCS) to support safe return to learn and activity for students. The framework draft was co-designed by school stakeholders and will be refined at organisational levels. We describe the theoretical underpinnings that informed the study design and outline the project phases. We use a systems thinking approach, Community Based Participatory Action Research, and Appreciative Inquiry approaches to co-develop FRANCS with community, policy, and professional stakeholders. The implementation and evaluation phases of FRANCS is guided by Step 5 of the Intervention Mapping protocol, Implementation outcomes, and Realist process evaluation. FRANCS will be adaptable to the context of individual secondary schools in Aotearoa New Zealand, ensuring that return-to-learning and -activity guides are implemented to support students who have sustained a concussion.

Salmon, D., Badenhorst, M., Keung, S., Lucas, P., Mossman, K., & Walters, S. (2023). Designing, implementing, and evaluating a framework for managing concussions in Aotearoa New Zealand secondary schools: A study protocol. *New Zealand Journal of Physiotherapy, 51*(3), S1–S9. https://doi.org/10.15619/nzjp.v51i3.276

Key Words: Adolescent, Brain, Concussion, Implementation, Methodology, Secondary Schools

INTRODUCTION

Concussions are a serious health concern in Aotearoa New Zealand, with the highest rates reported for adolescents (Theadom et al., 2020). Recent 12-month statistics suggest that 37% of all concussion claims accepted by the Accident Compensation Corporation (ACC, Aotearoa New Zealand's no-fault personal injury insurance scheme) were incurred in the age group ≤ 19 years. In this young age group, 45% were incurred during sports, with close to 40% of these sports-related concussions sustained in rugby union (Accident Compensation Corporation, 2022).

Most adolescents with a concussion recover within 4 weeks, but 26% have persistent symptoms (Thomas et al., 2018). Such symptoms can lead to ongoing fatigue, influence emotions, and reduce concentration, school and sport participation, and performance, and overall quality of life (Valovich McLeod, Wagner et al., 2017; Wan & Nasr, 2021). Early, appropriate care and staged return to learning and activity is critical for recovery following a concussion (Anderson et al., 2021; Davis et al., 2017; Kontos et al., 2020). However, teachers and school administrators often feel ill-equipped to implement return-to-learn protocols (Romm et al., 2018). Cognitive rest, academic adjustments, and return-to-activity guidelines are implemented inconsistently (Carson et al., 2014; Ha et al., 2020; Valovich McLeod, Lewis et al., 2017). Findings from the New Zealand Rugby Community Concussion Management Pathway initiative (Salmon et al., 2020) corroborate such observations, namely that interviewed stakeholders suggested that graduated return-to-learn guidelines were seldom implemented effectively in schools. Although the Te Tāhuhu o te Mātauranga – Ministry of Education provides web-based information and guidelines about concussion, there little evidence of its adoption in schools (Te Tāhuhu o te Mātauranga – Ministry of Education, 2019).

Countries such as Canada and the United States of America (USA) have successfully developed and implemented such guidelines in schools (Doucette et al., 2016; Hachem et al., 2016; Robins et al., 2023; Williamson et al., 2014). A Canadian national charity for injury prevention, Parachute,™ provides concussion awareness training tools (CATT) for healthcare and education professionals, sports organisations, students, and parents (Parachute, 2022). A framework outlining the "what", "where", "who", and "how" for managing concussion in schools is needed to address the knowledge translation gap from evidence to practice in Aotearoa New Zealand. Such a framework must be suitable and adaptable for the Aotearoa New Zealand context. It should be developed in partnership and with collective responsibility with the secondary school community, and aim to improve health-care access and outcomes for Māori, Pasifika, and other equity groups (Carlson, 2019).

The aim of this protocol paper is to describe the methodological underpinnings that informed this project, then to outline the project phases. The overarching purpose of the project is to develop a FRAmework for maNaging Concussions in New Zealand Secondary Schools (FRANCS) to support safe return-to-learn and -activity for all students. FRANCS was co-designed by school stakeholders and refined at organisational levels.

The objectives of this project are:

1. To co-design and implement a FRANCS with a pilot group of Aotearoa New Zealand secondary schools and relevant stakeholders (Phase 1a/b).
2. To evaluate FRANCS in those schools (Phase 2).
3. To refine FRANCS based on the implementation outcomes and process evaluation findings (Phase 3).
4. To determine the transferability of the framework to other contexts (Phase 4).
5. To develop recommendations and targeted strategies to implement FRANCS in a wider range of schools across Aotearoa New Zealand (Phase 5).

METHODOLOGICAL UNDERPINNINGS

We employed a systems thinking approach (Hulme & Finch, 2015) to co-design, implement, and evaluate the FRANCS in the schools and the wider community. Figure 1 presents the theoretical approaches informing the study design, and the five phases of the project. We completed phases 1a/b and 2 in 2021 and 2022, and are undertaking Phases 3 to 5 in 2023.

Systems thinking applied to schools

A systems thinking approach considers the system as a whole as opposed to individual components (Hulme & Finch, 2015). Multiple relationships or interactions between persons or processes lead to complexity within the system (Hulme & Finch, 2015). Such systems' interactions are non-linear: change in one component can result in either a negligible or a large effect on the system as a whole (Walton, 2014).

A school is a complex system, existing within a multi-ethnic and culturally diverse society, with substantial interactions between many interrelated "sub-components". These sub-components include the people, policy, curricula, reporting structures, physical environments, and socio-cultural and -economic contexts. The people include teaching staff, school leadership, ancillary staff, students, parents/kaitiaki (caregivers), whānau, coaches, other schools, the wider community, and external role players (i.e., law, curriculum, and policy makers) (Clacy et al., 2017; Hawkins & James, 2018; Hulme et al., 2019; Walton, 2014). The development and implementation of FRANCS needs to take into consideration such complexity of the school environment due to the different sub-components, stakeholders, and their respective behaviours and beliefs.

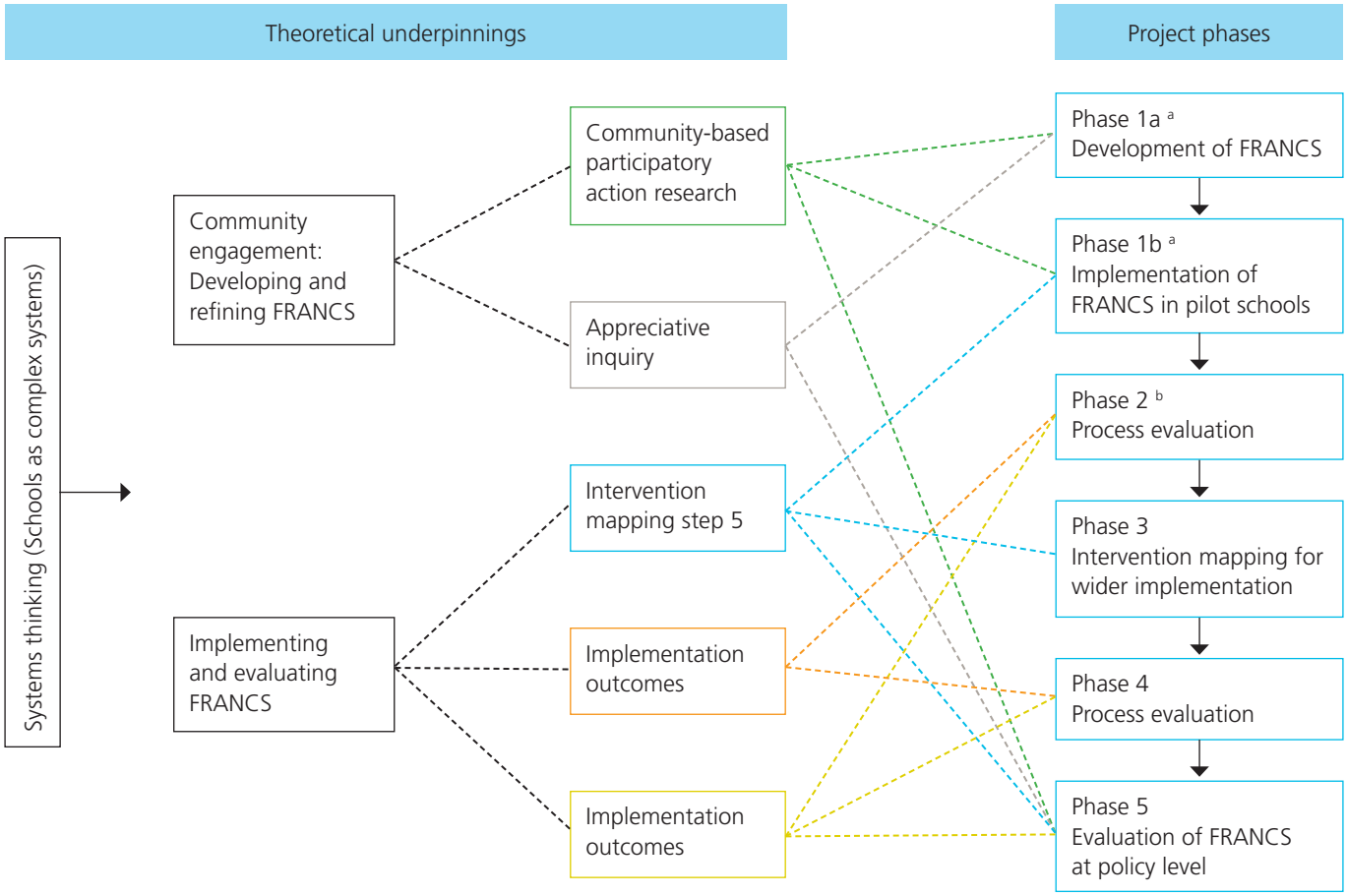
Engaging the community: Community-based Participatory Action Research and Appreciative Inquiry

In 2021, we used a qualitative Community-based Participatory Action Research (CBPAR) approach and Appreciative Inquiry to co-design FRANCS (Phase 1a). CBPAR supports a consensus-based approach to develop context-sensitive initiatives at a community level (Savin-Baden & Major, 2013). CBPAR entails a multidisciplinary partnership with communities, draws on several sources of knowledge, and is mutually beneficial (Schinke & Blodgett, 2016). We selected the CBPAR approach as the end-users of FRANCS are best situated to provide understanding of their school's context and to identify their own needs and preferences (Smith-Forbes et al., 2016). We invited community stakeholders to reflect actively on the challenges they experienced managing concussion in the school environment, instead of us, the researchers (as outsiders to these challenges), simply recommending solutions (Smith & Sparkes, 2016).

Appreciative Inquiry is a strengths-based approach that builds on positive experiences, ideally leading to lasting system changes. Organisations are invited to focus on what is working and on resources that are available to them, ensuring positive practices become standard across the organisation (Savin-Baden & Major, 2013). Appreciative Inquiry enabled us to move our thinking beyond trying to "fix the system", to focusing on identifying

Figure 1

Theoretical Underpinnings and Methodological Approaches Used to Co-design, Implement and Evaluate the FRANCS Framework in Schools and the Wider Community



Note. FRANCS = FRAmework for maNaging Concussions in New Zealand Secondary Schools.

[a] Phase completed. [b] Phase currently underway.

opportunities and possibilities that highlight and "supercharge" successful outcomes (Richer et al., 2010).

The Appreciative Inquiry process follows an iterative cycle. In the first phase, stakeholders are encouraged to explore the values of their organisation that allows it to function at its best. They reflect on positive past experiences and consider how these can be used to meet the goals of the project. In the next phase, stakeholders develop a goal-oriented plan that uses existing resources and strengths, and that can be sustained and maintained over the longer term. In the final phase, these desired changes or plans are put into practice and subsequently evaluated (Richer et al., 2010; Savin-Baden & Major, 2013).

Implementation and evaluation within a complex system

Intervention Mapping

Planning the implementation of FRANCS (Phase 1b, undertaken in 2022) was informed by Step 5 of the Intervention Mapping planning protocol (Donaldson et al., 2017). Intervention Mapping is a framework for theory- and evidence-based health promotion programme planning, consisting of six steps (Bartholomew et al., 2006). Intervention Mapping Step 5 can be used independently from the other steps to plan, adopt, implement, and maintain an intervention. During this step, we identified key adopters and implementers, and included representatives from end-users in the planning groups (Bartholomew et al., 2006).

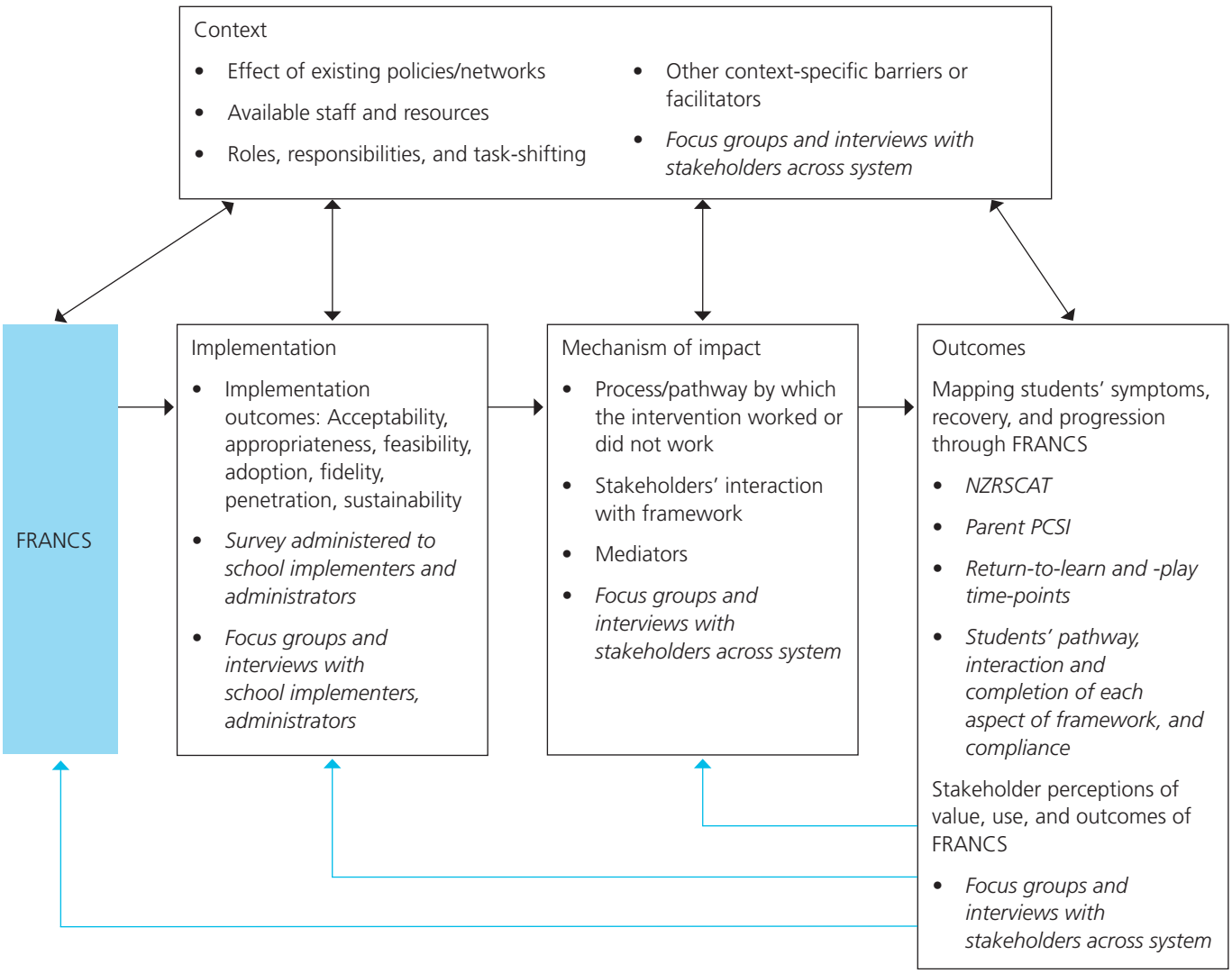
Implementation outcomes

We evaluated the successes and challenges of the implementation process during Phases 2 and 3 (Proctor et al., 2011). Implementation outcomes included:

1. Acceptability: Satisfaction with the framework, content, complexity, comfort, delivery, and credibility.
2. Appropriateness and feasibility: Perceived fit and actual fit, relevance, compatibility, suitability, usefulness, and cultural responsiveness.
3. Adoption: Uptake, utilisation, initial implementation, and intention.
4. Fidelity: Degree of intended FRANCS implementation, and quality of program delivery.

Figure 2

Process Evaluation (Phases 2 and 4)



Note. FRANCS = FRAmework for maNaging Concussions in New Zealand Secondary Schools. NZRSCAT = New Zealand Rugby Sport Concussion Assessment Tool; PCSI= Post-Concussion Symptom Inventory. *Italics* indicate the method of data collection employed as part of each construct.

5. Penetration: Integration within school system, and degree of adoption across schools.
6. Sustainability: Extent to which FRANCS is maintained or institutionalised.

Realist process evaluation

Effective intervention design should be informed by investigating underlying programme mechanisms (Moore et al., 2015). The aim of the evaluation is to understand how FRANCS "works" within specific contexts (different school environments with different resource capabilities), and what conditions may facilitate successful outcomes (Jagosh et al., 2012). Such evaluations provide insight into how findings might be transferred to other schools and settings in future (Moore et al., 2015).

As schools are complex adaptive systems, we expected that outcomes of FRANCS would not conform to strictly linear processes. We thus took a realist process evaluation approach to accommodate complexity. The realist process evaluation approach facilitates understanding of (a) the underlying mechanisms by which FRANCS operates (Pawson et al., 2005), and (b) how those mechanisms influence the outcomes of students with concussion progressing through that framework. Viewed from this perspective, the same intervention may have different outcomes at individual schools, depending on their contextual factors as well as the initial conditions within the systems (Prashanth et al., 2014). Contextual factors included geographical placement, rurality, resources available within the schools, staffing, and socio-economic and -cultural factors related to the school and its wider community.

Considering both system thinking and realist process evaluation principles, our research design was flexible so we could investigate unanticipated outcomes and identify potential patterns (Figure 2). An iterative process of inquiry and analysis was necessary to fully understand the implementation context, the mechanism by which FRANCs operates, and the outcomes for students who had sustained a concussion following the implementation of FRANCs in schools (Prashanth et al., 2014).

PHASES OF THE PROJECT PROTOCOL

Phase 1 – Development of FRANCS

Data collection

The University of Otago Human (Health) Ethics committee approved the study, and all participants signed written informed consent. In 2021, we undertook focus groups and semi-structured interviews with stakeholders from six schools to explore how concussions are currently managed, what factors facilitated their concussion management, and the key ingredients that constituted a "best practice" process. The six schools that agreed to participate had been part of the New Zealand Rugby Community Management Pathway initiative in Auckland and Otago in 2018–2019. These schools were purposely selected to include a range of socio-economic, gender, and ethnic distributions. Stakeholders included students with a concussion, and their parents/kaitiaki, teachers, school administrators and leaders (sports program coordinators/directors, heads of school), and health-care providers (nurses, physiotherapists, medical doctors). Key school contacts were asked to forward project information to students who had experienced a concussion and their parents/kaitiaki. The details of those who agreed to participate were forwarded to the research team. The perspectives of those stakeholders were used to co-develop a context-sensitive, adaptable framework, and ultimately provide clear, useable guidelines for schools.

Analysis

We used framework analysis (Gale et al., 2013) to develop a composite concussion management framework, informed by the participants' perceptions and proposed "action plans" of how concussion management could be operationalised in their schools. We used an iterative process, presenting the preliminary framework to participants and stakeholders at an interactive meeting, and revising the draft based on consensus. We then held focus groups with education and community partners and healthcare providers associated with the six schools (GPs, physiotherapists) to incorporate their input for the framework, and to provide insights regarding evidence-based "best practices" to further refine FRANCS. This phase was supported by content advisory groups, consisting of representatives from School Sport New Zealand (an organisation that coordinates, promotes, and protects secondary school sport), New Zealand School Nurses (a professional group connecting school nurses across Aotearoa New Zealand), New Zealand College of General Practitioners, and the New Zealand School Principals' Federation. We consulted with representatives from those groups via Zoom meetings while developing the project protocol and preparing grant applications. At the end of Phase 1a, we met with them again, presenting the first version of FRANCS (to be implemented in Phase 1b), and seeking their feedback.

Phase 1b – Implementation

The six schools involved in Phase 1a were invited to participate in Phase 1b, namely, the implementation of FRANCS. One of the four Otago-based schools declined to participate due to the complexity of the post-COVID environment. The two Phase 1a Auckland-based schools were also not available to participate in Phase 1b due to the lingering post-COVID impacts. We thus approached two schools in Hawke's Bay with information about the project, who agreed to participate. Five schools, three in Dunedin and two in Hawke's Bay, participated in Phase 1b.

Members of the research team worked with representatives of those five schools early in the 2022 school year to explain and field questions regarding FRANCS, guided by Intervention Mapping Step 5. Particular attention was given to the Hawke's Bay schools as they had not participated in Phase 1a, unlike the Dunedin-based schools. Prior to the implementation of FRANCS, we asked the representatives of the respective schools to identify their key stakeholders who would support the project. We then held meetings with those key school stakeholders to discuss the necessary implementation strategies, roles, and responsibilities of specific stakeholders (e.g., administrators, school nurses, deans, and individual teachers) and how FRANCS could be adapted to each school's local context. Field notes of the implementation process were collected by research assistants.

Phase 2 – Process evaluation

Quantitative data

Students who sustained a concussion were recruited via each school's representative. The representatives were asked to provide the participant information sheet to the student. If the student agreed, their contact details were provided to the assistant research fellow (ARF) working with the specific school. The ARF met with the student, provided more detailed information about the study, and gained written informed consent. For students younger than 16 years old, their parents/kaitiaki were contacted to provide consent. Throughout 2022, the ARFs collected data from students who sustained a concussion and their parents/kaitiaki on a weekly basis. Such data included return to learn and activity time-points, mapping of students' healthcare touchpoints, and completion/compliance of each aspect of the framework. During the weekly meetings, the ARF also assessed their concussion-related symptoms with the Symptom Score of the Child Sport Concussion Assessment Tool (SCAT5, Gavin et al., 2017), which is also included in the New Zealand Rugby Sport Concussion Assessment Tool (Salmon, Chua et al., 2022). Data were captured via the electronic data capture tool, Research Electronic Data Capture (REDCap), hosted at the University of Otago. Once the student reported having recovered, their kaitiaki were asked to complete the Parent Post-Concussion Symptom Inventory (Sady et al., 2014) via REDCap. We included all students with a suspected or confirmed concussion in the study who were referred by the school representative. Every effort was made to include all Māori and Pasifika students and kaitiaki who progressed through FRANCS in the evaluation. To ensure their voices and experiences are reflected in the development of FRANCS, their data was analysed as sub-units, wherever that was possible without compromising anonymity.

Towards the end of the school year, an online Likert-style questionnaire was administered via REDCap to school staff involved in the implementation of FRANCS to capture their satisfaction with FRANCS, and the implementation process (Proctor et al., 2011).

Descriptive demographic details were captured for the implementation (survey) and student outcomes (questionnaires, time-points, interactions with FRANCS). Appropriate bivariate analyses investigated potential relationships between demographic, survey outcomes, and various student outcomes.

Qualitative data

At the completion of Phase 2, we conducted focus groups and semi-structured interviews to cover the stakeholders' experiences with the implementation of FRANCS, and their perceptions of its value, utility, and outcomes for concussion management in their school. Participants included students and parents/kaitiaki with lived experiences of concussion as managed through FRANCS, and relevant sports directors, coaches, sports managers, teachers, and healthcare professionals.

We analysed transcribed data from the focus groups and interviews using a framework analysis method (Gale et al., 2013). We conducted cross-school analysis to iteratively identify patterns and differences across the different schools included in the study. All research team members reviewed and discussed the final analysis until consensus was reached.

Phase 3 – Intervention mapping for wider implementation

In this phase FRANCS was revised and tailored based on Phase 2 results. We followed the Intervention Mapping Step 5 again to plan implementation of the revised framework in the five schools that formed part of Phase 1b, as well seven additional schools to test the transferability of FRANCS. We approached potential schools to participate in Phase 3 using the same methods used for the two Hawke's Bay schools participating in Phase 1b. The seven schools that agreed included two in the wider Dunedin metropolitan area, three in North Otago, one in Hawke's Bay, and one in Auckland. In total, 12 schools participated in Phases 3 and 4.

Phase 4 – Second round process evaluation

We used the same process followed in phase 2 to evaluate the implementation of FRANCS in the additional seven schools recruited in phase 3 in 2023, and again in the five schools from Phase 2.

Phase 5 – Evaluation of FRANCS at policy level

Data collection

To be successful from a systems thinking perspective, implementation must be endorsed by key national governing organisations (Hulme & Finch, 2015). Concurrently to Phases 2 and 3, we sought insights and endorsement from relevant healthcare professional bodies, national sports organisations, and education stakeholders in different geographic areas. We undertook a snowball sampling approach by networking with these stakeholders, inviting them to recommend other organisations they believed relevant to the nationwide implementation of FRANCS.

Focus groups and semi-structured interviews in Phase 5 covered the stakeholders' perceptions of the value of FRANCS for their organisation or professional sector, recommendations to improve the framework, and for preparation of a national implementation of FRANCS. We transcribed interviews and focus group recordings, and analysed transcriptions using a framework analysis method (Gale et al., 2013), as described in Phase 2.

The findings of Phase 4 (process evaluation within the schools) will be merged with those of Phase 5 (evaluation by policy stakeholders) to inform the final FRANCS from this project. Input from those stakeholders, as well as from the advisory groups, will inform our plans for implementation beyond the 12 schools that participated in this project. Ongoing collaboration with all stakeholders will provide impetus for schools to embed FRANCS into their daily school practices to ensure student welfare, and into governance polices.

DISCUSSION

Early, evidence-informed best practice care is crucial for optimum recovery following concussion (Kontos et al., 2020). Although the Ministry of Education provides web-based information about concussion (Te Tāhuhu o te Mātauranga – Ministry of Education, 2019), there appears to be little awareness of these guidelines, and minimal implementation in schools. Several authors have emphasised the need for research to guide implementation of academic support or return-to-learn strategies for youth with concussion (Anderson et al., 2021; Gioia et al., 2016; Sarmiento et al., 2023). The aim of our project is to develop such guidelines through FRANCS, ensuring they have the flexibility to be adapted to each school's local context. The implementation and evaluation of FRANCS is using a staged approach with the goal to develop an adaptable guideline that could form the basis for regional, and, eventually, national roll-out.

In Canada, implementing concussion policies in high schools has contributed to general improved concussion awareness and concussion identification (Macartney et al., 2019; Matveev et al., 2018). Similarly, in the USA, online interventions such as "Brain 101: The concussion playbook" led to improved concussion knowledge of students, parents, and school staff (Glang et al., 2015). Students in schools who had implemented Brain 101 as an educational resource for concussion received more varied, individualised academic accommodations than students in control schools, and school, athlete, and parent knowledge improved for effective concussion management practices (Glang et al., 2015).

Based on the Canadian (Damji & Babul, 2018; Macartney et al., 2019; Matveev et al., 2018) and USA (Glang et al., 2015) experiences, adoption of FRANCS in Aotearoa New Zealand schools is likely to improve teacher and school awareness of concussions, in-class management, and provision of individual-specific academic accommodations (Mallory et al., 2022). FRANCS will provide clarity around recommended return-to-learn protocols, reassurance for parents and the student, and a flexible template to support stakeholder roles and responsibilities in the management of concussions. The framework may assist

the schools to meet their health and safety requirements and to develop context-specific concussion policies and procedures.

An important consideration for FRANCS is the inclusion of Māori and Pasifika knowledge, values, and practices to inform and improve students, parents/kaitiaki, and schools' awareness and accessibility to resources/care for concussions. In the New Zealand Rugby Concussion Management Pathway initiative, awareness of concussion guidelines and access to care were found to be a particular challenge for Māori or Pasifika players (Salmon et al., 2021). Lower awareness is likely to influence access to healthcare, and thus outcomes (Forrest et al., 2018; Gottgtroy et al., 2022).

We will continue to build collaborations and partnerships with Māori or Pasifika stakeholders to develop suitable resources, and with organisations that may already provide similar resources. A further critical feature of FRANCS is that it will apply to all students who have sustained a concussion, whether that was incurred during sports or non-sporting activities (Mallory et al., 2022). That is particularly relevant for the Aotearoa New Zealand context as less than 50% of concussion claims of the age group ≤ 19 years submitted to and accepted by ACC were sports-related (Accident Compensation Corporation, 2022).

The introduction of national or school concussion policies in other countries has enhanced stakeholder knowledge thereof, and of implementation of academic accommodations (Macartney et al., 2019; Mallory et al., 2022). Yet it is still unknown whether implementing such policies and frameworks lead to improved recovery time, and decreased risk of persistent symptoms and disability. Besides considering the sustainability and maintenance of FRANCS, its effectiveness for improving concussion outcomes of adolescent students would need to be established.

The FRANCS project is a multi-centred collaboration between New Zealand Rugby, Auckland University of Technology and the University of Otago. Our research team includes existing collaborations between New Zealand School Nurses, New Zealand College of General Practitioners, and the secondary schools involved in FRANCS. It includes input from health-care providers and their organisations, such as Physiotherapy New Zealand, and health-care providers contributing to Aotearoa New Zealand concussion services, thereby extending beyond sport-related concussion. We plan to extend these collaborations by working with those responsible for policy development and implementation within their sectors, seeking common goals to improve health, and education outcomes for youth who sustain concussion.

We bring together the triad of research, education, and industry (sport and healthcare) engagement to co-design flexible and culturally responsive concussion processes and policy to enhance the welfare of all secondary school students. These stakeholder-informed guidelines may be the first step towards developing a national framework enabling the integration between schools, and healthcare professionals, and ultimately improve health outcomes for students across Aotearoa New Zealand. Establishing an endorsed national level policy may be a critical step to these guidelines gaining traction within schools.

CONCLUSION

This protocol describes the methodologies and processes to develop, implement, and evaluate a concussion management framework to support safe return-to-learn and -sport for all students, regardless of concussion aetiology. This initiative has the potential to improve student outcomes, and decrease the risk of long-term consequences of concussion. A cohesive approach to students' recovery has the potential to reduce direct healthcare time and costs, while providing a flexible guide that outlines roles and responsibilities within the school to support the management of concussions.

KEY POINTS

1. This protocol describes a systems thinking approach for designing and implementing interventions in complex environments, such as schools.
2. Post-concussion return-to-learn guidelines are not yet effectively applied in schools, despite being important to support students during their recovery.
3. We outline the development and implementation of a context-sensitive and stakeholder-informed framework for managing concussion in Aotearoa New Zealand secondary schools.
4. A unified approach for optimal concussion management across secondary schools in Aotearoa New Zealand has the potential to transform concussion management in schools for all students, regardless of aetiology.

DISCLOSURES

This study is funded by a Lottery Health Grant and two grants of the Otago into Science–Participatory Science Platform of the Ministry of Business, Innovation and Employment. There are no conflicts of interest that may be perceived to interfere or bias this study.

PERMISSIONS

This study was approved by the University of Otago Human (Health) Ethics Committee (reference number, H22/025).

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CONTRIBUTIONS OF AUTHORS

Conceptualisation and methodology, DS, MB, GS, SW, SK, PL and KM; writing – original draft preparation, GS and MB; writing – review and editing, GS, MB, DS, SW, PL, KM and SK; visualisation: MB; project administration, GS; funding acquisition, GS, DS, MB, SW, SK, PL and KM.

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REFERENCES

Accident Compensation Corporation. (2022). *Concussion/TBI dataset*. https://catalogue.data.govt.nz/dataset/acc-concussion-tbi-data/resource/bd83401b-459b-4c51-9f15-d6b3b8c0c6b4

Anderson, D., Gau, J. M., Beck, L., Unruh, D., Gioia, G., McCart, M., Davies, S. C., Slocumb, J., Gomez, D., & Glang, A. E. (2021). Management of return to school following brain injury: An evaluation model. *International Journal of Educational Research*, *108*, 10.1016/j.ijer.2021.101773. https://doi.org/10.1016/j.ijer.2021.101773

Bartholomew, L., Markham, C. M., Ruiter, R. A. C., Fernandez, M. E., Kok, G., & Parcel, G. S. (2006). *Planning health promotion programs: An intervention mapping approach* (4th ed.). Jossey-Bass.

Carlson, T. (2019). Mana Motuhake o Ngāti Porou: Decolonising health literacy. *Journal of Social Anthropology and Cultural Studies*, *16*(2), 77–103. https://doi.org/10.11157/sites-id418

Carson, J. D., Lawrence, D. W., Kraft, S. A., Garel, A., Snow, C. L., Chatterjee, A., Libfeld, P., MacKenzie, H. M., Thornton, J. S., Moineddin, R., & Frémont, P. (2014). Premature return to play and return to learn after a sport-related concussion: Physician's chart review. *Canadian Family Physician*, *60*(6), e310, e312–e315. https://www.cfp.ca/content/60/6/E310.full

Clacy, A., Goode, N., Sharman, R., Lovell, G. P., & Salmon, P. M. (2017). A knock to the system: A new sociotechnical systems approach to sport-related concussion. *Journal of Sports Sciences*, *35*(22), 2232–2239. https://doi.org/10.1080/02640414.2016.1265140

Damji, F., & Babul, S. (2018). Improving and standardizing concussion education and care: A Canadian experience. *Concussion*, *3*(4), CNC58. https://doi.org/10.2217/cnc-2018-0007

Davis, G. A., Anderson, V., Babl, F., Gioia, G. A., Giza, C. C., Meehan, W., Moser, R. S., Purcell, R., Schatz, P., Schneider, K. J., Takagi, M., Yeates, K. O., & Zemek, R. (2017). What is the difference in concussion management in children as compared with adults? A systematic review. *British Journal of Sports Medicine*, *51*(12), 949–957. https://doi.org/10.1136/bjsports-2016-097415

Donaldson, A., Lloyd, D. G., Gabbe, B. J., Cook, J., & Finch, C. F. (2017). We have the programme, what next? Planning the implementation of an injury prevention programme. *Injury Prevention*, *23*(4), 273–280. https://doi.org/10.1136/injuryprev-2015-041737

Doucette, M. L., Bulzacchelli, M. T., Gillum, T. L., & Whitehill, J. M. (2016). The Massachusetts School Sports Concussions Law: A qualitative study of local implementation experiences. *Journal of Law, Medicine and Ethics*, *44*(3), 503–513. https://doi.org/10.1177/1073110516667946

Forrest, R. H. J., Henry, J. D., McGarry, P. J., & Marshall, R. N. (2018). Mild traumatic brain injury in New Zealand: Factors influencing post-concussion symptom recovery time in a specialised concussion service. *Journal of Primary Health Care*, *10*(2), 159–166. https://doi.org/10.1071/HC17071

Gale, N. K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Research Methodology*, *13*(1), 117. https://doi.org/10.1186/1471-2288-13-117

Gavin, A. D., Laura, P., Kathryn, J. S., Keith Owen, Y., Gerard, A. G., Vicki, A., Richard, G. E., Ruben, J. E., Michael, M., Allen, S., Grant, L. I., Jiří, D., Paul, M., Willem, M., Jon, P., Christopher, C. G., & Jeffrey, S. K. (2017). The Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5): Background and rationale. *British Journal of Sports Medicine*, *51*(11), 859–861. https://doi.org/10.1136/bjsports-2017-097492

Gioia, G. A., Glang, A. E., Hooper, S. R., & Brown, B. E. (2016). Building statewide infrastructure for the academic support of students with mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *31*(6), 397–406. https://doi.org/10.1097/HTR.0000000000000205

Glang, A. E., Koester, M. C., Chesnutt, J. C., Gioia, G. A., McAvoy, K., Marshall, S., & Gau, J. M. (2015). The effectiveness of a web-based resource in improving postconcussion management in high schools. *Journal of Adolescent Health*, *56*(1), 91–97. https://doi.org/10.1016/j.jadohealth.2014.08.011

Gottgtroy, R. B., Hume, P., & Theadom, A. (2022). Healthcare pathways for mild traumatic brain injury patients in New Zealand, determined from Accident Compensation Corporation data. *New Zealand Medical Journal*, *135*(1563), 36–51.

Ha, M. L., Kasamatsu, T. M., Valovich McLeod, T. C., Register-Mihalik, J. K., & Bacon, C. E. W. (2020). Teachers' perceived knowledge and confidence regarding adolescent concussion management. *Journal of Education and Learning*, *9*(5), 27–37. https://doi.org/10.5539/jel.v9n5p27

Hachem, L. D., Kourtis, G., Mylabathula, S., & Tator, C. H. (2016). Experience with Canada's first policy on concussion education and management in schools. *Canadian Journal of Neurological Sciences*, *43*(4), 554–560. https://doi.org/10.1017/cjn.2016.41

Hawkins, M., & James, C. (2018). Developing a perspective on schools as complex, evolving, loosely linking systems. *Educational Management Administration & Leadership*, *46*(5), 729–748. https://doi.org/10.1177/1741143217711192

Hulme, A., & Finch, C. F. (2015). From monocausality to systems thinking: A complementary and alternative conceptual approach for better understanding the development and prevention of sports injury. *Injury Epidemiology*, *2*(1), 31. https://doi.org/10.1186/s40621-015-0064-1

Hulme, A., McLean, S., Read, G. J. M., Dallat, C., Bedford, A., & Salmon, P. M. (2019). Sports organizations as complex systems: Using cognitive work analysis to identify the factors influencing performance in an elite netball organization. *Frontiers in Sports and Active Living*, *1*, 56. https://doi.org/10.3389/fspor.2019.00056

Jagosh, J., Macaulay, A. C., Pluye, P., Salsberg, J., Bush, P. L., Henderson, J., Sirett, E., Wong, G., Cargo, M., Herbert, C. P., Seifer, S. D., Green, L. W., & Greenhalgh, T. (2012). Uncovering the benefits of participatory research: Implications of a realist review for health research and practice. *Milbank Quarterly*, *90*(2), 311–346. https://doi.org/10.1111/j.1468-0009.2012.00665.x

Kontos, A. P., Jorgensen-Wagers, K., Trbovich, A. M., Ernst, N., Emami, K., Gillie, B., French, J., Holland, C., Elbin, R. J., & Collins, M. W. (2020). Association of time since injury to the first clinic visit with recovery following concussion. *JAMA Neurology*, *77*(4), 435–440. https://doi.org/10.1001/jamaneurol.2019.4552

Macartney, G., Chen, W., Vassilyadi, M., Zemek, R., Aglipay, M., Macartney, A., Lanos, M., & Goulet, K. (2019). The effect of the Parachute™ Awareness for Players Program on the acquisition of concussion knowledge and attitude in children who play soccer. *Canadian Journal of Neuroscience Nursing*, *39*(1), 14–22. https://www.proquest.com/docview/2284490018?pq-origsite=gscholar&fromopenview=true

Mallory, K. D., Saly, L., Hickling, A., Colquhoun, H., Kroshus, E., & Reed, N. (2022). Concussion education in the school setting: A scoping review. *Journal of School Health*, *92*(6), 605–618. https://doi.org/10.1111/josh.13156

Matveev, R., Sergio, L., Fraser-Thomas, J., & Macpherson, A. K. (2018). Trends in concussions at Ontario schools prior to and subsequent to the introduction of a concussion policy – An analysis of the Canadian hospitals injury reporting and prevention program from 2009 to 2016. *BMC Public Health*, *18*, 1324. https://doi.org/10.1186/s12889-018-6232-9

Moore, G. F., Audrey, S., Barker, M., Bond, L., Bonell, C., Hardeman, W., Moore, L., O'Cathain, A., Tinati, T., Wight, D., & Baird, J. (2015). Process evaluation of complex interventions: Medical Research Council guidance. *British Medical Journal*, *350*, h1258. https://doi.org/10.1136/bmj.h1258

Parachute. (2022, September 28). *Concussion collection*. https://www.parachutecanada.org/en/professional-resource/concussion-collection/

Pawson, R., Greenhalgh, T., Harvey, G., & Walshe, K. (2005). Realist review – A new method of systematic review designed for complex policy interventions. *Journal of Health Services Research and Policy*, *10*(1 Suppl), 21–34. https://doi.org/10.1258/1355819054308530

Prashanth, N. S., Marchal, B., Devadasan, N., Kegels, G., & Criel, B. (2014). Advancing the application of systems thinking in health: A realist evaluation of a capacity building programme for district managers in Tumkur, India. *Health Research Policy and Systems*, *12*, 42. https://doi.org/10.1186/1478-4505-12-42

Proctor, E., Silmere, H., Raghavan, R., Hovmand, P., Aarons, G., Bunger, A., Griffey, R., & Hensley, M. (2011). Outcomes for implementation research: Conceptual distinctions, measurement challenges, and research agenda. *Administration and Policy in Mental Health and Mental Health Services Research*, *38*, 65–76. https://doi.org/10.1007/s10488-010-0319-7

Richer, M.-C., Ritchie, J., & Marchionni, C. (2010). Appreciative inquiry in health care. *British Journal of Healthcare Management*, *16*(4), 164–172. https://doi.org/10.12968/bjhc.2010.16.4.47399

Robins, L., Taras, J., Ippolito, C., & Reed, N. (2023). Online youth concussion resources for Canadian teachers and school staff: A systematic search strategy. *Brain Injury*, *37*(10), 1179–1186. https://doi.org/10.1080/02699052.2023.2192525

Romm, K. E., Ambegaonkar, J. P., Caswell, A. M., Parham, C., Cortes, N. E., Kerr, Z., Broshek, D. K., & Caswell, S. V. (2018). Schoolteachers' and administrators' perceptions of concussion management and implementation of return-to-learn guideline. *Journal of School Health*, *88*(11), 813–820. https://doi.org/10.1111/josh.12687

Sady, M. D., Vaughan, C. G., & Gioia, G. A. (2014). Psychometric characteristics of the postconcussion symptom inventory in children and adolescents. *Archives of Clinical Neuropsychology*, *29*(4), 348–363. https://doi.org/10.1093/arclin/acu014

Salmon, D., Chua, J., Sullivan, S. J., Whatman, C., Brown, J., Register-Mihalik, J., Murphy, I., Walters, S., Clacy, A., Sole, G., Kerr, Z. Y., Rasmussen, K., & England, M. (2022). Sport concussion assessment in New Zealand high school rugby players: A collaborative approach to the challenges faced in primary care. *Brain Injury*, *36*(2), 258–270. https://doi.org/10.1080/02699052.2022.2033839

Salmon, D., Romanchuk, J., Murphy, I., Sullivan, J., Walters, S., Whatman, C., Clacy, A., Keung, S., & Van Der Vis, K. (2020). Infographic. New Zealand Rugby's concussion management pathway. *British Journal of Sports Medicine*, *54*(5), 298–299. https://doi.org/10.1136/bjsports-2019-100950

Salmon, D. M., Romanchuk, J., Sullivan, S. J., Walters, S., Clacy, A., Register-Mihalik, J. K., Kerr, Z. Y., Whatman, C., & Keung, S. (2021). Concussion knowledge, attitude and reporting intention in rugby coaches and high school rugby players. *International Journal of Sports Science & Coaching*, *16*(1), 54–69. https://doi.org/10.1177/1747954120961200

Sarmiento, K., Miller, G. F., & Jones, S. E. (2023). Sports-related concussions and adverse health behaviors among middle and high school students. *American Journal of Sports Medicine*, *51*(2), 503–510. https://doi.org/10.1177/03635465221141440

Savin-Baden, M., & Major, C. M. (2013). *Qualitative research: An essential guide to theory and practice* (1st ed.). Routledge.

Schinke, R. J., & Blodgett, R. (2016). Embarking on community-based participatory action research: A methodology that emerges from (and in) communities. In B. Smith & A. C. Sparkes (Eds.), *Routledge handbook of qualitative research in sport and exercise*. Routledge. https://doi.org/10.4324/9781315762012

Smith, B., & Sparkes, A. C. (2016) (Eds.), *Routledge handbook of qualitative research in sport and exercise*. Routledge. https://doi.org/10.4324/9781315762012

Smith-Forbes, E. V., Howell, D. M., Willoughby, J., Armstrong, H., Pitts, D. G., & Uhl, T. L. (2016). Adherence of individuals in upper extremity rehabilitation: A qualitative study. *Archives of Physical Medicine and Rehabilitation*, *97*(8), 1262–1268.E1. https://doi.org/10.1016/j.apmr.2015.11.008

Te Tāhuhu o te Mātauranga – Ministry of Education. (2019). *Supporting learners with acquired brain injury*. https://inclusive.tki.org.nz/guides/brain-injury/#Brain%20injury%20guide

Theadom, A., Mahon, S., Hume, P., Starkey, N., Barker-Collo, S., Jones, K., Majdan, M., & Valery. (2020). Incidence of sports-related traumatic brain injury of all severities: A systematic review. *Neuroepidemiology*, *54*(2), 192–199. https://doi.org/10.1159/000505424

Thomas, D. J., Coxe, K., Li, H., Pommering, T. L., Young, J. A., Smith, G. A., & Yang, J. (2018). Length of recovery from sports-related concussions in pediatric patients treated at concussion clinics. *Clinical Journal of Sport Medicine*, *28*(1), 56–63. https://doi.org/10.1097/JSM.0000000000000413

Valovich McLeod, T. C., Lewis, J. H., Whelihan, K., & Bacon, C. E. W. (2017). Rest and return to activity after sport-related concussion: A systematic review of the literature. *Journal of Athletic Training*, *52*(3), 262–287. https://doi.org/10.4085/1052-6050-51.6.06

Valovich McLeod, T. C., Wagner, A. J., & Bacon, C. E. W. (2017). Lived experiences of adolescent athletes following sport-related concussion. *Orthopaedic Journal of Sports Medicine*, *5*(12), 2325967117745033. https://doi.org/10.1177/2325967117745033

Walton, M. (2014). Applying complexity theory: A review to inform evaluation design. *Evaluation and Program Planning*, *45*, 119–126. https://doi.org/10.1016/j.evalprogplan.2014.04.002

Wan, A. N., & Nasr, A. S. (2021). Return to learn: An ethnographic study of adolescent young adults returning to school post-concussion. *Journal of Clinical Nursing*, *30*(5–6), 793–802. https://doi.org/10.1111/jocn.15617

Williamson, R. W., Gerhardstein, D., Cardenas, J., Michael, D. B., Theodore, N., & Rosseau, N. (2014). Concussion 101: The current state of concussion education programs. *Neurosurgery*, *75,* S131–S135. https://doi.org/10.1227/NEU.0000000000000482

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CONFERENCE ABSTRACTS

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Kōmiri Aotearoa

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ARE ORTHOPAEDIC SPECIAL TESTS OBSOLETE IN THE DIAGNOSIS OF ACROMIOCLAVICULAR JOINT AND SUB-ACROMIAL PATHOLOGY?

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Introduction: An accurate diagnosis of shoulder pain is integral to forming a prognosis and management plan. Chronic shoulder pathologies are often misdiagnosed due to the poor validity of tests and an over-reliance on imaging. For many clinicians the assumption is that clinical tests can discriminate between different structures in the shoulder. They are still widely used despite sufficient evidence calling into question the diagnostic accuracy of these tests.

Aims: To investigate the diagnostic accuracy of commonly utilised clinical tests for identifying acromioclavicular joint (ACJ) and subacromial (SA) pain in patients with chronic shoulder pathologies.

Methods: A diagnostic accuracy study was conducted in a tertiary care environment. Participants with chronic ACJ or SA pain were recruited. Two orthopaedic surgeons and one physiotherapist conducted the assessments. Each participant underwent a standardised interview and physical assessment followed by an anaesthetic injection (AI) into the SA space +/- the ACJ. A positive anaesthetic response threshold was set at ≥ 65% improvement on the numeric pain rating scale.

Results: Of the 38 participants, 17 had a positive anaesthetic response. None of the orthopaedic special tests (OSTs) demonstrated a statistically significant relationship with the anaesthetic response, and none demonstrated levels of accuracy that suggest they have any clinical utility as stand-alone tests to either rule in or out ACJ or SA pain in this cohort. A multivariate analysis identified a combination of positive and negative variables that have the potential to be clinically useful to predict a positive response to a SA AI. The variables were difficulty with overhead tasks, a strain injury onset, lowest pain ≥ 5/10, presence of muscle wasting, onset of pain from a repetitive activity, worst pain ≥ 8/10, the primary pain site over or above the clavicle, painful horizontal adduction with external rotation, painful passive internal rotation, and painful resisted flexion at 10°.

Conclusion: The study findings support the current research that OSTs as stand-alone tests are not able to identify an ACJ or SA diagnoses. In contrast, this research suggests that a combination of findings from the patient history and physical assessment can help to predict the presence or absence of these pathologies. Hence, clinicians should consider placing less emphasis on OSTs and more on the overall clinical picture.

These findings are specific to patients with chronic shoulder pain. Further research is required to determine if the results are reproducible and if they might be generalisable to patients with less severe pathology.

METASTATIC MELANOMA IN A PATIENT WITH UNRESOLVING KNEE PAIN – A CASE REPORT

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Introduction: The prevalence of serious pathology in the knee is low and, as a result, physiotherapists often have a low index of suspicion regarding serious pathology such as bony tumours and infections. While these causes are relatively rare, it is imperative

to discern them from more benign causes of knee pain, as they require early diagnosis and escalation of care. The following case describes the clinical reasoning employed in the triage of a patient with unresolving knee pain, that led to the timely diagnosis of metastatic melanoma.

Case Presentation: A 33-year-old female presented with a 1-month history of anteromedial knee pain, mild swelling, and instability following a twisting injury while descending stairs. Despite restricting her activity levels, these symptoms had not improved since the date of injury. Findings from the history and clinical examination were consistent with meniscal or chondral pathology. Despite manual and exercise therapy, her symptoms continued to worsen over the following month. An ongoing 5° painful loss of terminal knee extension and persisting pain and instability with short distances of walking warranted referral for radiographs and orthopedic consultation. She had no constitutional features of cancer-related pain but recalled a previous history of melanoma 4 years prior affecting her face.

Results: Radiographs were reported on and interpreted as being unremarkable both by the referring physiotherapist and upon orthopedic consultation. Magnetic resonance imaging revealed a large cystic bone lesion in the medial femoral condyle, which was subsequently characterised as metastatic melanoma by a specialist oncology team. Retrospective orthopedic review of the initial radiographs highlighted a lytic bone lesion, which was initially missed by the radiologist, specialist, and referring physiotherapist. The patient went on to develop further subcutaneous, intramuscular, and cerebral metastasis, the latter of which warranted craniotomy. At the time of publishing, the patient remains under the care of a specialised oncology team with the plan to continue immunotherapy treatment for a 2-year period.

Conclusion: Clinicians should have a high index of suspicion in patients with a prior cancer diagnosis and unresolving, worsening, or unexplained pain. The critical analysis of treatment response is an important facet of the clinical screening process and should aid clinical decision making towards appropriate escalation of investigations and care, where presumed timeframes are exceeded. The early recognition of a lack of anticipated improvement and referral to a specialist oncology team for further investigation was crucial to this patient having her cancer identified and undergoing timely intervention.

USE OF ELECTROMYOGRAPHY FOR DETERMINATION OF NECK MUSCLE FATIGUE; CAN IT STRENGTHEN VALIDITY OF CLINICAL OUTCOME MEASURES? A SCOPING REVIEW

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Introduction: Tests of neck muscle fatigue are commonly used to inform diagnostic and treatment decisions; however, very few have been validated.

Aim: The main aims of the scoping review were therefore to (1) identify and map literature examining use of electromyography (EMG) to measure neck muscle fatigue to inform validation experimental protocols; and (2) identify studies which had already used EMG to validate clinical measures of neck muscle fatigue.

Methods: Health-related databases: CINAHL, Cochrane Library, Embase, PubMed, Scopus, and Web of Science were searched from December 2022 to January 2023. Search terms based on population, concept, and context (PCC) criteria were developed with input from a specialist subject librarian and informed title and abstract screening and full text selection. Full texts included studies using EMG to evaluate muscle endurance or fatigue of a set of pre-defined neck muscles in adults aged 18 years and over.

Results: Three hundred and eighty-nine titles were screened with 48 full texts eligible for inclusion. Assessment of neck muscle fatigue was commonly performed during standardised submaximal isometric flexion and/or extension tasks, performed for specified durations (50%, *n* = 24), and or to exhaustion (31%, *n* = 15), or at varying % maximal voluntary contractions (19%, *n* = 9). Inclusion of neck muscles were specific to tasks performance with sternocleidomastoid most measured during flexion and splenius capitis during extension movements. Sixty-seven percent (*n* = 32) of studies used median frequency as the primary EMG outcome to evaluate fatigue with RMS of mean amplitude the second most used outcome (33%, *n* = 16). Analysis of outcomes was performed using overlapping and non-overlapping epochs although 69% (*n* = 33) of studies did not report window preference. Only one article used EMG to infer construct validity of the cervical flexor and extensor endurance tests.

Conclusion: Current evidence suggests that evaluation of neck muscle fatigue is possible using EMG; however, only one study has used EMG to evaluate validity of commonly used clinical outcomes of neck muscle fatigue.

THE EFFECT OF POSTERIOR PASSIVE ACCESSORY GLENOHUMERAL MOBILISATION ON SHOULDER AND SCAPULAR MUSCLE ACTIVITY DURING RESISTED SHOULDER ABDUCTION: A REPEATED-MEASURES STUDY ON ASYMPTOMATIC INDIVIDUALS

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Introduction: Shoulder mobilisations are commonly used by physiotherapists to treat shoulder disorders. The mechanisms through which they provide clinical benefit are unestablished. Investigation into the effect of shoulder mobilisation on muscle activity provides insight into the neurophysiological mechanisms of joint mobilisation. Knowledge of these mechanisms is important to enhance (1) research into the efficacy of mobilisations, and (2) the targeted use of mobilisation in clinical populations.

Aim: To assess the effect of posterior glenohumeral mobilisation on shoulder and scapular muscle activity during resisted shoulder abduction in asymptomatic individuals.

Methods: Laboratory-based, repeated measures, randomised crossover trial. Twenty-five asymptomatic participants took part in the study. Participants were randomised into one of two sequences corresponding to the order interventions delivered. Interventions consisted of the mobilisation condition (60 s, 3 sets, grade IV+ posterior shoulder mobilisation) and control (no mobilisation). Five repetitions of resisted shoulder abduction were performed before and after each intervention. Surface electromyography was used to assess muscle activity (expressed as % of maximal voluntary contraction) of eight shoulder and scapular muscles: upper and lower trapezius, middle and posterior deltoid, infraspinatus, serratus anterior, pectoralis major and latissimus dorsi muscles. A linear mixed effect model was used to assess the immediate effect of posterior mobilisation on shoulder muscle activity levels. Muscle activity for the concentric and eccentric phases of shoulder abduction were analysed separately using this model.

Results: No between-condition differences were observed for any muscle during both the concentric and eccentric phases of shoulder abduction (Table 1).

Table 1

Shoulder Muscle Activity Measured with EMG – Between Conditions

Movement phase and muscle	Mean difference	95% CI	
		LL	*UL*
Concentric phase			
Upper trapezius	5.2	–6.4	16.9
Lower trapezius	–1.2	–15.2	12.8
Infraspinatus	0.6	–8.8	10.1
Middle deltoid	1.6	–6.3	9.5
Posterior deltoid	0.6	–5.0	6.3
Latissimus dorsi	–0.3	–5.8	5.0
Serratus anterior	0.6	–8.1	9.4
Pectoralis major	–0.4	–3.3	2.4
Eccentric phase			
Upper trapezius	2.3	–11.5	16.2
Lower trapezius	–0.1	–21.4	21.2
Infraspinatus	–0.4	–10.7	9.8
Middle deltoid	2.8	–7.0	12.6
Posterior deltoid	1.7	–6.3	9.8
Latissimus dorsi	–1.5	–9.2	6.1
Serratus anterior	–0.8	–10.4	8.6
Pectoralis major	–0.3	–4.8	4.1

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit. All values expressed as a percentage of maximal voluntary isometric contraction.

Conclusion: Findings from this exploratory study suggest that posterior shoulder mobilisation had no effect on shoulder or scapular muscle activity levels compared to control in young asymptomatic individuals. Further research is required to assess the effects of

posterior shoulder mobilisation on muscle activity during different shoulder movements and in symptomatic populations. These findings may help future researchers in two ways: (1) in the design of studies that investigate the neuromuscular response of posterior mobilisation in patients with various shoulder disorders; and (2) in the design of studies investigating the mechanisms of manual therapy.

AUTONOMIC NERVOUS SYSTEM AND ENDOCRINE SYSTEM RESPONSE TO UPPER AND LOWER CERVICAL SPINE MOBILISATION IN HEALTHY MALE ADULTS: A RANDOMISED CROSSOVER TRIAL

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Introduction: Peripheral components of the stress response consist of the autonomic nervous system (ANS) and hypothalamic pituitary adrenal-axis (HPA-axis), the latter of which is the endocrine component of the stress response. Cervical spine mobilisations may differentially modulate both components of the stress response, depending on whether the target location is the upper or lower cervical spine. To date, this is the first study that has investigated the differential response of mobilisations applied to the cervical spine on both components of the stress response. This study provides a deeper understanding of the mechanisms of cervical spine mobilisation. Its results have important implications for clinicians, who may be able to selectively modulate the stress response depending on whether they mobilise the upper or lower cervical spine.

Aim: The aims of this study were to explore the physiological effects of mobilisation to the upper versus lower cervical spine in healthy male adults, by comparing (1) HPA-axis response measured with salivary cortisol, and (2) the ANS response measured with heart rate variability (HRV). Cortisol is the primary stress hormone and end-product of the HPA-axis, and HRV is a proxy measure of ANS activity.

Methods: A randomised controlled crossover trial investigated the effects of upper versus lower cervical spine mobilisation on both components of the stress response simultaneously. The primary outcome was salivary cortisol concentration. The secondary outcome was HRV measured with a smartphone application. Twenty healthy males, aged 21–35, were included. Participants were randomly assigned to block-AB (upper then lower cervical mobilisation, $n = 10$) or block-BA (lower then upper cervical mobilisation, $n = 10$), separated by a one-week washout period. All interventions were performed in the same room (University clinic), at the same time, by the same operator, under controlled conditions. Statistical analyses were performed with a Friedman's Two-Way ANOVA and Wilcoxon Signed Rank Test.

Results: Within groups, salivary cortisol concentration reduced thirty minutes following lower cervical mobilisation ($p = 0.049$). Between groups, salivary cortisol concentration was different at thirty minutes following the intervention ($p = 0.018$). Although non-significant, within groups, there was a trend for lower cervical mobilisation to increase salivary cortisol concentration the night following the intervention.

Conclusion: The results of this trial indicate that mobilisations applied to separate target locations within the cervical spine can differentially modulate the stress response.

AGE, GENDER, DELAY TO SURGERY, AND VOCATIONAL REHABILITATION SIGNIFICANTLY INFLUENCE OUTCOMES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION IN NEW ZEALAND

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Introduction: Rates of anterior cruciate ligament reconstruction (ACLR) have increased significantly in recent years. Patient outcomes following ACLR are variable and potentially influenced by multiple factors, including, but not limited to, age, gender, level of activity, time to surgery, and concomitant injury. However, the factors that may influence patient outcomes following ACLR in New Zealand (NZ) are currently unknown.

Aim: To determine the relationship between patient, treatment, and rehabilitation factors and patient-reported outcomes following ACLR in NZ.

Methods: Patient-reported outcome data from the NZ ACL Registry was matched to the corresponding Accident Compensation Corporation (ACC) claim under which the ACLR was funded, with relevant patient data extracted from the ACC claims management database. The patient-reported outcome measures used were the Knee Injury and Osteoarthritis Outcome Score (KOOS) and Marx Activity Rating Scale (MARS), with data collected pre-ACLR, and at 6, 12, and 24 months post ACLR. Outcomes of interest were the achievement of a Patient Acceptable Symptom State (PASS) on the KOOS4 or a normative score on the MARS. Variables included in the repeated measures logistic regression model were patient age at ACLR, gender, number of days between ACL injury and ACLR, presence of physiotherapy treatment, and presence of vocational rehabilitation (VR).

Results: The initial data set of 9,562 individuals was reduced to 5,345 once exclusion criteria were applied. Individuals over 21 years of age at ACLR were less likely to achieve a KOOS4 PASS score and a normative MARS score prior to, and following, surgery. Females were less likely to achieve a KOOS4 PASS score prior to ACLR and at six months post-ACLR, and less likely to achieve a normative MARS score following ACLR. A longer delay to ACLR increased the likelihood of achieving a KOOS4 PASS score prior to and following surgery; however, a longer delay to ACLR decreased the likelihood of achieving a normative MARS score following surgery. Physiotherapy treatment increased the likelihood of achieving a KOOS4 PASS score in the first 12 months following ACLR. Individuals who received VR were less likely to achieve a KOOS4 PASS and normative MARS score prior to, and following, ACLR.

Conclusion: Patient age, gender, delay to surgery, and physiotherapy treatment influence patient-reported outcomes following ACLR in NZ. Specific to the NZ context, the presence of VR decreased the likelihood of achieving a KOOS4 PASS and normative MARS score before and after ACLR. Awareness of factors that can affect outcomes following ACLR may influence decision making regarding how the initial ACL injury is managed, can assist with setting realistic post-operative goals, can help manage post-operative expectations, and enable optimisation of the rehabilitation programme.

A STREAMLINED APPROACH TO IDENTIFYING ADULTS SUITED TO NECK REHABILITATION ACUTELY FOLLOWING CONCUSSION: PROTOCOL FOR A FEASIBILITY STUDY

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Introduction: Concussion is a heterogeneous injury resulting in a diverse range of subsystem impairments of the head-neck complex. To address this, multidisciplinary assessment is often advised, although multidisciplinary management may not always be indicated. This raises a need to streamline processes directing patients to optimal treatment plans.

Aim: To examine feasibility of implementing a simplified physical examination (SPE) aimed at identifying concussion patients suited to neck rehabilitation within a New Zealand primary health care setting.

Methods: 160 acutely concussed adults aged 18–60 years, and 10 health service providers will be recruited between May 2023 and January 2024. A feasibility study will investigate health service provider and patient response to the SPE. A mixed methods study will examine health service provider attitudes toward use of the SPE in identification of individuals appropriate for neck rehabilitation, in the context of current practice. Exploration of patient reported compliance, satisfaction, and adverse reaction outcomes will inform feasibility from the patient perspective. A single-group pretest-posttest clinical design (including a 3-month follow up [part 3]) will provide preliminary evidence of efficacy of the SPE to preselect those suited to neck rehabilitation post-concussion.

Results: It is estimated that of 160 acutely concussed adults, 60 individuals suited to neck rehabilitation will be identified, and 30 will volunteer to receive treatment. We anticipate that use of the SPE will result in better identification of individuals suited to neck rehabilitation and, overall, health service providers attitudes toward the SPE will be positive. We also anticipate, due to perceived benefit of treatment, participant compliance will be high, dropouts low, and adverse events negligible. Based on previous randomised control trial results, we anticipate using the SPE will result in overall improvement in experimental outcomes of neck musculoskeletal and sensorimotor outcomes at 1-week and 3-month follow ups.

Conclusion: Results from this study will provide evidence of health service provider attitudes toward using the SPE in a primary health care setting, and participant compliance and satisfaction. Changes over time of experimental outcomes of neck musculoskeletal and sensorimotor function will provide preliminary evidence regarding the efficacy of the SPE to improve patient outcomes.

RETURNING FEMALES TO RUNNING FOLLOWING A TIBIAL BONE STRESS INJURY: EXPERT INTERVIEWS

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Introduction: Tibial bone stress injuries (BSI) are common among female runners and have one of the highest recurrence rates of all running-related injuries. Prior BSI has been shown to increase the recurrence rate 5–6 times among female runners. Following a tibial BSI, a critical component to complete rehabilitation is the successful return to running. While there is some evidence to guide clinicians in the return to running process, there are still areas where evidence is lacking.

Aim: To establish the process of how expert sport medicine clinicians return female athletes to running following tibial BSIs, while determining critical components of management.

Methods: A qualitative study design was used to investigate the knowledge and perceptions of Sports Medicine Clinicians on the return to running process following a tibial BSI in females. Semi-structured interviews were completed with 10 participants (four physiotherapists, five sports doctors, and one physiologist), and a reflexive thematic analysis was used to establish key themes.

Results: Three themes were established. With the first theme, "Health and Wellness", clinicians emphasised the importance of addressing the underlying reasons for the tibial BSI occurring, such as training errors, RED-S, and psychological health. In the second theme, "Bone Healing", clinicians described using clinical findings as opposed to radiological findings to guide the return to running process. The importance of symptom resolution and careful load management to build bone tolerance was emphasised when managing tibial BSIs. Finally, in the third theme, "Functional Return", clinicians described using functional tests to ensure adequate tissue capacity and movement competency, and to guide progression through the return to running process. Regular functional testing allows an individualised approach to management. Multiple progressions were discussed throughout the process in terms of building running distance, intensity, and frequency. These progressions were all guided by the athlete's end goal. Clinicians acknowledged the extensive literature citation of the "10% rule", which refers to progressively increasing running distance by 10% per week, but did not support its use following a tibial BSI due to the lack of scientific evidence to support it and a need for individuality. Introducing running on softer surfaces was recommended, while also including the athlete's normal training surfaces early in the process. The importance of addressing biomechanical factors was acknowledged; however, clinicians advised careful modification as athletes may adapt to their individual biomechanics.

Conclusion: When returning female athletes to running following a tibial BSI, their health should first be optimised. Progression should be gradual and guided by subjective and objective clinical findings. Expert clinicians identified the need to veer away from a "one size fits all approach' and individualise the return to running process. A notable thread that stretched across all three themes was the importance of establishing a multi-disciplinary management approach, reflecting the many facets involved in tibial BSI in female athletes.

IMAGING FOR LOW BACK PAIN – WHAT INFORMS CLINICAL DECISION MAKING? A SCOPING REVIEW

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Introduction: The overuse of imaging in the management of low back pain has been well documented. This has led to wasteful expenditure and potentially harmful consequences. ACC data 2009–2020 shows imaging makes up 17% of the total ACC spend of health care for LBP. Several strategies have been employed to encourage clinicians to use imaging more judiciously, with limited success. A number of factors have been shown to influence clinical decision making; however, these have not been fully explored. Investigating these factors would provide insight into how clinicians decide which person with LBP is appropriate for imaging.

Aim: The aim of this scoping review was to explore the literature on clinicians' decision making when referring for imaging for LBP. Identified factors were considered in the context of impact on clinical practice within Aotearoa New Zealand.

Methods: A scoping review was conducted following the PRISMA-ScR guidelines using the following databases: Medline, CINAHL, EBSCO, Scopus, and Cochrane Reviews. These databases were searched using the following key concepts: healthcare providers, clinical decision-making, LBP (all ages), medical imaging. Full text English language peer-reviewed articles published between 2010 and 2023 were included. Studies of elite athletes, wheelchair users, and people with neoplastic disease were excluded.

Results: Thirty-two peer-reviewed articles were included for final analysis. Data extracted covered 12 countries of study, 10 locations of service, and seven professions. Key factors influencing the decision-making process were charted and included *clinical setting* covering emergency care, primary care, community clinics, and specialist departments; *clinical features* such as pain characteristics, presence of red flags, and neurological symptoms; *patient characteristics* including age, sex, ethnicity, comorbidities, and socioeconomic factors; *patient beliefs* and expectations, for example demand for imaging and low expectation of recovery; *clinician characteristics* such as years' experience and workload; and *clinician beliefs* such as patient pressure and fear of consequences.

Conclusion: There are various influences on a clinician's decision-making process when referring patients with LBP for imaging. These are dependent on aspects related to the patient, the clinician, and the location of service. This study highlights those factors relevant to clinical practice in Aotearoa New Zealand. However, further investigation is required to examine these factors, how they relate to best practice guidelines, and how they could inform mechanisms to reduce unwarranted imaging. The current findings will inform a qualitative descriptive study interviewing clinicians to gain more insightful understanding of clinical decision making within an Aotearoa New Zealand context.

CLIENTS AND CONDITIONS ENCOUNTERED BY FINAL-YEAR PHYSIOTHERAPY STUDENTS IN PRIVATE PRACTICE. A RETROSPECTIVE ANALYSIS

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Introduction: Currently, little is known about the clients and conditions final-year physiotherapy students are exposed to in private practice settings. Private practices are community-based clinics where clients can access physiotherapy directly, and in New Zealand are the largest practice setting in which physiotherapists work. An understanding of the clients and conditions encountered by final-year students is needed to support physiotherapy students to transition to new graduate roles in private practice settings.

Aim: The aim of this study is to describe the clients and conditions encountered by final-year physiotherapy students during a six-week full-time private practice clinical placement.

Methods: Client data of conditions were collected over 11 years (2008–2018) from final-year physiotherapy students' client reports in a university clinic, Christchurch, New Zealand. Data for anatomical site and pathology were categorised using the Orchards Sports Injury Classification System 10 and descriptive analyses completed.

Results: Reports were collected from 190 students including data from 4,117 clients. In a clinical placement students saw a mean of 22 (*SD* 5) unique clients. The anatomical sites most encountered were the shoulder (97.4% of students), lumbar spine (96.3%), knee (95.8%), and ankle (91.2%). The pathologies most encountered were joint sprain (100%), muscle injury (90%), and tendon injury (88.4%).

Conclusion: While final-year physiotherapy students are exposed to a substantial number of clients encompassing major regions and condition types, this exposure is limited in scope. This contributes to our understanding of why the transition from final-year student to new graduate in a private practice setting is challenging, especially when considering skill development in areas such as manual therapy. When considering support initiatives, the data presented offer a basis for discussion.

SCREENING FOR DEGENERATIVE CERVICAL MYELOPATHY – PRELIMINARY RESULTS OF A NEW ZEALAND BASED NATIONWIDE PRIMARY HEALTHCARE SURVEY

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Introduction: Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord impairment in adults, affecting 2% worldwide. Patients experience symptoms including balance decline, upper and lower limb weakness, pain, and/or paraesthesia from degenerative cervical spinal elements causing stress on the spinal cord. Unfortunately, due to a lack of condition awareness and defined diagnostic criteria, people with DCM face significant diagnostic delays leading to progressive functional decline. Early

identification and diagnosis are key as timely intervention can cease progression and reduce impacts on quality of life. Primary healthcare clinicians are likely to encounter DCM in its early and mid-stages as it masquerades as benign musculoskeletal problems such as neck pain. Therefore, the awareness of DCM in primary care is essential for early identification and referral of suspected cases.

Aim: This survey aims to establish the current awareness and confidence to detect DCM among primary care clinicians in New Zealand.

Methods: Cross-sectional quantitative survey methodology was employed to collect anonymised responses from consenting New Zealand-registered primary healthcare clinicians, including GPs, physiotherapists, nurse practitioners, osteopaths, and chiropractors. After relevant literature review, survey questions were developed and modified after piloting the survey. The 12-question survey includes 5 demographic-based questions, two categorical questions on perceived awareness and screening confidence, and 5 condition knowledge-based, multiple-choice questions. Ethics approval was granted by the Auckland University of Technology Ethics Committee (23/113). Prospective clinicians were invited to participate via their respective professional organisations and social media groups. The data was analysed using descriptive statistics.

Results: Preliminary data surveyed from 255 primary healthcare clinicians, including GPs (28%), physiotherapists (44%), chiropractors (16%), nurse practitioners (12%), and osteopaths (2%). The mean years of clinical experience was 14.52 years (*SD* = 8.52). Over half had not received prior education on DCM (54%). Only 21% of clinicians rated their awareness as "very good" or "excellent", whereas 35% had limited or no awareness of DCM. Confidence to identify signs and symptoms was similar, with 44% of clinicians feeling "slightly" or "not confident at all" compared to 15.2% who felt "extremely" or "very confident". GPs reported receiving significantly less training ($p = 0.95$) than chiropractors and physiotherapists, and were significantly more likely to report limited awareness and lower confidence to detect the condition. The most recognised signs and symptoms among slightly to extremely confident clinicians were upper limb pain/paraesthesia (96.53%), neck pain and stiffness (91.91%), hand dexterity decline (87.28%), and gait disturbance (73.99%). Commonly recognised objective signs were tandem gait disturbance (65.90%), age > 45 years (61.85%), Babinski sign (57.23%), and Hoffman's sign (49.71%). Overall, 88% of surveyed clinicians were keen to attend further education on DCM.

Conclusion: In this survey only one in five primary care clinicians in New Zealand had good awareness of DCM and even fewer felt confident to detect the signs and symptoms clinically. This is likely to contribute to diagnostic delays and poorer outcomes for individuals with DCM. Clinicians who had undergone prior training reported higher levels of awareness and confidence. There is a large appetite for further training among surveyed clinicians at all career stages. The survey was limited by the low response rate and self-selection bias may overstate the actual percentage of clinicians who are aware of DCM.

RELIABILITY AND VALIDITY OF THE BRIEF PAIN INVENTORY SHORT-FORM IN INDIVIDUALS WITH ROTATOR CUFF-RELATED SHOULDER PAIN

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Introduction: Rotator cuff-related shoulder pain (RCRSP) is the term encompasses pain experience due to various shoulder disorders. Characterising pain experience and its associated interference is essential to optimise research and clinical outcomes in people with RCRSP. The Brief Pain Inventory-Short Form (BPI-SF) is a standardised tool for measuring pain severity and interference in people with chronic pain. However, the reliability and validity of the BPI-SF in individuals with RCRSP are undetermined. This study aimed to investigate the test-retest reliability and construct validity of the BPI-SF in individuals with RCRSP.

Methods: Sixty-one participants with RCRSP completed the BPI-SF twice with an interval of two to seven days and shoulder pain and disability index (SPADI) at the initial visit. The BPI-SF pain severity subscale, pain interference subscale, and stand-alone pain severity items were analysed using intraclass correlation coefficients (ICC) and minimal detectable change (MDC95). The construct validity of BPI-SF was assessed against SPADI using Pearson's correlation.

Results: The BPI-SF pain severity subscale demonstrated satisfactory test-retest reliability (ICC: 0.73, 95% CI: 0.58, 0.83) and an MDC95 of 2.05. Conversely, the BPI-SF pain interference subscale demonstrated low reliability (ICC: 0.53, 95% CI: 0.13, 0.75) and an MDC95 of 2.36. Of the stand-alone BPI-SF pain severity items, only "worst" pain demonstrated satisfactory test-retest reliability (ICC: 0.70, 95% CI: 0.55, 0.81). The correlation coefficients between the BPI-SF and SPADI subscales or total scores were high (r = 0.61 to 0.75, $p < 0.001$).

Conclusion: BPI-SF pain severity subscale and stand-alone pain severity item (i.e., "worst pain") are reliable in individuals with RCRSP. Both BPI-SF pain severity and interference subscales are valid in individuals with RCRSP. The MDC values can be useful metrics for interpreting a true change in BPI-SF scores following interventions in individuals with RCRSP.

PHYSIOTHERAPISTS' ATTITUDES AND BELIEFS ABOUT SELF-MANAGEMENT AS PART OF THEIR MANAGEMENT FOR LOW BACK PAIN

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Introduction: Low back pain (LBP) is a major cause of years lived with disability (YLDs) in New Zealand (NZ) and internationally, and places a large burden on individuals and health systems. Up to two thirds of people with LBP have symptoms a year after onset, with 70% having a recurrence within a 5-year period. Self-management is the ability of a person to make decisions and implement behaviours to manage their condition, including seeking health care support when required. Self-management for LBP thereby potentially reduces the burden on people with LBP and health care systems. To encourage physiotherapists to support self-management as part of their management for LBP, it is important to understand their current attitudes and beliefs, and to explore perceptions of how they implement self-management strategies in clinical practice.

Aim: This study aimed to explore physiotherapists' understanding of LBP; ascertain their knowledge of self-management concepts; and explore their attitudes and beliefs about supporting self-management for LBP within present NZ physiotherapy practice.

Methods: Interpretive Description qualitative methodology, involving in-depth data interpretation, was used. Semi-structured interviews with physiotherapists throughout NZ were conducted via video conferencing. Data was analysed and themes were defined.

Results: Seventeen physiotherapists (24–65 years old), with between one and 40+ years of experience, participated. Four main themes were defined:

1. Evolving understanding of LBP. Participants understood the complexity of LBP and were comfortable with the "non-specific LBP" diagnosis. Participants were empathetic to the multifactorial impacts of LBP on the person. However, most believed an episode LBP should fully resolve within a 6–12-week timeframe.
2. Apportioning responsibility. The reasons suggested for LBP persistence or recurrence were the person's lack of adherence with exercises and advice, or their lack of control over their psychological or behavioural barriers to recovery.
3. Self-management is important. Participants believed a greater focus on self-management could reduce LBP burden on the health system and individuals.
4. Understanding self-management. All participants considered exercises and individualised education as key components of self-management, but few could describe what self-management entails.

Conclusion: Novel findings from this research demonstrate examples of attitudes and beliefs that determine when and how self-management for people with LBP is implemented. In particular, beliefs about the natural history of back pain and how self-management skills are enabled may lead to inconsistencies in how physiotherapists throughout the profession provide self-management for people with LBP. Participants had good understanding of LBP, but lacked a contemporary knowledge of the natural history of LBP and tended to apportion responsibility for persistent or recurrent LBP to the person. Physiotherapists should be encouraged to assimilate more contemporary research evidence into their expectations of recovery for LBP. Further education about the role of physiotherapists in supporting self-management, the core components of self-management, including engagement, and reflection upon individual unconscious bias should be encouraged.

EXPLORING DRIVERS AND BARRIERS TO THE DEVELOPMENT OF MUSCULOSKELETAL ADVANCED PHYSIOTHERAPY PRACTITIONER ROLES IN NEW ZEALAND

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Introduction: Musculoskeletal conditions represent 12% of the non-communicable diseases in New Zealand (NZ) affecting one in four New Zealanders and accounting for 23% of its total annual health spend. The current model of musculoskeletal care in NZ has significant shortfalls leading to compromised access to care, long waiting times, resulting in increased chronicity and ultimately increased financial burden to the country. Internationally, advanced physiotherapy practitioner (APP) roles have demonstrated the ability to impact on orthopaedic waiting lists and improve timely patient access to specialist care and services. NZ policies such as the Musculoskeletal Workforce Review, advocate upskilling of physiotherapists into APP roles. Nevertheless, these roles have not gained traction in NZ.

Aim: This research investigated the drivers and barriers to APP role development in the NZ context.

Methods: An exploratory single embedded case study design was used. Document analysis, qualitative survey data analysis, and semi-structured interviews were utilised as data sources. A purposive sampling strategy was used. Data were analysed using qualitative content analysis and triangulated to ensure rigour.

Results: This research identified various drivers and barriers to the APP role development in NZ. Most facilitators echoed international shortfalls such as limited access to care, inability to meet patient needs, workforce shortages, and fiscal constraints. However, the unique NZ-relevant enablers related to surgeon as a champion, legislative driver, and profession-led catalysts. A dominant theme from the interviews focused on developing the APP role as an important area of workforce growth in NZ to help reduce musculoskeletal burden and improve patient journey. Interviewees identified unique NZ-related barriers connected to structural determinants in terms of duality of healthcare and intra-professional barriers. Others reflected global impediments to these roles such as lack of recognition, lack of training and career pathways, and inter-professional drivers.

Conclusion: This timely study provides a thought-provoking analysis of APP roles in NZ by examining their drivers and barriers. Currently, the APP roles in NZ are ad-hoc and opportunistic, dependent on the reactive needs of the organisation. There are drivers for these roles; nevertheless, the barriers are stronger. Stakeholders, policymakers, and professional and legislative bodies need to recognise these findings and overcome the barriers when considering developing and implementing APP roles in the NZ context.

UNDERSTANDING MUSCULOSKELETAL PHYSIOTHERAPY PRACTICE IN AOTEAROA: AN EXPLORATION OF MUSCULOSKELETAL PHYSIOTHERAPISTS' PERSPECTIVES OF PRACTICE

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Introduction: A contemporary musculoskeletal physiotherapy curriculum taught in Aotearoa New Zealand (AoNZ) must be responsive to the unique conditions shaping our society. However, little is known about the unique experience of becoming and being a musculoskeletal physiotherapist in AoNZ and the bespoke conditions that influence this. What does it mean to be a musculoskeletal physiotherapist in AoNZ? An inquiry into contemporary perspectives and the modern physiotherapy landscape in AoNZ is needed to inform the newest generation of physiotherapists and guide future curriculum development.

Aim: We aimed to (1) understand what it means to be a musculoskeletal physiotherapist in AoNZ, (2) explore musculoskeletal physiotherapists' perspectives of their physiotherapy practice, and (3) identify potential changes that could improve musculoskeletal physiotherapy curriculum design and implementation.

Methods: A diverse group of 15 musculoskeletal physiotherapists practising in AoNZ were individually interviewed. A qualitative Interpretive Descriptive approach alongside a reflexive thematic analysis framework was utilised. Data were coded and grouped independently, with provisional theme names and definitions constructed. The groupings and theme structure were discussed within the research team before being finalised.

Results: Four themes were generated. Theme 1, "Musculoskeletal physiotherapy is much more", described a narrow public view of musculoskeletal physiotherapy, as participants thought they had more to offer than "… the sports physio on TV". In Theme 2, "Evidence versus (patient) expectations", participants shared tensions between patient expectations and best practice: "Are we providing healthcare or hospitality?". Theme 3, "Being conflicted", included or referred to professional conflicts primarily shaped by bespoke AoNZ conditions, including ACC/funding, multi-culturalism, and cost versus quality. Theme 4, "My navigator", explored the need for patient support to navigate the health system, but also mentorship and career progression within the profession itself.

Conclusion: Our participants highlighted external (narrow public view and conflicting expectations) and internal (AoNZ-specific contexts and mentorship) conflicts that shaped their clinical practice. Within this study, challenges identified by the participants

centred around the perception of physiotherapy, balancing evidence and expectation, maintaining professional identity, and the need for advocacy. More so, it became apparent from this research the need to define musculoskeletal physiotherapy and improve awareness of our roles. Our participants provided valuable insights into contemporary musculoskeletal physiotherapy practice and education development in AoNZ.

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EXPLORING THE CURRENT AND FUTURE OSTEOARTHRITIS HEALTH SERVICE DELIVERY NEEDS IN AOTEAROA NEW ZEALAND

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Introduction: Globally, osteoarthritis (OA) is a leading cause of chronic pain and disability. OA can affect all aspects of a person's sense of hauora (health), including hinengaro (mental and emotional), tinana (physical), and whānau (social). In Aotearoa New Zealand (AoNZ), OA affects one in eight people and prevalence is predicted to increase by 76% in the next 20 years due to obesity and population demographics, and drive healthcare costs up by 86%. The rising burden of OA will place greater demand on clinical services. International OA clinical management guidelines recommend people with OA should have access to care that provides appropriate person-centred education, exercise, and weight loss (if applicable) before employing pharmacological or surgical management. In contrast to these recommendations, OA management in AoNZ has been described as fragmented and regionally variable. Still, little research has been undertaken on service delivery for people living with OA in AoNZ.

Aim: This study aimed to describe the views of interested people from the health sector regarding current and future OA health service delivery in the public health system in AoNZ.

Methods: Data were collected via a co-design approach within an interprofessional workshop at the Taupuni Hao Huatau Kaikōiwi: Osteoarthritis Aotearoa New Zealand Basecamp symposium in 2021 and analysed using direct qualitative content analysis. Participants came from various clinical (dietetics, general practice, nursing, orthopaedic surgery, physiotherapy, podiatry, psychology, rheumatology, sports medicine, and clinical exercise physiology), health research, and health funding backgrounds across AoNZ.

Results: The results highlighted several promising current healthcare delivery initiatives, such as steps to improve collaboration across primary and secondary care services, an appreciation for the need to develop health delivery fit for all (especially for Māori), and the success of more person-centred inter-professional approaches to care (i.e., Mobility Action Programme). Health literacy and obesity prevention policies featured in the thematic analysis suggesting a lifespan or systemwide approach is needed. Data highlighted a need for reformed systems that enhances hauora/wellbeing, promotes physical activity, and facilitates interprofessional service delivery and collaboration across care settings.

Conclusion: Our study identified several promising healthcare delivery initiatives for people with OA in AoNZ. Furthermore, our analysis recognised factors that could enhance OA care across the lifespan, including a greater focus on prevention, hauora/wellbeing rather than the disease, incorporation of a wider range of healthcare professionals, addressing capacity constraints, the potential value of a Model of OA Care or pathway that is evidence-based and integrates healthcare from OA prevention to secondary care. Yet, more work is needed to prioritise what stakeholders consider high-value care. Any Model of OA Care or pathway would need to acknowledge and support the diversity of needs within AoNZ and place value on interprofessional collaboration and practice and improvements in health literacy and self-management.

EXPLORING THE MEDIUM- TO LONG-TERM WELL-BEING OF PEOPLE WITH POST-TRAUMATIC KNEE OSTEOARTHRITIS FOLLOWING ANTERIOR CRUCIATE LIGAMENT RUPTURE IN AOTEAROA NEW ZEALAND: A QUALITATIVE STUDY

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Introduction: Osteoarthritis (OA) management has traditionally focused on the later stages in older adults. Recently, researchers have argued that to have a greater impact on the burden of OA, the focus should shift to earlier stages in younger adults. Anterior cruciate ligament (ACL) rupture frequently leads to post-traumatic osteoarthritis (PTOA) of the knee. Up to 75% of people with ACL-deficient knees develop PTOA, regardless of whether they have surgical management. Costs (healthcare, productivity, unemployment) of knee OA in Aotearoa New Zealand (AoNZ) are considerable. The presence of the Accident Compensation Corporation (ACC) in AoNZ creates a funding environment that can impact people with PTOA, with care only funded if a mechanism of injury is identified. This structure means people may be supported during the initial stages of ACL rehabilitation but receive little longer-term support. Management programmes to reduce the impact of PTOA are under development (Stop OsteoARthitis, Canada), promoting self-management, exercise, and healthy lifestyles to reduce the risk of PTOA after ACL rupture. Little is currently known about the longer-term experiences of people with PTOA in AoNZ, a better understanding of which is vital for developing management programmes bespoke to AoNZ.

Aim: To gain insight into the longer-term impacts of PTOA on the well-being of people in AoNZ following ACL rupture.

Methods: Qualitative study: Participants were 12 people in AoNZ with PTOA who experienced ACL rupture ≥ five years ago. Purposive sampling recruited participants with varying characteristics (age, symptoms duration, gender, perceived disability, ethnicity, geographical location). Data collection was through semi-structured interviews guided by literature about the lived experience of ACL rupture and PTOA, patient partners, and researcher experience. Data were analysed using an Interpretive Descriptive approach alongside a reflexive thematic analysis framework. Data were coded and grouped independently, with provisional theme names and definitions constructed. The groupings and theme structure were discussed before being finalised.

Results: Three themes emerged:

1. "Nobody ever told me …": There is a lack of evidence-based information given, immediately post-injury, to people who suffer ACL injury regarding their prognosis (e.g., return to sport, PTOA). Where PTOA was discussed, participants appeared to hold a very pessimistic view of the condition.
2. The post-rehabilitation void: Once people have completed their post-operative rehabilitation, they receive little information on longer-term knee management and are likely to only access care when symptoms have significantly worsened. Those doing well longer-term perceive they were motivated to do their initial rehabilitation well and have maintained their activity levels.
3. The elephant in the room – the psychological and social impact: This included perceived changes in identity related to sports/family participation, job loss, and rumination on the injury (even decades later). Participants suggested clinicians need to manage the psychological impact of the condition from immediately post-injury.

Conclusion: Our study explored people's experiences in AoNZ following ACLR and identified barriers to living well post-injury, most notably the gap in resources or services between the end of ACC-funded post-operative rehabilitation and re-entering the health care system with symptomatic PTOA. However, we also have enablers and opportunities, potential ways of providing ongoing support that would reduce the long-term burden for patients and the health system. Future health research and service planning should leverage these opportunities and enablers.

THE EFFECT OF MENSTRUAL CYCLE PHASE-BASED REHABILITATION FOR WOMEN FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A RANDOMISED CONTROLLED TRIAL

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Introduction: This study investigated menstrual cycle phase-based rehabilitation programme (MCPBR) versus usual care (UC) on limb symmetry index (LSI), quadriceps maximum strength, and self-reported lower limb function for women following anterior cruciate ligament reconstruction (ACLR).

Methods: Forty-one women participated in a 12-week intervention from six to 18 weeks post ACLR. Participants were randomly assigned to one of two groups: MCPBR or UC. Knee extensor strength of the non-injured leg was measured at baseline. Knee extensor strength of both legs and the LSI of participants' maximum isometric knee extensor strength were calculated at the end of the trial. Self-reported symptoms and function were also taken at baseline and at the end of the trial using the International Knee Documentation Committee Questionnaire (IKDC), the Knee Injury and Osteoarthritis Outcome Score (KOOS), and the Knee Self-Efficacy Scale (K-SES).

Results: Thirty-eight women completed the study, and four women's data that did not comply with menstrual cycle verification criteria were excluded, leaving 34 women's data for analysis. There was high engagement with both MCPBR and UC, with participants attending 19.7 and 18 sessions of out 24 available over the trial. MCPBR did not result in a significantly higher limb symmetry index at 18 weeks post-ACLR as compared to UC (LSI following MCPBT was 84% (74–93%) and 81% (62–88%) following UC (p = .24)). However, the injured leg strength trended higher at 18 weeks post ACLR following MCPBR, 39.3kg (14.1), compared to UC, 30.8kg (11.9) (p = .07). These findings demonstrate that MCBPR is feasible to carry out in physiotherapy clinics. MCPBR and UC resulted in similar LSI and self-reported function at 18 weeks post ACLR.

Discussion: Both groups achieved excellent outcomes and, therefore, this study supports twice-weekly, supervised, gym-based rehabilitation, with targeted quadriceps strengthening and regular strength testing. However, women in the MCPBR group had slightly higher LSI, and superior quadriceps maximum strength scores in their injured and non-injured legs following MCPBR. Therefore, while this study did not demonstrate differences in LSI following MCPBR, there is a possibility that female hormones may affect maximum isometric strength in women post ACLR. Future research should investigate a larger cohort of women, including pre and post strength measures of both legs over a longer period. Similarly, it would be pertinent to understand women's experience of and preferences for MCPBR post-ACLR.

THE EFFECT OF A TARGETED PREOPERATIVE REHABILITATION PROGRAMME ON POSTOPERATIVE OUTCOMES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Introduction: Anterior cruciate ligament (ACL) ruptures are a common sporting injury in New Zealand, with an incidence that is increasing over time. ACL injury management in New Zealand typically involves reconstructive surgery, with almost 3,000 surgeries completed each year. Pre- and post-operative quadriceps strengthening has been shown to improve outcomes for patients after ACL injury and reconstructive surgery. However, previous studies lack sufficient detail for key strength exercise descriptors.

Aim: To compare a documented targeted preoperative exercise programme, KneeCare (KC) with usual physiotherapy care (UC) in participants who have experienced an ACL injury followed by reconstructive (ACLR) surgery.

Methods: Thirty-two eligible and consented participants awaiting ACLR were randomised into either KC or UC groups. Outcome measures included isokinetic quadriceps and hamstring strength, and the Knee Osteoarthritis Outcome Score (KOOS) self-reporting tool. Outcome measures were assessed and analysed at baseline (T1), after 6 weeks of preoperative rehabilitation (T2) and 12 weeks after ACLR surgery (T3) using two-factor repeated measure ANOVA.

Results: No significant differences were found between groups in preoperative and postoperative strength measures, or patient-reported outcomes across the three time points.

Conclusion: Targeted preoperative exercise and usual physiotherapy care were both effective at improving preoperative quadriceps strength and postoperative outcomes after ACLR. These results are in keeping with other similar studies and reflect current best practice. To fully understand if a documented and targeted rehabilitation programme is superior to usual physiotherapy care in New Zealand, future studies need to be extended with larger cohorts.

ESCALATED CARE TO INTEGRATED CARE – THE FUTURE FOR MSK PRACTICE

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Introduction: In 2020 the Accident Compensation Corporation (ACC) initiated a series of pilot programmes named Escalated Care Pathways (ECP) to improve the pathway of people with knee, shoulder, and spinal injuries. The pilots were aimed to improve four key areas: faster return to work, improved utilisation of services, more timely access to surgery and rehabilitation, and improved

equity and access for Māori and Pacific peoples. Careway, based in Auckland, was one of the five successful pilot groups and was an inclusive model to join physiotherapists and specialists. These pilots will be completed by the end of 2023 and ACC will progress this to Integrated Care Pathways as a new way of managing key musculoskeletal conditions.

Aim: The aim of this presentation is to outline the processes and systems that were developed by Careway to meet the goals of ECP, current outcomes, and the next steps.

Methods: A series of working groups were set up to develop clinical pathways for acute knee injuries (ACL), traumatic rotator cuff tears, and leg dominant low back pain and ankle sprain. The groups consisted of leading orthopaedic surgeons, private practice physiotherapists, sports physicians, academics, and consumer groups. These groups developed resources and processes that were innovative, evidence- based, and patient centred.

Results: The new areas of innovation were (1) tight criteria for entry to the pathway for surgery and/or well-guided conservative care, (2) The use of patient-reported outcome measures at baseline and 6-weekly intervals, (3) the use of key strength measures per body site, (4) clear measures of success at discharge, and (5) the early implementation of vocational rehabilitation.

To date, the Careway education packages have engaged over 84 orthopaedic surgeons and sports medicine specialists, over 30 Careway trained vocational therapists, and over 700 physiotherapists across Auckland and Northland. Large-scale volumes (> 7,000 patients now; > 12,000 by end 2023) have been achieved, with a large dataset showing good-for-patient outcomes, and engagement with ACC and other stakeholders. Careway pathways have demonstrated that knee targets for reinjury rates are 339% ahead of target, spine 400.76% ahead of target, and ankle 608.51% ahead of target.

Conclusion: To date, these pathways have been well accepted by patients, surgeons, sports physicians, physiotherapists, and vocational therapist. Results indicate good outcomes ahead of ACC targets. The next steps are to engage with general practice to get a greater whole-of-system change with physiotherapists leading the initial triage process to determine the best pathway for the patient: surgical or conservative. Integrated care will be rolled out by ACC over 2024 so that all physiotherapy practices have access to this way of working. The future is here, time to engage!

MEDIATORS OF THE EFFECTS OF EXERCISE AND MANUAL THERAPY FOR PEOPLE WITH KNEE AND HIP OSTEOARTHRITIS: A SECONDARY, EXPLORATORY ANALYSIS OF THE MOA TRIAL

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Introduction: The mechanisms of action through which exercise and manual therapy may improve pain and function are unknown. Theoretically, these interventions may improve other variables (i.e., mediators), which, in turn, cause improvement in pain and function. Previous research has revealed some possible mediators of treatment effect in patients with hip or knee osteoarthritis. Those variables include lower limb muscle strength, self-efficacy, pain beliefs, and pain catastrophising thoughts. Better understanding of the mechanisms through which these interventions act may inform ways of enhancing the design of interventions for individuals with hip and/or knee osteoarthritis in the Management of OsteoArthritis (MOA) trial.

Aim: To explore whether pain beliefs, self-efficacy, fear, avoidance, catastrophic thinking, and functional strength mediate the treatment effect of manual therapy (MT) and exercise therapy (ET) on the Western Ontario and McMaster Osteoarthritis Index (WOMAC) composite scores and its subscales in individuals with hip and/or knee osteoarthritis in the MOA trial.

Methods: Secondary analysis of a randomised controlled trial that compared the incremental effects of supervised MT and ET in addition to usual care in patients with osteoarthritis of the hip or knee. Data from 206 participants enrolled in the MOA trial were analysed. The primary outcome measure was the WOMAC composite score after 1 year (MCID = 28 out of 240). We assessed the following variables as mediators: pain beliefs, self-efficacy, fear, avoidance, catastrophic thinking, and functional strength. These variables were measured at baseline and 6-month follow-up. We performed mediation analyses within the counterfactual framework. When performing mediation analyses, we assumed there was (1) no unmeasured confounding between the intervention-mediator relationship; (2) no unmeasured confounding between intervention-outcome relationship; (3) no unmeasured confounding between mediator and outcome; and (4) no mediator-outcome confounder that is affected by the intervention. In addition, we assumed the presence of temporal sequence from exposure (i.e., intervention), mediator to outcome. We performed mediation analysis by fitting two linear models: the mediator model and the outcome model. We performed sensitivity analyses to assess the robustness of our mediation analyses to the no unmeasured confounding assumption.

Results: Improvements in pain belief mediated the effect of MT (b: –10.7, 95% CI: –21.1, -2.6), ET (b: –8.8, 95% CI: –17.4, –1.9) and MT+ET (b: –8.3, 95% CI: –16.3, –1.7); improvements in catastrophic thinking mediated the effect of MT+ET (b: –6.5, 95% CI: –13.8, -0.8); and improvements in functional strength mediated the effect of ET, although this was a weak causal effect (b: –4.6, 95% CI: –11.3, –0.2) and MT+ET (b: –5.3, 95% CI: –13.0, –0.4) on WOMAC composite score. We did not observe a mediation effect for other putative mediators, when considering WOMAC composite scores as the outcome. Mediation sensitivity analyses suggest findings are likely to change if small confounding is present between those mediators and WOMAC composite score.

Conclusion: We identified possible mediators of MT, ET, or MT+ET. Future confirmatory studies could be designed to assess the mechanisms through which manual therapy and exercise cause improvements in pain and function scores in patients with hip or knee osteoarthritis.

MODERATORS OF THE EFFECTS OF EXERCISE AND MANUAL THERAPY FOR PEOPLE WITH KNEE AND HIP OSTEOARTHRITIS: A SECONDARY ANALYSIS OF THE MOA TRIAL

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Introduction: There is limited information about how to target exercise and manual therapy interventions to patients with hip or knee osteoarthritis. According to a recent review, there is insufficient evidence, with low risk of bias, for the following moderators of exercises interventions in patients with hip or knee osteoarthritis: presence, number and type of comorbidity, and psychosocial factors (e.g., anxiety or depression). When comparing therapeutic exercise versus another form of exercise for pain and function outcomes, there is (a) insufficient evidence with low risk of bias for number and type of comorbidities and psychological factors (e.g., anxiety or depression); and (b) mixed quality and unclear risk of bias for obesity and quadriceps strength. The review highlighted the need for RCTs to explore potential moderators of treatment effect in patients with hip or knee osteoarthritis.

Aim: To explore potential moderators of the effect of manual and exercise therapy in pain and function scores in individuals with knee and/or hip osteoarthritis.

Methods: Secondary analysis of a randomised controlled trial that compared the incremental effects of supervised MT and ET in addition to usual care in patients with osteoarthritis of the hip or knee. Data from 206 participants enrolled in the Management of OsteoArthritis (MOA) trial were analysed. The primary outcome measure was the WOMAC composite score after 1 year. Putative moderators included body mass index (BMI), pain self-efficacy, quadriceps strength, mental health, and education. We used linear regression models for assessing whether the effect of randomised interventions on pain and function were moderated by selected characteristics of participants at baseline. We performed linear regressions using composite WOMAC score at 1-year follow-up as dependent variable. Treatment allocation was included as independent variable, with age, BMI, number of years since symptom onset, quadriceps muscle strength, mental health, and pain self-efficacy as covariates. Regression models were adjusted to composite WOMAC scores at baseline. For assessing whether treatment effects were moderated by one of the putative moderators, we included a standard interaction term between the selected moderator and group intervention. We used R Software for conducting all analyses and set alpha at 0.05.

Results: BMI moderated the treatment effect of manual therapy interventions (effect = –4.6, 95% CI: –7.1 to –2.0), but did not moderate the effect of other interventions. Our findings suggest mental health, quadriceps muscle strength at baseline, or education do not moderate treatment effects.

Conclusion: Our findings suggest that BMI moderated the treatment effect of manual therapy on composite WOMAC scores in patients with hip or knee osteoarthritis, suggesting individuals with higher BMI presented better response to manual therapy techniques. Future confirmatory studies should be designed to assess the role of BMI as a moderator of manual therapy interventions in patients with hip or knee osteoarthritis.

TRANSLATING PACIFIC CULTURAL KNOWLEDGE INTO PHYSIOTHERAPY CLINICAL GUIDANCE

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Introduction: A culturally safe health workforce has the capability to remove or reduce the barriers Pacific peoples face in accessing and receiving high-quality health services. This type of workforce will have a greater ability to meet Pacific peoples' needs and improve health outcomes by translating cultural practices, concepts, and diverse world views into high-quality, evidence-informed health services. This is particularly important in the Aotearoa New Zealand context, where only 1% of physiotherapists identify as being of Pacific heritage. However, there is no available guidance on the physiotherapy profession's practice and standards of care when working with Pacific peoples. This research aims to explore the cultural knowledge, specifically pertaining to health, of Samoan families and physiotherapists living in Aotearoa and Samoa, with the view of illuminating how understandings of Samoan and Pacific cultural philosophies, ways of being, and practices can enhance the rehabilitative and healing role of physiotherapists when providing health services to Pacific families in Aotearoa. The lessons from this work include the importance of Indigenous-led health research, the importance of centralising Indigenous wisdoms and ways of being, and the critical roles non-Indigenous people play in promoting optimal Indigenous health and wellbeing.

Aim: To explore how Samoan and Pacific cultural knowledge can enhance the theory and practice of physiotherapy in Aotearoa New Zealand. One of the key outcomes of this research is to construct a model of health and/or guideline that may support physiotherapists working with Pacific peoples in Aotearoa and abroad, to provide health services that are not only clinically sound but culturally dignifying.

Methods: With the imperative of employing Pasifika research methodologies to seek more contextualised solutions for Pasifika issues, this qualitative research study is employing Talanoa and Kakala research methodologies as well as the Uputaua therapeutic approach. The themes distilled through the research process would form the basis of the guideline and/or model of care, which will be presented to the peak physiotherapy professional bodies in Aotearoa. These approaches are employed to conduct respectful dialogues with Samoan physiotherapists operating in Aotearoa and Samoan families who have received physiotherapy in Aotearoa. In a second arm of the study, these dialogues are then carried out with Samoan physiotherapists operating in Samoa and Samoan families who have received physiotherapy in Samoa. These two sets of interview data will be analysed, compared, and contrasted with the view of distilling the key themes that would inform the construction of a model of health and/or a clinical guideline.

Results: As this study is currently in progress, preliminary findings from the Talanoa dialogues in Aotearoa and Samoa will be presented. The model and/or guideline will also be presented at this conference to seek feedback from the physiotherapy profession.

Conclusion: These findings will have implications for clinical practice, health service delivery, health policy development, health curriculum development, and cultural competency evaluation not only for physiotherapists, but for all health professionals who serve Pacific peoples.

THE 'GLASS SHOULDER': INDIVIDUALS' PERSPECTIVES OF LIVING WITH TRAUMATIC GLENOHUMERAL DISLOCATION – A QUALITATIVE STUDY

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Introduction: Recurrence rates following traumatic anterior glenohumeral dislocations remain as high as 50%, even following surgical stabilisation. Fear of movement or re-injury is an unsurprising and rational response to the injury, influencing decisions for return to sport, work, and daily and social activities. More specific information is needed to fully understand the consequences of glenohumeral dislocations at a personal level.

Aim: To explore the lived experiences of persons with traumatic anterior glenohumeral dislocations and highlight strategies to manage fear of reinjury.

Methods: We interviewed 14 individuals (median age 27.5 years, range 21–40; two women) with traumatic anterior glenohumeral dislocation within 5 years (> 6 months), with or without past stabilising surgery, via Zoom or in person. They completed the Tampa Scale of Kinesiophobia (TSK-11; median 42.5/68, 33–54), QuickDASH (median 15/100, 0–55), and the Shoulder Instability Return

to Sport after Injury (median 34/100, 0–90). Recordings were transcribed verbatim and we analysed transcriptions using Interpretive Description.

Results: We developed three main themes with sub-themes:

1. Downward wellness spiral: The injury had shattered their lives, with immediate influences on their self-identity and confidence in their body, sleep disturbances adding to stress levels, grief and loss, and some describing bouts of severe depression and social isolation. The 'invisibility' of the injury and unrelenting risk could lead to being excluded by friends or sports mates.
2. Out of arm's reach: Each recurrence led to frustration as the prior disciplined rehabilitation (and surgery) appeared to have been unsuccessful, only to have to start again. Confidence and hope had to be constantly rebuilt. Support from clinicians and whānau was crucial to regain trust in the body. Yet communication with some clinicians could also lead to feeling misunderstood and that their individual context was not considered.
3. Obligatory compromise: Over time, some individuals accepted the re-injury risk, learned to head warning signals, or compromised by avoiding specific social and recreational activities, changing their sports or to other roles in their preferred sport, and adapting work-related and daily tasks wherever possible.

Conclusion: Participants described an in-depth emotional response following primary and recurrent shoulder dislocations. Regardless of undergoing surgical or non-surgical management, most participants described an ongoing interplay between fear and confidence in themselves and their shoulder, some were concerned about return to work, and others chose a different sport and ways to socialise with friends. All levels of postinjury experiences appeared to contribute to re-injury fear. A metaphor of a river can describe the outcomes: the physical consequences of the unstable 'glass shoulder' are represented by turbulence around large rocks visible to others. Ongoing emotional and social consequences are deeper turbulence around smaller rocks, invisible to people surrounding the individual, yet sufficiently strong to interrupt life. Ultimately, participants developed individual strategies to adapt to the ongoing re-injury risk, realising this may stay with them for life. The emotional and psychosocial consequences need to be recognised by clinicians and addressed as part of long-term rehabilitation and maintenance programmes.

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EXPLORING HEALTH PROFESSIONALS' PERCEPTIONS OF IMPLEMENTATION OF THE ADVANCED PRACTICE PHYSIOTHERAPY (APP) SCOPE OF PRACTICE IN NEW ZEALAND IN PRIMARY HEALTHCARE

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Introduction: Globally, advanced physiotherapy practice, titles, definition, scope, level of practice, and competencies vary. In New Zealand, advanced practice physiotherapist (APP) scope was approved by the Physiotherapy Board in 2021 to recognise physiotherapists who are practising at an advanced level and have met the specific competencies and academic qualifications. Formal assessment and recognition of an APP's clinical skills and their area of expertise would enable consumers and health professionals within and external to the physiotherapy profession to identify an APP.

Aim: This study aimed to explore physiotherapists' and other health professionals' understandings and views of advanced physiotherapy practice within the context of musculoskeletal management in New Zealand primary healthcare.

Methods: A qualitative study was conducted using the methodology of Interpretive Description. Fifteen participants from a variety of professional and stakeholder groups, including physiotherapists (n = 6), general practitioners (n = 4), medical specialists (n = 3), and Accident Compensation Corporation case managers (n = 2) were interviewed face to face. Interviews were audio-recorded, transcribed verbatim, and analysed.

Results: Three themes identified in the data will be presented. In the theme "Perceptions of current musculoskeletal management in primary healthcare", participants discussed the complexity of musculoskeletal presentations and challenges with management. Participants highlighted variability in physiotherapists' diagnostic accuracy; inappropriate use of investigations; lack of clear clinical pathways; fragmentation of (and delayed access to) services; and poor interprofessional communication. In the theme "How APPs might facilitate change in primary healthcare and what their role would be", participants discussed opportunities for APPs to address musculoskeletal management challenges including improving health system efficiency and patient journeys. Participants considered an APP could inform diagnosis and rehabilitation management options for complex cases and provide a clinical case review for patients who are not responding to the current management. This would provide an alternative patient review pathway.

Mentoring, peer support, and clinical supervision were noted as important roles for the APP. The theme "Implementation of the APP role into practice" identified potential opportunities, risks, and barriers for implementation of the APP role into practice. There was widespread support from participants for the APP role and the opportunities it provided for physiotherapists, other health professionals, and patients. Despite agreement regarding the need for the role, participants raised several risks, challenges, and barriers to the successful implementation of this new scope. Key among these were lack of stakeholder understanding and acceptance of the role; the need for APPs to demonstrate value and improve patient outcomes; formal recognition by funders; and how APPs would be integrated into new models of service delivery.

Conclusion: The APP scope of practice will enable health professionals, funders, the public, and physiotherapists to recognise physiotherapists with specific levels of expertise and skills in musculoskeletal management in primary healthcare. To improve recognition and acceptance of the role, APPs must demonstrate their value to healthcare delivery by improving patient pathways and outcomes.

DIAGNOSTIC ACCURACY IN THE CLINICAL EXAMINATION FOR IDENTIFYING A TRIANGULAR FIBROCARTILAGE COMPLEX INJURY

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Introduction: Triangular fibrocartilage complex (TFCC) injuries are a common cause of ulnar wrist pain. Diagnostic tests are routinely used to diagnose TFCC injuries; however, the reliability and diagnostic accuracy of such tests has not been established.

Aim: 1. To investigate the reliability and diagnostic accuracy of TFCC tests. 2. To determine if any combination of findings obtained from the clinical examination can accurately identify TFCC injuries.

Methods: A prospective pilot study was undertaken. Twenty-three participants were recruited from hand orthopaedic specialists. A standardised clinical examination was performed and information from that examination was compared against the criterion measure of specialist diagnosis based on MRI scans.

Results: This study demonstrated that the accuracy of TFCC diagnostic tests was limited. None of the included tests had high sensitivity or negative likelihood ratios (LRs) that suggest they would be useful clinically to rule out the presence of TFCC pathology. Two tests, the 'shear' and 'grind', had high specificity (both 0.86) and moderate positive *LR*s (3.0 and 3.5, respectively) suggesting they have some clinical utility; however, the LRs were not statistically significant.

The concurrent reliability study demonstrated moderate levels of inter-rater reliability for the 'grind', 'ulnar fovea sign', and 'piano key' tests with kappa scores of 0.57, 0.57, and 0.51, respectively. Similarly, reliability of the 'gripping rotational impaction' test was acceptable with an intra-class correlation of 0.60. The 'shear' test had poor reliability (k = 0.01).

In contrast, multivariate analysis identified a model that contained nine variables obtained from the clinical examination that predicted the diagnosis of TFCC injuries with 100% accuracy (within sample). With this model, the contribution of each variable is quantified, enabling an overall probability score that takes into account the presence or absence of that variable, to be calculated for individual patients. Male gender, strain injury, higher pain intensity with pronation-based ADLs, pain with supination-based ADLs, higher pronation range of motion (ROM), and higher grip strength in a neutral position all increased the probability of a TFCC injury. Passive radial deviation ROM, the presence of constant symptoms, and presence of crepitus all decreased this probability.

Conclusion: This pilot study demonstrates that diagnostic tests for the TFCC have insufficient accuracy to warrant their use as stand-alone tests. However, it provides evidence that information obtained from both the history and clinical examination can be combined to better predict the presence of this pathology. This is the first-known study to have investigated predictability of TFCC injuries based on combinations of findings. It provides new evidence to support the importance of considering the "whole" clinical picture during the diagnostic process and reinforces current evidence of the limited value for most "diagnostic" tests. These findings are preliminary and need to be confirmed by similar studies undertaken in a different population before clinicians can be confident the model we have proposed can be used clinically with confidence.

TEST-RETEST RELIABILITY OF MOVEMENT-EVOKED PAIN AND SENSITIVITY TO MOVEMENT-EVOKED PAIN IN PATIENTS WITH ROTATOR CUFF-RELATED SHOULDER PAIN

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Introduction: Movement-evoked pain (MEP) is defined as pain experienced during bodily movements, and sensitivity to movement-evoked pain (SMEP) is defined as an increase in pain intensity in response to repeated movements (e.g., repeated shoulder elevation). Although MEP and SMEP are used routinely to characterise rotator cuff-related shoulder pain (RCRSP), the test-retest reliability of such constructs is unknown.

Aim: We aimed to examine the test-retest reliability of MEP and SMEP measures in people with RCRSP.

Methods: Seventy-four participants with RCRSP participated in this test-retest study with an interval of 10 min. In each testing session, all participants performed five trials of active shoulder abduction to elicit pain under two experimental conditions in the following sequence: active shoulder abduction to the onset of pain and maximum range of motion (ROM). The primary outcome measures were average MEP intensity (measured via numeric pain rating scale, 0–10), the average SMEP index (mean of 4th and 5th trials of pain intensity minus mean of 1st and 2nd trials of pain intensity), and the average ROM measured during the experimental conditions. Test-retest reliability of MEP scores and SMEP index was examined using the intra-class correlation coefficients ($ICC_{3,1}$). The minimal detectable change ($MDC_{90\%}$), an index of measurement error, was determined.

Results: The reliability of MEP under both experimental conditions was good to excellent (ICC: 0.81 to 0.95), while the reliability of the SMEP index was poor in both conditions (ICC ≤ 0.45). The $MDC_{90\%}$ for pain intensity scores was 1.6 and 1.8 during shoulder abduction to the onset of pain and maximum ROM, respectively. The $MDC_{90\%}$ for ROM was 17.5° and 11.2° during shoulder abduction to the onset of pain and maximum ROM condition, respectively.

Conclusion: Movement-evoked pain is a reliable way to assess pain associated with shoulder movements in people with RCRSP. The derived measurement errors of MEP and ROM can help to interpret changes in pain intensity and shoulder ROM, thus making informed decisions regarding treatment plans.

TEST-RETEST RELIABILITY OF QUANTITATIVE SENSORY TESTING IN PATIENTS WITH ROTATOR CUFF-RELATED SHOULDER PAIN

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Introduction: Sensitisation could play an important role in the prognosis of patients with rotator cuff-related shoulder pain. Although there is no gold standard measure for sensitisation, quantitative sensory testing (QST) has been suggested for measuring sensitisation. The QST is a standardised psychophysical test procedure to characterise the somatosensory phenotype of patients with pain. QST can provide information about the potential underlying peripheral and central mechanisms contributing to pain. The reliability of QST procedures in people with rotator cuff-related shoulder pain (RCRSP) has yet to be established.

Aim: We aimed to examine the test-retest reliability of static and dynamic QST procedures in people with RCRSP.

Methods: Seventy-four participants with RCRSP participated in test-retest measurements of static (pressure pain threshold-PPT) and dynamic (mechanical temporal summation-MTS) QST procedures with an interval of 10 min. Both procedures were administered at the painful shoulder (local site) and the tibialis anterior muscles (remote site) contralateral to the painful shoulder. We tested the PPT of both sites alternatively using an electronic handheld pressure algometer, and the procedure was repeated three times. The average value of the three trials was calculated for each testing site and used for statistical analysis. We tested the MTS of both sites alternatively using a nylon monofilament, and the procedure was repeated twice. In each trial, we delivered 10 repetitive stimuli at each site with a frequency of 1 Hz. Participants immediately rated their pain level after the first stimulus and the worst pain experienced during the 10th stimulus on the numeric pain rating scale (NPRS). The index of MTS was calculated for each participant by subtracting the first stimulus rating from the highest pain rating from the 10th stimulus. The average of the two trials was calculated for each participant for each site. Test-retest reliability of PPT scores (kPa) and MTS index was examined using the intra-class correlation coefficients (ICC3,1). The minimal detectable change (MDC95%), an index of measurement error, was determined.

Results: PPT scores demonstrated excellent reliability (ICC = 0.93 to 0.95), whereas the MTS index demonstrated good reliability (ICC = 0.77 to 0.83) at local and remote sites. The MDC95% of PPT and MTS ranged from 102.8 to 118.1kPa and 1.7 to 1.9 (NPRS), respectively.

Conclusion: Good to excellent test-retest reliability of selected static and dynamic QST procedures in people with RCRSP was established. The derived measurement error of PPT scores and MTS index can help interpret scores when administering those tests in people with RCRSP.

SCOPING REVIEW FOR DOSAGE OF JOINT MOBILISATION FOR THE MANAGEMENT OF PATIENTS WITH ROTATOR CUFF-RELATED SHOULDER PAIN

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Introduction: Shoulder pain is one of the most common musculoskeletal complaints that patients consult in primary care. Rotator cuff-related shoulder pain (RCRSP) is the most common diagnosis of shoulder pain and accounts for approximately 50% of all cases of shoulder pain. Evidence supporting specific type and dosage of joint mobilisations and rationale for selecting a specific dosage of joint mobilisation for patients with RCRSP are limited.

Aim: To systematically (1) search, identify, and map the type and dosage of joint mobilisations used in previous trials for managing patients with RCRSP; and (2) summarise the rationale for adopting a specific joint mobilisation dosage.

Methods: We followed the methodological framework outlined by Arksey and O'Malley. We searched six databases (i.e., PubMed, Scopus, Web of Science, CINAHL, Cochrane Library, and SPORTDiscus) until August 2022 to identify studies. We included randomised controlled trials using joint mobilisation for patients with RCRSP if they reported at least some information on types or dosages of joint mobilisation. We extracted technique, within-session, and overall treatment dosages of joint mobilisation and rationale for adopting that specific dosage.

Results: We included 30 studies. Most studies did not report or only partially reported technique (71%) and within-session dosage (67%) of passive joint mobilisation, whereas overall treatment was fully reported in 95% of studies. The dosage used for passive joint mobilisation was heterogeneous. Most studies did not report or only partially reported technique (83%) of MWM, whereas within-session and overall treatment dosages were fully reported in more than 91% of studies. Three sets of 10 repetitions were commonly used in within-session dosage for MWM, while overall treatment dosage was heterogeneous. We found very limited information on the rationale for selecting dosage of joint mobilisation.

Conclusion: There was little information on dosage and rationale of selecting joint mobilisation, with a heterogeneous dosage being tested across trials. Our findings highlight the importance of detailed reporting for dosage and rationale for selecting a specific dosage of joint mobilisation.

THE INITIAL EFFECT OF MOBILISATION WITH MOVEMENT ON SHOULDER RANGE OF MOTION AND PAIN IN PATIENTS WITH ROTATOR CUFF-RELATED SHOULDER PAIN: A RANDOMISED CONTROLLED TRIAL (EVOLUTION TRIAL)

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Introduction: Mobilisation with movement (MWM) is commonly used to treat patients with rotator cuff-related shoulder pain (RCRSP). However, the evidence supporting MWM efficacy for improving range of motion (ROM) and pain in patients with RCRSP is limited. It is also unclear whether the volume of MWM affects the effect of MWM on clinical outcomes in people with RCRSP.

Aim: We aimed to assess (1) the initial effects of MWM on the angular onset of pain in people with RCRSP, and (2) the incremental effect of receiving two additional sets of 10 repetitions of the MWM treatment after receiving one single set of 10 repetitions of treatment.

Methods: Sixty-three participants with RCRSP were randomised to receive MWM or sham MWM intervention. Participants received three sets of 10 repetitions of MWM or sham MWM with a minute rest between each set. The primary outcome was the angular onset of pain during shoulder abduction. The angular onset of pain during shoulder abduction, pain at rest, and pain intensity during shoulder abduction to the onset of pain were measured at baseline, immediately after receiving one set and three sets of 10 repetitions of interventions. Global rating of change scale (GROC) was measured immediately after receiving three sets of 10 repetitions of interventions and follow-up on day 3. Brief pain inventory-short form (BPI-SF) was measured at baseline and follow-ups on days 1, 3, 5, and 7 post-intervention. Other secondary outcomes were measured at baseline and immediately after receiving three sets of 10 repetitions of interventions. A mixed-effects model with a random intercept was used to compare differences in changes in the outcome measures between MWM and sham MWM interventions.

Results: Compared with the sham MWM group, the between-group difference in change of the angular onset of pain was 6.5° (95% CI 6.3 to 21.0) and 13.7° (95% CI 6.3 to 21.0) immediately after receiving one set and three sets of 10 repetitions of interventions from baseline, respectively. The between-group difference in change of the angular onset of pain was 7.2° (95% CI –0.3 to 14.6) after receiving additional two sets of 10 repetitions of interventions from receiving one set of 10 repetitions of interventions. The between-group difference in change of the GROC was 1.1 (95% CI 0.4 to 1.8) immediately after receiving three sets of 10 repetitions of interventions. There was no difference between groups for other secondary outcomes.

Conclusion: In patients with RCRSP, MWM can improve the angular onset of pain when receiving one set or three sets of 10 repetitions of MWM. An additional two sets of 10 repetitions of MWM can also improve the angular onset of pain.